Regulated Price and Demand in China's IPO Market

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Abstract

We use simultaneous equations to model the bi-directional causality between IPO initial returns and oversubscription ratios in China. We find that the causality is one-directional from oversubscription ratios to IPO initial returns in the post-reform period (2005–2015), which is consistent with a demand effect. By contrast, a demand effect did not exist in the pre-reform period (1996–2004). Our findings suggest that the 2005 reform of the IPO pricing mechanism has allowed IPO prices to be determined by market forces in China.

JEL classifications: G15, G24, C01

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1. Introduction

Prior to 2005, China's Securities Regulatory Commission (CSRC) enforced a cap on initial public offering (IPO) pricing such that issuing prices were required to be set below a price-to-earnings (PE) multiplier ranging from 15 to 20 times. Even though the IPO price cap was removed officially in 2005, there is speculation that the CRSC has continued using implicit IPO pricing caps after the 2005 reform (Gao, 2010). Our study examines whether IPO prices have been determined by market forces in China after the 2005 reform.

In free markets, the oversubscription ratio affects the IPO initial return and this effect is one-directional, through two channels (shown as the solid lines with arrows in Figure 1). In the first channel, the oversubscription ratio determines the IPO price, which then enters into the calculation of the IPO initial return. The oversubscription ratio is the ratio of demand for shares to the supply of shares. In free markets, IPO prices are determined through a bookbuilding process where bids from investors at various price levels are used to build a demand curve. In a single IPO issue, the supply of shares is fixed within a price range and the demand curve is downward sloping.[1] Because bids for IPO shares are non-binding in a bookbuilding process, the IPO price is set before the demand line crosses the supply line to ensure that all shares will be bought by investors at the set IPO price. Cornelli and Goldreich (2001) show that investment bankers consider oversubscription ratios and price indications provided by investors to price IPO issues. Then, the IPO price enters into the calculation of IPO initial returns directly. The second channel from the oversubscription ratio to IPO initial return occurs via unmet demand and secondary market trading on the first trading day. Derrien (2005) and Aggarwal (2003)

[1] This supply-demand relation is illustrated by Figure 2 in Cornelli, F., Goldreich, D., 2001. Bookbuilding and Strategic Allocation. The Journal of Finance 56, 2337-2369..

both find that IPOs tend to be highly oversubscribed in hot IPO markets and that trading of shares on the first day of listing and initial returns increase with oversubscription ratios. Hence, in free markets the direction of causality is from oversubscription ratios to IPO initial returns. We refer to the effect of oversubscription ratios on IPO initial returns as the *demand effect*. By contrast, when IPO prices are capped at artificially low levels, as in China prior to 2005, high levels of expected IPO initial returns induce additional demand for IPO shares. This *price effect* is indicated by dashed arrow lines in Figure 1. When IPO pricing is regulated, the demand effect can coexist with the price effect. We explicitly model this bi-directional relationship with simultaneous equations estimated with a two-step general method of moments (GMM) approach.

If the 2005 IPO pricing reform succeeded in liberalising IPO pricing, we would expect causality to be one-directional from oversubscription ratios to IPO initial returns (or finding support for the demand effect but not the price effect). That is what we find, suggesting that the reform has achieved some of its intended effect of allowing market forces to determine IPO prices. In the post-reform period, a one-standard-deviation increase in the oversubscription ratio leads to a 0.36-standard-deviation increase in IPO initial returns and the result is significant at the 1% level. By contrast, the price effect in the post-reform period is insignificant. As for the pre-reform period, we fail to find a significant price effect, partially because we are unable to find strong instruments for IPO initial returns in the pre-reform period.

In our main analyses, we choose 1 January 2005 as the sample split point because on that day the CSRC started implementing the price inquiry system in order to price IPOs through a bookbuilding process. Our findings are robust to different sub-sample periods. The demand effect does not exist in the sample period with a quota approval system (1996–2000) or in the sample period after the burst of the internet bubble and before the 2005 reform (2001–2004).

Strong demand for IPO shares leads to high initial returns in both the "cold" and "hot" markets after the reform (2010 and 2011–2013).

The main findings in this paper are also robust to different measures for demand. In our main analyses, we use the online oversubscription ratio to proxy for demand for IPO shares. Online subscription ratios measure the demand from retail investors, and shares allocated online can be sold immediately after listing. On average, approximately 85% of shares issued in IPOs in China are allocated online to retail investors during our sample period. Total subscription ratios measure demand from both retail and institutional/corporate investors. Our findings are robust to using the total subscription ratio as a proxy for demand.

We contribute to the literature by showing that the 2005 reform of the IPO pricing mechanism in China, intended to liberalise markets, has been largely achieved. Agarwal et al. (2008) use hand-collected oversubscription ratios in Hong Kong between 1993 and 1997 and find that oversubscription ratios positively predict IPO initial returns. In free markets, like Hong Kong, we would expect to see that high demand causes increases in IPO initial returns. However, we do not find that it is the case in the pre-reform period in China. By contrast, in the post-reform period, strong demand leads to larger IPO initial returns – similar to what occurs in free markets. Our findings suggest that the CSRC's reform of the IPO pricing mechanism has liberalised the determination of IPO prices. This finding contradicts the anecdote that investing in IPOs has been a sure way to make profits in China since the reform of the IPO pricing mechanism.[2]

In addition, our study highlights the importance of correct model specification. When we run simple ordinary least squares (OLS) regressions similar to those used in prior studies

[2] See "Why China's IPOs Are Still Seen as a Sure Thing?", 2 February 2016, Bloomberg. http://www.bloomberg.com/news/articles/2016-02-01/as-china-stocks-sink-investors-turn-to-ipos-that-can-only-go-up

(for example, see (Chan et al., 2004; Chang et al., 2008; Chi and Padgett, 2005; Guo and Brooks, 2008; Hirshleifer et al., 2016; Tian, 2011; Ting and Tse, 2006)), we find that both before and after the IPO pricing reform, high demand for IPO shares is associated with high levels of initial returns to IPO shares. Similarly, results from OLS regressions appear to suggest that high initial returns of IPO shares also "attract" more demand for IPO shares. However, after controlling for endogeneity via GMM, demand no longer leads to increases in IPO initial returns in the period prior to the reform of IPO pricing in China.

The remainder of this paper proceeds as follows: Section 2 reviews the literature and develops hypotheses; Section 3 introduces the data and methodology; Section 4 analyses the results; and Section 5 concludes.

