Saving Speculative Markets from the Speculators *

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Abstract

We examine important consequences of investor preference for stocks with lottery-like payoffs. Specifically, the participation of investors seeking lottery-like payoffs increases the demand for Initial Public Offerings (IPOs), thus increasing IPO prices and potentially affecting firms' decision to go public. Our study is based on a natural experiment, in which the price moves of newly-listed IPO stocks are restricted within a narrow range, reducing the short-term upside potential for investors and limiting their ability to gamble. Pursuant to the introduction of these restrictions, investors with a preference for lottery-like payoffs reduce their participation in IPOs and their net buying in the IPOs' aftermarket. The reduced aftermarket demand is followed by an increase in subsequent returns of IPO firms, consistent with reduced asset prices. We also document a disappearance of IPOs most affected by the imposed price restrictions. Our overall findings shed new light on the role of speculative investors in equity markets, suggesting that the participation of such investors may increase prices in a market generally afflicted by high asymmetric information problems.

JEL classification: G11, G12, G15, G18, G40
Keywords: Speculative trading, trading restrictions, asset prices, IPOs

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1. Introduction

In January 2012, the Securities Exchange Board of India (SEBI) imposed pre-determined price bands on Initial Public Offering (IPO) stocks, for ten days post-listing.[1] Under the new rules, daily returns are effectively bound within a ±5 percent range for smaller IPOs (proceeds below INR 2.5 billion), and within a ±20 percent range for larger IPOs (proceeds greater than INR 2.5 billion).[2] The decision to implement a new framework of IPO trade controls, and in particular price bands, was in response to "high volatility and price movement observed on first day of trading" (SEBI circular CIR/MRD/DP/02/2012 dated January 20, 2012).

An IPO firm's stock price is naturally uncertain. Firms going public usually have a relatively short history and a limited availability of public information.[3] The uncertainty is reflected in the high price variability of IPO stocks, especially in the first several days of trading. For instance, Miller and Reilly (1987) and Asquith, Jones, and Kieschnick (1998) find that price volatility and skewness are relatively high immediately after the IPO stocks' listing. Existing research (Green and Hwang, 2012) has pointed out that the highly uncertain returns of IPO stocks in the initial days of trading could be attractive to investors with a preference for lottery-like payoffs. That is, there may be investor demand for assets delivering unusually high payoffs, albeit with a low probability.

The idea that attitudes towards gambling may have important ramifications for economic activity dates back to Friedman and Savage (1948) and Markowitz (1952). Motivated by these early ideas, recent theoretical and empirical research in finance focuses on the possible

[1] SEBI is the Indian equivalent of the US Securities and Exchange Commission.

[2] INR 1.00 billion could be exchanged for approximately USD 15.66 million at the end of our sample (i.e., December 29, 2017).

[3] While investment banks expend effort in discovering the demand for the shares, and price the IPO accordingly, this process still leaves information out of prices, information that the market incorporates in the initial days of trading.

consequences of investor preference for lottery-type stocks. The literature, which we review later, has produced the general insight that investors' preference for lottery-type stocks is associated with such stocks being priced at a premium and earning relatively low subsequent returns. Empirical studies have validated this insight and have provided significant evidence that, when compared to other investor groups, retail investors display a stronger preference for lottery-type stocks.

Motivated by existing literature on investor attitudes towards gambling, we use the unique opportunity provided by the regulatory changes in the Indian IPO market to examine how these changes affect (1) the distribution of returns for IPO stocks in the initial days of trading, (2) the demand for IPOs, (3) the trading behavior of retail investors in the post-IPO period, (4) IPO prices and expected returns, and (5) the types of firms going public.

Our main findings are summarized as follows. First, post regulation (relative to pre regulation) we find a pronounced decline in price variability for IPO stocks on their first day of trading. Moreover, IPO stocks post regulation provide a significantly lower upside potential relative to IPO stocks pre regulation. For instance, when we compare the daily high price to the daily open price, we find that one of five IPOs in the pre-regulation period experienced an intraday price movement in excess of 20 percent. In contrast, due to the strict price controls, no IPO experienced an intraday price move in excess of 20 percent in the post-regulation period.

Second, we find that the retail demand for IPO stocks, measured by the subscription rates of retail investors, has declined significantly from the pre-regulation to the post-regulation period. Third, when we examine the buying and selling activities for different investor types on the first day of trading, we find a significant drop in net buying by retail investors after the new regulations take effect. For example, retail investors were net buyers in the pre-regulation period, but they

became significant net sellers in the post-regulation period. Moreover, retail investors used the pre-market call auction introduced in the post-regulation period to sell a disproportionate amount of their IPO allocations.

Our fourth set of results pertains to both the first-day returns of IPO stocks and their subsequent one-year returns. While we do not find a discernable difference in IPO first-day returns between the two regimes, we find significant evidence of higher expected returns, and thus lower market prices post regulation, compared to the pre-regulation period. Based on estimates from a four-factor model, the monthly alpha of IPO stocks in the pre-regulation period is around -1.2 percent, leading to an excess return of around -13.5 percent per year. In stark contrast to the underperformance of IPO stocks pre regulation, IPO stocks in the post-regulation period earn a monthly excess return of around 1.5 percent, or around 19.5 percent per year.

For our final analysis, we examine the distribution of IPO sizes across the two regimes. We document a sharp decline in IPOs raising less than INR 2.5 billion and listing on the main exchanges. These are the very types of IPOs that are most affected by the new rules. For example, around 80 percent of all IPOs pre regulation, had issue proceeds below INR 2.5 billion. The corresponding proportion is reduced to 20 percent in the post-regulation period. One might reasonably conjecture that the documented trend is due to an overall decline in the supply of smaller IPOs. However, during the post-regulation period, the alternate Small and Medium Enterprises (SME) exchange witnessed an active market for small IPOs, with at least 327 IPOs listing on the SME exchange during the post-regulation sample period.[4] Importantly, none of the 327 IPOs had offer proceeds in excess of INR 2.5 billion.

[4] India's Small and Medium Enterprises (SME) exchange, established in 2008, is intended to list small and medium sized companies (i.e., companies whose post issue paid-up capital is less than or equal to INR 250 million, or around USD 4 million). The SME exchange allows small firms to raise capital and, once they grow, move onwards to the main exchanges.

Our study contributes to several aspects of the related literature. We contribute to the literature originating from Friedman and Savage (1948) and Markowitz (1952) that is concerned with individual attitudes towards gambling. In this respect, we provide direct evidence of how changes in the distributional properties of stock returns affect investor demand and trading behavior. We also contribute to prior research examining the effects of investor sentiment on the demand for, and pricing of, IPO stocks (Derrien, 2005, Green and Hwang, 2012). Our study also extends a third strand of literature that examines the ability of financial regulators to curb speculation by imposing price limits (see Kim and Rhee, 1997). In this respect, we explore the relevance of price limits for newly listed IPO stocks, and provide a different perspective from the one offered in prior literature, which typically focuses on the general population of stocks. Our paper also contributes to the literature examining the activity of primary equity markets, where several studies propose that firms prefer to go public when investor sentiment and optimism are high (e.g., Lee, Shleifer, and Thaler, 1991; Loughran, Ritter, and Rydqvist, 1994; Ljungqvist, Nanda, and Singh, 2006; Santos, 2017). Finally, our paper contributes to literature examining the importance of investor gambling preferences for their participation in financial markets (e.g., Dorn, Dorn, and Sengmueller, 2015; Gao and Lin, 2015, Cookson, 2018).

2. Literature review and hypotheses development

2.1. Lottery-like payoffs, investor demand, and equity prices

Economists have long proposed that individual attitudes toward gambling, particularly a preference for lottery-like payoffs, may have important ramifications for economic activity (Friedman and Savage, 1948; Markowitz, 1952). Growing theoretical and empirical research in

finance examines investor preferences for lottery-type stocks, i.e., stocks with a low probability of delivering unusually high payoffs.

On the theoretical side, Shefrin and Statman (2000) develop a positive behavioral portfolio theory in which, consistent with Friedman and Savage (1948), investors' optimal portfolios resemble combinations of bonds and lottery tickets. Brunnermeier and Parker (2005) and Brunnermeier, Gollier, and Parker (2007) present models in which agents experience higher utility under a small optimistic bias, compared to that under rational expectations. In a portfolio choice example, such investors exhibit a preference for individual assets with positive skewness. Consequently, positively skewed assets tend to sell at a premium and deliver lower returns, relative to assets with symmetric returns. Mitton and Vorkink (2007) present a single-period model, in which different investors have different preferences for skewness. In their model, some investors are willing to hold assets with increased skewness exposure even though holding such assets compromises mean-variance optimality, thus leading to a price premium for idiosyncratic skewness. In another study, Barberis and Huang (2008) explore a model based on cumulative prospect theory and derive a novel equilibrium in which, again, a security's skewness is priced.

Other theoretical advancements predict an individual preference for volatile stocks. Barberis and Xiong (2012) present a "realization utility" model wherein a stock with a highly variable price provides the possibility of a large profit. Realizing this profit immediately gives utility to the investor. If the stock drops in value instead, the investor postpones selling the stock. Hence, realized losses are in the distant and, importantly, discounted future. In a study of the neural activity of agents within an experimental market, Frydman et al. (2014) find evidence consistent with Barberis and Xiong (2012). Baele et al. (2019) develop a model with cumulative prospect

theory preferences where investors prefer high volatility stocks, and such stocks trade at a premium.[5]

Empirical studies also provide substantive evidence that (a) some investors, especially retail investors, display a preference for lottery-type stocks, (b) gambling preferences increase investor participation in financial markets, and (c) lottery-type stocks tend to earn relatively low subsequent returns. With regards to investor preferences, Kumar (2009) finds that retail investors, relative to institutional investors, exhibit a greater preference for stocks with lottery-like characteristics, i.e., low-priced stocks and stocks with high idiosyncratic volatility and skewness. Further tests provide evidence of a link between gambling attitudes and the documented retail investor preferences for lottery-type stocks (Kumar, Page, and Spalt, 2011 and 2016). Using data for 1,000 German brokerage clients, Dorn and Sengmueller (2009) also find evidence of a link between investor gambling attitudes, and a preference for positive skewness. Han and Kumar (2013) show that stocks where retail trading is more pronounced, especially trading by retail investors with a propensity to gamble, have lottery-like characteristics.

Based on natural experiments, studies by Dorn, Dorn, and Sengmueller (2015), Gao and Lin (2015), and Cookson (2018) provide significant evidence that gambling preferences encourage investor engagement in financial markets. Dorn, Dorn, and Sengmueller (2015) examine the increase in the jackpots of U.S. multistate lotteries and find that such increases are accompanied by significant reductions in small trades in the stock market. Gao and Lin (2015) examine lottery jackpots in Taiwan and find that when these jackpots reach abnormally high levels, the trading volume in lottery-like stocks declines significantly. Cookson (2018) examines the introduction of

[5] For the theoretical models to have an empirical bite, it is assumed that there is a limited supply of assets with lottery-like payoffs or an insufficient number of other investors with more standard utility functions.

prize-linked savings accounts in Nebraska and finds a concurrent reduction in gambling in casinos in the affected counties.

