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LISTING DELAYS AND INNOVATION: EVIDENCE FROM CHINESE IPOS

Lin William Cong
Sabrina T. Howell

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ABSTRACT

Regulators have suspended IPOs in China on numerous occasions, exposing firms already approved to IPO to indeterminate listing delay. These disruptions curtail firms' timely access to risk capital and increase uncertainty. After firms ultimately list, suspension-induced delay substantially reduces their innovation activity, measured using patent quantity and quality. These effects begin during the delay and endure for years after listing, while impacts on other firm outcomes are short-lived. The corporate innovation process, like an individual's accumulation of human capital, has a cumulative dimension. Interrupting it can be detrimental in the long term, highlighting the importance of well-functioning IPO markets.

Lin William Cong
Booth School of Business
University of Chicago
5807 S Woodlawn Ave,
Chicago, IL 60637
will.cong@chicagobooth.edu

Sabrina T. Howell
NYU Stern School of Business
KMC 9-93
44 West 4th Street
New York, NY 10012
and NBER
showell@stern.nyu.edu

1 Introduction

As public markets are central to the modern financial system, there is much interest in the firm's transition from being privately held to publicly traded. The literature has examined the effect of going public on outcomes such as the private benefits of control (Doidge et al. 2009), investment (Pagano, Panetta & Zingales 1998, Asker, Farre-Mensa & Ljungqvist 2014, Gilje & Taillard 2016), profitability (Pástor, Taylor & Veronesi 2009), and product markets (Chemmanur, He & Nandy 2009). In part because of its large social benefits, the role of public markets for innovation is especially important; Bernstein (2015) finds that patent citations, a measure of innovation quality, decline after a firm goes public, while Acharya & Xu (2017) show how public firms that are relatively dependent on external finance are more innovative than their private counterparts. Researchers in this literature have typically compared public firms with a carefully crafted control group of similar private firms.

This paper asks whether timely access to public markets affects innovation and other firm outcomes after firms ultimately go public. This question is relevant to policy, especially in developing countries where regulators must decide whether to prioritize predictable, well-functioning IPO markets. Using a novel identification strategy, we show that delaying a firm's access to public markets has immediate and enduring negative effects on innovation activity, and also appears associated with disruption to organizational capital relevant to innovation. Delay has short-term effects on the firm's capital structure and performance, but these effects do not endure. In addition to offering a first analysis of transient frictions to public market access, our results provide evidence that innovation is a cumulative process.

Specifically, we examine the effect of IPO delay among Chinese firms that ultimately go public on Chinese exchanges. Two facets of the IPO system in China enable causal identification of this effect. First, firms in China have little ability to time the IPO market. IPO approval takes two to three years in normal, non-suspension times, and once approved, firms wait several months to list. Second, regulators suspended all IPO activity on four occasions between 2004 and 2014, stranding a group of approved firms. The suspensions

lasted between six and fifteen months. While related to the state of the market, they were not scheduled and were widely viewed as unexpected. Affected firms faced a longer time between approval and listing as well as greater uncertainty about when they would list.

We consider firms approved to IPO on the Shanghai or Shenzhen main boards close in time to the suspension period, but which experienced sharply different amounts of delay because of their order of approval (see Figure 1). The treatment is additional delay, or time between approval and listing. We use two samples to ensure robustness of our results. One sample consists of firms approved in the twelve months before a suspension announcement. Those approved early in the year were ahead in a queue and listed with little delay, while the remainder were forced to wait until the suspension ended. The second sample consists of firms that listed in the twelve months after a suspension ended. Those approved after the end of the suspension listed with little delay, while the remainder were delayed by the suspension. The suspensions offer quasi-experimental variation in timely access to public capital, because suspension-induced delay is plausibly exogenous to firm-specific factors. High and low-delay firms are similar before approval. For the last and longest suspension we verify the absence of queue-jumping.[1] We also show that our main results are robust to instrumenting for delay with the approval date.

We estimate the effect of delay in regressions that control for the listing date and firm variables such as state ownership, size, age, and industry. An extra month of delay reduces innovation effort in the year following IPO, measured by the number of patent applications to China's State Intellectual Property Office (SIPO), by 13 percent of the mean, and delay higher than the 75th percentile reduces them by 35 percent of the mean. Delay also reduces two proxies for patent quality after listing. First, an extra month of delay reduces the number of citations to granted Chinese (SIPO) patents by about 10 percent.[2] Second, an

[1] Queue-jumping by politically connected or state-owned firms should bias our results against finding a detrimental effect of delay. There is abundant literature showing that politically connected Chinese firms underperform, including Fan et al. (2007), Dollar & Wei (2007), Piotroski & Zhang (2014) Chen et al. (2016), and Whited & Zhao (2016). If these firms have less delay because they jump the queue, it is even more striking to find that delay leads to underperformance.

[2] Previous work on Chinese firm innovation has primarily relied on patent counts. We are among the first to gather comprehensive data on citations for Chinese patents from global patent offices, and to our knowledge, the first that

extra month of delay reduces the number of global granted patents (filed in patent offices outside of China) by about 25 percent. These effects begin shortly after IPO approval and endure for years after listing.

In the year following IPO, delay leads to increased leverage, less cash as a share of assets, a lower price-to-book ratio, and lower return on sales. None of these effects lasts past the first year; delayed firms catch up with their peers on all measures other than innovation. There are also no effects after listing on tangible or non-tangible investment.[3]

We investigate two channels for the effects: capital supply and uncertainty.[4] While the two are are not mutually exclusive, they have different implications. For example, if financing constraints lead to less investment in innovation, our results imply that in China, IPO markets are important for capital provision. Alternatively, if uncertainty is the primary driver, then our results are an example of the important role that government policy uncertainty plays in firm outcomes, as in Baker, Bloom & Davis (2016).

Consistent with a capital supply shock, delay is associated with higher leverage, lower tangible (PPE) investment, and lower patent activity in the year following IPO approval, when delayed firms are still private but their non-delayed counterparts have listed. These results suggest that firms may be financially constrained during delay. Firms can raise debt, but do not employ it to finance risky investment, including innovation. Firms may view such projects as marginal, but from a social perspective this investment is quite valuable, for example through knowledge spillovers (Jones & Williams 1998, Greenstone, Hornbeck & Moretti 2008, Bloom, Schankerman & Van Reenen 2013). To the extent that our results demonstrate the importance of access to public equity financing for innovation, they complement Brown, Fazzari & Petersen (2009) and Acharya & Xu (2017).

Taken alone, the financing constraint channel implies that alternative forms of financ-

include citations to SIPO patents beyond WIPO family patents.

[3]We do not examine R&D investment because coverage is inadequate and the data quality is questionable.

[4]Window dressing is a well-known part of the IPO process. However, it does not appear to explain our main effects. Window dressing before IPO is inconsistent with our evidence of depressed innovation activity both during the delay period and after IPO. Further, delayed firms exhibit slightly lower discretionary accruals, the standard measure of window dressing.

ing such as risky debt or private equity (PE) are too costly or unavailable during delay. In this case, firms with better access to debt and private equity should be less affected by delay. Yet state-owned enterprises, which have advantaged access to credit, are not less affected than private firms. Similarly, firms with prior PE financing are not less affected, and delayed firms are not more or less likely to receive PE. Also, not a single delayed firm went public abroad. This likely reflects both high valuations in China, which offer a powerful inducement to wait, and the multi-year profitability requirements to list on China's main boards, which imply that approved firms are unlikely to be in desperate need of capital. Therefore, the capital supply channel does not seem to fully explain the main effects.

The suspensions, which were all of indefinite length, created uncertainty among affected firms about when they would be able to go public and how their business opportunities might change. We present anecdotal evidence of this, and also show that the suspensions were associated with lower VC investment in China, even among elite U.S. VC firms active in China. The real options literature shows that investment declines under uncertainty (Dixit & Pindyck 1994). This predicts the negative effects of delay on tangible investment and patenting that we observe during the delay period. Uncertainty is central to how our setting differs from the literature comparing public and private firms using U.S. data, including Bernstein (2015). There, treatment coincides with the firm learning that it will be at least semi-permanently public or private, allowing the firm to adjust its investment strategy. In our Chinese setting, the firm does not switch gears and pursue a private firm strategy, but instead becomes uncertain about when it will be able to pursue its intended public firm strategy. By focusing on ultimately public firms, we are able to isolate the effect of friction in a firm's access to public markets.

We also examine managerial turnover to shed light on how delay impedes innovation activity. Delay leads to higher rates of departure among technical executives, such as Chief Technology Officers, in the year following IPO, as well as lower rates of joining. A similar phenomenon occurs among human resources executives, but not financial executives. The

decline in technical and human resources management is consistent with delay disrupting the organizational capital that is central to the innovation process. With heightened uncertainty, firms and executives invest less in firm-specific human capital, which leads to team instability and higher turnover after listing, to the detriment of long-term corporate innovation.

It is likely that both the capital supply and uncertainty channels play a role in explaining why risky investment is foregone among delayed firms. The data are most consistent with uncertainty, and thus offer an example of policy uncertainty's deleterious effects on firms. Both channels lead to the conclusion that predictable public markets are important for funding innovative and risky projects, which relates to the literature on the role of financial markets in economic development (King & Levine 1993, Subrahmanyam & Titman 1999, and Rajan & Zingales 2001).

Uncertain listing delay causes a firm to pause its innovation investment. This temporary disruption has lasting effects because innovation investments are cumulative. In order for future innovation investments to be NPV positive, the firm must maintain its R&D infrastructure today. Feldman & Florida (1994) and Chang (1995) show how innovation builds on accumulated expertise and complements prior innovation. During delay, our findings suggest that the firm loses or fails to build an innovative, entrepreneurial culture in the sense of Gompers, Lerner & Scharfstein (2005). Similarly, as Cunha & Heckman (2007) formalize, individual investment in early childhood education serves to build human capital, and falling behind may have persistent effects. More broadly, short-term treatments are known to have enduring effects on people (e.g., Drago, Galbiati & Vertova 2009). We show that they can also have enduring effects on firms.

Corporate innovation is central to China's ongoing effort to transition from growth based on exports and infrastructure to growth based on high-tech industries and consumption.[5] While we cannot speak to the overall welfare effects of the IPO suspensions, our

[5]Innovation is prominently listed as the first guiding principle of economic policy in the 13th Five-Year Plan for 2016 to 2020. See http://www.apcoworldwide.com/docs/default-source/default-document- library/Thought-Leadership/13- five-year-plan-think-piece.pdf?sfvrsn=2

findings reveal an unintended consequence of government intervention in IPO markets that is persistent and costly.[6] This contributes to the literature on the importance of market-based mechanisms for Chinese firms' productivity growth (e.g. Aghion et al. 2015 and Fang, Lerner & Wu 2017).

2 Institutional Background

In this section, we summarize China's public equity markets and describe the IPO process. Then we explain the IPO suspensions that we use to identify the effect of listing delay.

2.1 The IPO Process in China

China's 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). In 1990, China established two domestic stock exchanges: the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE). In the 1990s, China's public markets primarily served state-owned enterprises (SOEs), and much research focuses on SOE performance and political economy (e.g. Fan et al. 2007, see Carpenter et al. 2016 for a review). The public markets have recently grown dramatically, and today there are about 3,000 firms listed and traded on the two exchanges. Domestic listings are either on a "main board" (SSE and SZSE) or on newer, smaller boards targeting younger firms (e.g. ChiNext), which have less stringent listing criteria. We do not use these smaller boards due to data unavailability and to be consistent with the existing literature. The Chinese A share market is now the second largest in the world, with a total market capitalization of more than 7 trillion USD at the end of 2015. As IPOs recede in importance in the U.S., they are growing in importance in China. In 2016, there were 103 IPOs on the Shanghai Stock Exchange main board, and 46 on the Shenzhen

[6] There is no convincing evidence that suspensions stabilized the market, one of the supposed objectives (Packer et al. 2016). IPO activity in China is small relative to total market capitalization. During the 2015 IPO boom, monthly issuance was at most 0.06 (.14) percent of the Shanghai (Shenzhen) market capitalization.

board, compared to a total of just 128 in the U.S.[7] This paper focuses on how public markets enable these private firms to access the resources they need to grow.

A firm seeking to conduct its IPO in China's domestic markets must navigate an elaborate approval process administered by the China Securities Regulatory Commission (CSRC). China approves IPOs via an administrative governance system, as opposed to a registration system as in the U.S. There are four central steps. First, the firm hires 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 compliance documents. This "restructuring period" often takes about three months but the preparation lasts $1-3$ years.[8]

Second, the firm and underwriter submit an application package to the CSRC. Unlike their Western counterparts, underwriters in China are legally responsible for the materials submitted (Chen et al. 2014). The Stock Issuance Examination and Verification Committee (the "committee") of the CSRC then determines whether the applicant meets the regulator's listing criteria and is eligible to undertake 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.[9]

Firms applying for IPO form a queue based on the order of application. According to the WIND commercial database, in late 2016 there were 726 firms in the queue. The CSRC has published this list weekly since February 2012, so it is now public how many candidates

[7] On China, see http://www.pwccn.com/en/press-room/archive/a-share-ipo-may-speed-up-in-2017-while-new-shares-will-increase-40-50.html. Only 128 companies IPOed in U.S. markets in 2016 (see http://fortune.com/2017/01/20/public-companies-ipo-financial-markets/).

