Impact of Liquidity Shocks on Stock Prices: Evidence from Chinese IPOs[☆]

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Abstract

Using a set of plausibly exogenous shocks to the funds that Chinese investors have available to purchase shares of stocks and other financial assets, we examine the impact of the shocks to investors' available funds on the levels of asset prices and market liquidity. We find statistically and economically significant declines in the stock market indexes on the dates investors' subscription funds are frozen, and significant increases on the dates the funds are unfrozen. Furthermore, we estimate the elasticity of stock market capitalization with respect to the shocks to available funds. Finally, we examine the impacts of the shocks to available funds on measures of trading liquidity and find only very limited impacts.

JEL Classification: G13, G14, G23

Keywords: Liquidity shocks, funding liquidity, market liquidity, Chinese stock market, initial public offering

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1. Introduction

How do shocks to investors' available funds impact the levels of asset prices and market liquidity? We answer this question using a set of plausibly exogenous shocks to the funds that Chinese investors have available to purchase shares of stocks and other financial assets. The liquidity shocks are created by institutional features of the Chinese IPO process, in which an investor who requests an allocation of IPO shares must have cash in his or her brokerage account greater than or equal to the value of the requested shares. When an investor requests an allocation cash in an amount equal to the value of the IPO shares requested is "frozen" and may not be used to purchase other securities for several days, until the investor learns whether he has received a share allocation. If he or she does not receive an allocation, or if the allocation he or she receives is less than the requested number of shares, the unused funds are "unfrozen" and available to be used to buy other securities. The shocks to available funds created by this process can be very large, as the total requests for shares are typically several hundred or more times the number of IPO shares offered for sale. We find statistically and economically significant declines in the stock market indexes on the dates the funds are frozen, and statistically and economically significant increases on the dates the funds are unfrozen. These price movements allow us to estimate the elasticity of stock market capitalization with respect to the shocks to available funds. We also examine the impacts of the shocks to available funds on measures of trading liquidity and find only very limited impacts.

These results are related to, but distinct from, the developing literature on the impact of funding liquidity on asset prices. This literature focuses on the impact on asset prices of funding liquidity constraints faced by dealers, market makers, and other financial institutions that rely on borrowed funds and play central roles in the financial markets of many countries. Theoretical research explores the importance of the funding liquidity of financial intermediaries and its impact on asset prices and trading liquidity (for example, Grombs and Vayanos (2002), Brunnermeier and Pedersen (2009), Garleanu and Pedersen (2011), He and Krishnamurthy (2013), Brunnermeier and Sannikov (2014)), while empirical research explores the impacts of inventories, monetary conditions, funding constraints, and shocks to capital (for example, Coughenour and Saad (2004), Comerton-Forde et al. (2010), Jensen and Moorman (2010),

Hameed, Kang, and Viswanathan (2010), Siriwardene (2018)). Our results are distinct from this literature because the liquidity shocks we study are primarily shocks to the available funds of retail investors rather than shocks to the capital and funding liquidity of levered financial intermediaries. Specifically, the majority of the demand for Chinese IPO shares is from retail investors, and at least some of the non-retail demand is from mutual funds and other unlevered investors. Thus, we present a novel set of results about the impact of shocks to available funds of a broad set of investors that complements the existing literature that mostly focuses on levered financial intermediaries. The paper that is closest to ours is Kahraman and Tookes (2017) who find that changes in margin requirements that in turn alter investors' ability to purchase shares impact measures of trading liquidity, but present no evidence on the level of market prices. In contrast, we find that the liquidity shocks in the Chinese stock market impact the levels of the stock market indexes but do not impact measures of trading liquidity.

Our results are also relevant to assessing the likely impact of some governmental interventions intended to impact stock market prices. As discussed by Brunnermeier, Sockin, and Xiong (2018) and Song and Xiong (2018), the Chinese government regularly intervenes in the stock market, using stamp taxes on stock trading, controls on IPO issuances, and restrictions on margin trading and other forms of leverage. Changes to margin requirements and other restrictions on leverage impact investors' ability to purchase shares, similar to the way the freezing and unfreezing of funds around Chinese IPOs changes investors' ability to purchase shares, and our estimates of the elasticity of stock prices with respect to investors' available funds are relevant to assessing the likely impact of such changes in margin requirements and other restrictions on leverage. Governments of countries other than China have also carried out large-scale asset purchases and so-called quantitative easing during the financial crisis and subsequent recession (Krishnamurthy and Vissing-Jorgensen (2011), Bridges and Thomas (2012), Christensen and Rudebusch (2012), Joyce, Miles, Scot and Vayanos (2012)), and often intervene in the financial markets in other ways. While our data and results are from the Chinese market, estimates from that market provide a starting point for thinking about how interventions in non-Chinese stock markets that impact investors' ability to purchase shares might impact prices and trading liquidity in those other markets.

The liquidity shocks we exploit are created by the interaction of regulatory restrictions on the price-earnings ratios at which IPO shares may be offered and the feature of IPO process in which funds are frozen when investors submit orders for IPO shares and then unfrozen when investors are told that the orders are unfilled. Many papers have documented the severe underpricing of Chinese IPOs (for example, Mok and Hui (1998), Su and Fleisher (1999), Su (2004), Chan et al. (2004), Wang (2005), Kimbro (2005) and Li (2006)). We confirm this in our data, where we find that the average first-day return from 1990 to 2018 is 139.8%. This severe underpricing appears to be caused by regulatory restrictions on the pricing of Chinese IPOs. From 1996 to the end of 1998, China's IPO pricing mainly adopted the price-earnings ratio method, which was determined according to the earnings per share of the issuing enterprises and a price-earnings ratio, that is, "IPO price = profit per share after tax × price-earnings ratio." To be specific, the CSRC did not approve IPOs with a P/E ratio of greater than a certain threshold, which changed from time to time.[1] This P/E ratio threshold was almost always binding, and typically severely binding, and caused the underpricing of Chinese IPOs to be much greater than the underpricing observed in other markets. For example, it is not surprising that a company which makes an initial public offering at a P/E ratio of 13 would realize a large first-day return during a period when the average Chinese stocks traded at a P/E ratio of 39.

The constraint on the P/E ratio and the resulting large first-day returns made it highly likely that any Chinese investor who obtained an allocation of IPO shares would experience a positive first-day return. From 1996 to the end of 2015 almost 95% out of the 2,358 IPOs in our sample experienced positive first-day returns, making investments in IPOs highly desirable. Starting from 1999, online bidding for IPO shares was dominated by retail investors who are very enthusiastic about IPOs. Offer prices were pushed to high levels, but with the limited P/E ratio, market prices would be pushed to even higher levels. This in turn results in higher enthusiasm about IPO new shares subscriptions. From 1996 to 2018 the average ratio of the number of shares requested to the number of shares offered by the issuing company was 931.66.

[1] According to Ritter (2011), the threshold of price-earnings (P/E) ratio has been changing from 1996 to present. From 1996 to 1999, the offer price was not permitted to result in a P/E ratio of greater than 15. From July 2002 to the end of 2004, the P/E ratio is meant to be no higher than 20. Starting from 2005, the P/E cap regulation was dropped, but fact, the CSRC did not approve IPOs with a P/E ratio of greater than 23.

The average median ratio was 800.22, and even the minimum ratio for the 2751 IPOs for which we can compute the ratio was 107.86.

This extremely high demand for IPO shares interacted with the freezing and unfreezing of investors' funds during the IPO sale process to create the exogenous liquidity shocks we exploit. Specifically, during most of the period since 1996 investors who wished to subscribe for IPO shares were required to have in their brokerage accounts available funds at least equal to the value (offering price × shares requested) of the IPO shares they requested. When they subscribed, funds equal to the value of the shares they requested were frozen and unavailable for other purposes. If he or she does not receive an allocation, or if the allocation he or she receives is less than the requested number of shares, the unused funds are released or "unfrozen" and available to be used to buy other securities several days after the subscription date. In this process, the investor's wealth does not change—it is simply that he or she is temporarily unable to use some of it to buy shares. Thus, this process creates shocks to investors' available funds that are not contaminated by simultaneous changes in wealth.

However, the liquidity shocks vary according to the change in IPO subscription policy in China, which provides us a very nice natural experiment to show the impact of change in policy of subscriptions on financial market. From 1996 to 1999, the subscription funds were frozen at day T and were unfrozen at T + 4. From the event analysis, we find the returns on day T+4 is strongly positive significant with a t-statistics of 2.77 during this period. From 2000 to 2006, SEC required that the subscription funds were frozen at day T and were unfrozen at T+3. Interesting, we indeed observe a significant positive returns of 0.19% with a *t*-statistics of 2.61 on T+3 instead of T+4.

We begin our investigation of the liquidity shocks by first carrying out event studies using the dates when funds are frozen and unfrozen. We find that the aggregate Chinese stock return, computed as the capitalization-weighted average of the returns on the Shanghai and Shenzhen indexes, is –11 basis points on the frozen date and 23 basis points on the unfrozen date. Thus, IPOs of individual stocks have detectable impacts on the aggregate stock market.

We then estimate regression models using data from windows around the unfrozen dates to estimate the relation between the magnitude of the liquidity shock and the aggregate stock

market return, where the magnitude of the liquidity shocks is measured as the ratio of the funds that are frozen and then unfrozen to aggregate stock market capitalization on the date before the IPO subscription date. The regressions show a significant positive relation between the magnitude of the frozen/unfrozen funds and the market return on the unfrozen date. A one standard deviation (0.02) increase in unfrozen subscription funds is associated with a 1.93 standard deviation (1.81) increase in the aggregate market index return. [2]

We also investigate whether the liquidity shocks result in changes in trading liquidity, our second step of analysis involve an event study testing the market liquidity during IPO frozen and unfrozen days and a panel regression examining the relationship between unfrozen subscription funds and market liquidity measures (Amihud illiquidity measure and effective bid-ask spreads). We find that Amihud illiquidity measure at t+3 is significantly higher than the average of that among t , t + 1 and t + 2 for the period of 2006 to 2016. However, we find limited significance for the effective bid-ask spread measure.