With regards to asset prices, Bali, Cakici, and Whiteclaw (2011) examine extreme positive returns and find that the maximum daily return over the previous one-month period is negatively related to subsequent stock returns.[6] Fong and Toh (2014) show that the Bali, Cakici, and Whiteclaw (2011) effect depends on investor sentiment, defined as investors' propensity to speculate. Several studies also find that stocks with high positive skewness deliver significantly negative alphas to investors. These findings are evident for expected skewness based on a predictive model (Boyer, Mitton, and Vorkink, 2010), for *ex ante* skewness estimated from option prices (Conrad, Dittmar, and Ghysels, 2013), for realized skewness (Amaya et al., 2015), and for a stock's exposure to market skewness (Chang, Christoffersen, and Jacobs, 2013). Eraker and Ready (2015) further study returns of over-the-counter (OTC) stocks, and find that the returns of these stocks are both highly positively skewed and extremely negative, on average. At the market level, Jondeau, Zhang, and Zhu (2019) find that skewness of the average stock is able to predict future market returns.[7]

Several studies that examine the relation between stock returns and investor preferences for lottery-type stocks focus on the ability of such a relation to explain other well-documented patterns in stock returns, such as the beta anomaly (see Bali et al., 2017) and the idiosyncratic volatility puzzle of Ang et al. (2006) (see Bali, Cakici, and Whiteclaw, 2011; Hou and Loh, 2016). Building on Campbell, Hilscher, and Szilagyi (2008), Conrad, Kapadia, Xing (2014) find that stocks with a

[6] Hung and Yang (2018) modify the measure of Bali, Cakici, and Whiteclaw (2011) for markets with price limits. The evidence based on the modified measure corroborates the core findings in Bali, Cakici, and Whiteclaw (2011).

[7] Bergsma and Tayal (2019) find that lottery-like stocks produce lower (higher) future returns when relative short interest is higher (lower).

high ex ante probability of default are also likely to produce abnormally high payoffs, which could explain the relatively high retail ownership and relatively low returns of high default stocks.[8]

Prior research has also pointed out that Initial Public Offerings (IPOs) produce highly uncertain returns in their initial days of trading (Miller and Reilly, 1987; Asquith, Jones, and Kieschnick, 1998), and thus could be attractive to investors with a preference for lottery-type payoffs. Green and Hwang (2012) document a significantly positive association between IPO first day returns and expected skewness, especially when investor sentiment is high. Further, IPOs with high expected skewness experience long-run negative abnormal returns. Green and Hwang (2012) also document that higher skewness is positively related with a greater fraction of smaller-sized trades on the first day of trading, evidence consistent with a transfer of IPO stock from institutions to individuals.

Wang et al. (2018) use a sample of IPOs in China and find that IPOs with higher (lower) positive skewness in returns produce higher (lower) first-day returns, a finding consistent with higher (lower) demand for such IPOs.

2.2. Price limits

Price limits in stock markets have received little interest from theoretical research.[9] This is perhaps not surprising, because under the efficient market hypothesis, restricting prices within pre-determined bands is unwarranted. Price limits not only provide no benefit if markets are efficient,

[8] In addition to stock prices, Byun and Kim (2016) examine the pricing of call options conditional on the lottery-like characteristics of the underlying stocks. They find that call options on lottery-type stocks have lower future returns, compared to call options on other stocks, and deviate from the put-call-parity, suggesting that these options are overpriced.

[9] Brennan (1986) provides a strong theoretical foundation for the existence of price limits in futures markets, where limits are used in lieu of costlier margin requirements to ensure contract compliance. Kodres and O'Brien (1994) further examines the effects of price limits in futures markets when there is implementation risk due to high price volatility and a gap in time between the decision to trade and the actual trade.

they also impose trading frictions that hinder price discovery and may reduce stock market liquidity, thus detracting from the value of the firm.[10]

Early empirical studies have focused on the general effectiveness of price limits in curbing excess volatility. Ma, Rao, and Sears (1989) report evidence that, following days when price limits are reached, prices tend to either stabilize or reverse direction and price variability tends to decline. While Ma, Rao, and Sears (1989) interpret these findings as being consistent with price limits providing a "cooling-off" period, Lehmann (1989) and Miller (1989) propose an alternate explanation. They posit that volatility is mean-reverting so that days with relatively high volatility, which are also days when stocks hit their price limits, are naturally followed by days with relatively low volatility. Further studies based on the Tokyo Stock Exchange (Kim and Rhee, 1997) and the Taiwan Stock Exchange (Kim, 2001) fail to find evidence that price limits lead to a reduction in volatility.[11]

One important caveat is that unlike the studies cited above, which draw their conclusions by examining the general population of stocks, in this study we focus on IPO stocks immediately following their listing. As discussed in Section 2.1 above, the return characteristics of IPO stocks, especially during their initial days of trading, differ substantially from those of the general population of non-IPO stocks. Therefore, we note that our findings, pertaining to the effects of price limits on price variability, should be interpreted within the confines of our setting. More importantly, it must be noted that our unique setting allows us to explore the ramifications of price limits in the presence of speculative investors, and assets with highly uncertain payoffs.

[10] The evidence presented in Chan, Kim, and Rhee (2005) is consistent with these predictions. In a deviation from these idea, Kim and Park (2010) derive a simple model in which price limits deter market manipulators by restricting their profits from price manipulation.

[11] Deb, Kalev, and Marisetty (2010) find price limits may be beneficial in markets with high costs of monitoring market quality.

2.3. Testable hypotheses

Building on prior literature, we develop five testable hypotheses that relate the introduction of price bands for IPO stocks to several aspects of the IPO market in India. The first hypothesis is directly motivated by the literature on price limits discussed in the previous section, and relates the presence of price bands to the variability of stock prices.

Hypothesis 1: *On the first day of trading after an IPO, we expect a lower variability of IPO prices in periods when price bands are in effect, relative to periods when price bands are not in effect. As a corollary, we expect the upside return potential of IPO stocks on the first day of trading to be lower when price bands are in effect, compared to periods when price bands are not in effect.*

To derive our second hypothesis, we rely on prior literature documenting retail investors' strong preference for stocks exhibiting lottery-like payoffs, i.e., stocks with a small probability of a relatively high return. When IPO prices are allowed to vary without constraints, IPO stocks possess lottery-like payoffs (Green and Hwang, 2012), making them attractive to retail investors. Given that the new rules substantially reduce the upside return potential, IPO stocks lose their lottery-like payoff structure and should become less attractive to retail investors.

Hypothesis 2: *We expect lower demand by retail investors for IPO stocks in periods when price bands are in effect, relative to periods when price bands are not in effect.*

It is a well-established fact that, on average, IPO stocks are underpriced; that is, the offer prices are typically lower than post-IPO market prices. Given that IPO underpricing allows investors to garner positive returns over a short period of time, many investors seek to participate in the primary offering, and gain from IPO underpricing. Even in the presence of price limits, IPO

underpricing may provide incentives for investors with a preference for lottery-like payoffs to participate in IPOs. However, price limits, by restricting the upside potential, reduce the incentives for such investors to hold on to their IPO allocations, or to buy shares in the IPO aftermarket. Instead, in the presence of price limits, investors with a preference for lottery-like payoffs will either be unwilling to buy the IPO stock, or even if they do, they will seek to sell their IPO allocations as soon as the first-day return can be realized. Because investors without a preference for lottery-type stocks are not as sensitive to the reduced upside potential, and because for every seller there has to be a buyer, the opposite expectation holds for investors without a preference for lottery-type stocks. This line of reasoning gives rise to our third hypothesis.

Hypothesis 3: *In the IPO aftermarket on the first day of trading, we expect less net buying by retail investors in periods when price bands are in effect, relative to periods when price bands are not in effect. As a corollary, we expect more net buying by institutional investors in periods when price bands are in effect, relative to periods when price bands are not in effect.*

Our fourth hypothesis relates the presence of price limits to equity prices. We derive this hypothesis based on several studies, discussed in Section 2.1, which find that stocks with lottery-like payoffs receive higher market valuations and subsequently experience lower returns. If IPO stocks lose their lottery-like payoff structure when price limits are imposed, we expect reduced valuations and increased subsequent returns. These arguments can be applied to derive predictions for both the IPO first-day returns (Hypothesis 4B) and their subsequent long-run returns (Hypothesis 4B).

Hypothesis 4A: *We expect lower first-day IPO returns in periods when price bands are in effect, relative to periods when price bands are not in effect.*

Hypothesis 4B: *We expect lower market prices, and thus higher subsequent returns, of freshly listed IPO stocks in periods when price bands are in effect, relative to periods when price bands are not in effect.*

The four hypotheses derived above focus on investor demand for IPO stocks and on firm value and subsequent returns. However, a decline in investor demand for IPO stocks and a decline in IPO valuations should result in a change in firms' incentives to issue equity to public investors. To investigate this possibility, we examine the activity of the Indian IPO market conditional on the *presence* and *severity* of price limits. We use a unique feature of our empirical setting which allows us to identify IPOs most affected by the new price limit rules (discussed in the next section). Since such IPOs are most likely to experience reduced incentives to list on the main exchanges, we derive our final hypothesis for these IPOs.

Hypothesis 5: *For IPOs most affected by the new price band rules, we expect fewer IPOs in periods when price bands are in effect, relative to periods when price bands are not in effect.*

3. Institutional setting

In January 2012, the Securities Exchange Board of India (SEBI) imposed trading controls for IPO firms listing on the two main exchanges, namely the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE). According to the new trading restrictions, the price of IPO firms with proceeds less than INR 2.5 billion are allowed to fluctuate within a ±5-percent price band around the opening price of the day, during normal trading sessions for the first 10 days after listing. The price band is widened to ±20 percent for larger IPOs raising more than INR 2.5 billion. The decision to implement a new framework of IPO trade controls, and especially price bands,

was in response to "high volatility and price movement observed on first day of trading" (SEBI circular CIR/MRD/DP/02/2012 dated January 20, 2012). The imposed price controls do not require trading stops if prices reach the prescribed limits. Accordingly, investors are permitted to trade at the price limits.

To provide an example of the price limits discussed above, Figure 1 plots the daily prices of two IPOs in our sample. The first IPO, plotted in Panel A, was conducted by Advanta India Ltd on April 19, 2007, when the prices of IPO stock were not constrained by price bands. The second IPO, plotted in Panel B, was conducted by Cochin Shipyard Ltd on August 11, 2017, when the discussed price bands were in effect. As is evident from the figure, the stock price of the first IPO is unconstrained throughout the day. In contrast, the price of the second IPO reaches its 20 percent price limit early in the trading day, thus severely limiting further price movement.

[Insert Figure 1 about here]

To facilitate price discovery, concurrently with the rules restricting price moves, SEBI also introduced a pre-trading session, conducted as a call auction. The pre-trading session for IPO stocks is conducted only on the first day of listing and has a duration of 60 minutes, from 9:00 a.m. to 10:00 a.m.[12] In the pre-trading session, traders enter their orders starting at 9.00 a.m. The process is randomly stopped between 9.44 a.m. and 9.45 a.m. Between 9.45 a.m. and 9.55 a.m., equilibrium prices are determined, orders are matched, and trades are confirmed. The time between 9.55 a.m. and 10.00 a.m. is used to ensure a timely start of the regular trading session at 10:00 a.m. The open price for the regular session is set to the equilibrium price in the pre-market auction. If an equilibrium price is not obtained, the offer price is used as the open price for the day. Appendix A provides a more detailed description of the pre-market auction for IPO stocks.

[12] Since October 2010, the Indian stock market uses pre-open sessions between 9:00 a.m. and 9:15 a.m. for all stocks listed on the NSE and the BSE.

4. Sample description

4.1. Sample and variables

The starting sample contains 431 IPOs listing between 2006 and 2017 on the main Indian exchanges, namely the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE), implying that there are around 36 IPOs per year, on average. We obtain the sample from Prime Database, a private agency which provides comprehensive data on the Indian primary capital markets. Of the 431 IPOs, 393 (or more than 90%) were priced using bookbuilding, while the remaining 38 IPOs were priced using a fixed price method.[13] To ensure that the pricing mechanism is consistent across our sample, the majority of our analysis is focused on the 393 bookbuilt IPOs. For a part of our analysis, we further examine IPOs listed on the Small and Medium Enterprises (SME) exchange between 2012 and 2017. This sample is also obtained from Prime Database and contains 327 IPOs between 2012 and 2017, or around 54 IPOs per year, on average.