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

[9] 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.

are waiting for IPO approval, as well as how many have been approved recently.[10] The exact length of the queue, however, is typically not a consideration for firms that want to list domestically. Since the wait for approval typically lasts multiple years, firms cannot time their listing as they do in the U.S. Typically, they apply as soon as they meet the requirements.

Third, the committee reviews the application documents and decides whether to approve the IPO.[11] 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).[12] 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 three to six months, but is highly variable. The committee typically rejects about 20 percent of IPO applications (Yang 2013). The approval rate is determined by the CSRC based on market conditions (Guo & Zhang 2012). The CSRC is concerned that too many IPOs will reduce liquidity and pull down the market (based on interviews with regulators and other stakeholders, and Braun & Larrain 2008). This concern arises because the state limits offer prices to a multiple of earnings that is typically far below the multiple that will prevail once the stock trades in the open market (Tian 2011). Currently, this multiple is about 23 times earnings per share.

In the fourth step, if the committee approves the IPO application, the firm 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

[10]The CSRC discloses the queue for application: http://www.csrc.gov.cn/pub/newsite/xxpl/yxpl/.

[11]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.

[12]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.

to approve or deny an IPO and exchange listing. Once approved, the firm can conduct its "road show" and list. This stage generally takes between two and six months, but the CSRC has been known to pressure firms to delay listing at this stage in order to stabilize the market. Very rarely do firms and the CSRC delay listing due to disagreements on share prices, according to a former deputy director at CSRC Shanghai. In general, firms have little ability to time the market in their IPO (Guo & Zhang 2012).

2.2 IPO Suspensions

As an extreme form of regulating the IPO market, the CSRC occasionally suspends IPO activities. During these suspensions, all steps beyond application submission stop. Between 1994 and 2016, there have been nine major IPO suspensions. Our data allow us to analyze four of them from 2004-2014, which lasted between six and fifteen months. Online Appendix Table A1 contains details about the nine suspensions. The suspensions are to some degree associated with bear markets, though the last and longest suspension in 2012-14 occurred under relatively stable conditions (see Figure 5). As explained below, our empirical strategy does not require the suspensions to be exogenous to market conditions.

The start and end of the suspensions are, to our knowledge, not announced beforehand. Market participants have found the CSRC IPO suspension decisions to be unpredictable.[13] For example, after October 19, 2012, the CSRC ceased holding weekly review meetings, with no initial public explanation. The financial press initially expected the suspension to be short, but instead it lasted more than a year. Apparently, the historically low stock market 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," not on individual firms' characteristics.[14] Further, once each suspension began, market participants did not

[13]Based on interviews with Liliang Zhu, deputy director of CSRC's department of Public Offering Supervision, Feng Yu, deputy director of CSRC Zhejiang, and George Jiang, a partner at 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.

[14]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.

know when it would end.[15] More importantly, there is no evidence of queue jumping (potentially because of political ties) to shift a firm's listing ahead of the suspension start. This is discussed further in Section 3.1.

In sum, the suspensions and three institutional features make China an ideal setting to study how access to public markets affects the firm. The three features are: (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; and (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.

3 Empirical Strategy

In this section, we explain how we use the IPO suspensions described above to identify a causal effect of uncertain listing delay on firm outcomes.

3.1 Approach

The suspensions exogenously imposed an uncertain period of delay on firms that were approved to IPO just before the suspensions were announced. Delay is costly because of the time value of money, and foregone strategic opportunities (e.g. to make acquisitions or large investments using public funds). Further, suspensions create uncertainty about the firm. These issues are widely recognized in Chinese and foreign media, and among practitioners.[16]

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 example, 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.

[15] For example, see http://finance.ce.cn/rolling//201310/01/t20131001_1574723.shtml and http://workingcapitalreview.com/2015/12/chinas-long-ipo-process-hinders-more-than-just-stock-offerings/. Also, Packer et al. (2016) show that past aggregate market return is the most significant factor correlated with IPO volume control.

[16] See e.g., http://www.ddjtsg.com/detail/?id=837,
http://dailynews.sina.com/gb/chn/chnoverseamedia/cna/20140610/01345796883.html,

Almeida, Campello & Weisbach (2011) and Wang & Zhu (2013) also discuss the cost of uncertainty in external financing from the public markets.

All firms in our sample ultimately do go public, and we focus on outcomes after listing.[17] We use two samples to ensure robustness of our results. One sample consists of firms approved to IPO on the Shanghai or Shenzhen main boards in the twelve months before a suspension announcement. Those approved early in the year were ahead in a queue and listed with little delay, while the remainder were forced to wait until the suspension ended. The second sample consists of firms that listed in the twelve months after a suspension ended. Those approved after the end of the suspension listed with little delay, while the remainder had been approved before and were delayed by the suspension.

Figures 1-4 describe our approach graphically. Each dot is an IPO, and the delay between approval and listing is on the y-axis. Figures 1 and 2 show firms approved in the twelve months before a suspension started (the first estimation sample), and Figures 3 and 4 show firms that listed in the twelve months after a suspension ended (the second estimation sample). In Figures 1 and 3, the approval date is on the x-axis, while in Figures 2 and 4, the listing date is on the x-axis. Firms approved in the first part of the twelve months before a suspension announcement list within a few months, as do firms approved shortly after the end of a suspension. Those approved closer to the suspension start are delayed; the 75th percentile of delay is 13 months.

We do not require the suspensions to be exogenous to markets. Our key assumption is that delay is exogenous to firm conditions, among firms approved near in time to a suspension. Interviews with market participants, the observable queue post-2012, and t-tests (summarized in Section 4) lead us to believe this is the case.[18] As with any quasi-

http://workingcapitalreview.com/2015/12/chinas-long-ipo-process-hinders-more-than-just-stock-offerings/, https://seekingalpha.com/article/3308655-chinas-ipo-freeze-misguided-should-end-quickly, and http://dailynews.sina.com/gb/chn/chnoverseamedia/cna/20140610/01345796883.html.

[17] 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.

[18] Based on interviews conducted with senior CSRC officials and CSRC documents, such as 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 orders of approval and of subsequent listing are largely

experimental strategy, and particularly given the relative paucity of information in China, it is impossible to completely rule out endogeneity in delay. The primary empirical concern is that some firms jump the queue in order to avoid delay. Note that queue-jumping by politically connected or state-owned firms should bias our results against finding a detrimental effect of delay. There is abundant literature showing that politically connected firms and SOEs underperform relative to their counterparts, including Fan et al. (2007), Dollar & Wei (2007), Chen et al. (2016), Whited & Zhao (2016), and Piotroski & Zhang (2014). If these firms have less delay because they jump the queue, it is even more striking to find that delay leads to underperformance. Nonetheless, to lessen concern that firms may jump the queue, we instrument for the months of delay using the month of IPO approval.

3.2 Specification

Our primary specification estimates variants of Equation 1, where t indicates year. The coefficient of interest is β_1 on months of delay. Estimation is within either the approved-before sample (approved to IPO in the twelve months before a suspension) or the listed-after sample (listed in the twelve months after a suspension). P_{jt} is an outcome such as patents filed after IPO.

$$P_{jt} = \alpha + \beta_1 MonthsDelay_j + \delta' \mathbf{V}_{jt} + \gamma' \mathbf{Y}_{Yr\ IPO} + \varepsilon_{jt} \tag{1}$$

We do not have an explicit treatment and control group, but more conservatively use continuous delay, measured in months. In alternative models, we use an indicator for high delay (above the 75th percentile, which is 13 months). We double cluster errors by industry and listing quarter.

$\mathbf{V}_{jt}$ is a vector of controls. It includes firm age, as firms that experienced delay will be older than their non-delayed peers, once they have both listed. Further, it includes industry

determined by a firm's position in the queue, and the approved firms could not have anticipated the 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.

fixed effects (25 industry classes from WIND, which is described in Section 4.1), a fixed effect for the exchange (Shanghai or Shenzhen), firm market capitalization, proceeds from the IPO, and indicators for whether the firm is state-owned and whether it previously received private equity or venture capital financing. Following Hsieh & Song (2015), we define a firm as an 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.

A concern is that because suspensions correlate with poor market conditions, it may be that delayed firms, once listed, have not yet recovered from the adverse market and thus exhibit negative outcomes unrelated to delay. $\mathbf{Y}_{Yr\ IPO}$ is a vector of listing year fixed effects. This controls for aggregate market conditions in the year of the IPO, which is the frequency at which we observe our primary outcomes. In the approved-after sample, we compare delayed and non-delayed firms just after their listing. Firms that listed in the same year should experience similar market-driven effects.

To address concerns that firms may jump the queue once approved, as suspensions near, we also instrument for the months of delay using the month of IPO approval. The intuition is that if firms do not jump the queue to list once approved, the month of approval should predict the duration of delay. The first stage consists of Equation 2, where $\lambda'\mathbf{ApprovalMonth}_t$ is a vector of approval month fixed effects. We do not show the results from the first stage due to the large number of coefficients. The first-stage F-statistic for the excluded instrument (delay) being significantly different from zero is 692.

$$\hat{MonthsDelay}_j = \alpha + \lambda'\mathbf{ApprovalMonth}_t + \delta'\mathbf{V}_{jt} + \gamma'\mathbf{Y}_{Yr\ IPO} + \varepsilon_{jt} \tag{2}$$

Finally, to examine the effect of delay between IPO approval and listing, we use monthly panel data and include all firm-months after approval but before listing. We estimate Equation 3, where m denotes month.

$$P_{jm} = \alpha + \beta_1 MonthsDelaySoFar_{jm} + \beta_2 AlreadyListed_{jm} + \delta'\mathbf{V}_{jt} + \gamma'\mathbf{Y}_{Qtr\ IPO} + \varepsilon_{jt} \tag{3}$$

Instead of using the total months of delay, our 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 within the sample of firms not yet listed. We control for whether or not the firm has listed in a given month ($AlreadyListed_{jm}$). We also include listing quarter fixed effects, and cluster standard errors by firm.

4 Data

In this section, we describe our data sources and the variables we use as outcomes. In Section 4.3, we test for ex-ante differences by delay status.

4.1 Sources of Data

We collect data from eight sources to construct variables used in this paper:

1. China Securities and Regulatory Commission (CSRC): We begin with the list of firms that applied to IPO on the A-share Shenzhen and Shanghai Main Boards. CSRC provides IPO application and approval data between 2004 and 2015 for 1,567 IPOs. We do not use data from the smaller boards (ChiNext and SME) for two reasons. First, they are relatively new. Second, there is less financial data available from the commercial databases for firms listed on these boards.

2. Hand-collected private equity investment data: We hand-collected data from IPO prospectuses for all IPOs between 2006 and 2013.[19] This data was checked for accuracy with the commercial ChinaVenture Source and SDC VentureXpert databases. Investor board membership was hand-collected from the resumes of board members included in the IPO prospectus.

[19]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.

3. China Securities Market and Accounting Research (CSMAR)/WIND: These commercial databases (the Bloomberg equivalents) provide IPO prospectus data (sometimes called "predisclosure" data), listing, and financial statement data.

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

5. SDC New Issues: This database provides listing information for Chinese companies, supplementing WIND.

6. State Intellectual Property Office (SIPO): We have annual and monthly invention, design, and utility patent application and grant data. The latter two types of patent applications are rarely rejected.

7. Google Patents: We match the firms in our sample to patent and citation data using the Google Patents, which include the entire collection (over 87 million) of granted patents and published patent applications from 17 major patent offices around the world (including US from 1790, EPO and WIPO from 1978), as well as many more technical documents and books indexed in Google Scholar and Google Books.

8. Private Capital Research Institute (PCRI): Our analysis of the effect of the IPO suspensions on contemporaneous VC investment relies on PCRI data. 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, VentureXpert, EMPEA, unquote, Venture Intelligence (India), and Startup nation (Israel).

4.2 Summary Statistics

Table 1 panels 1-6 describe data used in our analysis. Categorical IPO data is in Table 1 panel 1. We begin with the sample of 1,567 firms comprising all IPOs on the Shanghai

and Shenzhen exchanges between 2004 and 2015. Our first estimation sample consists of 425 firms approved to IPO in the year (365 days) prior to an IPO suspension. Our second sample consists of 529 firms that listed in the year (365 days) after an IPO suspension ended. One hundred and thirty firms overlap between the two samples, while 291 are uniquely in the approved-before sample and 399 are uniquely in the listed-after sample. Among all the 820 unique firms, only 18 did not ultimately list in China. In 14 of these cases, the firm did not list because fraudulent activities were discovered. No firm chose to go public abroad. Beyond this, all control and outcome variables are not always available for all firms causing the number of observations to be somewhat smaller than 425 and 529.