2. Literature Review and Hypotheses Development

The institutional setting in China is very different from that in developed markets; thus, as pointed out by Carpenter and Whitelaw (2017) on page 7, "it is not clear how much the US-based theories apply" to IPOs in China. Accordingly, instead of reviewing US-based IPO theories and empirical evidence, this section summarises the important and unique institutional background in China's IPO market and reviews the related literature on China's IPOs to develop our hypotheses.

After its birth in 1990, the stock market in the People's Republic of China grew rapidly to become the second-largest stock market in the world in 2015.[3] Over the last two decades, IPO pricing in China has gradually transitioned from regulated pricing to market pricing. A milestone in this transition occurred on 1 January 2005, when the CSRC rule on the pricing of

[3] According to the World Federation of Exchanges, the total market capitalisation of the Shanghai Stock Exchange and the Shenzhen Stock Exchange stands at over 6 trillion U.S. dollars as of 31 January 2015, making China's stock market the second largest in the world. As of 31 January 2015, the largest stock market is the US stock market with a total market capitalisation of 26 trillion U.S. dollars, and the third-largest stock market is in Japan with a total market capitalisation of 4.5 trillion U.S. dollars.

shares at IPOs through a tender-offering process came into effect. Before that date, IPO prices for essentially all companies were determined by PE multiples negotiated between the issuer and the CSRC, which typically set the ceiling of this multiplier at around 15–20 times. We refer to this pricing mechanism as *regulated pricing*. After 1 January 2005, the CSRC required that IPO prices be determined through a tender-offering process involving institutional investors, which more closely resembled the bookbuilding process in developed markets. We refer to this pricing mechanism as *bookbuilding pricing*.

In addition to the government's regulation of the supply of IPO shares and IPO pricing, the process of allocating IPO shares in the A-share markets also contrasts sharply with those in developed markets. In developed markets, the majority of IPO shares are allocated by investment banks at their discretion to institutional investors. Cornelli and Goldreich (2001) discuss the bookbuilding and share allocation process in detail. In a developed capital market, approximately 60% to 90% of IPO shares are allocated to institutional investors, with the remaining 10% to 40% allocated to individuals (Aggarwal, 2003). By contrast, in the A-share market only a small fraction (approximately 15% in our sample period) of shares are allocated to institutional and corporate investors in the *offline* tranche. The term "offline" is used because institutional and corporate investors can only apply for IPO shares offline, and they cannot use the retail investors' online system to apply for shares issued in IPOs. Shares allocated offline are subject to a lock-up period of three months or longer, meaning these shares can only be sold three months after the listing day. In the A-share market, an average of 85% of IPO shares are allocated online to retail investors through a lottery-like system. All retail investors' applications for shares issued in an IPO are submitted online and enter into the same lottery draw to decide the "winning" bids. Each application is in units of 500 or 1,000 shares. Investors are required to deposit cash in a designated account that covers 100% of the value of the shares applied for in order to validate their applications. The online application opens for one to five

days in our sample period. On the day following the last day of online application, winning applications are randomly drawn from all the applications, and the winning applications obtain IPO shares for cash. Cash with interest earned is refunded to all losing applications in three days from the last day of online application. Shares allocated online become immediately tradable at listing. The shares that are allocated online are not subject to any lock-up restriction and can therefore be "flipped" (or sold on the open market) on the first trading day after the IPO.

Initial returns of A-share IPOs are extremely high, averaging over 100% (Chan et al., 2004; Ting and Tse, 2006) and far exceeding the 15–20% average initial return in developed capital markets, according to Ritter and Welch (2002). A number of studies have attempted to explain such high IPO initial returns with institutional features specific to the A-share market. For example, the time gap between the offering and listing date (GAP) is longer for deals facing higher uncertainty in obtaining regulatory approvals. Mok and Hui (1998), Chan et al. (2004) and Tian (2011) find that the length of this lag is positively related with initial returns. Related to the IPO price cap, pre-IPO PE ratios are shown to be positively associated with initial returns (for example, see Ting and Tse, 2006). Consistent with the agency theory, prior studies on A-share IPOs also find that state ownership is associated with weak governance (Chau et al., 1999; Chen et al., 2004) because an issuer with weak corporate governance prior to an IPO needs to sell its shares more cheaply at the IPO to attract investors.

Our study is most closely related to Tian (2011), who hypothesises and finds that the oversubscription ratio, as a proxy for unmet demand for shares issued in an IPO, has strong explanatory power for IPO initial returns in the A-share market. Following Tian (2011), a large number of studies on China's IPOs (Chan et al., 2004; Chang et al., 2008; Chi and Padgett, 2005; Guo and Brooks, 2008; Hirshleifer et al., 2016; Tian, 2011; Ting and Tse, 2006) routinely use the oversubscription ratio to explain IPO initial returns in OLS regressions. IPO studies in

developed capital markets also use oversubscription ratios to explain IPO initial returns. Both Derrien (2005) and Aggarwal (2003) use the oversubscription ratio as a proxy for investor sentiment and find it positively predicts IPO initial returns in France and Hong Kong, respectively. This demand effect, can exist regardless of whether IPO prices are regulated or determined through bookbuilding.

When IPO prices are determined through bookbuilding, it is reasonable to assume that a strong demand for IPO shares leads to high IPO initial returns. Investment bankers use the demand curve and indicative prices provided by investors to determine IPO prices – the oversubscription ratio is an important factor in setting IPO prices, as discussed in Cornelli and Goldreich (2001). Consequently, if IPO prices are decided through bookbuilding, IPO initial returns are the result of IPO prices and oversubscription. However, expected IPO initial returns induce additional demand for IPO shares under a regulated pricing mechanism. When IPO prices were regulated with a PE cap in China prior to 2005, the level of demand for a single IPO issue was not considered in choosing the IPO price. Instead, investors applied for shares after the IPO price was determined. Because obtaining IPO shares translated to near-guaranteed high returns prior to 2005, demand increased with the level of expected IPO initial return. This price effect can co-exist with the demand effect – in this case, it is important to explicitly account for this bi-directional causality with simultaneous equations.

We test whether IPO prices have been determined primarily by market forces since the IPO price cap was removed officially in 2005. Our findings help to clarify the speculation that the CRSC continued using implicit IPO pricing caps after the 2005 reform (Gao, 2010). In a free market, we expect to see a strong demand effect but not a price effect (**H1**). By contrast, under a regulated IPO pricing mechanism, we expect to find a strong price effect (**H2**).