Our study makes use of unique and proprietary trading data, provided by the Bombay Stock Exchange (BSE). For each IPO stock in our sample, the BSE data contains detailed information on each trade for the first day of trading. Specifically, for each trade, the data includes the time stamp, the price and the quantity traded, and the type of investor buying as well as the type of investor selling the stock. Within this data, investors fall into three general types, namely institutional investors, individual investors, and non-individual investors. Institutional investors are mainly banks, mutual funds, and foreign institutional investors, while non-individual investors are mainly corporations, partnerships, and joint family (Hindu undivided families) accounts.[14]

[13] The overwhelming adoption of bookbuilding in India is also discussed in Clarke et al. (2016), who point out that, by 2006, more than 80% of Indian IPOs adopted the bookbuilding mechanism.

[14] Appendix C provides the full list of investor categories, as obtained from the Bombay Stock Exchange (BSE). The appendix also provides the relative trading activity of each investor category for the first day of trading in our IPO sample.

Prime Database provides information for several key IPO characteristics, such as offer price, shares offered, underwriter reputation, number of managers, venture capital (VC) backing, and post-IPO number of shares outstanding. To measure the market capitalization of the firm, we use the offer price multiplied by the post-IPO number of shares outstanding. Prime Database also provides information on subscriptions and allocations for five investor types, namely qualified institutional buyers, retail investors, high-net-worth individuals, employees, and existing shareholders.

To take into account firm characteristics related to profitability, leverage, growth opportunities, and uncertainty, we collect additional data from the Center for Monitoring Indian Economy's (CMIE) *Prowess* database. The CMIE data includes firms' total assets, total liabilities, and net income as of the IPO year. To measure profitability, we use return on assets (ROA), calculated as net income divided by total assets; to measure leverage, we use the debt-to-assets ratio, calculated as total liabilities divided by total assets; and to measure growth opportunities, we use the *Q* ratio (i.e., the market-to-book ratio of assets), calculated as the market capitalization of equity plus total liabilities, all divided by total assets. For 10 observations, the necessary data are missing in CMIE *Prowess*, and for these we obtain the data from Bloomberg. CMIE's *Prowess* database also provides data on each firm's year of incorporation, which we use to calculate the age of the firm at IPO, measured as the number of years since incorporation.

We obtain stock returns data from two separate sources. Daily returns for the post-IPO month are obtained from CMIE's *Prowess* database, whereas monthly returns for the 12 months following the IPO are obtained from the BSE. For some of our analysis we use the monthly returns on the market, size, and value factors of Fama and French (1993) and the momentum factor of Carhart (1997). The factor returns are calculated for the Indian equity markets and are adjusted for

survivorship bias. As a risk-free rate, we use the 91-day T-bill rate, sourced from the Reserve Bank of India's weekly auction data.[15] In addition to the factor returns, we gather data from Bloomberg on S&P CNX Nifty, an index composed of 50 firms listed on the NSE, to measure the market conditions at the time of each IPO.

4.2. Descriptive statistics

Table 1 provides descriptive statistics of the variables related to firm, offer, and market characteristics for our sample. For convenience, Appendix B outlines the construction of each variable used in the paper. The average IPO firm has a market capitalization, calculated at the offer price, of INR 55.5 billion, with a standard deviation of INR 129.3 billion.[16] The market capitalization of IPO firms is highly positively skewed, so that the median of INR 12.2 billion is substantially smaller than the mean. The average IPO offers around 26.4 percent of the post-IPO shares outstanding, with an average offer amount of INR 8.8 billion and an average offer price of INR 249.4.

[Insert Table 1 about here]

Firms in our sample are profitable, with an average return on assets (ROA) equal to around 7.6 percent. Examining the debt-to-assets ratio, we find that the total liabilities of the average firm in our sample are around 84.4 percent of its total assets. The *Q* ratio for the average firm is around 2.4, indicating that Indian IPO firms are expected to find significant growth opportunities in the future. The majority of firms in our sample have existed for at least a decade before going public.

[15] For details of the methodology see Agarwalla, Jacob, and Varma (2013). The returns on the four factors as well as the corresponding returns on a risk-free asset are available at https://faculty.iima.ac.in/~iffm/Indian-Fama-French-Momentum/.

[16] All amounts are expressed in constant 2017 Indian rupees, using India's consumer price index (CPI). We obtain the CPI from https://data.oecd.org/price/inflation-cpi.htm.

For example, the first quartile of firm age is 17 years, with the average firm waiting for around 24.8 years after incorporation before offering its equity to public investors.

Venture capital participation is not common within our sample, as only around 12 percent of our sample IPOs report VC backing. The majority, or 55 percent, of the IPOs are underwritten by highly reputable lead underwriters with the average IPO employing the services of around 2.5 managers. Finally, the return on the S&P CNX Nifty index over the 3 months prior to IPO is around 4.3 percent for the average IPO. Given that the average 3-month return of the S&P CNX Nifty index over our sample period is around 3.5 percent, firms in our sample appear to time their IPOs following favorable market performance, although the effect is modest.

5. Empirical approach

Our empirical approach relies on comparing several key variables related to price variability, investor demand, investor trading activity, and asset prices for IPOs conducted in the pre-regulation period and those conducted in the post-regulation period. To control for other confounding effects, such as the types of firms going public in the two periods, we use a propensity score matching approach, which we implement in two stages. In the first stage, we estimate a probit regression where the dependent variable is whether an IPO was conducted in the post-regulation period. As explanatory variables we use important firm, offer, and market characteristics discussed in the previous section. The estimates from the probit regression are reported in Table 2, Panel A.

[Insert Table 2 about here]

Examining the estimates from the probit regression, we find that, compared to pre-regulation IPOs, post-regulation IPOs offer a larger fraction of the firm, set higher offer prices, are younger, are more likely to be backed by VC firms, use more reputable lead underwriters, use more managers, and are conducted following lower returns on the S&P CNX Nifty index. The

propensity score matching approach allows us to identify matches based on these multiple relevant dimensions.

To create matched samples of treated (post-regulation) and control (pre-regulation) IPOs, we use the estimated propensity scores to identify the closest match. We further impose a caliper of 0.2 standard deviations of the propensity score to ensure the matched samples are comparable. Our main sample contains 96 IPOs post-regulation and 297 pre-regulation IPOs. The described procedure yields a sample of 87 IPOs from the post-regulation period and their matched IPOs from the pre-regulation period.[17] For 9 of the 96 post-regulation IPOs, the procedure does not yield close matches.

In Table 2, Panel B we compare the firm, offer, and market characteristics between the post-regulation sample of 87 IPOs and the matched pre-regulation sample. We find that for all but one of the variables, the two samples are indistinguishable from each other. The only difference in the pre-regulation versus the post-regulation samples that is statistically significant (at the 0.10 level) is the difference between the average market caps within the two samples. The sample in the post-regulation period has a somewhat smaller market cap than the matched sample. Given our focus on the ability of investors to engage in speculation, using smaller firms should bias our findings against finding the hypothesized differences between pre-regulation IPOs and post-regulation IPOs.

Following Imbens and Wooldridge (2009) and Imbens and Rubin (2015), the panel further reports the normalized differences for each variable. For a given variable *X*, the normalized difference, Δ_X, between the post-regulation and the pre-regulation samples is calculated as

[17] We present and discuss our findings based on the closest match, selected with replacement. In additional tests we verify that our findings are robust when using 2, 3, or 4 matches and when matches are selected without replacement. Moreover, excluding IPOs conducted in 2008 and 2009 leads to similar findings. The findings from these alternative specifications are available from the authors.

$\Delta_X = \left(\bar{X}_{POST} - \bar{X}_{PRE}\right) \Big/ \sqrt{SD^2_{POST} + SD^2_{PRE}}$, where $\bar{X}_{POST}$ (SD_{POST}) and $\bar{X}_{PRE}$ (SD_{PRE}) are the means (standard deviations) of the variable for the post-regulation and pre-regulation samples respectively. As recommended by the above-mentioned studies, the normalized variables are all less than 0.25 in absolute value, indicating that the two samples are well-balanced.

6. Main findings

This section presents our main findings from tests of the proposed hypotheses. We start by comparing measures of price variability between the pre-regulation and post-regulation periods. We then follow with an examination of investor demand, investor trading behavior and valuation effects. At the end of the section we document a disappearance of medium-sized IPOs, i.e., IPO most affected by the new rules. For this final analysis, we further examine a sample of IPOs listing on the SME exchange.

6.1. Price variability

To test the validity of Hypothesis 1, we start our empirical analysis by examining the variability of IPO stock prices on the first day of trading. An important question we address here is whether the new regulations are restrictive enough to materially affect the price movements of stocks. For example, if the imposed price bands are sufficiently wide so that the majority of IPO stocks experience price variations well within the price bands, the effects of the new regulations may be negligible.

In Panel A of Figure 2 we plot, by year, the ratio of daily high prices to open prices for the first day of trading. The horizontal dashes represent the annual means of the high-to-open price ratio whereas the vertical bars delimitate the interquartile ranges of the annual distributions. Consistent with the prediction of Hypothesis 1, we observe a steep drop in daily high prices relative

to open prices in 2012 and in all following years. The clear decline in upward price moves shows that the new rules indeed imposed significant restrictions on the price variability of IPO stocks. In the pre-regulation period, daily high prices were around 21.0 percent higher than open prices, on average. In the post-regulation period, daily high prices were, on average, only 5.8 percent higher than open prices, representing a nearly four-fold drop in upside potential for investors.

[Insert Figure 2 about here]

In Panel B of Figure 2, we present a similar plot, now showing the daily low prices to open prices. Examining the plot, we find a reduction in downside variability, which again begins in 2012 and persists through all subsequent years. Prior to the regulation, daily low prices were around 12.7 percent lower than open prices, on average. In the post-regulation period, daily low prices were around 4.4 percent lower than open prices.

To provide a somewhat different view on the changes in price variability from the pre-regulation to the post-regulation periods, Panel C of Figure 2 plots the cross-sectional kernel density of the returns from open to close on the first day of trading. As can be seen from the figure, the upside return potential is capped at 20 percent post regulation, whereas returns in excess of 20 percent are common in the pre regulation period.[18]

One potential concern in interpreting these findings as consistent with lower price variability stems from the fact that the price bands are only effective over the first ten day of trading. It is possible that price variability increases substantially once the price bands are removed, thus potentially fueling speculative trading. To examine this possibility of subsequent volatility spillover effects, we calculate the cross-sectional standard deviations of daily returns over the first

[18] We note that the return is capped at 5 percent for IPOs with proceeds below INR 2.5 billion, which in general are the more uncertain IPOs and hence the IPOs with the greater price uncertainty.

30 trading days in the post-IPO period. Figure 2, Panel D, plots these cross-sectional standard deviations separately for IPOs in the pre- and post-regulation periods.

Examining Figure 2, Panel D, and focusing on the post-regulation IPOs, we find that return volatility declines over the first ten trading days after an IPO: from around 7.9 percent on day one to around 2.6 percent on day ten. As might be expected based on prior literature documenting spillover effects due to price limits, we do observe some increase in return volatility on the 11th trading day, to around 3.7 percent, after the price bands are removed. However, the increase in volatility is relatively small and short-lived as volatility declines again to around 2.3 percent on the following day and remains relatively stable at around 2.7 percent for the remainder of the trading days covered in the plot. Most importantly, over the first 30 trading days after an IPO, the cross-sectional standard deviation of daily returns is highest on the IPO day compared to any of the subsequent 29 trading days. These findings show that, even if removal of the price bands leads to a small increase in price variability, by the time the price bands are removed, uncertainty about the IPO firm has also declined. Hence, opportunities for speculative trading have also declined.

A notable observation from Figure 2, Panel D, is that IPOs in the pre-regulation period exhibit a much higher volatility on the first trading day (volatility of around 29.3 percent), which is consistent with the findings presented in Panels A, B, and C of the figure. The volatility for these IPOs also steadily declines over time, reaching a level of around 3.9 percent by the end of the 30-day period.