Table 1 panel 2 contains continuous IPO data. IPO delay averages 4.3 months in the whole sample, 8.7 months in the approved-before sample, and 6.8 months in the listed-after sample. Average underpricing (the difference between the closing price on the first trading day and the offer price) in our data is about 80 percent, consistent with the literature finding large underpricing in China. At IPO, boards on average have 9.3 members, of which 3.4 are independent. Expansion of the board and more independent board directors are often associated with better corporate governance, and we are interested to see if they are affected by delay. However, evidence on the relationship between board variables and outcomes is mixed (Boone et al. 2007, Adams et al. 2010). For example, Yermack (1996) finds that board size and firm performance are negatively correlated. Further, some literature suggests that boards may play a somewhat different and more informal role in China than they do in the U.S. (Choi et al. 2011, Lin et al. 2016).

We collected data on executive mobility using the CSMAR Executive and Board Database. This is only available after IPO, and was not available for all firms. We manually translated and classified executive positions that appear more than 50 times in the database. We then examined entry and exit of holders of these positions in the years after IPO. We focus on three types of positions: finance, human resources, and technical. Summary statistics are in Table 1 panel 3. On average, many more executives in each category join than depart,

consistent with firm management growing after IPO.

Corporate variables for the year following IPO are shown in Table 1 panel 4. We follow precedent in the literature in constructing financial variables where possible, in particular Fan et al. (2007) and Piotroski & Zhang (2014). Leverage is the ratio of the firm's total liabilities to total assets at the fiscal year-end. Cash is also scaled by assets. Total investment has three components: financial investment, acquisition investment, and plant, property, and equipment investment.[20] Market share is a focal firm's share of total industry revenue.[21] Some of these variables are not available for pre-IPO years, including cash and revenue (and thus market share). A commonly used accounting measure for window dressing is the volume of discretionary accruals. This reflects the flexibility and scale of firms to manage their earnings and has been used by researchers in both the U.S. and Chinese contexts (Becker et al. 1998, Hutton et al. 2009, Chen et al. 2011, Kim & Zhang 2016). We measure discretionary accruals as the residual from a Jones model, adjusted by a performance matched firm, following Jones (1991) and Brau & Fawcett (2006).

We measure innovation activity using patent-based variables, summarized in Table 1 panels 5-6. China has three classes of patents: invention, utility model, and design. Invention patents, which we use in this paper, are akin to utility patents in the U.S.; they cover new technical solutions relating to a product, a process, or improvement.[22] Invention patent protection lasts twenty years from the application. We also collected data on R&D expenditure; however, we do not use it as these data appear to be poor quality, are missing for many firm-years, and only exist after 2007.

Patent applications represent firm effort to formalize intellectual property so as to

[20]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.

[21]Industry is defined using the nnindcd variable in CSMAR, which has 78 categories. We use only data on publicly traded firms.

[22]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. Applications for these latter two types are essentially never rejected.

temporarily monopolize it. We use the number of patent applications to reflect innovation effort, though we recognize they also represent the firm effort to codify, disclose, and protect (Kortum & Lerner 2001, Rajan 2012). In the approved-before sample, the average firm files 5.5 patents in the year following IPO. Patent grants are typically used as a measure of innovation quantity, and we also examine granted (mean of 1.89) and rejected (mean of 3.35) patents.

Patent applications in China have increased dramatically since China established formal patent law in 1985, and there are now more invention patents filed in China than in the U.S. Fang, Lerner & Wu (2017) show that while average quality may differ across countries, patents generally serve the same purpose in China as they do in the U.S., and firm patenting behavior is similar across the two countries. For example, in both countries, within-firm increases in patent stocks are associated with higher productivity, exports, and new product revenue. Interestingly, they find that SOE patents are more associated with TFP growth than private firm patents. Wei, Xie & Zhang (2016) find that the patent approval rate is not unusually high in China, and present comparisons suggesting robust improvement in Chinese patent quality over time.

We use two measures of patent quality. First, data from Google Patent permits us to observe citations to Chinese patents, which to our knowledge is a contribution to the literature measuring innovation among Chinese firms. China's patent office (SIPO) does not disclose citation data, and prior work has primarily relied on citations to patents that Chinese firms file in foreign countries. This approach has several limitations, including selection into foreign patent filing, different standards across offices, and home country bias (Michel & Bettels 2001, Harhoff et al. 2003, Bacchiocchi & Montobbio 2010). Google Patent covers SIPO citations and is searchable for non-English patents, providing wider coverage than previous measures.[23] The average firm has 8.4 citations to granted patents that were

[23]This complements earlier approaches in Boeing & Mueller (2016) and Rong et al. (2017), who use citations to patents filed via the Patent Cooperation Treaty (PCT). As these applications are published through WIPO, they are also included in Google Patent data.

filed in the year following IPO. Note that different industries have systematically different citation rates. The industry fixed effects that we include in regressions help to account for these systematic differences. However, since we are not doing cross-industry comparisons, the differences should not confound our results. Fang et al. (2016) also use unscaled citations. A second measure of patent quality is the number of granted patents filed in foreign (non-Chinese) patent offices. We term these "global" patents. The average firm has 0.02 global granted patents that were filed in the year following IPO.

4.3 Ex-ante Differences by Delay

We conduct t-tests for whether high delay firms appear different ex-ante than low delay firms. The results are in Table 2. We examine 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. 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.

High delay is on average associated with more underpricing. This is consistent with delay leading to greater market uncertainty about this firm. Ljungqvist (2007) finds that the best explanation for IPO underpricing is information asymmetry among investors or between the issuer and new investors. Beatty & Ritter (1986) show that uncertainty about valuation and firm quality should lead to greater underpricing. 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 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 use underpricing in estimation.

5 Results

This section first describes the effects of suspension-induced IPO delay on patent activity, starting with patent activity after listing (Section 5.1). We then consider the effect during the delay period (Section 5.1.2). Other firm outcomes are analyzed in Section 5.2. We consider two potential channels in Section 5.3: financing constraints and uncertainty. We also address window dressing and governance (Section 5.3.3). Finally, Section 5.4 explains how our results point to innovation having a cumulative dimension.

5.1 Patent Activity

5.1.1 Effect of Suspension-induced Delay after IPO

Suspension-induced listing delay significantly reduces firms' effort to obtain patents. Table 3 shows estimates of Equation 1, using our primary sample of firms approved in the year before an IPO suspension. In column 1, with a negative binomial model, an extra month of delay reduces patent applications by about 13 percent.[24] Columns 2 and 3 use OLS models. They show that an extra month of delay reduces patents by 0.49, and delay higher than the 75th percentile (13 months) reduces patents by 1.9. The mean is 5.5 patents. The effect is robust to instrumenting for delay with the approval committee meeting date (column 4). Table 4 uses the listed-after sample (firms listed in the year after a suspensions ends). We continue to find strong negative effects on patent quantity, though they are smaller than the effects in Table 3.

Delay also reduces patent quality, measured using Chinese patent citations and global (non-Chinese) granted patents. In the sample of firms approved in the year before an IPO

[24] We do not use the Poisson model because the patent counts are overdispersed.

suspension, a month of delay reduces citations in the year following IPO by about 10 percent, relative to the sample mean of 8.4 citations (Table 3 column 5). In the listed-after sample, an additional month of delay reduces citations by 6.2 percent, relative to the sample mean of 9.3 citations (Table 4 column 5). The indicator for high delay is significant only in the latter sample. We find extremely large negative effects of delay on global (non-Chinese) patents in all four specifications (Table 3 columns 7-8 and Table 4 columns 7-8). An extra month of delay reduces global patents by 25 percent. The coefficient on high delay (-17) is so large that it is well outside the sample range of zero to five global patents. There are very few firms with global patents (the mean is just .03), suggesting that these large effects are driven by a few firms. Together, the results in Tables 3 and 4 provide consistent and compelling evidence that delay reduces patenting activity, the standard measure of innovation output.

We conduct several sample splits and robustness tests in Table 5. We use the firms listed in the year after a suspension ended, as this is the larger sample. First, we limit the sample to the final, largest, and arguably most exogenous suspension (2012-14). This omits, for example, any possible confounding effect of the global financial crisis. It is also the suspension where we observe the approval queue and verify that firms do not "jump" ahead in line. The effects, in panel 1 columns 1 and 2, are roughly the same for this subsample as in Table 4. Next, we limit the sample to the Shenzhen exchange, and continue to see robust effects (columns 3 and 4). We separate the sample by industry type in panel 2 columns 1 and 2.[25] Intuitively, the effect is driven by high-tech sectors. Finally, we separately consider granted and rejected Chinese invention patent applications in panel 2 columns 3 and 4. The effect is driven by granted patents, indicating that delay does not simply affect low quality innovation effort.

The negative effects on patenting endure for years after IPO. Table 6 panel 1 columns 1-3 shows negative effects of delay on Chinese patent applications in the second, third, and fourth years after IPO. The effect grows stronger in each year, and is 23 percent in the fourth

[25] We use the SDC New Issues indicator for being in a "high-tech sector."

year after IPO, relative to a mean of 7.1 patents in that year. There is an even stronger effect on granted Chinese patents, shown in panel 1 columns 4-6. The effect in the fourth year after IPO is is 61 percent, relative to a mean in that year of 2.8 granted patents. Using the listed-after sample, the long-term effect is about the same in the second year after IPO as the first year but disappears in the third year (panel 2 columns 1-2). Similarly, the effect on Chinese patent citations persists in the second year but loses significance in the third year after IPO (panel 2 columns 3-4). The effect also on global (non-Chinese) patents also endures. It is 4 percent, significant at the .1 level, in the third year after IPO, relative to a mean in that year of .05 global patents (column 5).

5.1.2 Effect of Suspension-induced Delay between IPO Approval and Listing

To shed light on when delay affects patenting, we center analysis around the approval rather than the listing date. Figure 6 shows a local polynomial of the average patents by month around the IPO approval date. The left two plots include only firms with above-median delay (4 months), while the right two plots include only firms with below-median delay. In the top graphs, we consider only firm-months in which the firm has not yet listed. Therefore, all firms are included in months through zero, and then drop out of the sample as they list. The bottom graphs include all-firm months. For example, in the bottom left graph, all firms experience at least four months of delay. After the 4th month following IPO approval, some will have listed and some not.

Figure 6 reveals that patent applications rise leading up to approval as firms ready themselves for listing, perhaps reflecting a need to increase disclosure or, more nefariously, window dressing. It is comforting that firms affected by delay (left graphs) have similar pre-approval behavior as firms that did not experience abnormal delay (right graphs). After approval, patents decline much more for delayed firms, both when we exclude post-listing months (top graphs) and when we include them (bottom graphs).

Regression estimates using monthly data (Equation 2) between IPO approval and

listing are in Online Appendix Table A2. We find that an extra month of delay reduces Chinese patent applications in that month by about 13 percent (column 1). There is also a strong negative effect on citations to Chinese patents (column 3). However, the effect on global (non-Chinese) patents disappears. Monthly data also permits comparing our data to that in Bernstein (2015), where public firms tend to have lower innovation quality (fewer patent citations) than private firms. In Online Appendix Table A3, we limit the sample to the first 36 months after a firm's IPO approval. The dependent variable is the number of citations to patents applied for in a given month. We include quarter of approval fixed effects, and cluster errors by firm. We find that on average, citations fall after IPO in our data, consistent with Bernstein's result (column 1). This suggests that his finding is not specific to the U.S. context. Column 2 adds the months of delay so far, and finds that an additional month of delay reduces patent citations in the month by about 13 percent. The magnitude is large; at the 75th percentile of delay (13 months), the coefficient implies a total negative effect of 1.66 citations, almost exactly the same as the negative effect of IPO. This exercise highlights how our research question – how timely access to public markets affects innovation quantity and quality after firms ultimately list – differs from previous work.

Figure 7 shows the coefficient of months of delay on invention patent applications filed in a specific year relative to the IPO approval year. 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 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 patents relative to a sample mean of 7.9. In the fourth and fifth years, the coefficients continue to be strongly negative, but become noisy.

5.2 Other Firm Outcomes

Suspension-induced delay may also lead to changes in capital structure and performance. Table 7 considers the effect of delay on a number of such measures in the year following IPO, using the larger sample of firms listed in the year following the end of a suspension.[26] First, we examine investment in tangible assets (property, plant and equipment or PPE investment) in columns 1 and 2. We find no effect. Online Appendix Table A4 columns 3 and 4 also show that there is no effect of delay on other types of investment in the year after IPO. Delay leads to economically small increases in leverage and decreased cash (the ratios of total debt and cash to total assets) in the year following IPO. An extra month of delay increases leverage by 0.004, relative to a mean of 0.59 (Table 7 panel 1 column 3). An extra month of delay decreases cash by .0048, relative to a mean of .42 (column 5). These are not driven by the denominator, as there is no effect on total assets.