3. Data and the GMM Approach

3.1. IPO Sample

All data are sourced from the China Stock Market & Accounting Research database (CSMAR). Our sample includes all A-share IPOs between 1996 and 2015 that have allocated IPO shares online so that there is a valid oversubscription ratio ($OVSUB$, or total number of shares subscribed online divided by the total number of shares available for online subscription in an IPO).[4] IPOs in the first six years of the A-share market's life, or between 1990 and 1995, are not included in our study because they do not have valid oversubscription ratios. During this period, China's A-share market tested many methods for allocating IPO shares. In 1990, investors queued for physical lottery forms to apply for IPO shares. Later, the allocation was done through applications backed up with bank deposits. Between 1996 and 2015, 441 out of 2,559 A-share IPOs are excluded from our study. Panel A in Table 1 reports the number of IPOs in the A-share market by year between 1996 and 2015, the number of IPOs included in our study and the types of IPOs excluded from our study.

[Insert Table 1 about here.]

CSRC briefly tested pricing IPOs through auctions between 1996 and1998 without success. Auction pricing does not seem to assist in price discovery because share prices fell below the IPO prices on the first trading day in all deals. Because IPO prices in these auctions are set at the level where demand equals supply, valid oversubscription ratios do not exist for these deals. Thus, our study excludes IPOs priced by auctions, which make up less than 5% of total IPOs.

Our analysis also excludes IPOs that allocate shares with a secondary-market placement method because this placement method has not been widely used. In the period 2002–2005, CSRC also temporarily tested a secondary-market placement method, in which investors are not required to deposit cash to validate their IPO applications. Instead, the number of shares

[4] Refer to Appendix A for detailed definitions of variables.

that an investor automatically applies for is determined by the market value of the tradable A-shares held by the investor. Investors are not obliged to purchase the IPO shares that they "won" through the lottery draw in the secondary-market placement method. Instead, the underwriting investment bank must purchase these un-bought "winning" shares. Because investors do not have to buy the shares they have "won", oversubscription ratios in these placements do not reflect the true demand for IPO shares and are not comparable to those in online placements.

3.2. Simultaneous Equations

In order to test H1 and H2, we model the bi-directional relation between the IPO initial return and the oversubscription ratio with simultaneous equations similar to those found in Lowry and Shu (2002):

Demand effect: $IR = \alpha_1 + \beta_1 OVSUB + \boldsymbol{\gamma_1 X} + \boldsymbol{\theta_1 X_1} + \varepsilon_1$ (1)

Price effect: $OVSUB = \alpha_2 + \beta_2 IR + \boldsymbol{\gamma_2 X} + \boldsymbol{\theta_2 X_2} + \varepsilon_2$ (2)

where IPO initial return (IR) is the percentage change in price from the IPO price to the first-day closing price adjusted for the industry return over the same period for firm i; $OVSUB$ is the online oversubscription ratio in the IPO for firm i and proxies for demand; $\boldsymbol{X}$ is a vector of control variables that are common to both initial returns and demand; X_1 is an identifying variable that is uniquely related to the degree of IPO initial returns but not demand; and X_2 is an identifying variable that is uniquely related to the oversubscription ratio of an IPO but not the initial returns.

The objective of this system of equations is to investigate whether the high initial return of A-share IPOs is a result of the unmet demand for IPO shares, after considering the impact from IPO initial returns on demand. At the same time, we examine whether the strong demand for IPO shares is caused by the high IPO initial returns. We separately estimate this system of equations for the pre-IPO pricing reform period and the post-IPO pricing reform period.

Equation (1) examines whether unmet demand for IPO shares affects a firm's initial returns to its IPO. The demand for an IPO firm's shares is not exogenous because regulated low IPO prices (that is, higher initial return or larger under-pricing) attract more demand for IPO shares. For example, a firm issuing shares at an artificially low price will have a high error term, ε_1, and it is also likely to attract a large number of IPO applications. Thus, the error term and the explanatory variable ($OVSUB$ in Equation (1)) are not independent, which violates a basic OLS assumption. As a result, inferences from such an OLS regression will be incorrect.

Equation (2) tests whether high initial returns attract more investor demand. It is inappropriate to estimate this equation using OLS for reasons similar to those discussed above. We account for the interdependency between initial returns of IPO shares and oversubscription ratios by treating Equation (1) and (2) as simultaneous equations.

The identifying variables for Equation (1), $\boldsymbol{X_1}$, include the number of days between the IPO offering date and the listing date (GAP) as well as the market return during this gap ($GAPMKTRET$). Instrument variable(s) must meet both the relevance and exclusion criteria. The time gap between collecting IPO proceeds and the listing date represents a significant China-specific regulatory risk (Chan et al., 2004; Mok and Hui, 1998; Tian, 2011) and is positively associated with the initial return. GAP also meets the exclusion criterion because it does not affect the oversubscription ratio ($OVSUB$) directly. The length of this gap is determined by the extensive regulatory approvals required from the CSRC and any ministry deemed relevant by the law and rules at the time. This waiting period ranges between 7 days and 9 years during our sample period, with an average of 18 days. This time lag is unknown at the time of subscription, and it is unlikely that this gap affects the oversubscription ratio. In addition to GAP, we also follow Lowry and Shu (2002) to use the gap market return prior to the listing day ($GAPMKTRET$) to further identify IPO initial returns (IR). The market return during the period between IPO pricing and listing date positively predicts the IPO initial return

because the market return during this period contains information not reflected in the IPO price (Loughran and Ritter, 2002; Lowry and Schwert, 2004). However, it is not plausible that market return after the closure of applications for IPO shares should affect oversubscription. Therefore, the price effect equation (Equation (2)) does not include these two variables. These two variables are weak instruments for IR because Stock-Yogo tests can only reject the null hypothesis that this variable is a weak instrument at 25% critical levels (Stock and Yogo, 2005).[5] Therefore, to address the weak instrument issue and to allow for heteroscedasticity, we use a continuously updated GMM estimator (CUE) and are able to reject the null of weak instruments at 10% and 15% maximal limited information maximum likelihood (LIML) size for the pre-reform and post-reform periods, respectively. As suggested by Hansen et al. (1996), CUE can be viewed as the GMM version of LIML. Similar to LIML, this estimator is less biased when instrumental variables are weak. Unlike LIML, CUE allows for heteroscedasticity. In summary, these two variables do not over-identify the demand equation (Equation (1)), but they are slightly weak instruments so we use a GMM-CUE estimator to reduce the bias.