Finally, we explore whether the impacts on market returns differ in the cross-section of stocks. Specifically, we partition the universe of Chinese stocks into five groups based on market capitalization, compute the value-weighted returns of the stocks in each size group, and for each group carrying out event studies based on the frozen and unfrozen dates. We find significant increases in the unfrozen date returns for all five market capitalization groups. The magnitude is larger for small as compared to large capitalization stocks, consistent with the prices of small stocks being more sensitive to liquidity shocks. On the other hand, on the frozen date we find a significant market return only for large capitalization stocks. This is consistent with the hypothesis that investors tend to sell liquid large capitalization stocks when they need to raise cash to subscribe for IPOs.

Our paper provides some of the first evidence linking shocks to available funds to market prices by estimating the elasticity of market prices with respect to the subscription capital. One feature of our shocks that is that they are temporary—it is known that the frozen funds will be unfrozen three or four days, depending on the time period, after the subscription date. Our

[2] A one-standard-deviation (0.02) increase in unfrozen subscription funds is associated with 1.93% (0.02*1.744/1.81=0.0193) standard deviation (1.81) increase in the aggregate market index return.

empirical evidence also provides a lower bound on the impact of permanent shocks given that our liquidity shocks are very short-term but the impact of the shock is large. Although our results do not apply to the leveraged financial intermediaries that have been the focus of the theoretical literature on the relation between funding liquidity and market liquidity (Gromb and Vayanos (2002), Brunnermeier and Pedersen (2009), He and Krishnamurthy (2013), Brunnermeier and Sannikov (2014)), our finding that the shocks to available funds impact stock prices and some measures of stock market liquidity is consistent with that literature. They are also consistent with the empirical literature examining the relationship between funding liquidity constraints and market liquidity (Coughenour and Saad (2004), Comerton-Forde et al. (2010), Jensen and Moorman (2010), Hameed, Kang, and Viswanathan (2010)).

We are aware of three empirical papers that share the same flavor as our paper in that they also exploit plausibly exogenous shocks to market participants' funding constraints and/or financial capacity and use those shocks to examine whether the changes in funding constraints or financial capacity cause changes in market prices or trading liquidity. Wang, Wu, Yan and Zhong (2017) find that the shock to the funding requirements of CDS dealers due to the required upfront payments stemming from the CDS Big Bang causes increases in CDS bid-ask spreads. Siriwardane (2018) studies how the CDS spread of a firm respond when the CDS dealers who make markets in CDS on the firm suffer losses on CDS based on other firms due to the defaults of those firms. He finds that the firm's CDS spread is significantly positively correlated with the CDS dealers' capital losses. While the CDS market is an important market, it is a specialized one dominated by a limited number of dealer firms and it is not clear that the findings in these papers will generalize to other markets.

Kahraman and Tookes (2017) take advantage of unique features of the margin trading system in India to identify a causal relationship between traders' ability to borrow and a stock's market liquidity. This paper is the closest to ours, as it also studies the impact of changes in investors' ability to buy shares of stock that that are not associated with wealth changes. However, their shocks only apply to a limited number of traded stocks. They find that changes in investors' ability to borrow impacts measures of market (trading) liquidity. In contrast to us, they do not present any evidence of impacts on the levels of stock prices.

Our paper is also related to several strands of the literature studying the impact government interventions in financial markets. One older strand of literature shows that monetary policy can have important impacts on financial markets through large-scale asset purchases (Wallace (1981), Carpenter and Demiralp (2006), Schreft and Smith (1998)). Another more recent strand examines the impact of unconventional monetary policy such as quantitative easing during the financial crisis and subsequent recession (Krishnamurthy and Vissing-Jorgensen (2011), Bridges and Thomas (2012), Christensen and Rudebusch (2012), Joyce, Miles, Scot and Vayanos (2012)). Or estimates of the effect of shocks to investors' available funds is relevant to assessing the likely impact of interventions such as changes in margin requirements or other restrictions on leverage that impact the investors' ability to purchase stocks.

The next section of the paper describes the institutional setting, including the Chinese IPO market, the IPO pricing policy, and the subscription mechanism that involves freezing and unfreezing funds. Section 3 describes the data we use. Section 4 presents the results about the impact of liquidity shocks on aggregate stock market capitalization, while Section 5 presents the results about the impact on market trading liquidity. Section 6 briefly concludes.

2. Institutional Background

2.1 Chinese IPO market

The Chinese stock market has developed rapidly since the Shanghai and Shenzhen stock exchanges were established in 1990. Given the rapid growth of the Chinese economy and development of the financial sector, the markets have witnessed a large number of IPOs. From 1990 through the end of 2018, there were a total of 3,244 IPOs on the Shanghai and Shenzhen stock exchanges, or an average of about 112 per year. For instance, 2017 alone witnessed 436 IPOs. Due to the decrease in the number of listing approvals, both the number of listings and the total amount of funds raised decreased in 2018, when the Shanghai Stock Exchange and Shenzhen Stock Exchange recorded a total of 88 new listings. The total amount of funds raised also dropped to 93.4 billion yuan in the first half of 2018 from 125.4 billion yuan during the same period in 2017. Though the total amount of funds raised decreased, the average transaction size increased from 510 million yuan to 1.46 billion yuan, nearly tripling.

Many aspects of Chinese IPOs have been thoroughly studied, and it is well known that the average underpricing (as measured by the first-day returns) of Chinese IPOs has been severe (Mok and Hui (1998), Su and Fleisher (1999), Su (2004), Chan et al. (2004), Wang (2005), Kimbro (2005) and Li (2006)). The average first day returns of Chinese IPOs are much larger than is typical of other markets, for example the U.S.[3]

During the eight years from 1990 to the end of 1998, China's IPO pricing mainly adopted the price-earnings ratio method, which was determined according to the earnings per share of the issuing enterprises and a relatively fixed price-earnings ratio, that is, "IPO price = profit per share after tax × price-earnings ratio." As described in Ritter (2011), the China Securities Regulatory Commission (CSRC) determined the maximum offer price based on a fixed price-earnings ratio between 13 and 15. After November 2001, the pricing method of new shares returned to a fixed price mechanism with substantial restrictions on the P/E ratio. To be specific, from July 2002 to the end of 2004, the CSRC returned to a controlled P/E system with offer prices capped at a P/E of around 20. On December 7, 2004, the CSRC issued a "Notice on Several Issues Concerning the Trial Inquiry System for Initial Public Offering" and the supporting document "Memorandum of Standards for Examination of Stock Issuance No. 18 - Regulatory Requirements on the Conditions and Behavior of Inquiry Objects for Initial Public Offering" formally introducing a new stock inquiry system to be used to help determine IPO offering prices. The core of the inquiry system is to stipulate that the issuer and its sponsor shall determine the issue price by means of accumulative bidding inquiry from institutional investors. But in practice, the CSRC did not approve IPOs with a P/E ratio greater than 23. These constraints on offering prices are an important institutional feature that causes of Chinese IPOs to be so severely underpriced. It is not surprising that a company which goes IPO at a P/E ratio of 13 would see huge first-day returns during periods when the average Chinese stock traded at a P/E ratio of 39.

Figure 1 confirms that the IPO underpricing exists in our sample by showing the number of Chinese A-share IPOs (left scale) and equal-weighted average first-day returns (right scale)

[3]The literature documenting underpricing of U.S. IPOs includes McDonald and Fisher (1972), Logue (1973), Ibbotson and Jaffe (1975), Reilly (1977), Miller and Reilly (1987), Smith (1986), and Ritter (1984)).

during each calendar quarter from 1990 to 2018. As we can see from the graph, Chinese stock market experienced extreme underpricing early in its history during 1990-1993, when the average first-day return in China exceeded 1400%. The underpricing becomes lower after 1996 but it is still much higher than that in the U.S. market.

2.2 IPO pricing policy

Starting from 1996, "Internet Pricing" was adopted to issue IPO new shares. This means that the lead underwriter uses the trading system of the stock exchange, with the lead underwriter as the sole "seller" of IPO shares, and investors purchase shares within a specified time online. From 2006-2016, the IPO system in China is a hybrid auction in that it combines a price-setting offline tranche (an auction conducted in the offline stage where only institutional investors are allowed to participate) with an online tranche with only retail investors to place orders without specifying a price. During this period, online bidding for IPO shares was dominated by retail investors who were very enthusiastic about IPOs. Offer prices were pushed to high levels, typically the maximum level permitted by the CSRC. But because the offering price was constrained by the P/E ratio, the high demand for IPO shares made secondary market prices much higher and resulted in very high first day returns. This in turn may have helped create even greater enthusiasm about subsequent IPOs.

Figure 2 shows the subscription for Chinese IPOs, computed as the number of shares requested by investors divided by the number of shares offered by the issuing company. Table 1 presents information about the subscription ratios of offline (institutional) and online (retail) investors in tabular form. The ratio of oversubscription is very high in China especially in recent years.

2.3 Freezing and unfreezing policy

As an initial matter, we note that before 1996 the regulation of IPO subscriptions was very preliminary, and we are uncertain about the policies that were in effect. In addition, the key data that we need for our analysis are often missing from the databases maintained by Chinese financial data vendors. Thus, our analysis will exploit the IPO policies starting from 1996 and use data starting from 1996.

An important aspect of the IPO sale process is that during most of the period since 1996 the IPO subscription process involved the freezing and unfreezing of funds, creating large shocks to investors' available funds. The process was not constant over time. Examining the policies that prevailed at various times, we can separate sample period into four periods.