We next turn to performance measures. The first day price to book (P/B) ratio provides a proxy for market expectations about the firm's assets in place.[27] There is a negative effect of delay on first day P/B, shown in Table 7 panel 2 columns 1 and 2. An extra month of delay reduces it by .18, relative to a mean of 14. This effect is especially strong for the most delayed quartile, whose P/B is a third lower than the mean (column 2). We find no effect on IPO proceeds. There is no effect of delay on market share (columns 3 and 4). Delay does lead to a slightly lower return on sales (ROS), however, as shown in Table 7 panel 2 columns 5 and 6. An extra month of delay decreases ROS by .0012, relative to a mean of 1.16. This is consistent with the firm experiencing a negative shock to normal operations. These effects on non-innovation outcomes are short-lived. Table 8 repeats the models in Table 7, but for the second year after IPO. In contrast to the patent effects, which endure for years, the effects on capital structure and performance do not last beyond the year following IPO. Here, we use the average P/B over the year. Once the firm is publicly

[26] We find directionally similar results using the other sample, but they are less robust, which appears likely due to the smaller sample.

[27] The P/B ratio is calculated as the first day market value divided by the book value of assets.

listed, it "bounces back" to parity with non-delayed firms along these dimensions.

We find no effects of delay after IPO or in subsequent years for a number of other outcomes, including abnormal stock returns, number of employees, total payroll, senior manager salaries, or board variables such as independent board members (latter shown in Online Appendix Table A5 columns 3 and 4).

5.3 Potential Channels

The results thus far demonstrate that temporary listing delays have a lasting effect on innovation, and short-term effects on other real outcomes. In this section, we first discuss two potential channels for the initial disruption during delay: financing constraints (i.e., reduced capital supply) and uncertainty. Then, in Section 5.3.3, we discuss the hypothesis that the enduring effect on innovation reflects its cumulative nature.

5.3.1 Financing Constraints

If financial constraints during delay are the primary channel, alternative forms of financing such as debt or private equity must be too costly or unavailable. As explained in Section 2.1, firms going public on the main boards are in a "Goldilocks" position. They are less constrained than young, unprofitable firms that go public in the U.S. Not a single one of the firms in our estimation samples chose to go public abroad rather than wait for the IPO suspension to end. The substantial investment needed to obtain IPO approval is sunk, so we expect that firms desperately in need of capital would have gone public in Hong Kong or elsewhere. At the same time, the exceedingly high valuations in China offer a powerful inducement to wait.[28]

In the absence of financial frictions, the delayed firm should be able to fill its financing gap with debt and private equity. Frictions in these markets may make IPO markets

[28] One recent example is online security firm 360 Security which has seen its market capitalization soar to $52 billion since it re-listed in Shanghai in late February–up from $9.3 billion when it exited the New York Stock Exchange in 2016. (https://www.forbes.com/sites/ywang/2018/03/16/china-is-stepping-its-up-efforts-to-draw-tech-giants-like-alibaba-and-baidu-back-home/#257a55a450e0)

especially important for risk capital provision in China. This is consistent with our findings that during the delay period, affected firms experience higher leverage, while patenting and tangible investment fall (Table 9 and Online Appendix Table A2). In the year following IPO, delay is not associated with lower investment but continues to lead to higher leverage. Thus it seems that firms are able to increase debt, but that the debt cannot be used to finance risky investments - tangible assets and innovation. These activities may be constrained by the absence of risk capital.

Firms with better access to alternative forms of financing should be less affected by listing delays in a capital supply channel. We conduct two tests of this hypothesis. First, we expect that venture capital and private equity (VC/PE) backed firms may be able to return to private markets for risk capital. We therefore interact delay with an indicator for whether the firm is state-owned or has VC/PE backing in Online Appendix Table A6. Using a variety of outcome measures, we do not find that delay affects VC/PE backed firms differently from their non-VC/PE backed counterparts (columns 1, 3, 5, and 7). The coefficients are near-zero but imprecise. In all cases, the independent effect of delay, which estimates the effect of delay among non-VC/PE backed firms, is large and robust. VC/PE backed firms on average do more patenting than their non-VC/PE backed counterparts. We also do not find that delayed firms are more or less likely to ever receive private equity or venture capital (VC/PE) investment before their IPO, suggesting that firms do not react to delay by raising money in private capital markets.

Second, we expect that firms with better access to debt will be less affected. Cong & Ponticelli (2016) show that SOEs are advantaged in accessing credit, especially after the introduction of China's stimulus package towards the end of 2008, so they should be less affected in a capital supply channel. Conversely, we find that SOEs are more affected (Online Appendix Table A6 columns 2, 4, 6, and 8). As with the VC/PE interaction, in all cases the independent effect of delay (among non-SOEs) is large and robust. SOEs do not independently do more patenting than their private counterparts. Together, the evidence

presented in this section suggests that financing constraints alone do not fully explain the chilling effect of delay on innovation.

5.3.2 Heightened Uncertainty and Instability

The suspensions, which were all of indefinite length, created uncertainty among affected firms about when they would be able to go public and what market conditions they would face. In Section 2 we provided anecdotal and industry press evidence that although there was little doubt that eventually IPOs would resume, delay caused market uncertainty about affected firms. To push further on whether there was meaningful uncertainty about the IPO market during suspensions, we examine VC investment. If IPO suspensions were perceived as short and unimportant hiatuses, contemporaneous VC investment should not be affected because of its highly illiquid nature, with portfolio companies held for multiple years before seeking liquidity through IPO. Conversely, if suspensions caused serious uncertainty about the future of IPO markets in China, VC investors may have become concerned about exit possibilities and reduced investment. We show an association between VC investment and the suspensions in Online Appendix B. Controlling for domestic market conditions and rest-of-world VC, we find that the suspensions were associated with depressed VC investment, particularly later stage VC investment, in Chinese portfolio companies. This persists among elite U.S.-headquartered VC firms active in China. While not causal, this analysis suggests that the suspensions had a chilling effect on VC.

Uncertainty is central to how our setting differs from the literature comparing public and private firms using U.S. data. In that literature, firms know immediately whether they will be public or private, and adjust their investment strategy accordingly. For example, Bernstein (2015) argues that the decline in patent citations that he observes after firms go public is partially intended, as public firms shift strategies to focus more on acquiring innovation and commercializing products. In our setting, the firm is unsure when it will be able to pursue its planned as-public-firm investment strategy. It does not switch gears and

pursue an as-private-firm strategy, because it ultimately does plan to go public.

The real options literature shows that investment declines under uncertainty (Dixit & Pindyck 1994). Indeed, we find strong negative effects of delay on tangible investment and leverage in the year following IPO approval, shown in Table 9. Note that this exercise compares listed and unlisted firms, as non-delayed firms will typically list within a few months of approval. Tangible investment likely accompanies R&D investment; both are relatively long-term and risky relative to other types of expenditure.

Human capital is central to innovation; its firm-specific component represents a shared investment by the firm and employees (Jovanovic 1979, Hashimoto 1981). Firm-specific human capital investments can be viewed through the lens of real options theory. Increased uncertainty about the firm increases the value to the employee of leaving, making both parties less willing to invest in firm-specific human capital (Fister & Seth 2007). Relatedly, Cornelli, Simintzi & Vig (2017) demonstrate the importance of team stability to firms. Uncertainty that disrupts the firm's innovation process may also reduce firm-specific human capital investment during delay and lead to higher rates of managerial departures and turnover even after public listing.

We do not observe personnel movements during delay, but we examine whether high delay is associated with greater key personnel turnover in the year following IPO in Table 10. Delay leads not only to greater turnover, but to an excess of departures. We are most interested in technical executives, such as Chief Technology Officers. These are likely to be the individuals managing the innovation process. When a firm's delay is above the 75th percentile (13 months), the number of technical executives who join the firm falls by .29, and the number who depart increases by .034 (Table 10 columns 1 and 2). Both effects are more than 100 percent of their respective means. We also find a large, similar effect on human resources executives, but not on finance executives (columns 3-6).[29] The effects do not persist in subsequent years. The decline in technical and human resources management

[29]Online Appendix Table A7 repeats the specifications in Table 10 using continuous delay, and finds similar albeit somewhat weaker effects.

in the year after IPO is consistent with delay disrupting the accumulation of innovation-related organizational capital, in the sense of Eisfeldt & Papanikolaou (2013). This offers a window into how the firm's patent activity declines.

It is likely that both the capital supply and uncertainty channels play a role in explaining why delayed firms forego innovation investment. However, the data are most consistent with uncertainty being the primary mechanism. If financing constraints play a role, it is likely through the interaction with heightened uncertainty.[30]

5.3.3 Window Dressing

An alternative channel is that the effects of delay on innovation reflect firm window dressing behavior, or efforts to artificially mislead the market about their worth temporarily (see e.g. Stein 1989 and Jain & Kini 1994). Window dressing is almost certainly at play, and may help explain the run-up in patent applications that we observe two years prior to the firm's approval (Figure 6). We examine the standard measure of window dressing, discretionary accruals, in the year after IPO (we do not observe them before the IPO). Delayed firms in fact have slightly lower discretionary accruals in the year after IPO (Online Appendix Table A5 columns 1 and 2).

While this is tentative evidence that window dressing does not explain our results, it may reflect firms having exhausted window dressing resources during delay, and having less flexibility to use them after the IPO. That is, firms may maintain short-term operating performance at the expense of longer-term operating performance. Yet this version of window dressing cannot explain the persistent effects on innovation that we observe during delay and after the IPO, combined with the absence of a long-term effect on operating performance.

The second possible window dressing scenario is that delayed firms may perceive a need to maintain a certain standard innovation under the CSRC's watch as they wait to

[30]Note that the mechanisms potentially at play in our setting – uncertainty and financial constraints during delay – are quite different from the mechanism that Bernstein (2015) argues leads to lower innovation quality after listing. He focuses on agency problems in the form of career concerns after public listing, which lead publicly traded firms to pursue lower quality innovation.

list. In particular, if a firm exhausts resources for innovation during delay, we might expect it to have lower innovation after ultimately going public. Contrary to this hypothesis, we observe patent applications drop precipitously during the delay period (Figure 6). Therefore, window dressing does not explain our main effects.

5.4 Cumulative Nature of Innovation

The evidence is most consistent with uncertainty during delay leading the firm to reduce investment in innovation, with capital supply frictions playing a secondary role. The remaining question is why delay has lasting effects on innovation, unlike, for example, tangible investment or return on sales. As we saw in Tables 7 and 8, tangible investment among delayed firms returns to parity with non-delayed firms after listing. However, innovation outputs do not. Thus it seems that something is different about innovation.

The most natural explanation is that innovation investments are cumulative, such that investing today sets the stage for continuing to have positive NPV investment opportunities in the future. That is, the productivity of firms' future innovation investment depends on whether it remains at the frontier today and maintains its R&D infrastructure. This relates to the literature showing how innovation capability depends on years of accumulated expertise and infrastructure (e.g., Feldman & Florida 1994, Bates & Flynn 1995). New innovations build upon and complement prior innovation (Chang 1995).

This is much like an individual's investment in education to build human capital, as Cunha & Heckman (2007) formalize. Attending third grade offers little in the way of labor market returns, but it is crucial to ultimately attending college. A child who misses a year of schooling may fall permanently behind her peers. Similarly, falling behind in the corporate innovation process may have persistent effects. Uncertain listing delay causes a firm to pause its innovation investment, disrupting its ability to build or maintain an innovative, entrepreneurial culture in the sense of Gompers, Lerner & Scharfstein (2005). The temporary disruption has long-term effects on the firm's innovation infrastructure.

6 Conclusion

The impact on firms of timely access to public markets is difficult to study; the ideal experiment would observe the same economy with and without it. While imperfect, China's IPO suspensions provide a quasi-experiment in an important economy. We find that temporary listing delay leads to reductions in tangible investment, firm-specific human capital, and most importantly innovation. The effects on innovation are economically significant and endure through the fourth year after IPO, while impacts on other outcomes are short term.

The evidence is most consistent with uncertainty about delayed firms being the primary mechanism. Financing constraints caused by the public equity capital supply shock may also play a role. However, this channel seems secondary as no firms react to delay by listing abroad and the negative effect on innovation persists or grows stronger among firms that should have better access to alternative financing. The enduring negative effects of delay on innovation, lasting for years after listing, reflect the cumulative nature of innovation investment.

Previous literature has examined the impact of listing in environments where the firm's demand to list, while perhaps dependent on market conditions, determines its public status. In contrast, our variation is supply side, exploiting a regulatory shock to listing opportunities. Our findings therefore have policy implications, particularly in light of how crucial private firm innovation is to China's future growth. Our results suggest that – from the perspective of firms seeking public financing – it is valuable to be able to predictably list in a timely manner. Therefore, China's innovation ecosystem might benefit from fostering accessible IPO markets with transparent rules. More generally, our paper sheds light on how frictions in the provision of timely access to risk capital impact corporate innovation.