To identify Equation (2), we use the number of competing IPOs ($CMPTIPO$) as an instrument for $OVSUB$. Because applying for A-share IPOs uses up cash, we choose the number of competing IPOs to identify the level of demand for IPO shares. Cash equivalent to the value of an application has to be deposited no later than the closing date of an offering. The cash of losing applications is only returned three days after an IPO subscription closes. During this window, the cash cannot be used to apply for other IPOs. Because investors have limited funding, competing IPOs divert investor demand, and the number of competing IPOs is expected to be negatively associated with the oversubscription ratio. $CMPTIPO$ directly and negatively impacts $OVSUB$, thus meeting the relevance criterion in choosing an instrumental

[5] After a two-step GMM estimation, we compare Kleibergen-Paap *rk* Wald F-statistics (Kleibergen et al., 2006) and critical values from the Stock-Yogo weak identification test to check for a weak instrument.

variable. To meet the exclusion criterion, we require that cash returned for the losing bids in the competing IPO be available on the day before the listing day of this IPO, so that the cash from competing IPOs can be used to trade shares of this IPO on its listing day. In this way, the number of competing IPOs has a strong direct effect on demand but does not have a strong direct effect on the initial return of the IPO considered. In addition, $CMPTIPO$ is largely exogenously determined by the CSRC. A firm has little control over the choice of the timing of the marketing window because the CSRC restricts the supply of IPO shares by implementing a quota system first and after that by closing the IPO markets occasionally. Thus, at any time a large number of firms are waiting for CSRC approvals for IPOs. Consequently, $CMPTIPO$ is excluded from the demand equation (Equation (1)). In addition to the economic argument put forward to validate the number of competing IPOs ($CMPTIPO$) as an instrumental variable for $OVSUB$, we use the Stock-Yogo test to check whether it is a weak instrument. The test rejects the null hypothesis that this variable is a weak instrument comfortably at the 1% critical level (Stock and Yogo, 2005).[6]

The common control variables ($\boldsymbol{X}$) that affect both initial returns and oversubscription ratios include firm age (AGE), the natural logarithm of total IPO proceeds ($PRCDS$), the IPO price divided by earnings per share prior to an IPO (PE) and the percentage of shares owned by the state prior to an IPO ($STAT$E). AGE and IPO proceeds ($PRCDS$) proxy for the uncertainty in the valuation of IPO shares, both of which are expected to be negatively related to the amount of IPO initial returns (Beatty and Ritter, 1986; Ritter, 1984). Motivated by Shleifer and Vishny (2002) and prior studies on Chinese IPOs (Chen et al., 2004), we also control for the effect of corporate governance on IPO initial returns by including in our regressions the percentage of

[6] After the two-step GMM estimation, we compare the Kleibergen-Paap rk Wald F-statistic (Kleibergen et al., 2006) and critical values from the Stock-Yogo weak identification test to decide whether we can reject the null of weak instrument at any reasonable critical level. We use Kleibergen-Paap rk Wald F-statistics because they do not impose *i.i.d.* conditions and allow for heteroscedasticity.

shares owned by the state prior to an IPO ($STATE$). Because IPO prices were explicitly regulated by the CSRC at a level below a PE multiple cap prior to 2005, and an implicit cap on the PE multiple still exists today, we include the pre-IPO PE multiple as a control variable to explain IPO initial return and oversubscription. Finally, we also include indicator variables for firms listed on the SME board (SME) and the CHINEXT board ($CHINEXT$), which were introduced in 2004 and 2009, respectively. These two boards cater for small and young companies. Compared with the main board, these two boards have lower requirements in terms of profitability and operating history and allow for a simpler IPO pricing procedure, but they have more stringent ongoing disclosure requirements.[7]

4. Results

4.1. Summary Statistics and Correlations

This change from regulated IPO pricing to bookbuilding pricing is evident in Panel B of Table 1. PE multiples at the time of an IPO (PE) average around 15.7 times before 2005 but increase to 30.0 times after 2005. Initial returns (IR) average 131.7 percentage points in the pre-reform period, dropping drastically by 75.8 percentage points to 55.9 percentage points in the post-reform period. Initial returns are also very volatile in both periods – displaying standard deviations of 83.9 and 68.5 percentage points in the pre- and post-reform periods, respectively. Among the 2,118 IPOs included in our study, only 139 IPOs have a negative initial return, and the highest initial return is over 800 percentage points, resulting in large standard deviations of IR in both periods.

The average of online oversubscription ratios ($OVSUB$) slightly increases from 288 times to 339 times from the pre-reform to the post-reform period. We can use the *total* oversubscription ratio ($TOVSUB$) as a proxy for demand. The total oversubscription ratio is

[7] Refer to Appendix B for a comparison of listing requirements and the pricing mechanism for the main board, SME and CHINEXT.

the total bids submitted online and offline divided by the number of shares offered in an IPO. Total oversubscription ratios tend to be lower than online oversubscription ratios (Panel A of Table 1).

Table 2 reports the correlation coefficients among variables for the pre-IPO pricing reform period (Panel A) and for the post-IPO pricing reform period (Panel B). Initial returns (IR) and oversubscription ratios ($OVSUB$) are significantly correlated at 0.41 and 0.51 prior to the reform and after the reform, respectively. The percentage of interest owned by the state prior to an IPO ($STATE$) and the age of the firm at an IPO (AGE) are most highly correlated at -0.42 (prior to the reform) because state-owned enterprises are normally formed through restructuring shortly prior to an IPO. The identification variables for each equation (Equation (1) and (2)) are related to the main variable in the expected manner. The number of competing IPOs ($CMPTIPO$) is significantly and negatively correlated with the total oversubscription ratio in each of the sample periods (-0.36 and significant at a 1% level in Panel A of Table 2 and -0.22 and significant at a 1% level in Panel B of Table 2). The delay between an IPO offering and listing (GAP) is significantly and positively correlated with IPO initial returns (IR) at 0.11 with a p −value of 5% and at 0.18 with a p −value of 1% during the pre-reform period and the post-reform period, respectively.

[Insert Table 2 about here.]

4.2. Two-step GMM Estimations

We estimate Equation (1) and (2) using a two-step instrumental variable approach. First, we estimate the demand equation (Equation (1)). In the first stage, we regress online oversubscription ratios ($OVSUB$) on all exogenous variables and present the results in columns (1) (the pre-reform period) and (3) (the post-reform period) in Panel A of Table 3. In the second-stage regressions, we replace the oversubscription ratio ($OVSUB$) with an instrument,

which is the fitted values from the first-stage regression, to explain IPO initial returns. Columns (2) and (4) present the results of the second-stage regressions for the demand effect before and after 2005, respectively. Similarly, for the price effect (Equation (2)), results from the first- and second-stage regressions are presented in column (6) for the pre-reform period and column (8) for the post-reform period, respectively.