Another potential concern is that the types of IPOs have changed over time. Indeed, as shown in Table 2, the average IPO in the pre-regulation period differs across several dimensions, compared to the average IPO in the post-regulation period. To take into account a possible systematic shift in the types of firms going public on the main exchanges, we use the matched

sample approach described in Section 5. Specifically, we compare 87 post-regulation IPOs to their matched pre-regulation IPOs, based on several measures of price variability on the first day of trading. As one of our measures, we calculate the standard deviation of stock returns over 5-minute intervals.[19] As additional measures of price variability, we examine the stock's daily high price and daily low price in relation to the stock's open price. Another of our measures examines the difference between the daily high and low prices with respect to the midpoint of the two prices. Our final four measures capture whether the return of a stock from open price to high price exceeds 5%, 10%, 15%, or 20%.[20]

Table 3 reports the averages of these eight measures of price variability for the pre- and post-regulation IPO sub-samples, as well as the differences between the two sub-samples. For all eight measures, we find that price variability is significantly lower for post-regulation IPOs, compared to pre-regulation IPOs. Moreover, all differences are significant at the 0.01 level. For example, we find that the standard deviation of 5-minute returns is 1.05 percent for IPOs in the pre-regulation period and 0.76 percent for IPOs in the post-regulation period. We also find that the average high-to-open price ratio is around 1.13 in the pre-regulation period and a significantly lower 1.06 in the post-regulation period. These estimates show that, before the regulatory change, investors faced an upside potential of around 13.0 percent, on average; whereas after the regulatory change, the upside potential declined to around 6.0 percent, on average. A similar decline in price variability is also evident when we compare the low-to-open price ratios between the two periods. The percentage difference between the first-day high price and the first-day low price for pre-regulation

[19] Our findings are not sensitive to the choice of time interval. Measures of return volatility based on 1-minute or 2-minute intervals lead to similar conclusions.

[20] For these measures we use open prices rather than offer prices, which allows us to focus on the returns investors may earn by trading on the open market. Such returns are highly relevant because they allow for speculation on the secondary market of IPO stocks. In a subsequent section, we examine the returns investors may earn from purchasing IPO shares at the offer price.

IPOs is around 25.4 percent, on average. In contrast, the percentage difference between the high and the low prices is much lower, at around 9.8 percent.

[Insert Table 3 about here]

Examining the remaining four variables, we find that in the post-regulation period IPO investors are significantly less likely to earn returns in excess of 5%, 10%, 15%, or 20%. For example, in the pre-regulation period, more than one out of three IPOs experienced returns of 15% or higher, where returns are measured from the open price to the daily high price. In contrast, in the post-regulation period, only around one out of ten IPOs experienced returns of 15% or higher. As another example, in the pre-regulation period one out of five IPOs experienced returns of 20% or higher whereas virtually no IPO in the post-regulation period provided a return of 20% or higher.

The findings presented in this section provide strong support for Hypothesis 1, which states that the new regulations had a significant effect on dampening the price variability of IPO stocks on the first day of trading. The reduction in price movements should significantly limit investor opportunities to garner high returns on the first day of trading.

6.2. Investor demand for IPO stocks

According to Hypothesis 2, the demand for IPOs by retail investor should be lower in the post-regulation period compared to the pre-regulation period. To evaluate the validity of the hypothesis, in this section we examine how investor demand for IPO stocks differs between the two regulatory regimes.

In Table 4 we compare the subscription rates and allocation rates of different investor types between the pre-regulation and post-regulation periods. Examining the subscription rates, we find a significant decline in the subscription rate of qualified institutional investors. In the pre-regulation period, qualified institutional investors subscribed for, on average, approximately 36

times the shares originally allotted to them. In other words, for each share originally allotted to qualified institutional investors, these investors subscribed for 36.1 shares. The times subscribed ratio for qualified institutional investors in the post-regulation period declined to 12.6 times; the decline is statistically significant at the 0.01 level. We also find a decline in the subscription rate of retail investors, for which the times subscribed ratio drops from around 9.0 pre-regulation to approximately 4.7 post-regulation. The difference between the two subscription rates is also significant at the 0.01 level. The decline in the subscription rates by retail investors is consistent with Hypothesis 2.

[Insert Table 4 about here]

In contrast to qualified institutional investor and retail investors, high-net-worth individuals show an increased demand for IPO stocks. Prior to the regulatory change, high-net-worth individuals subscribed for nearly 49 times the shares originally allotted to them. After the regulations took effect, high-net-worth individuals subscribed for around 75 times the shares allotted to them. Examining the remaining two investor types, employees and existing shareholders, the subscription rate of employees is somewhat lower post regulation compared to pre regulation (or around 0.4 times versus 0.2 times). The subscription rates of existing shareholders do not show a significant difference between the two regimes.

The allocation rates, which are presented in the bottom half of Table 4, are relatively stable across the two regimes. We do find that allocations to high-net-worth individuals have increased from around 11.7 percent in the pre-regulation period to around 14.8 percent in the post regulation period. This is consistent with the increased demand by such investors, as evidenced by the increased subscription rates discussed above. We also find a lower allocation rate to employees,

from around 1.5 percent to around 0.7 percent, which is also consistent with the reduced demand by this investor type.

We do not find significant differences in the allocations to qualified institutional investors, when comparing the two regimes. In both regimes, qualified institutional investors were allocated around 54% to 55% of the IPO shares. Retail investors also received similar allocations between the two regimes, at around 30% to 31%. The explanation for the relatively stable allocation rates across the two regimes is that IPO share allocations are determined by specific regulatory guidelines in India. As long IPO are oversubscribed by each investor type (i.e., the subscription rates for each investor type are greater than 1.0), rules on allocations limit the variability of allocations over time and across IPOs. Allocations over the prescribed ratios are made only in the event one of the investor groups declines to pick up the shares allocated to that investor group.

The findings in this section are consistent with Hypothesis 2, according to which the demand by retail investors should be lower post regulation, compared to pre regulation. However, we also find an even larger decline in the demand by qualified institutional investors, a decline which is not directly predicted by the decline in price variability. However, it is possible that the demand by institutional investors is driven, at least in part, by retail investors' demand.

6.3. Investor trading behavior

In this section we test Hypothesis 3 by examining the buying and selling activity of institutional investors, individual investors, and non-individual investors. Since there is a seller for every buyer, and vice versa, we construct our measures of buying and selling activity by investor type in relation to all trading activity. The investor types for this data are derived from a different data source than the investor types for the subscription and allocation data. However, we are still

able to identify the trades by institutional investors and the trades by individual (i.e., retail) investors.

In this analysis we focus on the first day of trading because IPO stocks are most volatile on that day. As we show in Section 6.1, price variability declines steadily and significantly in subsequent days, especially for the pre-regulation period. Focusing on the first day of trading, therefore, should provide the sharpest tests for Hypothesis 3.

In Table 5, Panel A, we examine the overall trading activity on the first trading day after an IPO. Overall trading activity is often used as a measure of investor sentiment, and relatively high trading activity is considered to reflect high investor sentiment. Once again, we use the matched sample analysis to compare trading activity in the pre-regulation period to trading activity in the post-regulation period. We find a significant decline in the number of trades per minute post regulation. Specifically, there are around 502 trades per minute in pre-regulation; this number declines to around 247 trades per minute in the post-regulation period. The decline is both economically and statistically significant (at the 0.01 level) as trading activity drops in half. We find a similar significant decline in trading activity for the other two measures, namely the shares traded per minute relative to shares offered, and shares traded per minute relative to shares outstanding. For the second measure, for example, we find that shares traded per minute decline from around 0.11 percent of shares outstanding to around 0.01 percent of shares outstanding.

[Insert Table 5 about here]

In Table 5 we further examine the buy and sell volume (Panel B) and the number of buy and sell trades (Panel C) by investor type. Since our findings are similar across both panels, we focus our discussion on the buy and sell volume, as reported in Panel B of the table. We find that around 8.5 percent of all buy volume pre regulation is attributable to institutions, whereas 24.2 percent of

all buy volume post regulation is due to institutions. The increase of around 15.7 percentage points is statistically significant at the 0.01 level. The selling activity of institutional investors has remained relatively stable between the two regimes, at around 16.2 to 14.9 percent. Comparing the buying and selling trades, institutional investors were net sellers pre regulation, with net selling at around 7.7 percent, and were net buyers post regulation, with net buying of around 9.3 percent.

For individual investors, we find that their buying activity declined from around 50.2 percent pre regulation to around 36.0 percent post regulation. The decline of 14.2 percentage points is significant at the 0.01 level. We also find an increase in the selling volume due to individual investors, from around 47.1 percent pre regulation to around 52.1 percent post regulation. However, the increase in selling of around 3.0 percentage points is not significant at conventional levels. Therefore, pre regulation, the percentage of buying volume and the percentage of selling volume due to individual investors were approximately equal, leading to a stable net position by such investors. In contrast, post regulation, individual investors were net sellers, to the extent that their sell volume was around 16.1 percentage points higher than their buy volume. These findings provide support for Hypothesis 3, which predicts increased net selling by retail investors in the post-regulation period.

Examining the other two investor types, non-individual investors and other investors, we find that non-individual investors show stable net buying activity of around 6.5 percent pre regulation and around 6.3 percent post regulation. The group of other investors shows a slight increase in net buying activity of around 0.5 percentage points; however the estimate is not statistically significant.

Table 6 further examines the buying and selling activity of each investor type during the pre-market auction. To measure trading activity, we again use the buy-and-sell volume, as well as the

numbers of buy and sell trades by investor type. Given that the pre-market auction mechanism for IPO stocks was implemented in 2012, our sample for these tests covers the post-regulation period from 2012 to 2017. We find that, in the pre-market auction, individual investors were the main sellers, accounting for approximately 68.9 percent of all sell volume, and for around 82.5 percent of all sell trades. In terms of buying activity, individual investors accounted for around 38.4 percent of all buy volume, and for around 43.3 percent of all buy trades. When we examine the difference between buying and selling activities, we find that individual investors were net sellers both in terms of trading volume and number of trades, while the other three types of investors net buyers.

[Insert Table 6 about here]

In summary, the findings presented in this section provide significant support for Hypothesis 3, which predicts that, post regulation, individual investors increased their propensity to sell their IPO allocations immediately after the IPO. Moreover, we find significant evidence that individual investors also use the opportunities provided by the pre-market auction to sell their IPO allocations. The net selling by individual investors is met by a net buying by institutional and non-individual investors. The overall findings in this section are consistent with the idea that a reduction in speculative trading opportunities leads to a lower demand and thus to higher selling by retail investors. In the following sections, we examine the implications of such behavior for IPO prices by examining both IPO first-day returns and subsequent returns on IPO stocks.

6.4. IPO first-day returns

To examine the predictions of Hypothesis 4A, in Table 7 we compare the first-day returns for our samples of pre-regulation IPOs and post-regulation IPOs. While existing literature mainly uses offer-to-close returns, here we also examine offer-to-open returns, which allows us to

understand the effects on IPO first-day returns while excluding the returns incurred on the first day of trading (i.e., from open to close).

We initially examine the first-day returns using unmatched samples. Examining the numbers in Table 7, we find that, pre regulation, IPOs experienced offer-to-open returns of around 15.0 percent whereas, post regulation, IPOs experience offer-to-open returns of around 11.5 percent. In comparison, pre-regulation IPOs experienced offer-to-close returns of around 19.5 percent whereas post-regulation IPOs experienced offer-to-close returns of around 12.5 percent. While for both return measures IPOs in the post regulation period earn lower first-day returns compared to IPOs in the pre-regulation period, the differences are not significant at conventional levels.

[Insert Table 7 about here]

We reach similar conclusions when we examine the matched samples. We again find that first-day returns were higher in the pre-regulation period than in the post-regulation period. Comparing the returns from offer price to open price, for example, we find first-day returns of around 14.2 percent pre regulation and first-day returns of around 10.9 percent post regulation. However, again we do not find the differences to be statistically significant.