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Table 1: Summary Statistics

Panel 1: Categorical IPO 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 (SOE)	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

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
Approved to IPO in year before suspension	421	8.7	4.0	9.0	0.63	38.4
Listed (IPOd) in year following suspension	529	6.8	2.93	8.29	0.43	34.57
Market cap at listing (million RMB)	1460	684	143	5374	21.4	160000
IPO proceeds (million RMB)	1544	119.61	41.14	454.73	-1.31	8800.15
Company age at listing (years)	1421	11.3	10.0	5.9	1.0	48
Price-to-book ratio first day of trading	1483	14.1	11.6	10.4	1.27	108.3
IPO underpricing	1390	-.78	-.80	0.12	-.97	2.46
Num board members	421	9.33	9	2.11	5	17
Num independent board members	421	3.43	3	0.86	2	8

Panel 3: Executive mobility data (in year following IPO)

	N	Mean	Median	S.d.	Min	Max
# finance executives who join	1247	0.16	0	0.42	0	4
# finance executives who depart	1247	0.005	0	0.07	0	1
# HR executives who join	1247	0.2	0	0.51	0	5
# HR executives who depart	1247	0.01	0	0.1	0	2
# technical executives who join	1247	0.07	0	0.41	0	8
# technical executives who depart	1247	0.002	0	0.08	0	3

Panel 4: Corporate data (in year following IPO, except where noted)

	N	Mean	Median	S.d.	Min	Max
PPE Investment$^{\pm}$	1551	0.14	0.11	0.14	0	1.47
Leverage$^{\pm}$	1555	0.59	0.3	1.43	0.01	27.71
Return on sales	1555	1.16	1.13	0.11	0.94	2.32
Abnormal return‡	1558	-0.4	0.93	217.41	-1537.95	3772.21
Market share*	803	3.11	0.4	8.26	0.02	78.58
Revenue	1531	3091.85	570.83	25749.91	62.8	8.40E+05
Earnings‡‡	1555	509.95	72.51	4867	-254.06	1.40E+05
Cash/Assets	1518	0.42	0.41	0.21	0	0.96
Employees	1526	4267.29	956.5	23626.28	63	4.70E+05
Payroll	1528	346.69	54.8	2551.72	3.73	62484
Discretionary accruals	1473	0.08	0.06	0.15	-0.54	1.16

Panel 5: Annual patent variables in year following IPO

	N	Mean	Median	S.d.	Min	Max
Approved to IPO in year before suspension						
Chinese invention patent applications	409	5.5	1	12.48	0	146
Citations to granted Chinese invention patents	409	8.44	1	30.91	0	571
Granted global (non-Chinese) utility patents	409	0.02	0	0.27	0	5
Chinese granted invention patents	409	1.89	0	4.3	0	32
Chinese rejected invention patents	409	3.35	0	9.17	0	122
Listed (IPOd) in year after suspension						
Chinese invention patent applications	491	5.77	1	16.52	0	211
Citations to granted Chinese invention patents	491	9.39	2	22.11	0	250
Granted global (non-Chinese) utility patents	491	0.03	0	0.25	0	4
Chinese granted invention patents	491	2.82	0	10.31	0	143
Chinese rejected invention patents	491	2.67	0	8.25	0	100

Panel 6: Monthly patent variables in year following IPO

	N	Mean	Median	S.d.	Min	Max
Approved to IPO in year before suspension						
Chinese invention patent applications	42685	0.8	0	5.74	0	290
Citations to granted Chinese invention patents	42685	1.19	0	7.24	0	449
Granted global (non-Chinese) utility patents	42685	0.46	0	2.01	0	49
Listed (IPOd) in year after suspension						
Chinese invention patent applications	12634	0.74	0	3.27	0	64
Citations to granted Chinese invention patents	12634	1.35	0	7.7	0	283
Granted global (non-Chinese) utility patents	12634	0.52	0	2.13	0	47

Note: This table contains summary statistics about all IPOs on the Shenzhen and Shanghai exchanges. Panel 1 contains categorical data about the IPOs. "Whole sample" indicates all IPOs on these exchanges between 2004 and 2015. Estimation samples are IPOs approved in the 365 days prior to an IPO suspension announcement, and IPOs that occurred in the 365 days following the end of a suspension. Panel 2 describes IPO data that is in continuous form. IPO underpricing is defined as $\frac{OpeningPrice-OfferPrice}{OfferPrice}$. Panel 3 contains variables about entry and exit of executives by occupational area. Panel 4 describes corporate variables in the year after IPO. "Change" variables are the difference between the variable in the year after IPO and the year before IPO. Panels 5 and 6 describe the patent variables we use (patents in the year following IPO) separately for both estimation samples. Currency-denominated variables are in 000s nominal RMB, except payroll, earnings, and sales, which are in millions. $^{\pm}$Investment and leverage calculated as fraction of total assets. ‡Buy-and-hold stock return less value-weighted market return for the first year after IPO. ‡‡Equivalent to net income, in nominal RMB. *Revenue of firm i in year t scaled by total revenue of industry in year t; Industry is CSRC industry (2 digits if in manufacturing, 1 digit otherwise).

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)
Panel 1: Observed in year before IPO approval										
Chinese invention patent applications	173	4.84	14.07	168	4.18	8.08	0.66	0.60	0.70	0.30
Citations to Chinese invention patents	190	18.81	46.32	184	19.12	54.81	-0.31	0.95	0.48	0.52
Granted global utility patents	190	0.05	0.30	184	0.02	0.13	0.03	0.19	0.90	0.10
Chinese granted invention patents	173	2.69	9.34	168	2.51	4.98	0.19	0.82	0.59	0.41
Chinese rejected invention patents	173	2.15	6.36	168	1.68	4.18	0.47	0.42	0.79	0.21
Total investment	208	0.18	0.15	156	0.15	0.15	0.02	0.16	0.92	0.08
PPE investment	208	0.15	0.13	156	0.13	0.12	0.02	0.16	0.92	0.08
Revenue	208	6678	50624	204	2139	12434	4538	0.21	0.89	0.11
Earnings	210	959	9933	207	222	765	737	0.29	0.86	0.14
Leverage	210	1.65	3.87	207	1.19	1.08	0.47	0.10	0.95	0.05
Panel 2: Observed at IPO										
Market cap	210	513	2313	211	370	1424	143	0.45	0.78	0.22
IPO proceeds	210	209	817	211	146	532	64	0.34	0.83	0.17
Company age	210	10.10	5.00	211	10.84	4.98	-0.75	0.13	0.06	0.94
IPO underpricing	203	-0.76	0.10	202	-0.80	0.06	0.04	0.00	1.00	0.00
CEO at listing is founder	210	0.68	0.47	211	0.66	0.47	0.01	0.78	0.61	0.39

Note: This table summarizes t-tests for differences of means across low and high delay. For variables that we can observe in the year prior to IPO approval, we show these in Panel 1. Other relevant variables are only observed at IPO (Panel 2). Delay is separated at the median of 4 months.

Table 3: Effect of delay on patents filed in year after IPO among firms approved in the year prior to an IPO suspension

Dependent variable:	Chinese invention patent applications				Citations to granted Chinese invention patents		Granted global (non-Chinese) utility patents	
		OLS	OLS	IV**				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Delay (months)	-.12***	-.49**		-.42***	-.1*		-.22***	
	(.03)	(.25)		(.15)	(.054)		(.072)	
High delay			-1.9***			-.22		-17***
			(.68)			(.69)		(.89)
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	407	407	407	407	407	407	407	407
R^2	.048	0.19	.052	-	.051	.051	.26	.27
First stage F-test±				692				

Note: This table shows the effect of IPO delay on patenting, within the sample of firms approved in the 12 months prior to an IPO suspension. The dependent variables are the number of patents filed in the 12 months after IPO, and number of citations to global (non-Chinese) patents filed in the 12 months after IPO. Negative binomial variants of Equation 1 are used except in columns 2 and 3. The 75th percentile of delay is 12.8 months. †Controls are total investment that year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). ±The F-statistic for the excluded instrument (delay) being significantly different from zero. ** We instrument for delay with the approval date. The exponential conditional mean model with endogenous variables, implemented in Stata with ivpoisson; while there is no direct weak instrument test, we use the F-statistic from the first stage since the reduced form for the endogenous explanatory variable is linear. The R^2 is pseudo except for column 3. Errors clustered by industry-quarter. *** indicates p-value$<$.01.

Table 4: Effect of delay on patents among firms listed in the year after an IPO suspension

Dependent variable:	Chinese invention patent applications				Citations to granted Chinese invention patents		Granted global (non-Chinese) utility patents	
		OLS	OLS	IV**				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Delay (months)	-.029***	-.19**		-.037***	-.062***		-.23***	
	(.01)	(.084)		(.0091)	(.012)		(.066)	
Delay >75 pctile			-.63***			-1.3***		-17***
			(.24)			(.2)		(.26)
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	486	486	486	486	486	486	486	486
R^2	.058	0.11	.059		.045	.044	.14	.14
First stage F-test±				692				

Note: This table shows the effect of IPO delay on patenting, within the sample of firms listed in the 12 months after the end of an IPO suspension. The dependent variables are the number of patents filed in the 12 months after IPO, and number of citations to global (non-Chinese) patents filed in the 12 months after IPO. Negative binomial variants of of Equation 1 are used except in column 2. The 75th percentile of delay is 12.8 months. †Controls are total investment that year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). ±The F-statistic for the excluded instrument (delay) being significantly different from zero. ** We instrument for delay with the approval date. The exponential conditional mean model with endogenous variables, implemented in Stata with ivpoisson; while there is no direct weak instrument test, we use the F-statistic from the first stage since the reduced form for the endogenous explanatory variable is linear. The R^2 is pseudo except for column 3. Errors clustered by industry-quarter. *** indicates p-value<.01.

Table 5: Robustness tests of patent effect in year following IPO

Panel 1

Dependent variable:	Chinese invention patent applications	Citations to granted Chinese invention patents	Chinese invention patent applications	Citations to granted Chinese invention patents
Sample:	Last suspension (2012-14) only		Shenzhen only	
	(1)	(2)	(3)	(4)
Delay (months)	-.034**	-.051***	-.023**	-.048***
	(.014)	(.018)	(.011)	(.01)
Controls†	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y
N	117	117	417	417
R^2	.054	.07	.045	.042

Panel 2

Dependent variable:	Chinese invention patent applications		Granted Chinese invention patents	Rejected Chinese invention patents
Sample:	High-tech firms only	Non high-tech firms only		
	(1)	(2)	(3)	(4)
Delay (months)	-.033***	-.038	-.033**	.027
	(.0084)	(.027)	(.017)	(.019)
Controls†	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y
N	356	130	486	486
R^2	.046	.067	.091	.068

Note: This table shows robustness tests of the effect of IPO delay on patent applications in the year following IPO. The sample is firms listed in the twelve months after the end of an IPO suspension. Negative binomial variants of of Equation 1 are used. †Controls are total investment that year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). The R^2 is pseudo. Errors clustered by industry-quarter. *** indicates p-value<.01.

Table 6: Long-term effect of delay on patent activity

Panel 1

Dependent variable:	Chinese invention patent applications in:			Granted Chinese invention patent applications in:		
	2nd year after IPO	3rd year after IPO	4th year after IPO	2nd year after IPO	3rd year after IPO	4th year after IPO
	(1)	(2)	(3)	(4)	(5)	(6)
Delay (months)	-.088***	-.11***	-.21***	-.073**	-.15***	-.48***
	(.023)	(.03)	(.029)	(.032)	(.054)	(.12)
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	407	407	407	407	407	407
R^2	.072	.052	.063	.083	.12	.23

Panel 2

	Chinese invention patent applications (listed-after sample) in:		Citations to granted Chinese invention patents in:		Granted global (non-Chinese) utility patents in:	
	2nd year after IPO	3rd year after IPO	2nd year after IPO	3rd year after IPO	2nd year after IPO	3rd year after IPO
	(1)	(2)	(3)	(4)	(5)	(6)
Delay (months)	-.025*	.068	-.09*	-.06	-.031	-.041*
	(.015)	(.043)	(.049)	(.057)	(.025)	(.021)
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	486	486	407	407	407	407
R^2	.062	.055	.053	.067	.067	.08

Note: This table shows the effect of IPO delay on patenting in the longer term. All models use the sample of firms approved in the 12 months prior to an IPO suspension, except Panel 2 columns 1 and 2, which use the sample of firms listed in the twelve months after a suspension. All models use negative binomial variants of Equation 1. †Controls are total investment that year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). Errors clustered by industry-quarter. The R^2 is pseudo. *** indicates p-value$<$.01.