From 1996 to 1999, the subscription process included the following features. On the day of purchase (date *T*), investors submit orders to purchase IPO shares and the stock exchange acknowledges receipt of the orders. On *T* + 1, The China Securities Depository and Clearing Corporation (CSDC) freezes the subscription funds equal to the value (offering price ×quantity) of the IPO shares requested.[4] So on day *T*, investors must either already have in their brokerage accounts cash at least equal to the subscription funds, or else sell stocks in order to raise cash so that they can bid for the IPO shares. Thus, we predict a negative market wide return on date T as investors either sell shares to raise case or fail to buy shares to preserve cash. Foreshadowing the results, we indeed observe a market-wide negative return on day *T*.

On the third day after the subscription date (*T* + 3), the lead underwriter is responsible for organizing the lottery and announcing the winning bids. On *T* + 4, the funds of the non-winning investors who are unable to purchase IPO shares are unfrozen. (The funds of the winning investors are used to pay for the IPO shares.) Thus, we predict a negative market wide return on date *T* + 4 as investors are able to buy stock using the cash that was unfrozen. Further foreshadowing the results, the average return on day *T* + 4 when the funds are unfrozen is positive and significantly different from zero. Throughout this process, there is no change in the wealth of an investor who subscribes for IPO shares. The frozen funds remain the property of the investor, and will either be made available to him on date *T* + 4 or used to pay for IPO shares the investor seeks to acquire.

From 2000 to 2006, the subscription policy was mixed in that the online pricing issuance was combined with the allocation to secondary market investors (market value allotment). Starting from 2000, some of the IPOs still follow the subscription policy in 1996 and 1999.

[4] If the subscription funds cannot be recorded in time due to the bank settlement system, it shall provide the remittance voucher through the electronic interbank system of the People's Bank of China on *T* + 1 and ensure that the subscription funds are recorded in the account on the morning of *T* + 2.

Gradually, the old subscription policy was abandoned and all IPOs follow the market value allotment without freezing the subscription funds.

From 2006-2016, the IPO system is a hybrid auction in that it combines a price-setting offline tranche (an auction conducted in the offline stage where only institutional investors are allowed to participate) with an online tranche with only retail investors to place orders without specifying a price.

The subscription policy from 2006 to 2016 was very similar to that from 1996 to 2000 expect that the unfrozen date was changed from $T + 4$ to $T + 3$. The specific process is as the following: on $T + 1$, investors submit subscription orders. On that date, investors pay the full subscription funds according to the subscription quantity and the issuance price stipulated in the issuer's issuance announcement within the specified time. In order to do this, investors have to have the full amount of subscription funds available on date *T*. Due to this process, prior to the IPO investors either sell stocks in order to raise cash or avoid buying stock to preserve cash so that they can bid for the IPO shares. As a result, we predict a negative return on day T during this period. On $T + 1$, the issuer and its lead underwriter, together with China Securities Depository and Clearing Corporation (CSDC) and accounting firms with qualifications for securities and futures related businesses, will check the availability of subscription funds and the accounting firms will issue a capital verification report. On the $T + 2$ day, China Securities Depository and Clearing Corporation (CSDC) sent the winning rate to brokerage firms participating in the purchase after the closing of the day. On the third trading day after the subscription date ($T + 3$), China Securities Depository and Clearing Corporation (CSDC) unfreezes the funds for new share subscription and deducts the new share subscription funds from the funds settlement account of participants. As a result, we predict a positive return on day $T + 3$.

From 2016 to the present, the subscription process is changed so that there is no freezing and unfreezing of funds. Both online (retail) and offline (institutional) investors who meet the purchase conditions do not need to pay in advance, and pay the purchase amount according to the actual allocated amount after they have obtained the allotment. This indicates that investors do not have to subscription funds before the shares are allocated. As a result we do not expect to

see any positive returns resulting from shocks to available funds on and shortly after the IPO subscription date T.[5]

3. Data Description

We begin with a sample of all IPOs offered on the Shanghai and Shenzhen stock exchanges from 1990 to 2018, covering the entire history of the Chinese stock market. The main data source for this study mainly comes from two major sources: China Stock Market and Accounting Research (CSMAR), which is available from Wharton Research Data Services (WRDS), and the Wind Financial Database (WIND), another leading integrated service provider of financial data, information, and software. As mentioned above, our main analyses do not use data from before 1996 because we are uncertain about the details of the IPO subscription process and some of the key data we require are frequently missing from the databases.

From CSMAR, we retrieve all available information about IPO share issuance related to share subscription. For each IPO stock, the information include the number of shares issued online and offline, the number of online and offline subscribers, online lottery rate, online and offline oversubscription rate, number of market value placement shares, market value subscribers, number of shares allocated to strategic investors, lockup periods for institutional investors including mutual funds, insurance companies and other strategic investors.

From WIND, we retrieve the same set of information about IPO share issuance including IPO first-day performance, IPO issuance process, IPO pricing information, roadshow process and share subscription. The set of variables related to IPO subscription include the number of shares issued online and offline, the number of online and offline subscribers, online lottery rate, online and offline oversubscription rate, online and offline frozen and unfrozen capital, pre-determined P/E ratio and number of shares allocated to strategic investors, lockup periods for institutional investors. We crosscheck the two databases to ensure the accuracy of all information.

[5] On $T + 1$, the lead underwriter uploads the preliminary placement results. On date $T + 2$, the lead underwriter announces the preliminary placement results, according to which investors will pay the IPO subscription funds by 16: 00 on the same day. In un-tabulated results we find a negative return on date $T + 1$ on which date investors might need to sell some of their stocks in order to prepare for the subscriptions funds on date $T + 2$.

The sentiment measure we use in the paper is the sentiment index from CSMAR which is constructed based on the principle component analysis in Baker and Wurgler (2006). The composite index of sentiment is based on the common variation in six underlying proxies for sentiment: the closed-end fund discount, Shanghai and Shenzhen stock exchange share turnover, the number and average first-day returns on IPOs, the number of new accounts opened for both Shanghai and Shenzhen stock exchange, the consumer confidence index. The sentiment proxies are measured annually from 2003 to 2018.

The high frequency trading data we use to calculate effective bid-ask spread (liquidity measure) is from RESSET, which is another famous data vendor that provides China financial market trading data established by Tsinghua University. This database provides high-frequency trading information for stocks, indexes, bonds, funds, warrants, buybacks, etc, including trading time, transaction price, trading volume, five best quoted bid prices and sizes, five best quoted ask prices and size, relative spread, relative effective spread, and market depth. We calculate daily effective spread for each stock in both Shanghai and Shenzhen stock exchange using the high frequency trading data. Following the literature (for example, Bessembinder (2003)), effective spreads are computed as

$$Effective\ Spread = 100 \times \frac{2 \times |Trade\ Price - 0.5 \times (Bid + Ask)|}{0.5 * (Bid + Ask)}.$$

4. Empirical Methodology

The main analyses include event studies and regressions using data from windows around the IPO issuances.

4.1 Main Variables and summary statistics

In this section, we describe the main variables used in our empirical analysis. We use two variables to proxy for the exogenous liquidity shocks. The first variable is a dummy variable equal to 1 if the unfrozen date of the subscription funds of each IPO, and 0 otherwise. Another main variable is the amount of subscription funds that are unfrozen for each IPO on date t, scaled by the total amount of market capitalization on *t* - 1 for the Shanghai and Shenzhen stock exchanges. The variable we use to proxy for market return is the value-weighted average market return of SSE composite index and SZSE composite index. The two liquidity variables in the

paper are daily average percent effective spreads (*Espread*) and Amihud illiquidity measure. Effective spreads are defined as

$$Effective\ Spread = 100 \times \frac{2\times|Trade\ Price - 0.5\times(Bid+Ask)|}{0.5*(Bid+Ask)},$$

which captures the difference between the transaction price and a proxy for the fair value for the average trade. Effective spread (*Espread*) is a better measure for actual transaction costs because it takes into account the fact that many trades execute inside the quoted spread $\frac{Ask-Bid}{0.5*(Ask+Bid)}$ or outside of the spread. The variable *Amihud illiquidity measure* is constructed according to the Amihud (2002), which is calculated as the daily ratio of absolute stock return to its dollar volume averaged over some period. Amihud illiquidity ratio, *ILLIQ*, is one of the most widely used in the industry and is used by regulators to estimate liquidity trends.

Table 1 presents summary statistics of IPO related information. *IPO_size_mean* is the equal-weighted average of the ratio (IPO market value/total market capitalization of Shanghai and Shenzhen stock exchange) for each IPO in each calendar year. *IPO_size_sum* is calculated as the total value of IPOs divided by the total market capitalization in each year. *Online_portion_Mean* is the equal-weighted average of the ratio (number of shares distributed for online subscription/total number of shares issued). *offline_portion_Mean* is the equal-weighted average of the ratio (number of shares distributed for offline subscription/total number of shares issued). *Online_oversub_Mean* is the equal-weighted average of the ratio (number of shares subscribed online/number of shares distributed for online subscription). *Online_oversub_Median* is the median of the ratio (number of shares subscribed online/number of shares distributed for online subscription). *offline_oversub_Mean* is the equal-weighted average of the ratio (number of shares subscribed offline/number of shares distributed for offline subscription). *offline_oversub_Median* is the median of the ratio (number of shares subscribed offline/number of shares distributed for offline subscription). *Frozen_percent_mean* is the equal-weighted average of the ratio (the total amount of RMB value of capital frozen at day t/total market capitalization at day $t-1$) in each year. *Frozen_percent_median* is the median of the ratio (the total amount of RMB value of capital frozen at day t/total market capitalization at day t-1) in each year. *Frozen_percent_online_mean* is the equal-weighted average of the ratio (the

total amount of RMB value of capital frozen online at day t/total market capitalization at day t-1) in each year. *Frozen_percent_online_median* is the median of the ratio (the total amount of RMB value of capital frozen online at day t/total market capitalization at day t-1) in each year. *Frozen_percent_offline_mean* is the equal-weighted average of the ratio (the total amount of RMB value of capital frozen offline at day *t* divided by total market capitalization at day *t* - 1) in each year. *Frozen_percent_offline_median* is the median of the ratio (the total amount of RMB value of capital frozen offline at day t/total market capitalization at day *t* - 1) in each year.