[Insert Table 3 about here.]

We do not find that strong demand for IPO shares causes the extraordinarily high initial returns in the A-share market before 2005. The coefficient on the estimated oversubscription ratio ($OVERSUB\_PRED$) is -0.05 and insignificant in column (2) of Panel A in Table 3. However, we fail to find a significant price effect in the pre-IPO pricing reform period – the coefficient on the predicted initial returns (IR_PRED) is 18.16nd insignificant in the pre-reform period (column (6) of Panel A in Table 3). Thus, we do not find evidence for H2, where we expect a significant price effect and an insignificant demand effect under a regulated IPO pricing mechanism.

By contrast, we find that oversubscription ratios ($OVSUB$) strongly and positively predict initial returns (IR) in the post-reform period. The slope coefficient estimate for $OVERSUB\_PRED$ is 0.09 and significant at a 1% level, as shown in column (4) of Panel A in Table 3. The demand effect in the post-reform period is also significant economically. The coefficient of 0.09 means that an increase of one standard deviation in the estimated oversubscription ratio (or 264.7 times) leads to an increase of a 0.36 standard deviation of IR, which is the initial return of IPO shares (or 21 percentage points). While the demand effect is significant in the post-reform period, we do not find a price effect in this period – coefficient on IR_PRED on column (7) of Panel A in Table 3 is -0.81 and insignificant. These findings

suggest that IPO pricing in China's A-share market is likely to be primarily determined by market forces after the 2005 reform.

In all regressions, all the coefficient estimates for identifying variables have expected signs. For example, the online oversubscription ratio ($OVSUB$) drops if there are more IPOs competing for applications during the same period ($CMPTIPO$). In the pre-reform period, an increase of one additional competing IPO decreases the oversubscription ratio by approximately 46 times (as shown in column (1) of Panel A in Table 3). Similarly, an increase in the length of time from the allocation of IPO shares to listing (GAP) is associated with a higher IPO initial return (as shown in columns (5) and (7) of Panel A in Table 3). As expected, an IPO initial return is positively associated with stock market returns during this window ($GAPMKTRET$) in the post-reform period (2005–2015) (column (7) of Panel A in Table 3). However, when IPO pricing was primarily determined by the strict PE ceiling set by the CSRC (1996–2004), we find IPO initial return is negatively associated with the stock market return over the window between offering and listing.

The adjusted R-squares ("r-sqr") in the first-step regressions that explain the IPO initial return are 16.8% and 25.4% for the pre- and post-reform samples, respectively (columns (5) and (7) of Panel A in Table 3), and are comparable to those in Table 7 of Cheung et al. (2009), suggesting that our first-stage models have reasonable explanatory power for IPO initial returns.

4.3. Robustness Tests

We choose 1 January 2005 to split the sample because the CSRC removed the IPO pricing cap based on PE ratios (15–20 times) on that day. It is possible that the existence and abandonment of the annual quota system to approve IPOs could have affected our results. The 1996–2000 period also corresponds to the internet bubble period and 2001–2004 to the post-

internet-bubble period. The result in the pre-reform period is primarily drawn from the 1996–2000 period. Our main findings remain unchanged if we use the 86 observations in the 2001–2004 period because we find no evidence for the demand effect or the price effect (results are untabulated).

We are also interested in whether our results are specific to "cold" or "hot" markets. Güçbilmez (2015) identifies hot and cold IPO markets in the A-share market and points out that the formation of hot markets in China is affected by regulatory choices. We conduct two-step GMM analyses on the hot and cold market sub-samples identified by Güçbilmez (2005). Panel A in Table 4 reports the estimation results for the hot and cold markets in the post-reform period. We find that the demand effect in the hot market (2010) is similar to that in the cold market (2011–13). The slope estimate on the predicted demand (OVSUB_PRED) is 0.21 in either the hot or cold markets.

[Insert Table 4 about here.]

The split-share reform (2005–2007)[8] made a large amount of additional shares available to investors. This exogenous shock dramatically increased investment opportunities, which would have reduced the demand for IPO shares and weakened the demand effect.

[8] The split-share structure is a legacy in China's stock markets where state-owned enterprises issued minority tradable shares and state-owned shares were non-tradable. Liao, L., Liu, B., Wang, H.J.J.o.F.E., 2014. China′ s secondary privatization: Perspectives from the split-share structure reform. Journal of Financial Economics

113, 500-518. summarise the problems brought by the split-share structure succinctly, "Although it played a positive role in assisting China's SOE ownership reform at an early stage, the split-share structure jeopardized China's continued privatization efforts by restricting trading of state-owned shares in the secondary market. It also caused serious corporate governance problems, encouraged speculation in the stock market, and blocked mergers and acquisitions activities." The split-share reform aims at making state-owned shares tradable and transferrable and was largely completed between 2005 and 2007 ibid..

However, we still find a strong demand effect in the period between 2005 and 2015. In addition, results for 2010 and 2011–2013 still show a strong demand effect. Thus, our results are robust to the split-share reform.

So far, we have used the online oversubscription ratio ($OVSUB$) as a proxy for demand to be consistent with existing studies of IPO under-pricing in China. IPO shares are allocated online to retail investors and they can be sold on the first day of listing, while shares allocated offline to corporate and institutional investors are subject to a lock-up period of three months or longer. Thus, compared with total oversubscription ratios, online oversubscription ratios more accurately capture the demand for IPO shares that can be sold on the first day of listing to benefit from the high initial returns of IPO shares. We believe that online oversubscription ratios, compared with total subscription ratios, are more suitable for testing the bi-directional causal relations between demand and IPO initial return. However, the literature normally uses $TOVSUB$ to measure demand for IPO shares. Thus, we use $TOVSUB$ as a proxy for demand and estimate the simultaneous equations with two-step GMM estimation. Our findings are robust to this proxy for demand (results are untabulated).