Table 7: Effect of suspension-induced IPO delay on capital structure and market performance in year following IPO

Panel 1

Dependent variable (in year after IPO):	PPE investment		Leverage		Cash/Assets	
	(1)	(2)	(3)	(4)	(5)	(6)
Delay (months)	.00058		.0039**		-.0048***	
	(.00041)		(.0019)		(.0011)	
Delay >75 pctile		.014*		.082**		-.097***
		(.0083)		(.036)		(.02)
2 dependent variable lags	Y	Y	Y	Y	Y	Y
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	503	503	518	518	516	516
R^2	.38	.38	.97	.97	.52	.52

Panel 2

Dependent variable (in year after IPO):	First day price/book		Market share		Return on sales	
	(1)	(2)	(3)	(4)	(5)	(6)
Delay (months)	-.18***		.0024		-.0012***	
	(.062)		(.0052)		(.00036)	
Delay >75 pctile		-5.2***		.041		-.022***
		(1.6)		(.11)		(.0076)
2 dependent variable lags	N	N	N	N	Y	Y
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	507	507	510	510	520	520
R^2	.5	.53	.97	.97	.78	.78

Note: This table shows the effect of delay on capital structure and market performance, using variants of Equation 1, within the sample of firms listed in the 365 days after the end of an IPO suspension. First day price/book is first day market value divided by the book value of assets. The 75th percentile of delay is 12.8 months. Controls 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). *** indicates p-value<.01.

Table 8: Effect of suspension-induced IPO delay on capital structure and market performance in 2nd year following IPO

Panel 1

Dependent variable (in 2nd year after IPO):	PPE investment		Leverage		Cash/Assets	
	(1)	(2)	(3)	(4)	(5)	(6)
Delay (months)	-.00017		.0026		.0013	
	(.00064)		(.0025)		(.0008)	
Delay >75 pctile		-.00076		.052		.027
		(.012)		(.052)		(.018)
2 dependent variable lags	Y	Y	Y	Y	N	N
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	518	518	520	520	510	510
R^2	.33	.33	.96	.96	.77	.77

Panel 2

Dependent variable (in 2nd year after IPO):	Price/book		Market share		Return on sales	
	(1)	(2)	(3)	(4)	(5)	(6)
Delay (months)	.0027		-.0016		-.0014	
	(.019)		(.0076)		(.001)	
Delay >75 pctile		-.11		-.017		-.028
		(.41)		(.16)		(.019)
2 dependent variable lags	N	N	N	N	Y	Y
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	514	514	510	510	520	520
R^2	.55	.55	.11	.11	.61	.61

Note: This table shows the effect of delay on capital structure and market performance, using variants of Equation 1, within the sample of firms listed in the 365 days after the end of an IPO suspension. The 75th percentile of delay is 12.8 months. Controls 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). *** indicates p-value<.01.

Table 9: Effect of suspension-induced IPO delay on capital structure in year following IPO approval

Dependent variable (in year after IPO approval):	PPE investment		Leverage	
	(1)	(2)	(3)	(4)
Delay (months)	-.0015**		.025***	
	(.00067)		(.0057)	
Delay >75 pctile		-.02*		.29***
		(.011)		(.085)
2 dependent variable lags	Y	Y	Y	Y
Controls	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y
N	467	467	476	476
R^2	.33	.33	.92	.91

Note: This table shows the effect of delay on capital structure and market performance, using variants of Equation 1, within the sample of firms listed in the 365 days after the end of an IPO suspension. The 75th percentile of delay is 12.8 months. Controls 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). *** indicates p-value<.01.

Table 10: Effect of suspension-induced IPO delay on executive mobility

Dependent variable (in year after IPO):	# technical executives who		# HR executives who		# finance executives who	
	Join	Depart	Join	Depart	Join	Depart
	(1)	(2)	(3)	(4)	(5)	(6)
Delay >75 pctile	-.29**	.034**	-.21***	.08**	-.078	.033
	(.14)	(.017)	(.074)	(.036)	(.056)	(.02)
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	352	352	352	352	352	352
R^2	.13	.034	.25	.1	.13	.037

Note: This table shows the effect of high delay on departures and entry of executives by occupational area, using OLS variants of Equation 1, within the sample of firms listed in the 365 days after the end of an IPO suspension. The 75th percentile of delay is 12.8 months. Controls 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). *** indicates p-value<.01.

Figure 1: IPO approval dates and delay from approval to listing (approved-before sample)

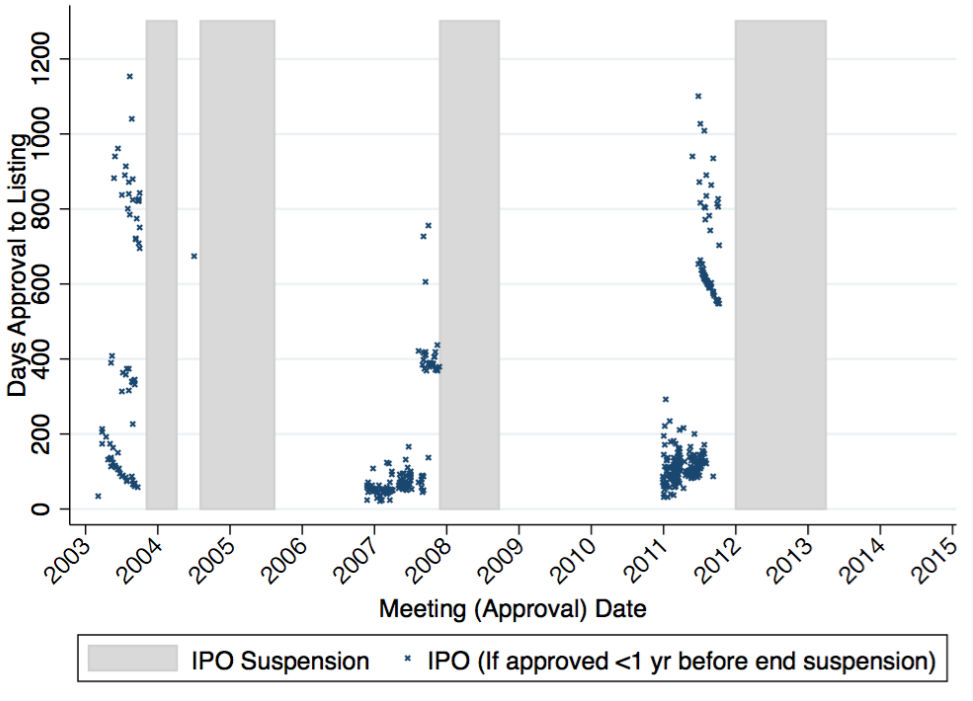
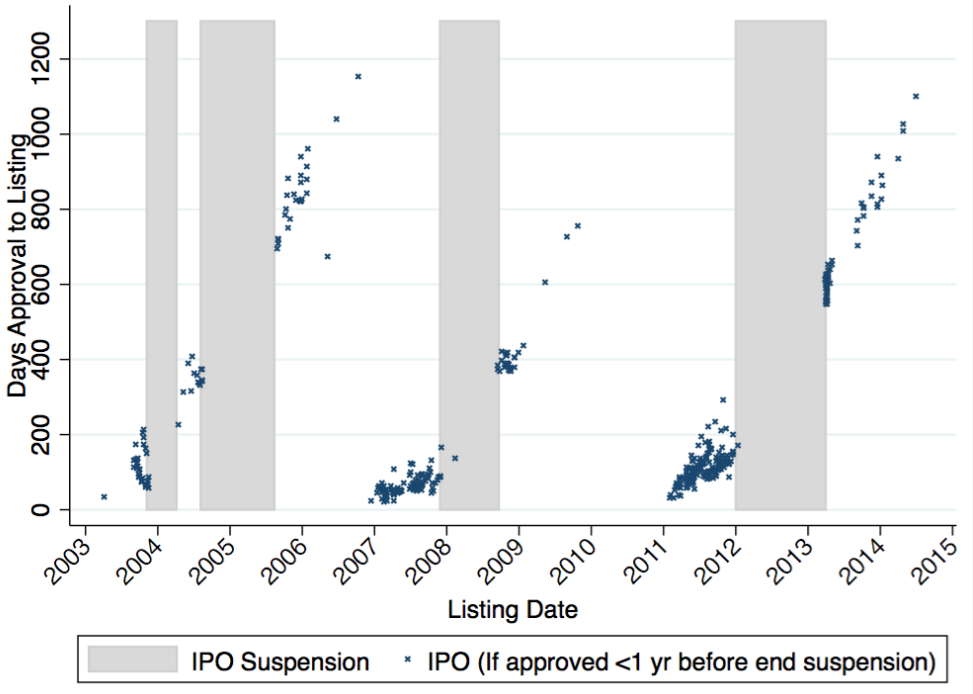


Figure 2: IPO listing dates and delay from approval to listing (approved-before sample)



Note: Each point in the above figures is a unique IPO on the Shanghai or Shenzhen exchange. The sample is restricted to firms that were approved to IPO in the twelve months before the start of an IPO suspension. Periods in which the government suspended IPO activity shaded.

Figure 3: IPO approval dates and delay from approval to listing (listed-before sample)

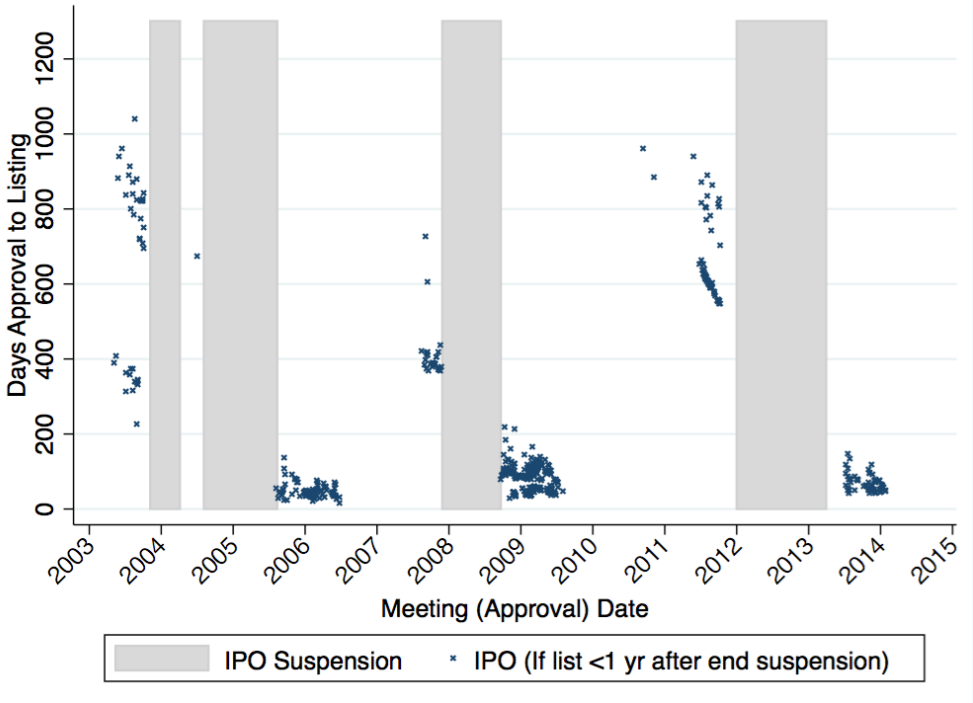
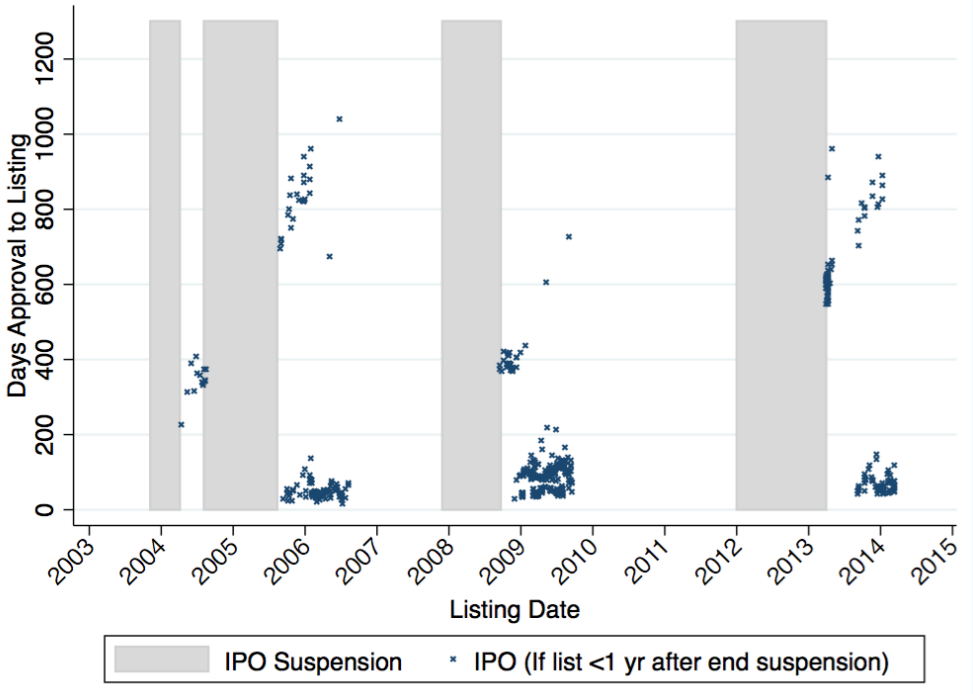
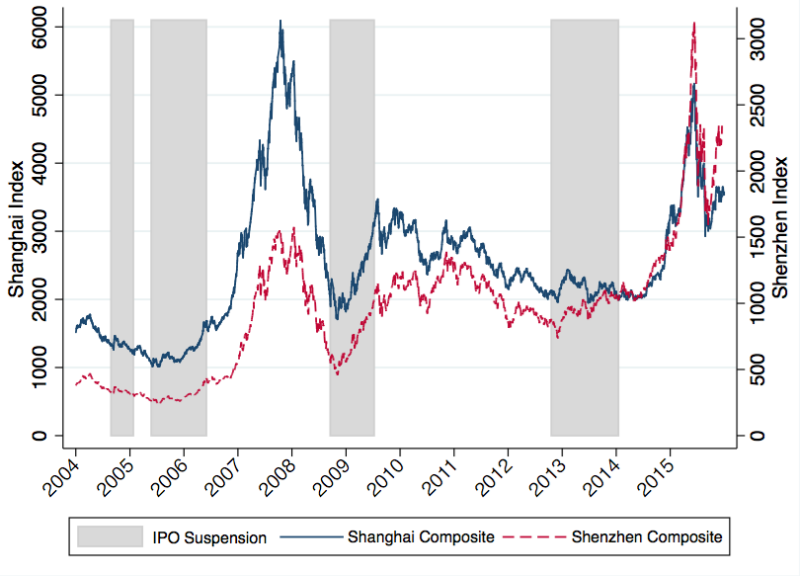