The overall findings of no discernable changes in IPO first-day returns between the two regimes are inconsistent with the predictions of Hypothesis 4A. One potential explanation for these results is that the bookbuilding method used in India, while providing no share allocation discretion to investment banks, provides substantial discretion to investment banks in pricing each IPO. It is possible that, when pricing an offering, investment banks take into account the aggregate demand for IPOs and adjust offer prices accordingly. Therefore, shifts in aggregate demand between the two regimes may not have led to changes in IPO first-day returns. Alternatively, according to some theories, IPO underpricing is a result of asymmetric information amongst the different market

participants (e.g., Rock, 1986; Benveniste and Spindt, 1989). If asymmetric information is similar between the two regimes, then IPO underpricing will remain similar.

6.5. One-year returns

While the reduced demand by retail investors in IPO stocks may not have led to changes in IPO first-day returns, it is possible that other valuation effects exist.[21] For example, speculation during the first days of trading should lead to increased market prices and reduced expected future returns. As proposed in Hypothesis 4B, a decline in speculative activity after the regulation should lead to reduced stock prices and increased expected returns. To shed light on this hypothesis, in this section we examine IPO returns over the following one year, again focusing on our matched sample of IPOs as discussed in Section 5.

In Figure 3, we construct two event-time portfolios, one based on pre-regulation IPOs and the other based on post-regulation IPOs. Each portfolio tracks the value of an INR 1.0 investment in an equally-weighted portfolio of IPO stocks over the one-year period post IPO. To account for market returns, we calculate the value of the investment in excess of the return on the market portfolio. Specifically, the value of the portfolio as of month m is calculated as $V_{P,m} = \prod_{t=1}^{m} \left(1 + R_{P,t} - R_{MKT,t}\right)$, where $R_{P,t}$ is the return of the portfolio in month t and $R_{MKT,t}$ is the return of the market in month t. As can be seen from the figure, IPOs in the pre-regulation period deliver negative abnormal returns so that the value of the portfolio declines and remains consistently below INR 1.0 over the following one year. In contrast, IPOs in the post-regulation period deliver positive abnormal returns so that the value of the portfolio increases over time.

[21] For example, Chan (2010) and Neupane and Poshakwale (2012) find that retail investor demand is positively related to IPO prices.

[Insert Figure 3 about here]

To account for additional factors that may affect IPOs differently in the pre- and the post-regulation periods, we further estimate monthly portfolio regressions using calendar time portfolios. Each month, the portfolio contains IPO stocks that listed on the main exchanges over the past 12 months. To model the returns of these portfolios, we use the three factors of Fama and French (1993) and the momentum factor proposed by Carhart (1997). Now we estimate the following portfolio regression model:

$$R_{p,t} - R_{rf} = \alpha + \beta_{MKT}\left(R_{MKT,t} - R_{rf}\right) + \beta_{SMB}R_{SMB,t} + \beta_{HML}R_{HML,t} + \beta_{MOM}R_{MOM,t} + u_{i,t}. \quad (1)$$

In the above model, $R_{MKT,t}$ is the monthly return on the market portfolio as discussed above, R_{rf} is the monthly return on the risk-free asset, and $R_{SMB,t}$, $R_{HML,t}$, and $R_{MOM,t}$ are the monthly returns on the size, value, and momentum factors respectively. The regression is estimated separately for IPOs conducted in the pre-regulation period and for IPOs conducted in the post-regulation period. To allow for comparison of factor sensitivities between the two regimes, we estimate the two subsamples using Seemingly Unrelated Regression (SUR). The estimates from the two regression equations and the differences are reported in Table 8.

[Insert Table 8 about here]

We find that IPO stocks in the pre-regulation period have a monthly alpha of around -1.2 percent, thus providing investors with an annualized excess return of around -13.5 percent. The underperformance of IPO stocks is consistent with existing studies based on IPO stocks in the U.S. (see, among others, Ritter, 1991 and Loughran and Ritter, 1995).[22] In stark contrast to the underperformance of IPO stocks in the pre-regulation period, IPO stocks in the post-regulation

[22] The documented underperformance is concentrated among relatively smaller companies.

period have a monthly alpha of around 1.5 percent, which leads to an annualized excess return of around 19.5 percent. These findings provide strong support for Hypothesis 4B that a reduction in speculative demand and in speculative net buying post-regulation has led to a reduction in the prices of IPO stocks and an increase in their expected returns.

Examining the estimates for the sensitivities, we find that factor sensitivities of IPO stocks have not changed significantly between the two periods. For example, the coefficient on the market factor equals 1.03 in the pre-regulation period and equals 1.13 in the post-regulation period, where the difference in coefficient estimates is not statistically significant. The stable factor sensitivities between the two regimes are informative for at least two reasons. First, they further confirm the comparability of the two matched samples. Second, they show that the market's overall view on the risks of IPO stocks has not changed across the two regimes.

6.6. The disappearance of medium-sized IPOs

For our final analysis we test Hypothesis 5 by examining in greater detail the distribution of IPO sizes between the two regimes. According to the proposed hypothesis, we expect a lower incidence of IPOs, which were most affected by the new rules. The analysis is augmented by an additional sample of IPOs listing on the SME exchange, which allows us to examine the Indian IPO market in its totality.

We first examine the incidence of IPOs with proceeds below INR 2.5 billion. The new rules provided for relatively stricter restrictions for such IPOs, such that the prices of these IPOs were allowed to vary only within a relatively narrow ±5 percent range. In comparison, the prices of IPOs with proceeds above INR 2.5 billion were allowed to vary within a wider ±20 percent range.

Examining Figure 4, Panel A, and the related frequencies presented in Table 9, we find a steep decline in the proportion of IPOs with proceeds below INR 2.5 billion. In the pre-regulation

period, around 71.0 percent of all IPOs raised proceeds below INR 2.5 billion. This proportion drop significantly (at the 0.01 level) to around 20.8 percent in the post-regulation period. In the *last* two years of our sample, 2016 and 2017, only 11 percent of the IPOs (or 6 out of 57) raised proceeds below INR 2.5 billion. This is in stark contrast to the *first* two years of our sample, 2006-2007, when 75 percent of the IPOs (or 107 out of 143) raised proceeds below INR 2.5 billion.

[Insert Table 9 about here]

One possibility is that firms in the Indian market have experienced a significant systemic growth over our sample period, so that relatively fewer small private firms exist in more recent years. To examine this possibility, we collect a sample of IPOs that listed on the SME exchange over the 2012-2017 period. With 327 IPOs, or around 54 IPOs per year on average, the SME exchange was highly active over that period. We find that all these IPOs raised proceeds lower than INR 2.5 billion. These findings demonstrate that there is no shortage of tiny firms willing to go public in more recent year.

To provide a direct comparison between the distribution of IPO proceeds between the two regimes and between the main and the SME exchanges, in Figure 4, Panel B, we plot the kernel densities of IPO proceeds for three subsamples. The first subsample contains all IPOs between 2006 and 2011 listing on the main exchanges; the second subsample contains all IPOs between 2012 and 2017 listing on the main exchanges; and the third subsample contains all IPOs between 2012 and 2017 listing on the SME exchange. Given that we are interested in a comprehensive set of IPO firms for this part of the analysis, we include both bookbuilt and fixed-price IPOs.

[Insert Figure 4 about here]

Examining the figure, we again observe that, post regulation, there is a sharp decline in IPOs raising below INR 2.5 billion and listing on the main exchanges. This finding is consistent with

Hypothesis 5. Of even greater interest is the apparent paucity of medium-sized IPOs on all exchanges. So even though the SME exchange has experienced an active IPO market during our sample period, most of these IPOs are small relative to the general sample of IPOs listing on the main exchanges. For instance, the first percentile of IPO proceeds for all IPOs listing on the main exchanges between 2006 and 2017 is equal to around INR 0.24 billion. Out of a total of 327 IPOs listing on the SME exchange, only 25 (or around 7.6 percent) raise proceed that are greater than that number. The disappearance of medium-sized IPOs could be explained by such firms facing significantly reduced valuations, whether they list on the main exchanges or on the SME exchange. As a result, these firms may choose to remain private.

7. Concluding remarks

We position this paper amidst a large and growing literature that documents that some investors, especially retail investors, show a strong preference for investments with lottery-like payoffs, and that such preferences affect both the trading behavior of investors and the prices of financial assets.

We conduct our empirical analysis relying on a natural experiment to examine several important features of IPO markets. In January 2012, the Securities Exchange Board of India (SEBI) introduced new rules that impose pre-determined price bands on Initial Public Offering (IPO) firms, for 10 days post listing. Under the new rules, daily returns are effectively bound within a ±5 percent range for smaller IPOs (proceeds less than INR 2.5 billion) and within a ±20 percent range for larger IPOs (proceeds greater than INR 2.5 billion). In addition to reducing price variability, the imposed price restrictions effectively reduced the short-term upside daily potential for investors, limiting investors' ability to gamble.

We perform a series of empirical tests to evaluate the impact of these restrictions on the distribution of returns for IPO stocks, the demand for IPOs by different investor groups, the buy and sell activity of different investor groups, the first-day and long-run returns of IPO stocks, and the types of stock going public. The results from our analyses reveal that the imposed price restrictions led to a significant decline in the price variability and upside return potential of IPO stocks. Moreover, we find a significant decline in the subscription rate and the net buying by retail investors and institutional investors. While there is no discernable change in IPO first-day returns post regulation, we do find significant evidence of higher long-run returns, and thus lower market prices, in the post-regulation period when compared to the pre-regulation period. Finally, we document a disappearance of medium-sized IPOs in the Indian primary equity markets. As a result, post regulation IPO sizes followed a bimodal distribution, where large-sized IPOs listed exclusively on the main exchanges while small-sized IPOs listed exclusively on the SME exchange. Since medium-sized IPOs were the most affected by the new rules, their disappearance could be explained by the possibility that such firms faced lower valuations, and were hence, choosing to remain private.

Overall, our findings shed new light on the role of speculative investors in primary equity markets, suggesting that the participation of such investors may increase prices in a market generally afflicted by significant asymmetric information problems. Restricting the participation of these investors, either directly or indirectly, could lead to a significant increase in the firm's cost of capital and a reduction in the incentives of firms to sell their equity to public investors.

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Appendix A: Description of the pre-market auction for IPO stocks

In the pre-market call auction, buyers set the maximum price at which they are willing to buy the shares and sellers set the minimum price at which they are willing to sell the shares. Only limit orders are permitted. Orders are accumulated in the order book but remain unexecuted until the end of the order entry period. All buy orders are aggregated into a downward sloping demand curve and all sell orders are aggregated in an upward sloping supply curve. A single equilibrium price is derived based on the aggregated supply and demand, where the equilibrium price is determined to maximize the volume traded, i.e. to minimize order imbalance. In case several prices lead to the same minimum order imbalance, the equilibrium price is the price closest to the base price. In case the base price is the mid-value of pair of prices which are closest to it, then the base price itself will be taken as the equilibrium price. The equilibrium price determined in call auction pre-open session is considered as the open price for the day. All unmatched limit orders in the pre-open session are moved to the order book of the continuous trading session at their limit prices on a Price-Time priority basis, regardless of whether the equilibrium price has been discovered or not. If the limit price of any unmatched order moved to the continuous trading session is beyond the applicable price band for that stock, then such outstanding orders are returned.