4.4. Simple OLS Regressions

To compare our results with those in prior studies, we also present results from simple OLS regressions. Columns (1) and (2) of Table 5 test the demand effect where we use oversubscription ratios to explain initial return for the periods before and after 2005, respectively. Columns (3) and (4) of Table 5 test the price effect for the period before and after 2005, respectively, by using initial return to explain oversubscription ratios. These OLS regressions are similar to the analysis conducted in Tian (2011) and Cheung et al. (2009). Consistent with prior studies, this paper also finds that, without accounting for the simultaneity between initial returns and demand, high oversubscription ratios seem to "lead" to high initial return and vice versa, in both the regulated IPO pricing period and the market pricing period.

In columns (1) and (2) in Table 5, estimates for the slope coefficients on online oversubscription ratios ($OVSUB$) in pre- and post-reform periods are estimated at 0.11 and 0.04, respectively, and both are significant at a 1% level. The Durbin-Wu-Hausman chi-square test (Durbin, 1954; Hausman, 1978; Wu, 1973) strongly rejects the null hypothesis that oversubscription ratios ($OVSUB$) are exogenous to IPO initial return (IR) in both periods at significance levels below 1% (Panel B of Table 3). Because demand is, in fact, endogenous to initial return, we refrain from making further inferences from the results in columns (1) and (2) in Table 5. Similarly, we refrain from making inferences from the results in columns (3) and (4) in Table 5 because the Durbin-Wu-Hausman chi-square test strongly rejects the null hypothesis that IPO initial return (IR) is exogenous to oversubscription ratios ($OVSUB$) in both periods at significance levels below 1%. These test results support our choice of a GMM approach over making inferences from OLS regressions.

[Insert Table 5 about here.]

5. Conclusion

Regulators in China have exercised tight control over the number of IPO deals and have closed IPO markets from time to time, as well as limiting prices of IPO shares through their approval processes. From 1 January 2005 onward, issuers and investment banks have determined IPO prices through a process resembling the bookbuilding process used in developed capital markets. Prior to that, IPO prices in China were negotiated between issuers and the CSRC and subject to a PE cap. These regulated low IPO prices could have attracted strong demand for IPO shares. Meanwhile, unmet demand for IPO shares should further push up closing prices of shares in the first days after IPOs. Modelling the bi-directional relation between IPO initial return and demand with a two-step GMM approach, we show that in the period following this reform, IPO initial return is more strongly and significantly determined

by risk factors, compared with the pre-reform period. In the post-reform period, the expected IPO initial return estimated from the first-stage regression does not further affect demand for IPO shares, suggesting that IPO prices in the post-reform period are likely to be primarily determined by market forces. More importantly, in the post-reform period oversubscription ratios are positively associated with the initial returns of IPO shares, even after we control for the impact of the expected IPO initial return on demand. This result suggests that in the post-reform period, the functioning of the A-share market may have become more similar to that of developed capital markets, where the oversubscription ratio serves as a proxy for investor sentiment, as documented by Derrien (2005).[9] Overall, we show that the reform of the IPO pricing mechanism appears to have allowed IPO prices to be determined by demand.

[9] Regulators in developed capital markets do not often require that underwriters disclose oversubscription ratios. Derrien (2005) uses a unique dataset of oversubscription ratios of retail investors in France to proxy for investors' sentiment and finds that oversubscription ratios are positively associated with initial returns of IPO shares.

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Appendix A. Source and Construction of Each Variable

Variable name	Definition
AGE	Firm age at listing, or years between the establishment day (estbdt) and the listing day (listdt).
CHINEXT	An indicator variable that takes the value of one if the stock is listed on CHINEXT and zero otherwise (the six-digit stkcd starts with 300).
CMPTIPO	Number of competing IPOs, used as an instrument for OVSUB in explaining IR. A competing IPO must meet two conditions. *First*, it meets the relevance criterion. The competing IPO competes for cash to be deposited to subscribe to IPO shares online for the IPO considered. A competing IPO directly and negatively affects OVSUB, thus meeting the relevance criterion for an instrumental variable. In our IPO sample, bids for shares issued online must be supported by 100% cash deposit. On the last day of subscription, the book closes and the lottery is drawn. Winning bids exchange cash for shares. Cash deposited for losing bids is returned in three days. Note that the settlement cycle for IPO bids is T+3, which is longer than the T+1 settlement cycle for share trading in China's A-Share markets. For each IPO, we assign an online subscription funding window starting from the first day of the online subscription period (sdtnetsb) and ending at three days after the last day of the online subscription period (edtnetsb + 3). Two IPOs are competing IPOs if the online subscription funding windows of the two IPOs overlap because investors cannot use the cash returned for unsuccessful bids to bid for shares issued in the other IPO. *Second*, it meets the exclusion criterion for an instrument. The competing IPO does *not* compete for the cash available to trade shares of this IPO on the first day of listing; thus it is *not* affecting IR directly. To meet this criterion, we require that the cash deposited to back up losing bids for competing IPOs be available before the listing date of this IPO.
GAP	Number of days between the closing day of the subscription to IPO shares (subcldt) to the listing day (listdt).
MKTRET	Percentage returns to the corresponding Shanghai or Shenzhen market indices over the seven calendar-day period prior to the listing day.
GRSPRCDS	IPO gross proceeds in millions of RMB (grsprc / 1,000,000).
IR	The initial return of an IPO, or percentage changes in price less percentage return to the corresponding industry portfolio from the IPO pricing day (subcldt) to the first day of listing (listdt). $IR = \frac{P_1 - P_{IPO}}{P_{IPO}} - \frac{I_1 - I_0}{I_0}$ where P_1 is the closing price of the stock on the first day of listing (clsprc), P_{IPO} is the IPO price (aiprc), I_1 (I_0) is the closing market capitalisation of corresponding industry portfolios on the first day of listing (on the IPO pricing day) (subcldt). We use the industry classification code issued by the CSRC.
ONL_PCT	Percentage of shares allocated online (nopliss / nshripopub * 100).
OVSUB	The online oversubscription ratio (osmonl), or total number of shares subscribed online divided by the total number of shares available for online subscription in an IPO. If missing, fill with 1/ plotonln. Plotonln is the online winning ratio, or the number of shares issued online divided by total online subscription. Shares allocated online can be sold on the first day of listing. By contrast, shares allocated offline must be held for at least three months from the day of listing. During our sample period, approximately 80% of shares are allocated online.