Figure 4: IPO listing dates and delay from approval to listing (listed-before sample)



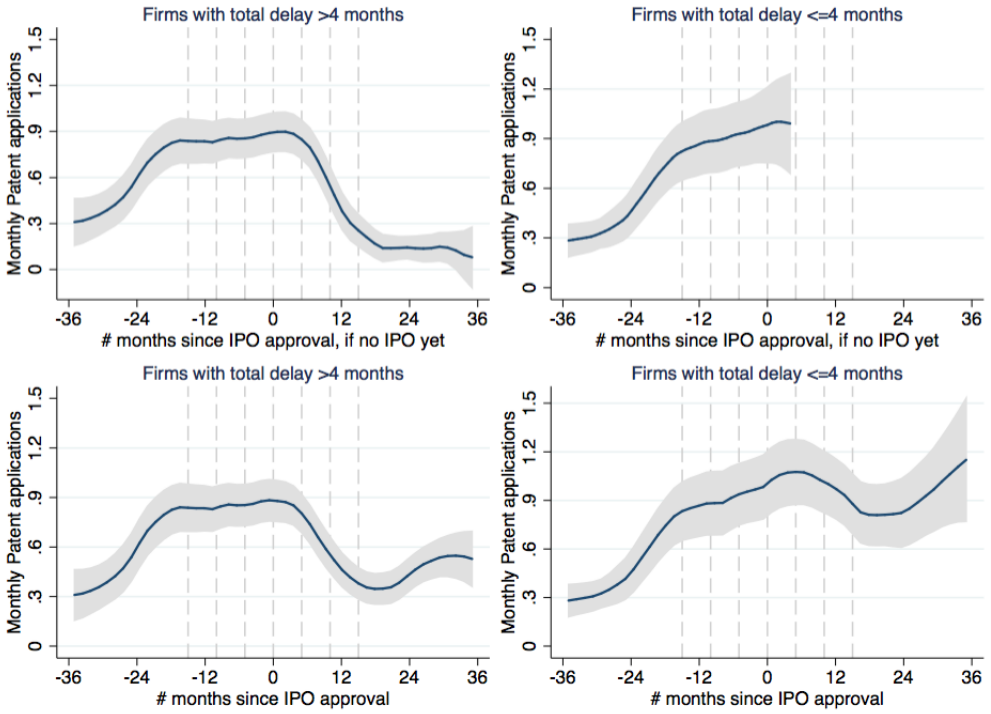
Note: Each point in the above figures is a unique IPO on the Shanghai or Shenzhen exchange. The sample is restricted to firms that were approved to IPO in the twelve months after the end of an IPO suspension. Periods in which the government suspended IPO activity shaded.

Figure 5: Shanghai and Shenzhen Composite Indices (Daily 2004-2015)



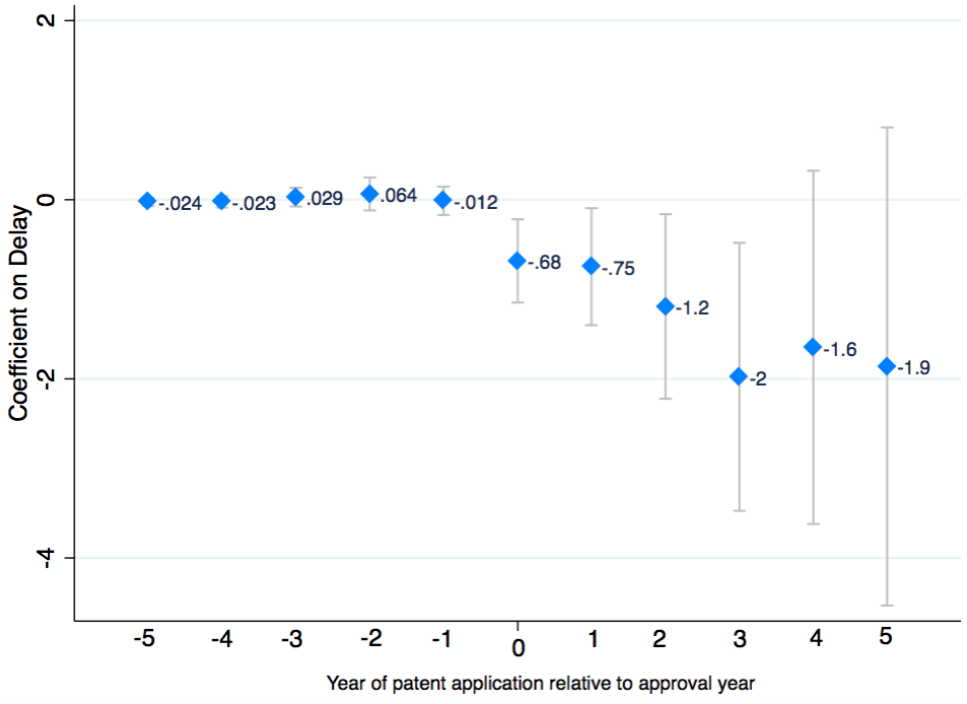
Note: This figure shows the daily Shanghai and Shenzhen composite indices daily close (SHCOMP:IND and SZCOMP:IND in Bloomberg, respectively).

Figure 6: Average monthly invention patent applications around IPO approval



Note: This figure shows invention patent applications by the month around the committee approval date, using the approved-before sample. We sort firm-months around the month that a firm was approved to IPO. In the top graphs, firms drop out of the sample as they list, and all firms are included at month zero and before. In the bottom graphs, all firms have delay of more than 4 months, but in any given month since IPO approval after the 4th month, some will have listed and some not. We use a local polynomial with Epanechnikov kernel using Stata's optimal bandwidth; 95% confidence intervals shown.

Figure 7: Long term effect of delay on invention patent applications (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 Equation 1.

Appendix A to Listing Delays and Innovation: Evidence from Chinese IPOs

(for Online Publication)

Table A.1: IPO Suspensions

Suspension start - end	Rationale	Details
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.

Note: Sourced from 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 monthly patent applications after IPO approval and before IPO

Dependent variable:	Chinese invention patent applications		Citations to granted Chinese invention patents	Granted global (non-Chinese) utility patents
	IV (OLS)			
	(1)	(2)	(3)	(4)
Delay thus far (months)	-.13**	-.11***	-.052**	-.022
	(.065)	(.03)	(.024)	(.026)
Controls†	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y
Listing quarter f.e.	Y	N	Y	N
Listing year f.e.	N	Y	N	Y
N	3555	3555	3555	3555
R^2	.086	.051	.21	.41
First stage F-test$^{\pm}$		11,000		

Note: This table contains regression estimates of the effect of months so far of delay on monthly patents after IPO approval, but before IPO. We use negative binomial variants of Equation 2 (except for the IV, where it does not converge). The sample limited to firms approved in the 12 months prior to an IPO suspension. †Controls 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). $^{\pm}$F-statistic for the excluded instrument (delay) being significantly different from zero. Errors clustered by firm. *** indicates p-value<.01.

Table A.3: Effect of IPO and delay on monthly patent citations after IPO approval, comparing listed and unlisted firms (Bernstein comparison)

Sample: Firm-months in the 36 months after IPO approval		
Dependent variable: Citations to granted Chinese invention patents		
	(1)	(2)
Public (=1 if month is in or after IPO month)	-.69***	-1.7***
	(.16)	(.25)
Delay so far (months) (=total delay once Public=1)		-.13***
		(.018)
Controls†	Y	Y
Industry f.e.	Y	Y
Quarter of approval f.e.	Y	Y
N	14586	14586
R^2	.042	.047

Note: This table shows the effect of being public and delay so far on patent quality using monthly patent data and a negative binomial model †Controls are total investment that year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). The R^2 is pseudo. Errors clustered by firm. *** indicates p-value<.01.

Table A.4: Effect of suspension-induced IPO delay on non-PPE investment

Dependent variable:	Non-PPE investment in year after IPO approval		Non-PPE investment in year after IPO	
Sample	Listed after	Approved before	Listed after	Approved before
	(1)	(2)	(3)	(4)
Delay (months)	.00037	-.0018	.0021	.00058
	(.0068)	(.0063)	(.0018)	(.0028)
Controls[†]	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y
N	328	197	408	282
R^2	.51	.4	.4	.076

Note: This table shows the effect of delay on non-PPE investment (financial and acquisitions), using variants of Equation 1, within the sample of firms listed in the 365 days after the end of an IPO suspension. The 75th percentile of delay is 12.8 months. [†]Controls are PPE investment in the year prior, pre-listing year successful invention patent applications, age, market cap, IPO proceeds , and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). Errors clustered by industry-quarter. [††]Standard deviation of first 100 days' returns after IPO. [±]The F-statistic for the excluded instrument (delay) being significantly different from zero. Errors clustered by industry-quarter. *** indicates p-value$<$.01.

Table A.5: Effect of suspension-induced IPO delay on governance measures

Dependent variable:	Discretionary accruals in year after IPO		# independent board members in year after IPO	
	(1)	(2)	(3)	(4)
Delay (months)	.00038		.0016	
	(.00071)		(.002)	
Delay >75 pctile		.015		.041
		(.018)		(.038)
2 dependent variable lags	Y	Y	N	N
Controls	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y
N	399	399	521	521
R^2 / Pseudo-R^2	.2	.2	.013	.013

Note: This table shows the effect of IPO delay on governance measures, using variants of Equation 1, within the sample of firms listed in the 365 days after the end of an IPO suspension. Model is OLS for accruals and negative binomial for board. The 75th percentile of delay is 12.8 months. Discretionary accruals calculated using a matched Jones model with intercept; results similar with alternative measures, including non-matched and without intercept. The 75th percentile of delay is 12.8 months. Controls 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). Errors clustered by industry-quarter. *** indicates p-value<.01.

Table A.6: Effect of delay on patents by VC-backing and SOE status

Dependent variable:	Chinese invention patent applications in:				Granted Chinese invention patents		Citations to granted Chinese invention patents	
	Yr after IPO		2nd year after IPO					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Delay (months)· VC/PE	-.017		-.0086		-.039		.0096	
	(.023)		(.028)		(.027)		(.025)	
Delay (months)·SOE		-.072**		-.058***		-.053		-.056**
		(.029)		(.021)		(.043)		(.025)
Delay (months)	-.12***	-.1***	-.085***	-.065***	-.089***	-.096***	-.1*	-.087*
	(.033)	(.03)	(.025)	(.024)	(.034)	(.033)	(.052)	(.048)
VC/PE	.53**	.36*	.23	.16	.66**	.33	.14	.22
	(.24)	(.21)	(.24)	(.23)	(.28)	(.27)	(.28)	(.22)
SOE	.19	.83**	-.16	.28	.27	.57	.21	.7*
	(.27)	(.36)	(.19)	(.26)	(.34)	(.41)	(.26)	(.38)
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	407	407	407	407	407	407	407	407
R^2	.048	.051	.072	.074	.086	.085	.051	.052

Note: This table shows the effect of IPO delay on patenting by venture capital/private equity (VC/PE) and state-owned (SOE) status, within the sample of firms approved in the 12 months before IPO suspension. Negative binomial variants of Equation 1 are used except in column 2. The 75th percentile of delay is 12.8 months. †Controls are total investment that year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). $^{\pm}$The F-statistic for the excluded instrument (delay) being significantly different from zero. ** We instrument for delay with the approval date. The exponential conditional mean model with endogenous variables, implemented in Stata with ivpoisson; while there is no direct weak instrument test, we use the F-statistic from the first stage since the reduced form for the endogenous explanatory variable is linear. The R^2 is pseudo except for column 3. Errors clustered by industry-quarter. *** indicates p-value$<$.01.