As we can see from table 1, the online and offline subscription rate of IPO new shares across years is consistently high with the maximum value of 4167.86 and 15048.56, respectively. When we look at the amount of frozen capital scaled by total market capitalization, the maximum is 23.38%. As we further divided the frozen capital into online and offline subscription, most of the over-subscription is due to the online subscription by retail investors.

4.2 Impact of liquidity shocks on market prices

In this section, we conduct analysis to test the impact of exogenous liquidity shocks on market prices. We mainly adopt two sets of empirical tests: event study analysis to study the market reaction on the liquidity shocks and panel regression analysis to quantify the elasticity of the stock market prices on the liquidity shocks.

In the event study analysis, we start with a baseline test based on both the frozen date and unfrozen date. In this baseline event study test, we aggregate IPOs of periods from 1996 to 2000 and from 2006 to 2016 in which regulations from CSRC have clear rules on the frozen and unfrozen date of the subscription funds. Table 2 presents the main results of the baseline event study analysis. *Ret_market* is the value-weighted average market return of SSE composite index and SZSE composite index at the frozen date. *Ret_market_lag1* and *ret_market_lag2* are the lagged 1 and 2 days' aggregate market returns before the frozen date while *ret_market_next1* and *ret_market_next2* are the forward 1 and 2 days' aggregate market returns after the frozen date at event day t. *Ret_unfrozen* is the value-weighted average market return of SSE composite index and SZSE composite index at the unfrozen date for each IPO. *Ret_unfrozen_lag1* and *ret_unfrozen_lag2* are the lagged 1 and 2 days' aggregate market returns before the unfrozen

date while *ret_unfrozen_next1* and *ret_unfrozen_next2* are forward 1 and 2 days' aggregate market returns after the unfrozen date at event day t.

As we can see from table 2, *ret_market* is significantly negative on the frozen date t with the average return of -0.11%, indicating that investors need to raise capital for the IPO new share subscription by selling existing stocks in their accounts. Meanwhile, *ret_unfrozen* is significantly positive on the unfrozen date t+n (n can be 3 or 4 days after t depending on periods) with the average return of 0.23% and t-statistics of 3.71. This shows that when the large amounts of subscription funds were unfrozen, the stock market indeed reacts positively to the shocks.

We further divide the Chinese IPO history into 4 periods. Period 1 is from 1996 to 2000 in which investors are required to deposit the subscription funds at day t and the subscription funds would be unfrozen at day $t + 4$. Period 2 is from 2000 to 2006 where CSRC adopted a mixed strategy for the subscription funds. Period 3 is from 2006 to 2016 in which investors are required to deposit the subscription funds at day t and the subscription funds would be unfrozen at day $t + 3$. Period 4 is from 2016 afterwards in which investors do not need to deposit the subscription funds in advance but only need to do it after they win the lottery draw. Our main analysis would focus on period 1 and 3 in which regulations from CSRC have clear rules on the frozen and unfrozen date of the subscription funds. *Ret_market* is the value-weighted average market return of SSE composite index and SZSE composite index at the frozen date. *Ret_market_lag1* to *ret_market_lag10* are the lagged 1 to 10 days' aggregate market returns before the frozen date while *ret_market_next1* to *ret_market_next10* are the forward 1 to 10 days' aggregate market returns after the frozen date.

Table 3 presents the results of the event analysis based on the frozen date in different periods. In period 1 from 1996 to 2000, the subscription policy is that investors deposit their subscription funds on date t and the subscription funds that lose the lottery will be unfrozen at date t+4. As show in table 3, we observe a significant positive market return of 0.33% with a t-statistics of 2.77 on day t+4. In period 1 from 2006 to 2016, the subscription policy is that investors deposit their subscription funds on date t and the subscription funds that lose the lottery will be unfrozen at date t+3. As show in table 3, we observe a significant positive market return of 0.19% with a t-statistics of 2.61 on day t+3. We find the change of significance in market

return is impressive because only t+4 and t+3 obtain positive and significant market returns. This indicates two important issues: first of all, the unfrozen subscription funds indeed have significant impacts on the whole market index returns. Secondly, it is indeed the change of regulations on the unfrozen date that makes the difference. Furthermore, we observe insignificant negative market return on date t when the subscription funds are frozen, which is reasonable because investors may start to sell their existing stocks a few days before the frozen date in order to prepare for the subscription capital.

We further conduct the event study analysis on the cross-sectional stocks. We divide the whole sample of stocks into 5 size groups. Group 1 is the small cap stocks and group 5 is the large cap stocks. We would like to see if the stock market reaction would be different for 5 size groups. Table 5 shows the cross-sectional evidences of the event analysis based on frozen and unfrozen date. *ret_market_mean* is the equal-weighted average of daily stocks returns for each size groups. *Ret_market_lag1_mean* and *ret_market_lag2_mean* are the lagged 1 and 2 days' equal-weighted average of daily stocks returns for each size groups before the frozen date. *Ret_unfrozen_lag1_mean* and *ret_unfrozen_lag2_mean* are lagged 1 and 2 days' equal-weighted average of daily stocks returns for each size groups before the unfrozen date. Panel A presents the results based on frozen date, as we look at *ret_market_mean,* we can see a significant negative return with a t-statistics of -1.68 only for large cap stocks. Panel B presents the results based on unfrozen date. As we look at *ret_unfrozen_mean,* we can see significant positive returns for all size groups. The results indicate that investors may be more likely to sell large cap stocks when they are preparing for the subscription funds.

In the next step, we try to use panel regression analysis to quantify the magnitude of the impacts of the liquidity shocks on the market prices. Our sample periods include IPOs of periods from 1996 to 2000 and from 2006 to 2016 in which regulations from CSRC have clear rules on the frozen and unfrozen date of the subscription funds. Our panel is constructed in the following methodology: for each day, we aggregate all IPOs on that day. The aggregated IPO-day is the cross-section variation and each IPO cross-section has 41 days including the unfroze date, 20 days before the unfrozen date and 20 days after the unfrozen date. Specifically, we estimate the following panel regression models:

$$Market\ returns_t = a_0 + b_1 \times D\_unfrozen_{i,t} + c_2 \times X_t + +\varepsilon_t$$

$$Market\ returns_t = a_0 + b_1 \times Unfrozen\_percent_{i,t} + c_2 \times X_t + +\varepsilon_t$$

Where $Market\ returns_t$ is the value-weighted average market returns of SSE composite index and SZSE composite index at the frozen date at day t. $D\_frozen_{i,t}$ is a dummy variable equal to one if date *t* is a unfrozen date for IPO *i*, and zero otherwise. $Unfrozen\_percent_{i,t}$ is the total amount of IPO unfrozen funds at day t scaled by the total market capitalization on day t-1, 0 otherwise for the rest of the 40 days. The vector $X_{j,t}$ stacks a list of region-level control variables including *ret_market_lag1, ret_market_lag2, abs_ret_market_lag1, abs_ret_market_lag2* and *sentiment index. ret_market_lag1* is the lagged 1 day aggregate stock market returns before the unfrozen date. *ret_market_lag2* is the lagged 2 day aggregate stock market returns before the unfrozen date. *abs_ret_market*_lag1 is the absolute value *ret_market_lag1. abs_ret_market_lag2* is the absolute value of *ret_market_lag2* . *sentiment index* is the CICSI sentiment index based on Chinese market from CSMAR and is constructed based on Baker and Wurger (2006) sentiment index matrix.

Table 4 shows the main empirical results of the panel regression. Remember that $D\_frozen_{i,t}$ is a dummy variable equal to 1 if day t is a unfrozen date for IPO I, 0 otherwise. We can see that the market return is positively correlated with the unfrozen dummy with a t-statistics of 3.29. . $Unfrozen\_percent_{i,t}$ is the total amount of IPO unfrozen funds at day t scaled by the total market capitalization on day t-1, 0 otherwise for the rest of the 40 days. We tabulate the magnitude of the impact of the liquidity shocks on the market returns: one-standard deviation (0.02) increase in $Unfrozen\_percent_{i,t}$ is associated with a 1.93% standard deviation (1.81) increase in stock market returns. The results are robust when we control for the lagged 1 or 2 days' market index returns, absolute value of the lagged 1 or 2 days' market index returns and sentiment index.

5. Impact of liquidity shocks on market trading liquidity

In this section, we try to explore the impact of liquidity shocks on market liquidity. We mainly adopt two market liquidity measures: Amihud illiquidity ratio and the effective spreads. Amihud

illiquidity ratio, which is calculated as the daily ratio of absolute stock return to its dollar volume averaged over some period and is one of the most widely used in the industry and is used by regulators to estimate liquidity trends. Effective spreads are defined as $100 * \frac{|Transactionprice - 0.5*(Bid+Ask)|*2}{0.5*(Bid+Ask)}$, which captures the difference between the transaction price and the fundamental value for the average trade. Effective spread (*Espread*) is a better measure for actual transaction costs because it takes into account the fact that many trades execute inside the quoted spread $\frac{Ask-Bid}{0.5*(Ask+Bid)}$ or outside of the spread.

Table 6 presents the results of the funding liquidity shocks on market liquidity based on the Amihud illiquidity ratio. The analysis is conducted in period 1 and 3. Period 1 is from 1996 to 2000 in which investors are required to deposit the subscription funds at day t and the subscription funds would be unfrozen at day t+4. Period 3 is from 2006 to 2016 in which investors are required to deposit the subscription funds at day t and the subscription funds would be unfrozen at day t+3. Panel A shows the equal-weighted average of Amihud Illiquidity measure and panel B shows the value-weighted average of Amihud Illiquidity measure. *Amihud_illiquidity_Mean* is the equal-weighted average of Amihud Illiquidity ratio on frozen day t. *d_amihud_ilq_mean_3* is the difference between *Amihud_illiquidity_mean_next3* and the average of *Amihud_illiquidity_Mean, Amihud_illiquidity_mean_next1* and *Amihud_illiquidity_mean_next2*. *d_amihud_ilq_mean_4* is the difference between *Amihud_illiquidity_mean_next4* and the average of *Amihud_illiquidity_Mean, Amihud_illiquidity_mean_next1*, *Amihud_illiquidity_mean_next2* and *Amihud_illiquidity_mean_next3*. Amihud_illiquidity_mean_next1-10 is the forward 1-10 values of the Amihud Illiquidity ratio before frozen date.