PE	Pre-IPO PE ratio (epedlt), or IPO price divided by earnings per share prior to IPO. If epedlt is missing, fill in with the last year net profit prior to IPO (B002) dividend by the number of shares prior to IPO (Total in the IPO_ShareStructure file).
PRCDS	Natural logarithm of GRSPRCDS.
SME	An indicator variable that takes the value of one if the stock is listed on the SME and zero otherwise (stkcd between 2000 and 2999).
STATE	The percentage of shares owned by the state prior to the IPO (StateOwnedShares divided by Total in the IPO_ShareStructure file).
TOVSUB	The total oversubscription ratio (tosmul), or total number of shares subscribed divided by the total number of shares issued in an IPO. If missing, fill with 1/ totalplot. Totalplot is the winning ratio, or the number of shares issued divided by the total subscription.

Appendix B. Listing on the Main Board, SME and CHINEXT

The Shenzhen Stock Exchange introduced the SME board and the CHINEXT board in 2004 and 2009, respectively. The SME board caters for medium-sized firms with a market capitalisation below RMB 100 million, while firms with larger market capitalisation at IPO are listed on the main board. Other than the market value of stocks, the SME board and the main board have identical listing requirements in terms of operating history, profitability and total assets. CHINEXT serves early-stage and high-growth firms in innovative industries. Thus, the profitability standard for listing on CHINEXT is lower than those of the SME board and the main board. CHINEXT requires that applicants be profitable in the most recent two years and have realized an accumulated profit of no less than RMB 10 million over this period. By contrast, both the SME board and the main board require a minimum of three years profitability and RMB 30 million of accumulated profits. Since 1 November 2010, the IPO pricing process for a listing on CHINEXT or SME has become simpler than listing on the main board. On these two boards, the underwriter can choose to skip the bookbuilding process and set offer prices after collecting feedback on pricing from institutional investors during roadshows. After listing on the SME or CHINEXT, firms face more stringent ongoing disclosure requirements (for example, use of IPO proceeds and change in director shareholdings) than firms listed on the main board.

Figure 1 Causality between Oversubscription Ratio and IPO Initial Return

The solid arrow lines indicate the demand effect. The dashed arrow lines indicate the price effect.

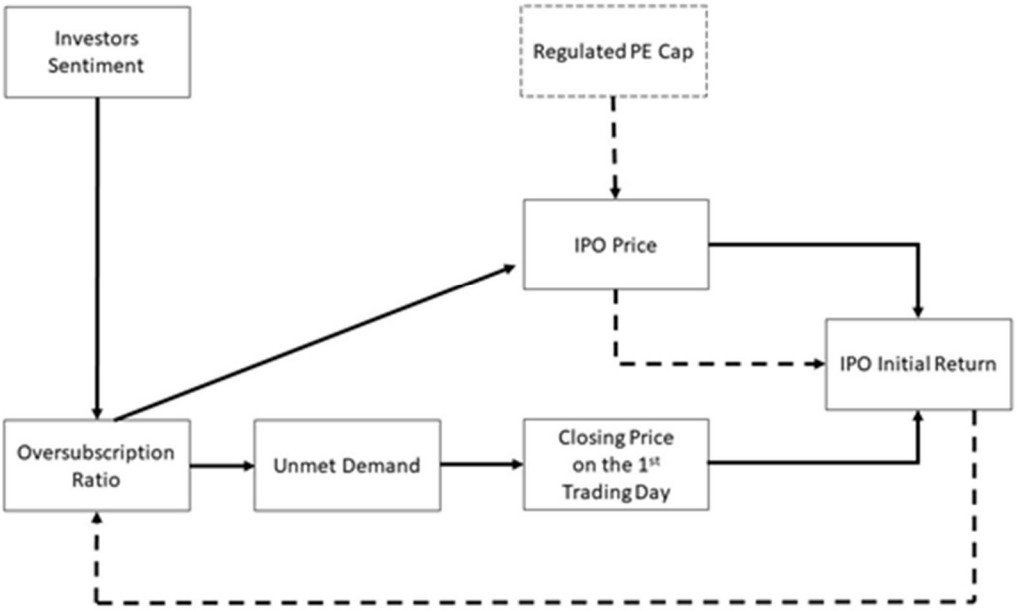

Table 1 Summary statistics

Panel A presents the mean and standard deviation of key variables in the pre-reform period (1996–2004) and the post-reform period (2005–2015) used in our analyses. There are 637 and 1,481 observations with non-missing values for all regression variables in each period. t −tests are conducted for the hypothesis that the difference in means is zero with unequal variance. Refer to Appendix A for variable definitions.

Panel B summarises the number of all A-share IPOs in each year and those included in our study.

A. Number of IPOs in each year

	Number of IPOs			
Year	All A-share IPOs	Our study	# of IPOs excluded	Main types of IPOs excluded
1996	194	103	91	auction, non-public placement
1997	201	121	80	auction, non-public placement
1998	103	87	16	auction, non-public placement
1999	96	95	1	share swap
2000	133	133	0	
2001	75	72	3	auction
2002	71	23	48	second mkt placement
2003	67	2	65	second mkt placement
2004	100	1	99	second mkt placement
2005	15	0	15	second mkt placement
2006	66	65	1	share swap
2007	126	123	3	share swap
2008	77	76	1	share swap
2009	99	99	0	
2010	349	347	2	spin-off
2011	282	281	1	share swap
2012	155	154	1	share swap
2013	2	0	2	share swap
2014	125	125	0	
2015	223	211	12	share swap
Total	2,559	2,118	441	

B. Key variables

	Pre-reform period 96-04		Post-reform period 05-15		Difference
	Mean	S.D.	Mean	S.D.	in Means
IR	131.7	83.9	55.9	68.5	-75.8***
TOVSUB	284.7	273.4	303.2	527.2	18.5
OVSUB	288.4	264.7	339.2	642.5	50.8**
AGE	2.5	2.4	9.1	5.2	6.7***
GRSPRCDS	488.4	836.1	1,339.5	4,502.9	851.1***
PRCDS	5.8	0.8	6.4	0.9	0.6***
PE	15.7	8.0	30.0	15.5	14.2***
STATE	0.69	0.35	0.11	0.26	-0.57***
SME			0.49	0.50	0.49***
CHINEXT			0.33	0.47	0.33***
CMPTIPO	3.8	2.3	8.7	6.9	4.9***
GAP	33.7	29.1	11.3	3.8	-22.3***
GAPMKTRET	1.4	9.0	1.0	5.8	-0.4
ONL_PCT	96.4	9.3	80.4	8.3	-16.0***

Table 2 Correlation coefficients

This table presents the Pearson correlation coefficients between all important variables for the pre-reform period (1996–2004) and for the post-reform period (2005 –2015) in Panel A and B, respectively. Refer to Appendix A for definitions of important variables.