Table A.7: Effect of suspension-induced IPO delay on personnel using continuous delay

Dependent variable (in year after IPO):	# technical executives who		# HR executives who		# finance executives who	
	Join	Depart	Join	Depart	Join	Depart
	(1)	(2)	(3)	(4)	(5)	(6)
Delay (months)	-.013*	.0016	-.0098***	.0036*	-.0039	.0013
	(.007)	(.0011)	(.0037)	(.0019)	(.0027)	(.00096)
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	352	352	352	352	352	352
R^2	.13	.034	.25	.096	.14	.031

Note: This table shows the effect of continuous delay on departures and entry of executives by occupational area, using variants of Equation 1, within the sample of firms listed in the 365 days after the end of an IPO suspension. The 75th percentile of delay is 12.8 months. Controls 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). *** indicates p-value$<$.01.

Appendix B to Listing Delays and Innovation: Evidence from Chinese IPOs
(for Online Publication)

Market Uncertainty Test: Effect on Contemporaneous VC

Our model predicts that if the suspensions generated uncertainty in the market about the future of IPOs in China, they would have depressed contemporaneous VC investment. VC returns depend on IPOs for liquidity events. During a suspension, investors who believed China's IPO market could be jeopardized in the medium term, perhaps through a change in IPO regulations or stringent future restrictions on the number of IPOs, might be expected to reduce investment activity. Anecdotal evidence suggests this occurred. 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 term hiatuses, we would not expect an effect. This is because VC investments are typically illiquid and held for three to ten years.

B.1 Empirical Approach

We are interested in the effect of an IPO suspension on VC investment. This exercise relates to Gompers, Kovner, Lerner & Scharfstein (2008), who document that VCs react rationally to public market signals about fundamentals. In Equation 3 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 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.

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

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. The suspensions themselves were not exogenous to Chinese economic conditions. For example, it may be that during IPO suspensions it is more difficult for private equity investors to fundraise from limited partners. While we control for the market index and show similar results for elite U.S. VCs who likely do not face such fundraising cycles, we cannot rule out this channel.

B.2 Results

We find a correlation between the suspension periods and depressed VC investment in China. Figure 12 (13) shows later stage VC in in mainland Chinese (rest-of-world) portfolio companies. Online Appendix Figures B1-A4 show weekly frequencies and investment in real 2010 RMB. The negative correlation between suspension periods and VC investment in China is obvious, especially for the 2012-14 suspension.

Table B1 confirms this visual evidence in regression estimates, using versions of Equa-

tion 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 B1 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. We find similar results for both early and late stage investment using real 2010 RMB, and using monthly rather than weekly data.

We turn to investment by the location of the VC firm in Table B2. 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. In Online Appendix Table B2 panel 2, the dependent variable is the number of VC deals in Chinese companies by elite U.S. VCs active in China. As the PCRI data do 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 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 less robust than the results in Table 10.

We conduct several robustness tests in Table B3. First, a placebo test 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 a strong reduction in overall and later stage VC investment, of about 26 deals relative to a mean of 152. We confirm that the result is specific to VC in Table B4, where we show no effect of the suspensions on monthly aggregate bank lending.

In sum, this analysis suggests that the suspensions created uncertainty about the overall regulatory environment and the future of IPOs in China, and had a chilling effect on VC investment.

Table B.1: IPO Suspensions and 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.

Table B.2: 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 B.3: Robustness Tests of Effect of IPO Suspensions on Contemporaneous VC Investment, Newey-West Standard Errors

	Placebo test		Alternative data source: Monthly number of VC deals in China*			
Dependent variable:	VC investment rest of world‡		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.

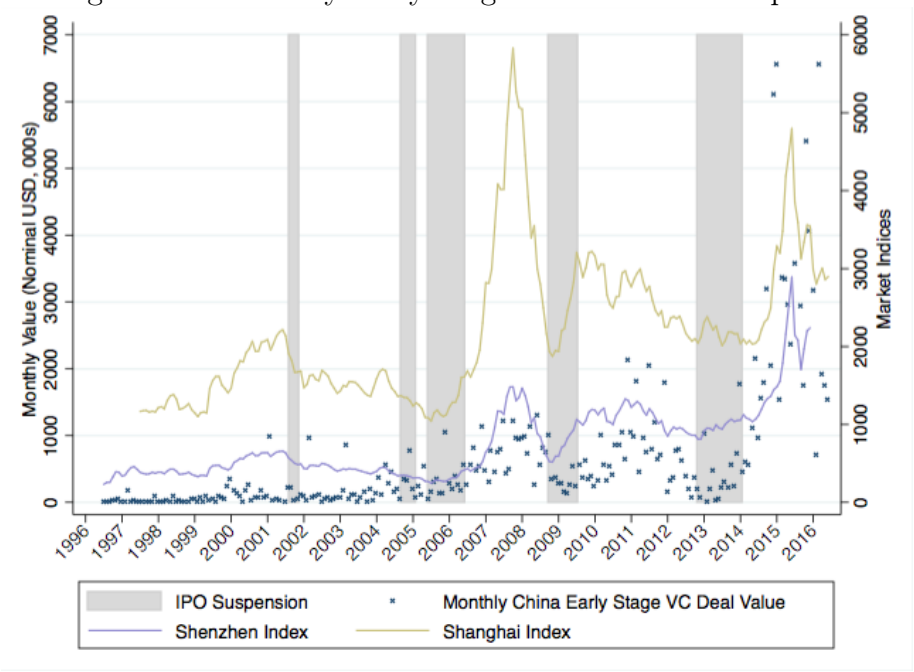
Table B.4: Effect of IPO Suspensions on Contemporaneous Monthly Aggregate Bank Lending to Non-Financial Firms, Newey-West Standard Errors

Dependent variable: Monthly aggregate bank lending to non-financial firms in China*

	(1)	(2)
IPO suspension in effect	1358.68	1234.41
	(825.68)	(822.80)
Shenzhen index†	2.166***	
	(.602)	
Shanghai index†	-1.216***	
	(.265)	
China index††		-0.544.
N	108	108
R^2	.16	.07

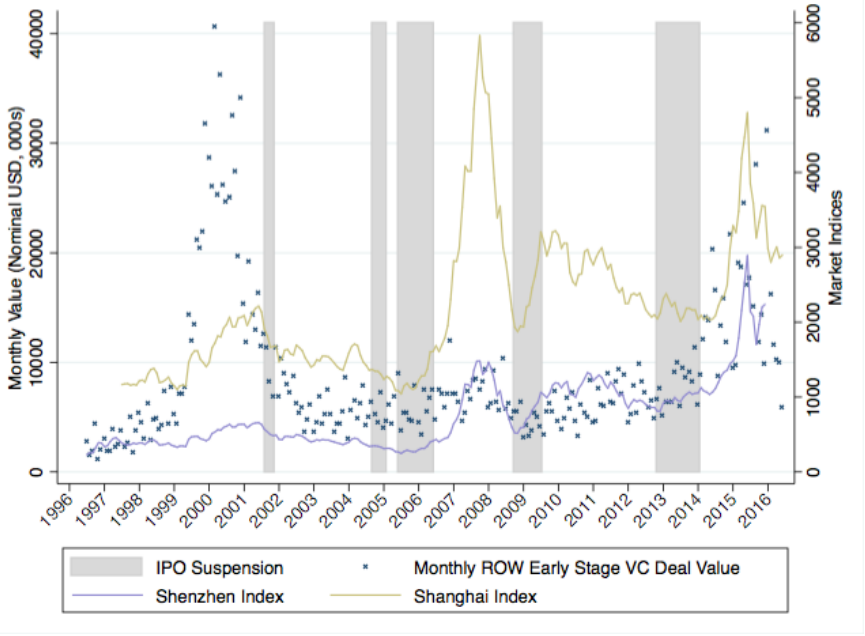
Note: This table contains OLS regression estimates of the relationship between bank lending and whether the government has suspended IPOs. Data is monthly. We use variants of: $VC_m = \alpha + \beta_1 (1 \mid IPO\ Suspension_m) + X_m + \varepsilon_m$. *Data from WIND; this variable is the value in nominal USD †Monthly average of daily closing price for the Shenzhen/Shanghai composite index. ††Monthly overall China market index, based on Shanghai and Shenzhen indices. 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 B.1: Monthly Early Stage VC to China Companies



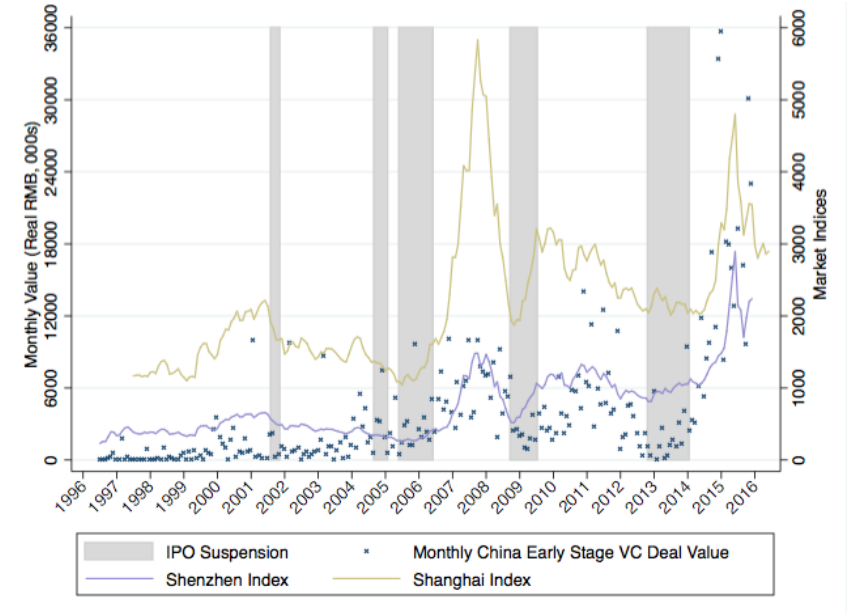
Note: Each point is the monthly value of VC investments in mainland China-based portfolio companies in nominal USD. Only seed and early stage VC investment included.

Figure B.2: Monthly Early Stage VC to Non-China (Rest of World) Companies



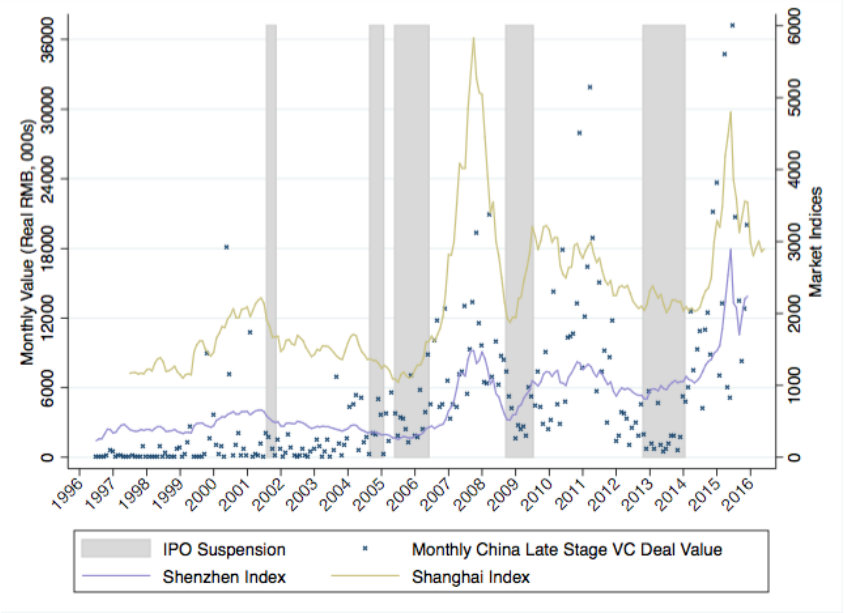
Note: Each point is the monthly value of VC investments in non-China-based portfolio companies in nominal USD. Only seed and early stage VC investment included.

Figure B.3: 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 B.4: 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.