As we can see from table 6 panel A, which shows the results of the equal-weighted Amihud illiquidity ratio. For period 3 from 2006 to 2016, there is a significant market liquidity increase on date *t* + 3 compared with that of the average market liquidity of date t, t+1 and t+2.

Table 7 presents the results of the impact of funding liquidity shocks on market liquidity based on the effective spread measure. The sample period is 2006 to 2016 because the intra-day high frequency trading data we obtain from RESSET is only available starting from 2000.

Eff_spread_mean is the equal-weighted average effective spreads for all stocks at frozen date t. *d_eff_spread_mean_3* is the difference between *eff_spread_mean_next3* and the average of *eff_spread_mean, eff_spread_mean_next1* and *eff_spread_mean_next2.*

As we can see from table 7, For period 3 from 2006 to 2016, we do not see significant results of market liquidity on date $t + 3$ compared with that of the average market liquidity of dates t, $t + 1$ and $t + 2$.

6. Conclusion

In this paper, we use a large set of plausibly exogenous liquidity shocks to the Chinese stock market to study the impacts of funding liquidity shocks on market prices. The liquidity shocks are created by institutional features of the Chinese IPO process, in which an investor who requests an allocation of IPO shares must have cash in his or her brokerage account greater than or equal to the value of the requested shares. The liquidity shocks vary according to the change in IPO subscription policy in China, which provides us a very nice natural experiment to show the impact of change in policy of subscriptions on financial market.

Taking advantage of the event study analysis, we find statistically and economically significant declines in the stock market indexes on the dates the funds are frozen, and statistically and economically significant increases on the dates the funds are unfrozen. We take further steps to estimate the elasticity of stock market capitalization with respect to the shocks to available funds. Finally, we examine the impacts of the shocks to available funds on measures of trading liquidity and find only very limited impacts.

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Table 1. Summary Statistics

This table presents descriptive statistics of the data from 1996 to 2018 used in this paper and reports numbers of observations, means, and median values of the main variables, including related information of the IPOs and regression variables. N denotes the number of IPOs in each calendar year. *IPO_size_mean* is the equal-weighted average of the ratio (IPO market value/total market capitalization of Shanghai and Shenzhen stock exchange) for each IPO in each calendar year. *IPO_size_sum* is calculated as the total value of IPOs divided by the total market capitalization in each year. *Online_portion_Mean* is the equal-weighted average of the ratio (number of shares distributed for online subscription/total number of shares issued). *offline_portion_Mean* is the equal-weighted average of the ratio (number of shares distributed for offline subscription/total number of shares issued). *Online_oversub_Mean* is the equal-weighted average of the ratio (number of shares subscribed online/number of shares distributed for online subscription). *Online_oversub_Median* is the median of the ratio (number of shares subscribed online/number of shares distributed for online subscription). *offline_oversub_Mean* is the equal-weighted average of the ratio (number of shares subscribed offline/number of shares distributed for offline subscription). *offline_oversub_Median* is the median of the ratio (number of shares subscribed offline/number of shares distributed for offline subscription). *Frozen_percent_mean* is the equal-weighted average of the ratio (the total amount of RMB value of capital frozen at day t/total market capitalization at day t-1) in each year. *Frozen_percent_median* is the median of the ratio (the total amount of RMB value of capital frozen at day t/total market capitalization at day t-1) in each year. *Frozen_percent_online_mean* is the equal-weighted average of the ratio (the total amount of RMB value of capital frozen online at day t/total market capitalization at day t-1) in each year. *Frozen_percent_online_median* is the median of the ratio (the total amount of RMB value of capital frozen online at day t/total market capitalization at day t-1) in each year. *Frozen_percent_offline_mean* is the equal-weighted average of the ratio (the total amount of RMB value of capital frozen offline at day t/total market capitalization at day t-1) in each year. *Frozen_percent_offline_median* is the median of the ratio (the total amount of RMB value of capital frozen offline at day t/total market capitalization at day t-1) in each year.

Year	N	Ipo _size _mean	Ipo _size _sum	Online _portion _Mean	Offline _portion _Mean	Online _oversub _Mean	Online _oversub _Median	Offline _oversub _Mean	Offline _oversub _Median	Frozen _percent _Mean	Frozen _percent _Median	Frozen_percent _online_Mean	Frozen_percent _online_Median	Frozen_percent _offline_Mean	Frozen_percent _offline_Median
1996	157	0.00172	0.2698	0.8595	0	143.0262	114.7861	0	0	0.0343	0.0357	0.0343	0.0357	0	0
1997	176	0.00136	0.2385	0.9184	0	126.3246	96.3256	0	0	0.0799	0.0710	0.0799	0.0710	0	0
1998	97	0.00081	0.0789	0.8992	0	294.4617	287.0826	0	0	0.1577	0.1552	0.1577	0.1552	0	0
1999	86	0.00098	0.0846	0.9031	0.0051	253.6676	236.3058	0	0	0.0696	0.0322	0.0696	0.0322	0	0
2000	55/135	0.00078	0.1052	0.7256	0.0352	407.7249	357.3394	0	0	0.1118	0.0991	0.1118	0.0991	0	0
2001	18/67	0.00057	0.0383	0.9016	0.0153	639.1608	431.0082	0	0	0.1287	0.1392	0.1287	0.1392	0	0
2002	15/66	0.00059	0.0388	1	0	710.7379	550.7221	0	0	0.2338	0.2284	0.2338	0.2284	0	0
2003	0/65	0.00063	0.0407	0	0	0	0	0	0	0	0	0	0	0	0
2004	0/97	0.00029	0.0280	0	0	0	0	0	0	0	0	0	0	0	0
2005	0/14	0.00035	0.0049	0	0	0	0	0	0	0	0	0	0	0	0
2006	70	0.00273	0.1910	0.7570	0.2018	491.8734	398.8242	90.6888	90.7378	0.1688	0.1487	0.1515	0.1358	0.0173	0.0072
2007	118	0.00172	0.2024	0.7708	0.2069	1080.7360	605.7480	198.7237	193.2741	0.1585	0.1195	0.1378	0.1107	0.0207	0.0045
2008	76	0.00016	0.0121	0.7984	0.2016	1741.0350	1509.7169	244.2833	247.8941	0.1420	0.1204	0.1343	0.1184	0.0077	0.0038
2009	110	0.00040	0.0441	0.7918	0.2082	287.5841	209.6151	145.6054	132.4516	0.0530	0.0453	0.0425	0.0411	0.0105	0.0051
2010	344	0.00010	0.0337	0.7916	0.2046	162.4469	154.4842	62.5083	57.2810	0.0275	0.0269	0.0244	0.0239	0.0031	0.0024
2011	275	0.00005	0.0147	0.7972	0.2028	115.9883	96.4317	16.3221	12.7501	0.0078	0.0065	0.0074	0.0061	0.0004	0.0002
2012	149	0.00004	0.0063	0.7299	0.2659	107.8858	84.6647	23.2147	9.1667	0.0036	0.0030	0.0033	0.0028	0.0003	0.0001
2014	124	0.00003	0.0035	0.7795	0.2165	141.3336	141.4258	384.7563	286.2336	0.0086	0.0062	0.0064	0.0049	0.0022	0.0012
2015	220	0.00002	0.0043	0.8908	0.1092	270.1519	236.9944	908.3875	741.8598	0.0185	0.0135	0.0125	0.0097	0.0060	0.0033
2016	248	0.00001	0.0034	0.9217	0.0783	3350.1760	2981.7968	15048.5589	13606.0718	0	0	0	0	0	0
2017	419	0.00001	0.0049	0.9210	0.0790	4167.8551	3761.4249	9334.9103	8196.7213	0	0	0	0	0	0
2018	82	0.00003	0.0022	0.9089	0.0874	2988.4944	2700.0511	6045.8493	5813.9535	0	0	0	0	0	0

Table 2: Baseline Event Analysis

This table presents the results of the event study analysis based on frozen date and unfrozen date. This baseline event analysis includes IPOs of periods from 1996 to 2000 and from 2006 to 2016 in which regulations from CSRC have clear rules on the frozen and unfrozen date of the subscription funds. *Ret_market* is the value-weighted average market return of SSE composite index and SZSE composite index at the frozen date. *Ret_market_lag1* and *ret_market_lag2* are the lagged 1 and 2 days' aggregate stock market returns before the frozen date while *ret_market_next1* and *ret_market_next2* are the forward 1 and 2 days' aggregate market returns after the frozen date. *Ret_unfrozen* is the value-weighted average market return of SSE composite index and SZSE composite index at the unfrozen date for each IPO. *Ret_unfrozen_lag1* and *ret_unfrozen_lag2* are the lagged 1 and 2 days' aggregate market returns before the unfrozen date while *ret_unfrozen_next1* and *ret_unfrozen_next2* are forward 1 and 2 days' aggregate market returns after the unfrozen date. t-statistics are in parentheses. *** denotes significance at the 1% level, ** denotes significance at the 5% level, *denotes significance at the 10% level.