Appendix B: Definition of variables

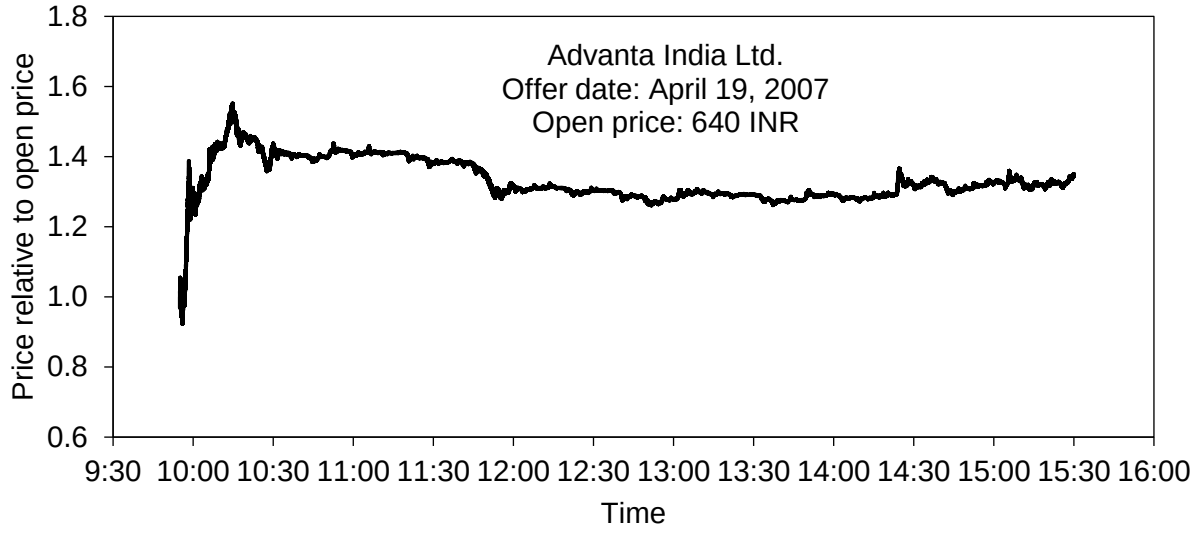
Variable	Description	Data Source
Buy (sell) trades by investor type (%)	Number of buy (sell) trades for a given investor type as a percent of all buy (sell) trades on the first day of trading after IPO.	BSE
Buy (sell) volume by investor type (%)	Number of shares bought (sold) for a given investor type as a percent of all shares bought (sold) on the first day of trading after IPO.	BSE
Close price	The close price on the first day of trading after IPO.	BSE
Debt-to-assets	Total liabilities divided by total assets in the year of the IPO.	CMIE Prowess
Firm age	Number of years from firm incorporation date to IPO date.	CMIE Prowess
Fraction offered	Shares offered divided by shares outstanding after the IPO.	Prime Database
High price	The maximum price over the first day of trading after IPO.	BSE
High-minus-low factor	The monthly return on a portfolio of high book-to-market stocks minus the monthly return on portfolio of low book-to-market stocks.	†
Low price	The minimum price over the first day of trading after IPO.	BSE
Market cap	Offer price times shares outstanding after the IPO.	CMIE Prowess
Market factor	The monthly return on a value-weighted market portfolio minus the risk-free rate.	†
Market-to-book (*Q* ratio)	Market cap plus total assets minus total liabilities, all divided by total assets. Market cap is measured as offer price times shares outstanding after the IPO. Assets and liabilities are in the year of the IPO.	Prime Database and CMIE Prowess
Momentum factor	The monthly return on a portfolio of past winner stocks minus the return on a portfolio of past loser stocks.	†
Number of managers	The number of managers underwriting the IPO.	Prime Database
Offer amount	Total shares offered times offer price.	Prime Database
Offer price	The offer price of the IPO.	Prime Database
Open price	The open price on the first day of trading after IPO.	BSE
Percent allocation by investor type	Shares allocated to all investors of a given type as a percent of total shares offered in the IPO.	Prime Database
Reputable lead dummy	Equals 1 if the lead underwriter is highly reputable and 0 otherwise.	Prime Database
ROA	Net income divided by total assets in the year of the IPO.	CMIE Prowess
S&P CNX Nifty 3-month return (%)	The return of the S&P CNX index over the 3 months prior to each IPO.	Bloomberg
Small-minus-big factor	The monthly return on a portfolio of small stocks minus the monthly return on a portfolio of big stocks.	†
Standard deviation of 5-minute returns	The standard deviation of intraday returns calculated at 5-minute intervals for the first day of trading after IPO.	BSE
Times subscribed by investor type	Number of shares subscribed by investors of a given type divided by all shares originally allotted to investors of that type.	Prime Database
VC backed	Equals 1 if the IPO is venture capital back and 0 otherwise.	Prime Database

† https://faculty.iima.ac.in/~iffm/Indian-Fama-French-Momentum/

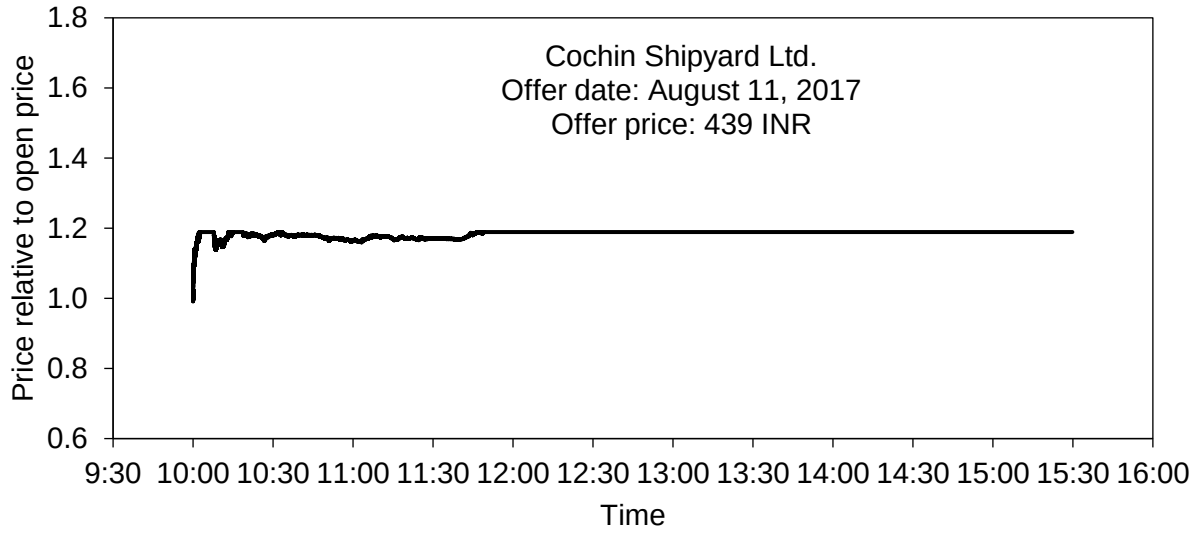
Appendix C: Client categories in the intra-day data

Category Description	Buy trades (%)	Sell trades (%)
Institutional investors		
BANKS	8.37%	5.08%
FOREIGN INSTITUTIONAL INVESTORS	1.94%	1.10%
DOMESTIC FINANCIAL INSTITUTIONS	0.00%	0.03%
INSURANCE	0.13%	0.04%
MUTUAL FUNDS	1.78%	0.24%
NEW PENSION SCHEMES	0.00%	0.00%
FOREIGN DIRECT INVESTMENT / DEP. RECEIPTS	0.00%	0.00%
FOREIGN PORTFOLIO INVESTOR – 1	0.00%	0.00%
FOREIGN PORTFOLIO INVESTOR – 2	0.00%	0.00%
FOREIGN PORTFOLIO INVESTOR – 3	0.00%	0.00%
ALTERNATIVE INVESTMENT FUND	0.01%	0.00%
Individual investors		
INDIVIDUALS	56.34%	62.97%
NON-RESIDENT INDIANS	0.02%	0.00%
HIGH NETWORTH INDIVIDUALS	0.00%	0.00%
FOREIGN NATIONALS	0.00%	0.00%
PORTFOLIO MANGT SERVICES – INDIVIDUAL	0.05%	0.00%
QUALIFIED FOREIGN INVEST. – INDIVIDUAL	0.00%	0.00%
FOREIGN DIRECT INVESTMENT / DEP. RECEIPTS	0.00%	0.00%
FOREIGN PORTFOLIO INVESTOR – 1	0.00%	0.00%
FOREIGN PORTFOLIO INVESTOR – 2	0.00%	0.00%
FOREIGN PORTFOLIO INVESTOR – 3	0.00%	0.00%
Non-individual investors		
BODY CORPORATES	24.60%	23.87%
OTHERS	0.64%	0.56%
PARTNERSHIP FIRMS	3.72%	3.12%
LIMITED LIABILITY PARTNERSHIPS	0.03%	0.02%
PORTFOLIO MANGT SERVICES - NON-INDIVIDUAL	0.00%	0.00%
QUALIFIED FOREIGN INVEST. - NON-INDIVIDUAL	0.00%	0.00%
ASSOCIATION OF PERSONS	0.00%	0.00%
FOREIGN VENTURE CAPITAL FUNDS	0.00%	0.00%
HINDU UNDIVIDED FAMILY	1.91%	2.68%
MERCHANT BANKERS	0.00%	0.00%
TRUST	0.07%	0.05%
OVERSEAS CORPORATE BODY	0.09%	0.07%
BODY OF INDIVIDUALS	0.00%	0.00%
NON-GOVERNMENT ORGANISATIONS	0.00%	0.00%
VENTURE CAPITAL FUNDS	0.00%	0.00%
DEFENSE ESTABLISHMENTS	0.00%	0.00%
SOCIETY	0.00%	0.00%
CHARITIES	0.00%	0.00%
STATUTORY BODIES	0.00%	0.00%
FOREIGN DIRECT INVESTMENT / DEP. RECEIPTS	0.00%	0.00%
FOREIGN PORTFOLIO INVESTOR – 1	0.00%	0.00%
FOREIGN PORTFOLIO INVESTOR – 2	0.00%	0.00%
FOREIGN PORTFOLIO INVESTOR – 3	0.00%	0.00%
Other investors (unclassified)	0.30%	0.16%

* Source: Bombay Stock Exchange

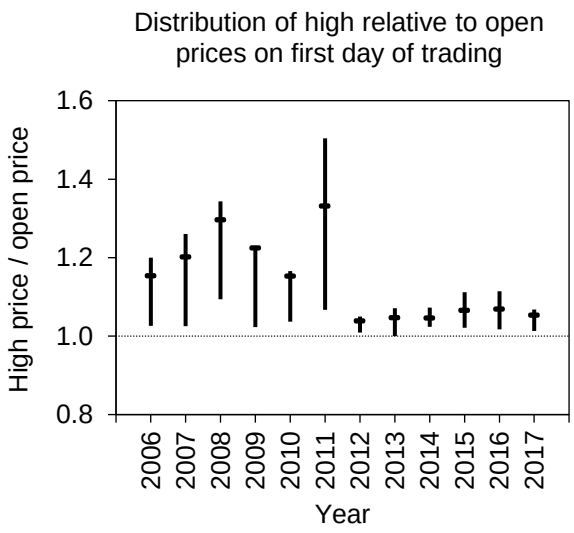


Panel A

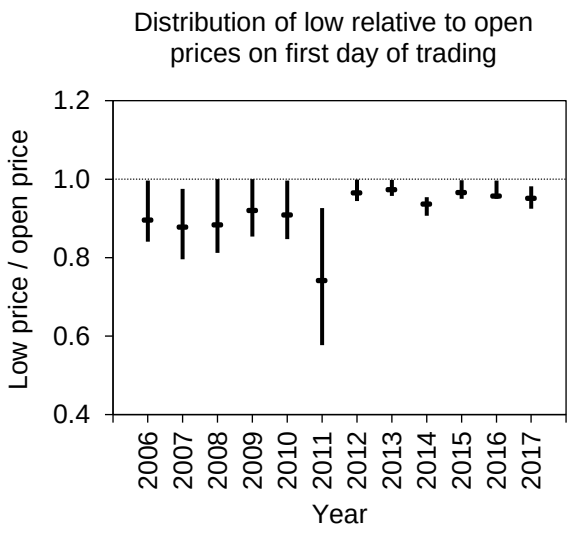


Panel B

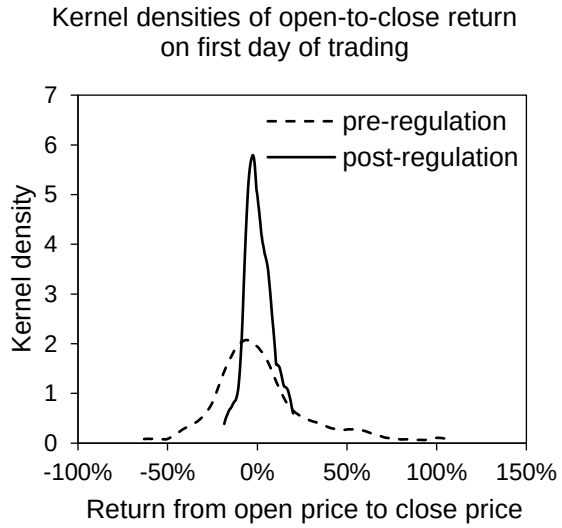
Fig. 1.: The figures plot the intraday prices on the first day of trading for two IPOs in our sample. The first IPO, plotted in Panel A, was conducted in 2007 by Advanta India Ltd and was not subject to price bounds. The second IPO, plotted in Panel B, was conducted in 2017 by Cochin Shipyard Ltd and was subject to price bounds of ±20 percent relative to the open price.