A. Pre-IPO pricing reform (1996–2004)

	IR	OVSUB	AGE	PRCDS	PE	STATE	CMPTIPO	GAP
OVSUB	0.41***							
AGE	0.09**	0.15***						
PRCDS	-0.34***	-0.12***	-0.01					
PE	0.07*	0.15***	0.20***	0.27***				
STATE	-0.05	0.00	-0.42***	0.20***	-0.08**			
CMPTIPO	0.08*	-0.36***	-0.06	-0.11***	0.05	0.00		
GAP	0.11***	0.03	-0.04	0.06	-0.13***	0.06	-0.17***	
GAPMKTRET	0.06	-0.06	0.02	-0.11***	-0.04	-0.06	-0.10**	-0.09**

B. Post-IPO pricing reform (2005–2015)

	IR	OVSUB	AGE	PRCDS	PE	STATE	CMPTIPO	GAP	GAPMKTRET	SME
OVSUB	0.51***									
AGE	-0.16***	-0.15***								
PRCDS	-0.29***	-0.29***	-0.13***							
PE	-0.16***	-0.18***	-0.19***	0.28***						
STATE	0.14***	0.11***	-0.12***	0.34***	-0.13***					
CMPTIPO	-0.17***	-0.22***	0.26***	-0.15***	-0.16***	-0.13***				
GAP	0.18***	0.08***	-0.21***	0.00	0.09***	0.08***	-0.13***			
GAPMKTRET	0.09***	-0.08***	0.04*	-0.13***	-0.17***	-0.01	0.22***	0.13***		
SME	0.27***	0.29***	-0.15***	-0.14***	-0.06**	-0.08***	-0.31***	0.07***	-0.08***	
CHINEXT	-0.21***	-0.20***	0.08***	-0.20***	0.25***	-0.22***	0.18***	-0.04	0.02	-0.69***

Table 3 Results from two-step GMM estimations

Panel A presents results from the two-step GMM estimations of the simultaneous equations (Equation (1) and (2)). IR_PRED is the estimated initial returns from the first-stage regressions. OVSUB_PRED is the estimated online oversubscription ratio from the first-stage regressions. Standard errors are robust to heteroscedasticity. Refer to Appendix A for definitions of variables.

Panel B reports the result of statistical tests for endogeneity and weak instruments.

A. **GMM estimation results**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Demand effect				**Price effect**			
	96-04		05-15		96-04		05-15	
	STG1	STG2	STG1	STG2	STG1	STG2	STG1	STG2
	OVSUB	IR	OVSUB	IR	IR	OVSUB	IR	OVSUB
OVSUB_PRED		-0.05		0.09***				
IR_PRED						-18.16		-0.81
AGE	14.69***	3.94**	-14.78***	-0.24	3.21**	61.50	-1.52***	-15.85***
PRCDS	-78.69***	-43.58***	-265.65***	-5.84*	-39.69***	-745.90	-28.96***	-273.87***
PE	6.96***	2.29***	-3.45***	0.18*	1.95***	39.01	-0.12	-2.93***
STATE	87.96***	22.22**	410.81***	16.10	17.88*	422.53	51.84***	390.68***
SME			113.17***	-1.83			8.01*	106.91***
CHINEXT			-151.51***	-9.66***			-22.84***	-173.33***
CMPTIPO	-45.96***		-15.27***		2.27	-24.07	-1.33***	-17.25***
GAP	-0.14	0.48	4.63	1.54***	0.49		1.94***	
GAPMKTRET	-3.35***	0.24	-10.94***	1.74***	0.40		0.79**	
const	717.82***	319.54***	2319.58***	43.67*	284.09***	5996.90	245.46***	2471.82***
adj r-sqr (%)	22.5		24.9		16.8		25.4	
N	637	637	1,481	1,481	637	637	1,481	1,481

B. Tests for endogeneity, over-identification and weak instruments

	Demand effect		Price effect	
	96-04	05-15	96-04	05-15
Durbin-Wu-Hausman chi-sq test for endogeneity				
Null	OVSUB is exogenous to IR	OVSUB is exogenous to IR	IR is exogenous to OVSUB	IR is exogenous to OVSUB
Chi-sqr	44.60	7.46	2.85	7.20
p-value	<0.001	<0.01	<0.09	<0.01
Weak instrument test				
Null	weak instrument	weak instrument	weak instrument	weak instrument
Confidence level	1%	1%	25%	1%

Table 4 Hot and cold IPO markets

This table presents estimations for the demand effect in the hot and cold IPO markets in China's A-share markets as defined by Güçblimez (2015).

	(1)	(2)	(3)	(4)
	Demand effect			
	2010(hot)		2011-13(cold)	
	STG1	STG2	STG1	STG2
	OVSUB	IR	OVSUB	IR
OVSUB_PRED		0.21**		0.21***
IR_PRED				
AGE	1.50**	0.85*	0.52	-0.13
PRCDS	-74.67***	-7.68	-78.00***	-14.56***
PE	-0.16	0.20*	1.19***	-0.28***
STATE	41.15**	39.41***	11.23	14.64
SME			-16.51	-21.57***
CHINEXT			-48.79***	-26.47***
CMPTIPO	-9.59***		-9.54***	
GAP	-5.70***	0.09	1.10	-0.59
GAPMKTRET	-1.83***	1.53***	-1.88**	2.32***
const	802.44***	39.89	648.13***	130.54***
adj r-sqr (%)	46.1		34.1	
N	345	345	425	425

Table 5 Results from simple OLS regressions

This table presents regression results for IPOs in the pre-reform period and the post-reform period. Standard errors are robust to heteroscedasticity. Refer to Appendix A for variable definitions.

	Demand effect		Price effect	
	96-04	05-15	96-04	05-15
	(1)	(2)	(3)	(4)
	IR	IR	OVSUB	OVSUB
OVSUB	0.11***	0.04***		
IR			1.26***	3.30***
AGE	1.07	-1.06***	10.73***	-8.86***
PRCDS	-33.73***	-17.56***	-25.97***	-161.00***
PE	1.34***	0.04	4.90***	-2.52***
STATE	8.38	37.66***	67.10**	236.94***
SME		7.41**		100.00***
CHINEXT		-15.19***		-66.31**
CMPTIPO			-45.72***	-12.89***
GAP	0.41	1.86***		
GAPMKTRET	0.54	1.09***		
CONST	250.42***	138.28***	294.63***	1400.93***
adj. r-sqr (%)	27.6	35.0	34.9	33.5
N	637	1,481	637	1,481