Panel A: Event analysis based on frozen date				
Event date	Mean	t	Probt	N
ret_market_lag2	0.04	0.62	0.54	843
ret_market_lag1	0.02	0.4	0.69	843
ret_market	-0.11*	-1.77	0.08	843
ret_market_next1	-0.05	-0.75	0.45	843
ret_market_next2	-0.01	-0.11	0.92	843
Panel B: Event analysis based on unfrozen date				
Event date	Mean	t	Probt	N
ret_unfrozen_lag2	-0.04	-0.73	0.47	843
ret_unfrozen_lag1	0.02	0.26	0.8	843
ret_unfrozen	0.23***	3.71	<.01	843
ret_unfrozen_next1	0.05	0.76	0.45	843
ret_unfrozen_next2	0.02	0.28	0.78	843

Table 3: Event Analysis in Different Periods

This table presents the results of the event analysis based on the frozen date in different periods. The entire Chinese IPO history was divided into 4 periods with different regulations on the subscription process. Period 1 is from 1996 to 2000 in which investors are required to deposit the subscription funds at day t and the subscription funds would be unfrozen at day t+4. Period 2 is from 2000 to 2006 where CSRC adopted a mixed strategy for the subscription funds. Period 3 is from 2006 to 2016 in which investors are required to deposit the subscription funds at day t and the subscription funds would be unfrozen at day t+3. Period 4 is from 2016 afterwards in which investors do not need to deposit the subscription funds in advance but only need to do it after they win the lottery. Our main analysis would focus on period 1 and 3 in which regulations from CSRC have clear rules on the frozen and unfrozen date of the subscription funds. *Ret_market* is the value-weighted average market return of SSE composite index and SZSE composite index at the frozen date. *Ret_market_lag1* to *ret_market_lag10* are the lagged 1 to 10 days' aggregate stock market returns before the frozen date while *ret_market_next1* to *ret_market_next10* are the forward 1 to 10 days' aggregate market returns after the frozen date. t-statistics are in parentheses. *** denotes significance at the 1% level, ** denotes significance at the 5% level, *denotes significance at the 10% level.

Event date	Period 1: 1996-2000				Period 3: 2006-2016			
	Mean	t	Probt	N	Mean	t	Probt	N
ret_market_lag10	0.03	0.23	0.82	246	-0.03	-0.43	0.67	597
ret_market_lag9	-0.15	-1.15	0.25	246	0.04	0.69	0.49	597
ret_market_lag8	-0.02	-0.11	0.92	246	0.13	1.94	0.05	597
ret_market_lag7	-0.02	-0.15	0.88	246	0.1	1.53	0.13	597
ret_market_lag6	0.01	0.05	0.96	246	0.06	0.9	0.37	597
ret_market_lag5	-0.18	-1.22	0.22	246	-0.01	-0.14	0.89	597
ret_market_lag4	0.05	0.35	0.72	246	-0.01	-0.21	0.83	597
ret_market_lag3	0.25	1.9	0.06	246	-0.09	-1.46	0.15	597
ret_market_lag2	0	-0.01	0.99	246	0.05	0.77	0.44	597
ret_market_lag1	0.04	0.35	0.73	246	0.02	0.24	0.81	597
ret_market	-0.15	-1.19	0.23	246	-0.09	-1.32	0.19	597
ret_market_next1	-0.03	-0.21	0.83	246	-0.05	-0.78	0.43	597
ret_market_next2	-0.02	-0.17	0.87	246	0	-0.01	0.99	597
ret_market_next3	0.06	0.46	0.64	246	**0.19**	**2.61**	**<.01**	**597**
ret_market_next4	**0.33**	**2.77**	**<.01**	**246**	0.07	0.99	0.32	597
ret_market_next5	-0.01	-0.07	0.94	246	0.06	0.84	0.4	597
ret_market_next6	-0.08	-0.65	0.52	246	-0.02	-0.25	0.8	597
ret_market_next7	0.01	0.11	0.91	246	0.07	0.98	0.33	597
ret_market_next8	-0.02	-0.15	0.88	246	0.01	0.09	0.93	597
ret_market_next9	0.14	1.26	0.21	246	-0.02	-0.24	0.81	597
ret_market_next10	-0.07	-0.55	0.58	246	0.02	0.21	0.83	597

Table 4: The Impact of Funding Liquidity Shocks on Market Prices

This table provides empirical evidences on the impact of liquidity shocks on market prices. Our sample periods include IPOs of periods from 1996 to 2000 and from 2006 to 2016 in which regulations from CSRC have clear rules on the frozen and unfrozen date of the subscription funds. Specifically, we estimate the following panel regression models:

$$Market\ returns_t = a_0 + b_1 \times D\_unfrozen_{i,t} + c_2 \times X_t + +\varepsilon_t$$

$$Market\ returns_t = a_0 + b_1 \times Unfrozen\_percent_{i,t} + c_2 \times X_t + +\varepsilon_t$$

Where $Market\ returns_t$ is the value-weighted average market returns of SSE composite index and SZSE composite index at the frozen date at day t. $D\_frozen_{i,t}$ is a dummy variable equal to 1 if day t is a unfrozen date for IPO I, 0 otherwise. $Unfrozen\_percent_{i,t}$ is the total amount of IPO unfrozen funds at day t scaled by the total market capitalization on day t-1, 0 otherwise. The vector $X_{j,t}$ stacks a list of region-level control variables including *ret_market_lag1, ret_market_lag2, abs_ret_market_lag1, abs_ret_market_lag2* and *sentiment index. ret_market_lag1* is the lagged 1 day aggregate market returns before the unfrozen date. *ret_market_lag2* is the lagged 2 days' aggregate market returns after the unfrozen date. *abs_ret_market_*lag1 is the absolute value of *ret_market_lag1. abs_ret_market_lag2* is the absolute value of *ret_market_lag2*. *sentiment index* is the CICSI sentiment index from CSMAR and is constructed based on Baker and Wurger (2006) sentiment index matrix. t-statistics are in parentheses. *** denotes significance at the 1% level, ** denotes significance at the 5% level, *denotes significance at the 10% level.

Variable	(1)	(2)	(3)	(4)	(5)
	Market Returns				
d_unfrozen	0.208***				
	3.29				
unfrozen_percent		1.744***	1.733***	1.656***	1.452***
		3.38	3.36	3.22	2.16
ret_market_lag1			0.008	0.025***	0.037***
			1.53	4.61	5.87
ret_market_lag2			-0.029***	-0.028***	-0.035***
			-5.45	-5.18	-5.6
abs_ret_market_lag1				0.116***	0.118***
				14.86	13.07
abs_ret_market_lag2				-0.050***	-0.011
				-6.38	-1.16
Sentiment index					-0.009***
					-4.84
constant	0.024**	0.026***	0.026***	-0.058***	0.234***
	2.41	2.62	2.69	-3.65	3.19
No. of Observation	34563	34563	34563	34563	25912
R-Sqr	0.0003	0.0003	0.0013	0.0079	0.0098

Table 5: Cross-sectional Evidences

This table presents the cross-sectional evidences of the event analysis based on frozen and unfrozen date. The whole sample of stocks are divided into 5 size groups. Group 1 is the small cap stocks and group 5 is the large cap stocks. *ret_market_mean* is the equal-weighted average of daily stocks returns for each size groups. *Ret_market_lag1_mean* and *ret_market_lag2_mean* are the lagged 1 and 2 days' equal-weighted average of daily stocks returns for each size groups before the frozen date. *Ret_unfrozen_lag1_mean* and *ret_unfrozen_lag2_mean* are the lagged 1 and 2 days' equal-weighted average of daily stocks returns for each size groups before the unfrozen date. t-statistics are in parentheses. *** denotes significance at the 1% level, ** denotes significance at the 5% level, *denotes significance at the 10% level.

Panel A: Cross-sectional evidence based on frozen date

size_group	ret_market_lag2_Mean				ret_market_lag1_Mean				ret_market_Mean				ret_market_next1_Mean				ret_market_next2_Mean			
	Mean	t	Probt	N	Mean	t	Probt	N	Mean	t	Probt	N	Mean	t	Probt	N	Mean	t	Probt	N
1	0.09	1.22	0.22	843	0.06	0.85	0.4	843	-0.02	-0.31	0.76	843	0.06	0.85	0.4	843	0.09	1.22	0.22	843
2	0.06	0.85	0.39	843	0.03	0.4	0.69	843	-0.05	-0.72	0.47	843	0.03	0.4	0.69	843	0.06	0.85	0.39	843
3	0.02	0.24	0.81	843	0	0.02	0.99	843	-0.08	-1.14	0.25	843	0	0.02	0.99	843	0.02	0.24	0.81	843
4	0.01	0.1	0.92	843	-0.01	-0.17	0.86	843	-0.09	-1.21	0.23	843	-0.01	-0.17	0.86	843	0.01	0.1	0.92	843
5	0	0	1	843	-0.04	-0.64	0.52	843	-0.12	-1.68	0.09	843	-0.04	-0.64	0.52	843	0	0	1	843
Diff of 5-1	-0.09	-2.85	<.01	843	-0.1	-3.46	<.01	843	-0.09	-2.98	<.01	843	-0.1	-3.46	<.01	843	-0.09	-2.85	<.01	843

Panel B: Cross-sectional evidence based on unfrozen date

size_group	ret_unfrosen_lag2_Mean				ret_unfrosen_lag1_Mean				ret_unfrosen_Mean				ret_unfrosen_next1_Mean				ret_unfrosen_next2_Mean			
	Mean	t	Probt	N	Mean	t	Probt	N	Mean	t	Probt	N	Mean	t	Probt	N	Mean	t	Probt	N
1	0.06	0.93	0.35	843	0.12	1.74	0.08	843	0.31	4.48	<.01	843	0.15	2.18	0.03	843	0.11	1.69	0.09	843
2	0.05	0.67	0.5	843	0.08	1.1	0.27	843	0.28	4.03	<.01	843	0.12	1.65	0.1	843	0.09	1.34	0.18	843
3	0	0.02	0.99	843	0.04	0.58	0.56	843	0.26	3.64	<.01	843	0.09	1.27	0.21	843	0.08	1.2	0.23	843
4	-0.02	-0.27	0.79	843	0.03	0.47	0.64	843	0.24	3.46	<.01	843	0.09	1.25	0.21	843	0.07	1.08	0.28	843
5	-0.05	-0.72	0.47	843	0.03	0.37	0.71	843	0.25	3.64	<.01	843	0.07	1.11	0.27	843	0.04	0.63	0.53	843
Diff of 5-1	-0.11	-3.75	<.01	843	-0.1	-3.28	<.01	843	-0.07	-2.2	0.03	843	-0.07	-2.48	0.01	843	-0.07	-2.36	0.02	843