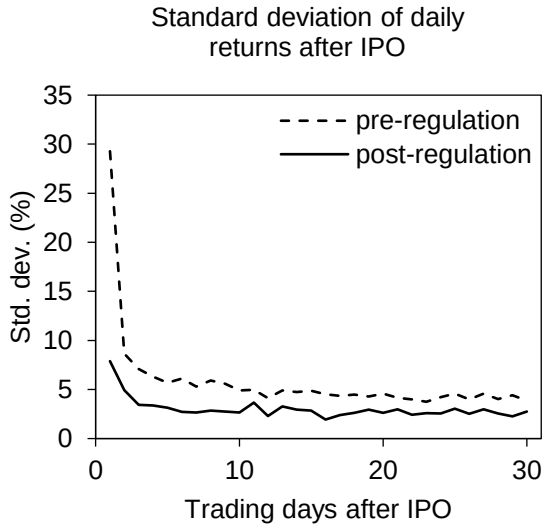
Panel A



Panel B



Panel C



Panel D

Fig. 2.: The first two panels of the figure plot the cross-sectional distribution, by year, of IPO intraday high-to-open price ratios (Panel A) and low-to-open price ratios (Panel B) on the first day of trading. The horizontal dashes plot the mean ratios while the vertical bars delimitate the interquartile ranges. Panel C plots the kernel densities of the first-day returns from open prices to close prices for two sub-periods: pre-regulation (dashed) and post-regulation (solid). Panel D plots the cross-sectional standard deviation of daily returns over the first 30 trading days for two sub-periods: pre-regulation (dashed) and post-regulation (solid). The first sub-period, between 2006 and 2011, contains 297 IPOs whose price movements were not constrained by price bands. The second period, between 2012 and 2017, contains 96 IPOs whose price movements were constrained by price bands over the first ten trading days.

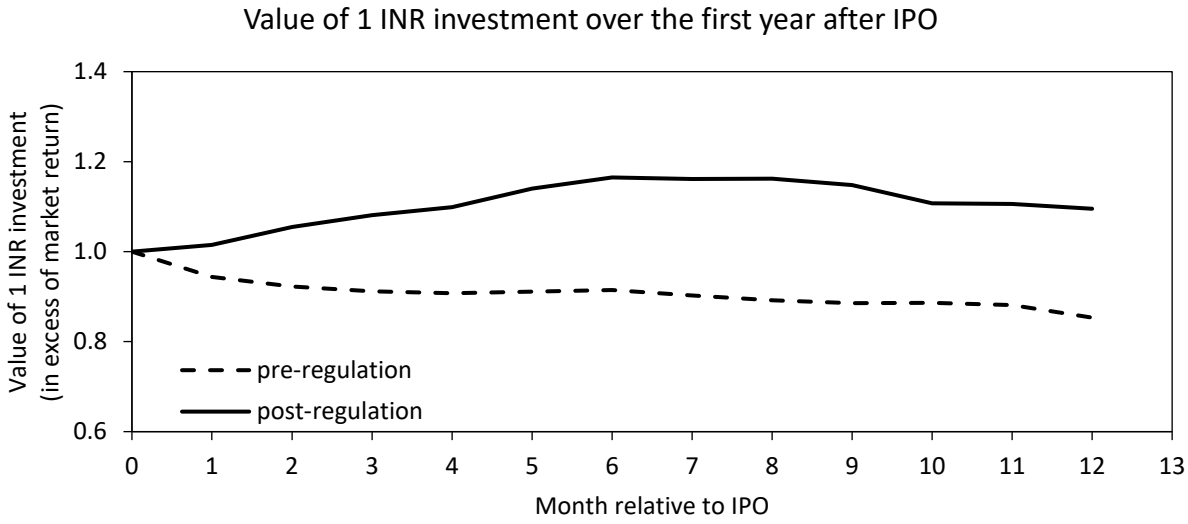
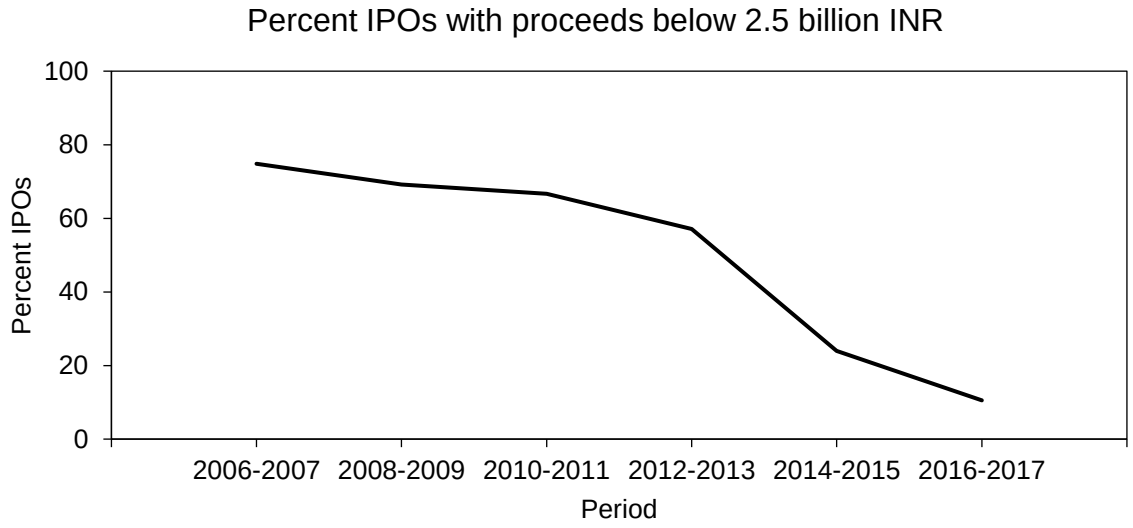
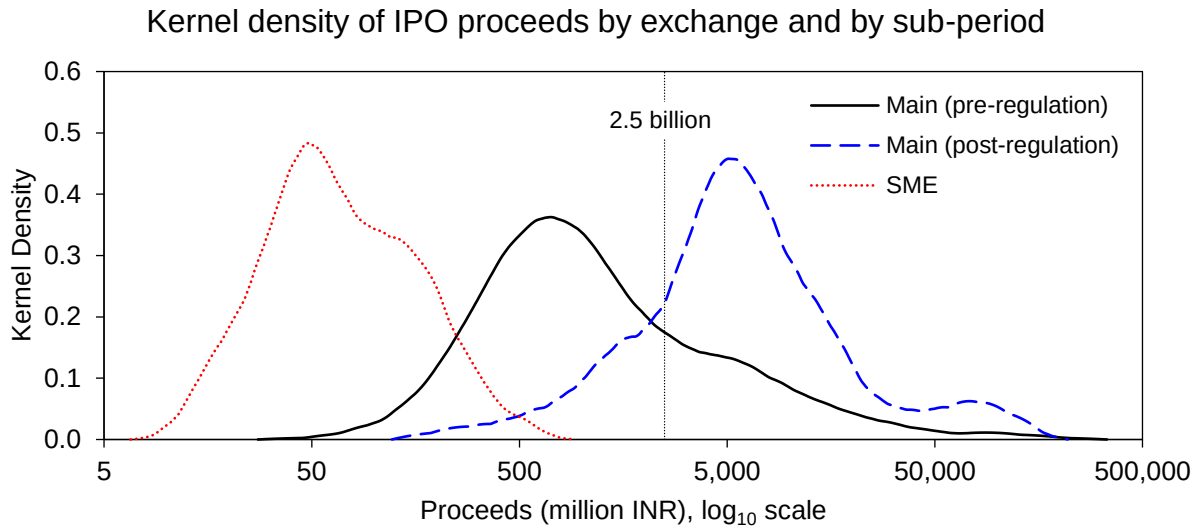


Fig. 3.: The figure plots in event time the value of a 1.0 INR investment in an equally-weighted portfolio of IPOs for two sub-periods. We track the value of the investment over the 12 months after the IPO. The value is calculated in excess of the return on a market portfolio of Indian equities obtained from CMIE Prowess and adjusted for survivorship bias. We divide the IPO sample into two sub-periods: pre-regulation (solid) and post-regulation (dashed). In the first sub-period, between 2006 and 2011, the price movements of IPO stocks were not constrained by price bands. In the second sub-period, between 2012 and 2017, the price movements of IPO stocks were constrained by price bands over the first ten days of trading.



Panel A



Panel B

Fig. 4.: Panel A of the figure plots over time the percent of IPOs with proceeds below 2.5 billion Indian rupees. Each period consists of two years. Panel B of the figure plots the kernel densities of IPO proceeds for IPOs listing on the main exchanges (NSE and BSE) for two sub-periods: pre-regulation (solid, black) and post-regulation (dashed, blue). In the first sub-period, between 2006 and 2011, the price movements of IPO stocks were not constrained by price bands. In the second sub-period, between 2012 and 2017, the price movements of IPO stocks were constrained by price bands over the first ten days of trading. Panel B also plots the kernel density of IPO proceeds for IPOs listing on the Small and Medium Enterprises (SME) exchange (dotted, red), which became active starting with 2012. The thin vertical line marks proceeds of 2.5 billion Indian rupees. The *x*-axis is presented on a $\log_{10}$ scale.

Table 1
Firm, offer, and market characteristics
The table reports summary statistics of variables related to firm and offer characteristics for a sample of 393 bookbuilt IPOs between 2006 and 2017. The sample of IPOs is obtained from Prime Database. Prime Database and CMIE Prowess are the two main data sources used to construct the different variables. All variables are described in Appendix B. Amounts are expressed in constant 2017 Indian rupees.

	Mean	Std. dev.	1st quartile	Median	3rd quartile
Market cap based on offer price and shares outstanding post IPO (bill 2017 INR)	55.49	129.25	4.50	12.20	39.01
Fraction offered relative to shares outstanding post IPO (%)	26.40	11.18	18.18	25.37	32.35
Offer amount (bill 2017 INR)	8.76	17.77	1.38	2.92	7.68
Offer price (INR)	249.35	228.94	91.00	170.00	320.00
ROA (%)	7.56	7.00	3.01	6.71	10.63
Debt-to-assets (%)	84.35	125.96	12.19	41.30	84.04
Market-to-book	2.38	2.05	1.19	1.69	2.77
Firm age (years)	24.75	13.75	17.00	23.00	28.00
VC backed IPO dummy	0.12	0.32	0.00	0.00	0.00
Reputable lead dummy	0.55	0.50	0.00	1.00	1.00
Number of managers	2.46	1.75	1.00	2.00	3.00
S&P CNX Nifty 3-month return prior to IPO(%)	4.30	10.50	– 3.40	4.00	12.30

Table 2
Constructing a matched sample

Panel A of the table reports coefficient estimates (t-statistics in parenthesis) from a probit regression where the dependent variable equals 1 if the IPO was conducted in the post-regulation period (from 2012 to 2017) and 0 if the IPO was conducted in the pre-regulation period (from 2006 to 2011). As explanatory variables we use firm, offer, and market characteristics. The sample contains 393 bookbuilt IPOs, with 297 IPOs conducted in the pre-regulation period and 96 IPOs conducted in the post-regulation period. Based on the estimates from the probit model, we construct a matched sample, where an IPO in the post-regulation period is matched to one IPO in the pre-regulation period with the nearest propensity score. To identify similar matches, we further impose a caliper of 0.2 standard deviations of the propensity score. This procedure results in a sample of 87 IPOs from the post-regulation period and their matched IPOs from the pre-regulation period. Panel B reports the means of firm, offer, and market characteristics for the resulting matched samples of 174 IPOs. The panel further reports differences between the means with t-statistics, p-values (in parenthesis), and the normalized differences (Δ_X). All amounts are expressed in 2017 Indian rupees.