Table 6: The Impact of Funding Liquidity Shocks on Market Liquidity (Amihud Illiquidity)

This table presents the results of the impact of funding liquidity shocks on market liquidity. The market liquidity is measured by Amihud Illiquidity measure, which is calculated as the daily ratio of absolute stock return to its dollar volume averaged over some period. Amihud illiquidity ratio, *ILLIQ*, is one of the most widely used in the industry and is used by regulators to estimate liquidity trends. The analysis is conducted in period 1 and 3. Period 1 is from 1996 to 2000 in which investors are required to deposit the subscription funds at day t and the subscription funds would be unfrozen at day t+4. Period 3 is from 2006 to 2016 in which investors are required to deposit the subscription funds at day t and the subscription funds would be unfrozen at day t+3. Panel A shows the equal-weighted average of Amihud Illiquidity measure and panel B shows the value-weighted average of Amihud Illiquidity measure. *Amihud_illiquidity_Mean* is the equal-weighted average of Amihud Illiquidity ratio on frozen day t. *d_amihud_ilq_mean_3* is the difference between *Amihud_illiquidity_mean_next3* and the average of *Amihud_illiquidity_Mean, Amihud_illiquidity_mean_next1* and *Amihud_illiquidity_mean_next2. d_amihud_ilq_mean_4* is the difference between *Amihud_illiquidity_mean_next4* and the average of *Amihud_illiquidity_Mean, Amihud_illiquidity_mean_next1, Amihud_illiquidity_mean_next2* and *Amihud_illiquidity_mean_next3.* Amihud_illiquidity_mean_next1-4 is the forward 1-4 days' Amihud Illiquidity measure after the frozen date.

Panel A: Value-weighted Amihud Illiquidity Measure								
Event Date	Period 1: 1996-2000				Period 3: 2006-2016			
	Mean	t	Probt	N	Mean	t	Probt	N
Amihud_illiquidity_Mean	317.34	3.15	<.01	223	0.4	15	<.01	597
d_amihud_ilq_mean_3	-357.48	-0.95	0.34	223	0.03	1.67	0.09	597
d_amihud_ilq_mean_4	-35.6	-0.15	0.88	223	0.02	0.94	0.35	597
Amihud_illiquidity_mean_next1	916.71	1.98	0.05	223	0.38	22.89	<.01	597
Amihud_illiquidity_mean_next2	387.07	3.51	<.01	223	0.4	15.12	<.01	597
Amihud_illiquidity_mean_next3	897.86	2.44	0.02	223	0.37	22.42	<.01	597
Amihud_illiquidity_mean_next4	665.34	3.53	<.01	223	0.37	20.28	<.01	597
Panel B: Equal-weighted Amihud Illiquidity Measure								
Event Date	Period 1: 1996-2000				Period 3: 2006-2016			
	Mean	t	Probt	N	Mean	t	Probt	N
Amihud_illiquidity_Mean	2924.55	3.51	<.01	223	3.4	12.84	<.01	597
d_amihud_ilq_mean_3	-1924.71	-1.14	0.26	223	0.32	1.68	0.09	597
d_amihud_ilq_mean_4	-1074.58	-0.8	0.43	223	0.26	1.46	0.15	597
Amihud_illiquidity_mean_next1	4238.23	3.79	<.01	223	3.12	17.66	<.01	597
Amihud_illiquidity_mean_next2	4873.36	3.76	<.01	223	3.33	10.62	<.01	597
Amihud_illiquidity_mean_next3	5936.76	3.69	<.01	223	2.97	17.83	<.01	597
Amihud_illiquidity_mean_next4	5567.81	4.28	<.01	223	2.95	17.62	<.01	597

Table 7: The Impact of Funding Liquidity Shocks on Market Liquidity (Effective Spreads)

This table presents the results of the impact of funding liquidity shocks on market liquidity based on the effective spread measure. Effective spreads are defined as $100 * \frac{|Transactionprice - 0.5*(Bid+Ask)|*2}{0.5*(Bid+Ask)}$, which captures the difference between the transaction price and the fundamental value for the average trade. Effective spread (*Espread*) is a better measure for actual transaction costs because it takes into account the fact that many trades execute inside the quoted spread $\frac{Ask-Bid}{0.5*(Ask+Bid)}$ or outside of the spread. The sample period is 2006 to 2016 because the intra-day high frequency trading data we obtain from RESSET is only available starting from 2000. *Eff_spread_mean* is the equal-weighted average effective spreads for all stocks at frozen date t. *d_eff_spread_mean_3* is the difference between *eff_spread_mean_next3* and the average of *eff_spread_mean, eff_spread_mean_next1* and *eff_spread_mean_next2*.

Event Date	Period 3: 2006-2016			
	Mean	t	Probt	N
eff_spread_mean_lag1	0.2366	58.6714	<.0001	594
eff_spread_Mean	0.2428	36.9554	<.0001	594
d_eff_spread_mean_3	**0.0013**	**0.2158**	**0.8292**	**594**
eff_spread_mean_next1	0.2403	59.0052	<.0001	594
eff_spread_mean_next2	0.2475	37.9313	<.0001	594
eff_spread_mean_next3	0.2422	37.8087	<.0001	594
eff_spread_mean_next4	0.2383	57.9	<.0001	594
eff_spread_mean_next5	0.2363	63.6812	<.0001	594

Figure 1
Number of IPOs and average IPO first-day returns. This figure shows the number of Chinese A-share IPOs and equal-weighted average first-day returns for each quarter from 1990 to 2018.

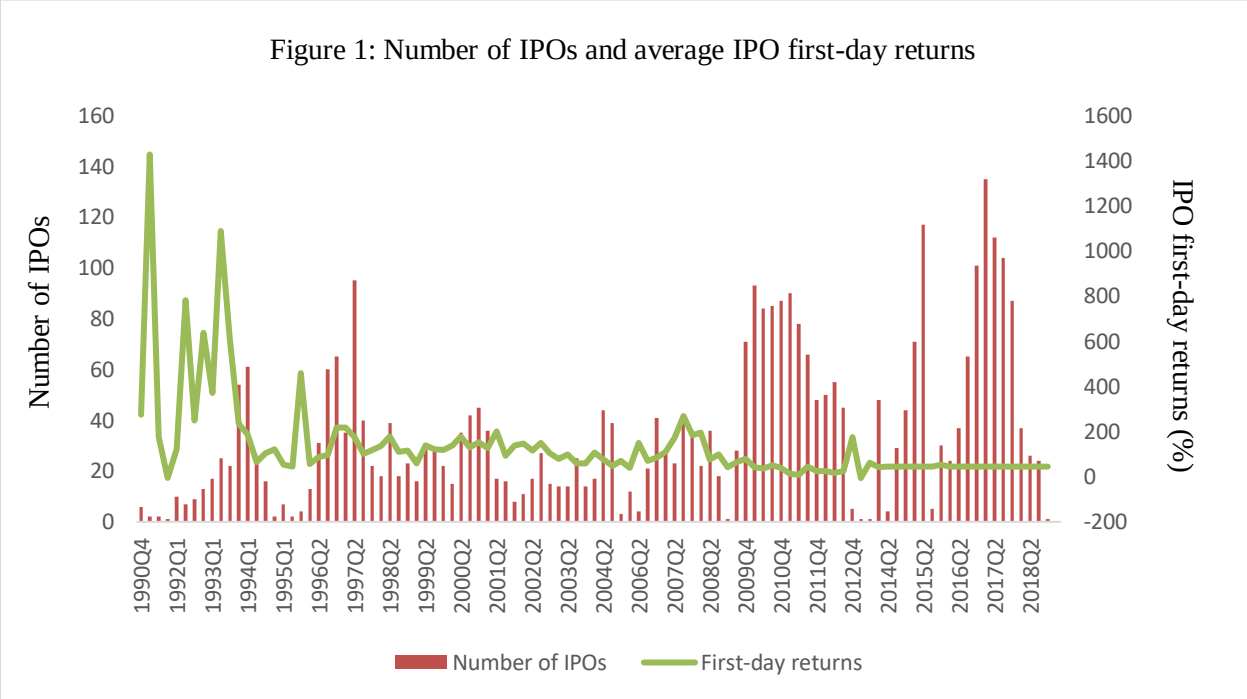


Figure 2
Over-subscription ratio for Chinese A-share IPOs. The ratio of subscription is calculated as the number of shares subscribed by the investors divided by the number of shares offered by the issuing company for all IPOs in each quarter from 1990 to 2018.

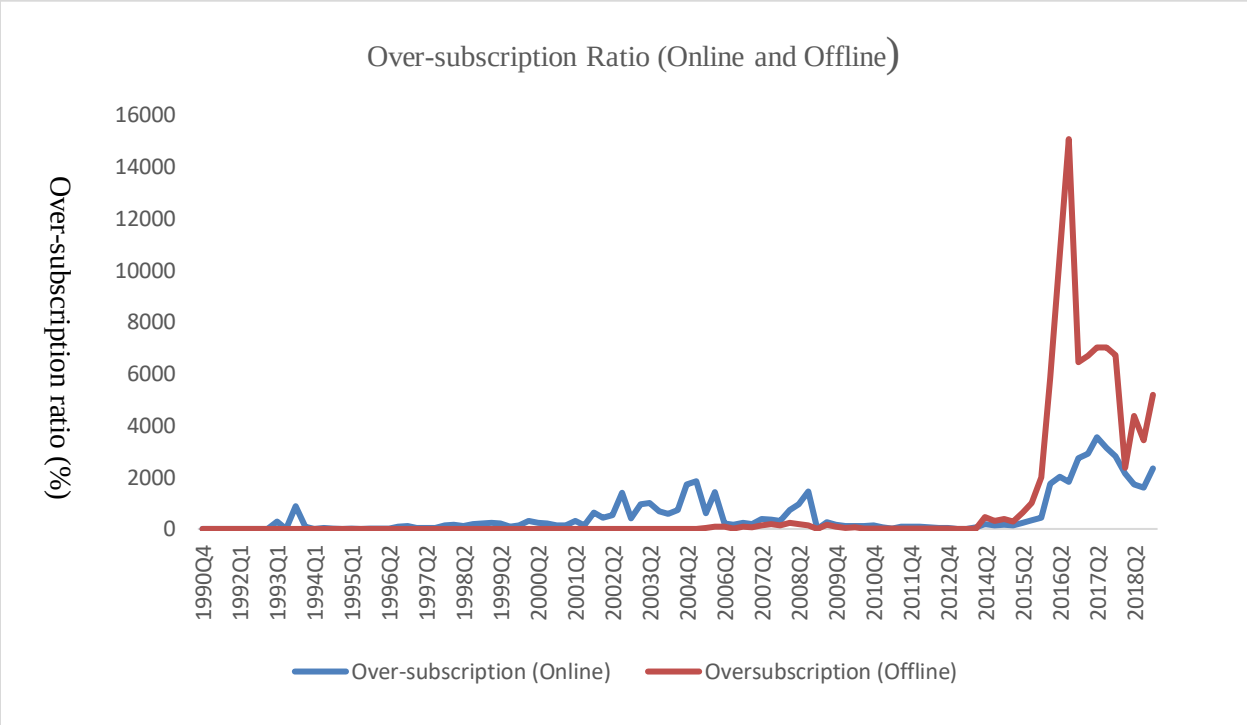
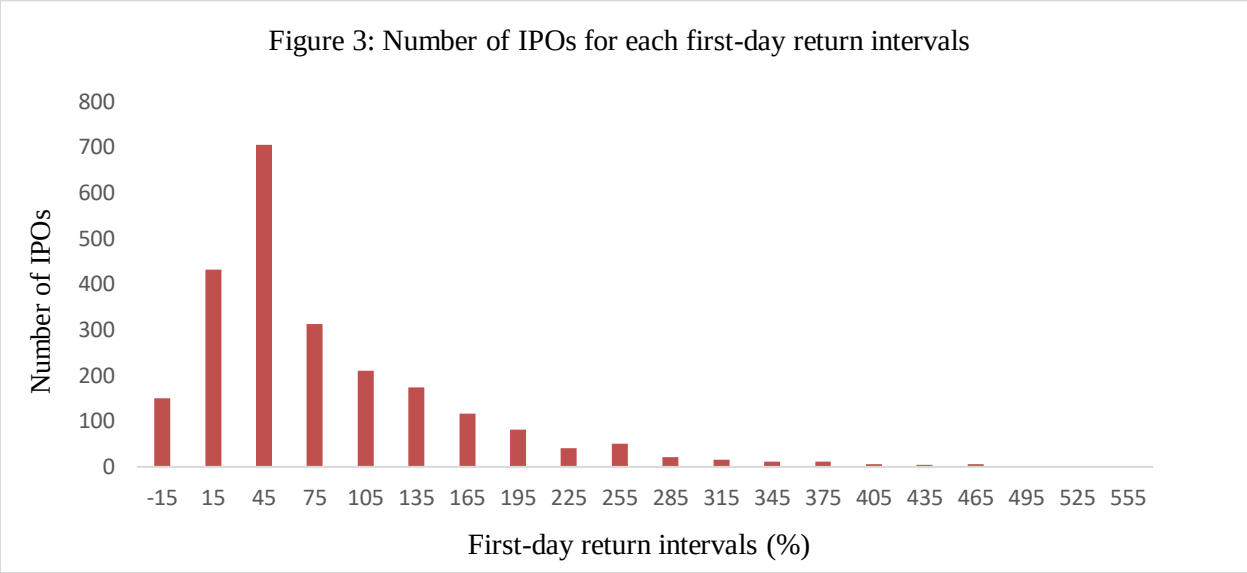


Figure 3

Number of IPOs for each first-day return intervals. This figure shows the number of IPOs located in each of the first-day return intervals between 1990 to 2018.



Internet Appendix

Funding Liquidity Shocks and Market Prices: Evidence from IPO Market in China

Internet Appendix 1. History of IPO subscription Policy

	Subscription policy	T-2	T-1	T	T+1	T+2	T+3	T+4	Document
1991-1993		sale of subscription certificates							国务院：《国务院关于进一步加强证券市场宏观管理的通知》
8/18/1993	payment after allocation	sale of subscription certificates, connected with bank deposits, no prepayment of subscription							国务院：《国务院证券委关于1993年股票发售与认购办法的意见》
1994	full prepayment of subscription	full prepayment, allocations on a pro rata basis							
12/26/1996	full prepayment of subscription			Investors submit subscription orders to the stock exchange	The China Securities Depository and Clearing Corporation (CSDC) freezes the subscription funds	The China Securities Depository and Clearing Corporation verifies the subscription funds and assigns a series of bidder identification codes to subscribers; the stock exchange sends the codes to the underwriter and announces the winning rate	The lead underwriters presided over the lottery draw where shares are allocated randomly; The stock exchange does the liquidation and clearing and shareholder registration according to the results of the lottery draw	The stock exchange unfreezes subscription funds of the losing bidders	证监会：《关于股票发行与认购方式的暂行规定》（证监发字[1996]423号）
7/28/1999		Online pricing issuance combined with book building to legal persons							证监会：《关于进一步完善股票发行方式的通知》
2/1/2000		Online pricing issuance combined with market value allotment (repeal the policy after 2006 Split-share reform)							《关于向二级市场投资者配售新股有关问题的通知》
5/20/2006	full prepayment of subscription			Investors submit subscription orders to the stock exchange	The CSDC freezes the subscription funds	The CSDC verifies subscription funds; the stock exchange assigns a series of bidder identification codes to subscribers and announces the winning rate	The lead underwriters presided over the lottery draw where shares are allocated randomly; The stock exchange does the liquidation and clearing and shareholder registration according to the results of the draw	The stock exchange unfreezes subscription funds of the losing bidders	深交所：《资金申购上网定价公开发行股票实施办法》
9/18/2006				Investors submit subscription orders to the Shenzhen stock exchange	The CSDC freezes the subscription funds and verifies the amount of subscription funds; the stock exchange assigns a series of bidder identification codes to subscribers and announces the winning rate	The lead underwriters presided over the lottery draw where shares are allocated randomly; The stock exchange does the liquidation and clearing and shareholder registration according to the results of the draw	The stock exchange unfreezes subscription funds of the losing bidders		关于深市新股资金申购上网发行的补充通知（2006.9.18）
9/18/2006				Investors submit subscription orders to the Shanghai stock exchange	The CSDC freezes the subscription funds and verifies the amount of subscription funds; the stock exchange assigns a series of bidder identification codes to subscribers and announces the winning rate	The lead underwriters presided over the lottery draw; The stock exchange does the settlement and shareholder registration according to the results of the draw	The stock exchange unfreezes subscription funds of the losing bidders		关于沪市股票上网发行资金申购的补充通知（2006.9.18）
9/19/2006	full prepayment of subscription			Investors submit subscription orders to the stock exchange	The CSDC freezes the subscription funds and verifies the amount of subscription funds; the stock exchange assigns a series of bidder identification codes to subscribers and announces the winning ratee after 4pm	The lead underwriters presided over the lottery draw where shares are allocated randomly; The China Securities Depository and Clearing Corporation sends the winning rate to the underwriters after market closes	The stock exchange announces the winning rate and unfreezes subscription funds of the losing bidders; the subscription funds of winning bidders should be deducted from the settlement accounts		深交所：《关于深市新股资金申购上网发行的补充通知》
6/18/2009	full prepayment of subscription			Investors submit subscription orders to the stock exchange	The CSDC freezes the subscription funds and verifies the amount of subscription funds; the stock exchange assigns a series of bidder identification codes to subscribers and announces the winning rate after 4pm	The stock exchange announces the offering price and assigns a series of bidder identification codes to subscribers	The stock exchange announces the winning rate and unfreezes subscription funds of the losing bidders		上交所：《沪市股票上网发行资金申购实施办法（2009年修订）》
12/13/2013	full prepayment of subscription	calculate market value		Investors inquire about the market value and the available subscription amount; investors submit orders to the stock exchange and fully prepay the subscription according to the offering price	The CSDC freezes the subscription funds and verifies the amount of subscription funds; the stock exchange assigns a series of bidder identification codes to subscribers and announces the winning rate after 4pm	The lead underwriters presided over the lottery draw where shares are allocated randomly; The China Securities Depository and Clearing Corporation sends the winning rate to the underwriters after market closes	The stock exchange announces the winning rate and unfreezes subscription funds of the losing bidders		上交所：《上海市场首次公开发行股票网上按市值申购实施办法》
1/5/2016	paymnet after allocation	calculate market value		Investors inquire about the market value and the available subscription amount; investors submit orders to the stock exchange	The lead underwriter announces the winning rate and presides over the lottery draw where shares are allocated randomly; The CSDC carries out the liquidation and clearing and sends the winning rate to the underwriters at the end of the day; Investors prepare for the subscription funds according to the results of auction	The stock exchange announces the winning rate; investors ensure sufficient capital in accounts at the end of T+2 after winning the draw	The settlement participant shall report the abandonment of the subscription to the CSDC before 5pm; At 4pm, the CSDC deducts the actual subscription capital from investors' accounts and transfers to the lead underwriter's fund settlement account		上交所：《上海市场首次公开发行股票网上发行实施细则》
9/8/2017	cancel subscription prepayment policy								证监会：《关于修改《证券发行与承销管理办法的决定》提出》