Panel A: Probit regression

Dependent variable is whether an IPO was conducted post-regulation	
Intercept	– 0.433
	(– 0.158)
Market cap (2017 INR, log)	– 0.143
	(– 1.200)
Fraction offered (%)	0.023*
	(1.927)
Offer price (INR, log)	0.575***
	(4.671)
ROA (%)	– 0.008
	(– 0.605)
Debt-to-assets (%)	0.000
	(0.086)
Market-to-book	0.090
	(1.503)
Firm age (years, log)	– 0.538***
	(– 2.917)
VC backed IPO dummy	0.806***
	(3.502)
Reputable lead dummy	0.485**
	(2.104)
Number of managers (log)	0.773***
	(3.703)
S&P CNX Nifty three-month return (%)	– 0.017**
	(– 1.973)
Observations	393
Pseudo R-squared (%)	29.48

Table 2 -- continued

Panel B: Matched sample comparisons for 174 IPOs

	Pre-regulation	Post-regulation	Difference	t-statistic	p-value	Δ_X
Market cap (bill 2017 INR)	142.52	83.07	– 59.46	– 1.86	(0.065)	– 0.199
Fraction offered (%)	21.00	23.33	2.33	1.59	(0.114)	0.170
Offer price (INR)	386.08	358.05	– 28.03	– 0.73	(0.467)	– 0.078
ROA (%)	7.80	7.78	– 0.02	– 0.02	(0.981)	– 0.003
Debt-to-assets (%)	68.30	98.80	30.51	1.64	(0.102)	0.176
Market-to-book	3.20	3.04	– 0.16	– 0.43	(0.665)	– 0.047
Firm age (years)	20.32	22.49	2.17	1.20	(0.232)	0.129
VC backed IPO dummy	24.14	20.69	– 3.45	– 0.54	(0.588)	– 0.057
Reputable lead dummy	75.86	79.31	3.45	0.54	(0.588)	0.057
Number of managers	3.63	3.37	– 0.26	– 0.70	(0.486)	– 0.075
S&P CNX Nifty three-month return (%)	1.34	2.63	1.29	0.97	(0.332)	0.104

Table 3
Price variability for 87 matched IPOs in each period

The table reports, by period, means of several measures of price variability during the first day of trading after an IPO. The first measure of price variability is the standard deviation of intraday returns calculated at 5-minute intervals. The second and third measures compare the intraday high and low prices to the open price. The fourth measure calculates the difference between the intraday high and low prices relative to the mid-point of the two prices. The remaining four measures indicate whether the intraday high price is 5%, 10%, 15%, or 20% higher than the open price. We compare IPOs in the pre-regulation period (from 2007 to 2011 when IPO stock returns were not limited by price bands) to IPOs in the post-regulation period (from 2012 to 2017 when IPO stock returns were limited by price bands). The table compares the means of the price variability measures between two matched samples, where an IPO in the post-regulation period is matched to one IPO in the pre-regulation period. The table further reports differences between the means with t-statistics and p-values (in parenthesis). We construct the matched samples based on the propensity scores estimated from the probit model reported in Table 2, Panel A. To identify matches, we use the nearest propensity score and impose a caliper of 0.2 standard deviations. This procedure results in a sample of 87 IPOs from the post-regulation period and their matched IPOs from the pre-regulation period.

	Pre-regulation	Post-regulation	Difference	t-statistic	p-value
Standard deviation of 5-minute returns	1.05	0.76	– 0.29	– 3.56	(<0.001)
High price / Open price	1.13	1.06	– 0.08	– 4.91	(<0.001)
Low price / Open price	0.88	0.96	0.07	4.83	(<0.001)
(High price – Low price) / Mid price (%)	25.39	9.78	– 15.61	– 8.49	(<0.001)
High / Open > 1.05 dummy (%)	72.41	43.68	– 28.74	– 3.99	(<0.001)
High / Open > 1.10 dummy (%)	40.23	17.24	– 22.99	– 3.44	(0.001)
High / Open > 1.15 dummy (%)	34.48	11.49	– 22.99	– 3.72	(<0.000)
High / Open > 1.20 dummy (%)	19.54	0.00	– 19.54	– 4.57	(<0.000)

Table 4
Subscriptions and allocations by investor type
The table reports, by period, means of subscription rates and allocation rates for qualified institutional buyers, retail investors, high-net-worth individuals, employees, and existing shareholders for 87 matched IPOs in each period. We compare IPOs in the pre-regulation period (from 2007 to 2011 when IPO stock returns were not limited by price bands) to IPOs in the post-regulation period (from 2012 to 2017 when IPO stock returns were limited by price bands). The table compares the means of the subscription and allocation variables between two matched samples, where an IPO in the post-regulation period is matched to one IPO in the pre-regulation period. The table further reports differences between the means with t-statistics and p-values (in parenthesis). We construct the matched samples based on the propensity scores estimated from the probit model reported in Table 2, Panel A. To identify matches, we use the nearest propensity score and impose a caliper of 0.2 standard deviations. This procedure results in a sample of 87 IPOs from the post-regulation period and their matched IPOs from the pre-regulation period.

	Pre-regulation	Post-regulation	Difference	t-statistic	p-value
Times subscribed:					
Qualified institutional buyers	36.086	12.603	– 23.483	– 4.520	(<0.001)
Retail investors	9.042	4.678	– 4.364	– 3.060	(0.003)
High-net-worth individuals	48.643	75.437	26.794	1.830	(0.069)
Employees	0.384	0.208	– 0.176	– 2.270	(0.024)
Existing shareholders	0.038	0.171	0.133	0.920	(0.357)
All investors	28.613	18.970	– 9.643	– 2.080	(0.039)
Percent allocation:					
Qualified institutional buyers	55.174	53.954	– 1.220	– 1.030	(0.305)
Retail investors	31.343	30.051	– 1.292	– 1.210	(0.229)
High-net-worth individuals	11.684	14.817	3.133	11.880	(<0.001)
Employees	1.457	0.672	– 0.784	– 2.790	(0.006)
Existing shareholders	0.342	0.506	0.164	0.550	(0.581)
All investors	100.000	100.000	0.000	0.000	(1.000)

Table 5
First-day trading activity by investor type
The table reports, by period, means of overall trading activity measures (Panel A), buy and sell volume as a percent of total (Panel B), and number of buy and sell trades as a percent of total (Panel B) for four investor types: institutional, individual, non-individual, and other. We compare IPOs in the pre-regulation period (from 2007 to 2011 when IPO stock returns were not limited by price bands) to IPOs in the post-regulation period (from 2012 to 2017 when IPO stock returns were limited by price bands). The table compares the means of the trading variables between two matched samples, where an IPO in the post-regulation period is matched to one IPO in the pre-regulation period. The table further reports differences between the means with t-statistics and p-values (in parenthesis). We construct the matched samples based on the propensity scores estimated from the probit model reported in Table 2, Panel A. To identify matches, we use the nearest propensity score and impose a caliper of 0.2 standard deviations. This procedure results in a sample of 87 IPOs from the post-regulation period and their matched IPOs from the pre-regulation period. In Panel B and Panel C, *Difference (% of total)* indicates difference between sell volume (number of trades) and buy volume (number of trades), as a percent of total.

Panel A: Overall trading activity

	Pre-regulation	Post-regulation	Difference	t-statistic	p-value
Number of trades per minute	502.540	246.850	– 255.690	– 5.530	(<0.001)
Shares traded / shares offered per minute (%)	0.438	0.051	– 0.387	– 9.350	(<0.001)
Shares traded / shares outstanding per minute (%)	0.107	0.011	– 0.096	– 7.080	(<0.001)

Panel B: Buy and sell volume, percent by investor type

	Pre-regulation	Post-regulation	Difference	t-statistic	p-value
Buy volume (% of total)					
Institutional investors	8.502	24.194	15.692	5.520	(<0.001)
Individual investors	50.239	36.003	– 14.236	– 6.800	(<0.001)
Non-individual investors	40.841	34.499	– 6.342	– 2.330	(0.021)
Other	0.419	5.304	4.885	2.250	(0.025)
Sell volume (% of total)					
Institutional investors	16.156	14.911	– 1.245	– 0.430	(0.670)
Individual investors	49.059	52.056	2.997	1.370	(0.171)
Non-individual investors	34.298	28.152	– 6.146	– 2.260	(0.025)
Other	0.487	4.881	4.394	2.070	(0.040)
Difference (% of total)					
Institutional investors	7.655	– 9.282	– 16.937	– 4.270	(<0.001)
Individual investors	– 1.180	16.053	17.233	7.510	(<0.001)
Non-individual investors	– 6.543	– 6.347	0.196	0.060	(0.953)
Other	0.068	– 0.423	– 0.491	– 1.210	(0.227)

Table 5 -- continued

Panel C: Number of buy and sell trades, percent by investor type

	Pre-regulation	Post-regulation	Difference	t-statistic	p-value
Buy trades (% of total)					
Institutional investors	5.147	21.160	16.013	6.230	(<0.001)
Individual investors	63.092	39.430	– 23.662	– 11.400	(<0.001)
Non-individual investors	31.395	34.284	2.889	1.130	(0.261)
Other	0.366	5.127	4.761	2.240	(0.027)
Sell trades (% of total)					
Institutional investors	10.407	10.746	0.339	0.150	(0.883)
Individual investors	64.209	59.687	– 4.522	– 1.930	(0.056)
Non-individual investors	24.892	24.953	0.061	0.030	(0.979)
Other	0.492	4.613	4.121	1.910	(0.058)
Difference (% of total)					
Institutional investors	5.260	– 10.414	– 15.674	– 4.450	(<0.001)
Individual investors	1.117	20.258	19.141	7.470	(<0.001)
Non-individual investors	– 6.502	– 9.330	– 2.828	– 1.010	(0.313)
Other	0.126	– 0.513	– 0.639	– 2.050	(0.042)

Table 6
Pre-market auction trading activity by investor type
Using pre-market auction data for 96 bookbuilt IPOs, the table reports buy and sell volume (as a percent of total) and the number of buy and sell trades (as a percent of total) for four investor types: institutional, individual, non-individual, and other. The table further reports the difference between the Sell variables and the Buy variables, with t-statistics and p-values (in parenthesis). The sample contains only trades executed during the pre-market auction, conducted between 9:00am and 10:00am. The pre-market auction for newly listed IPO stocks was introduced in January of 2012 and, as a result, the sample for this table covers IPOs between 2012 and 2017.

	Buys	Sells	Difference	t-statistic	p-value
Volume (% of total)					
Institutional investors	24.900	11.700	– 13.200	4.084	(<0.001)
Individual investors	38.400	68.900	30.500	– 9.086	(<0.001)
Non-individual investors	31.700	14.500	– 17.200	5.730	(<0.001)
Other	5.000	4.900	– 0.100	0.211	(0.834)
Trades (% of total)					
Institutional investors	22.600	2.300	– 20.300	6.703	(<0.001)
Individual investors	43.300	82.500	39.200	– 10.918	(<0.001)
Non-individual investors	29.500	11.000	– 18.500	6.459	(<0.001)
Other	4.600	4.200	– 0.400	0.965	(0.337)

Table 7
IPO first-day returns

The table reports, by period, means of two measures of first-day returns: the return from offer price to first-day open price and the return from offer price to first-day close price. We compare IPOs in the pre-regulation period (from 2007 to 2011 when IPO stock returns were not limited by price bands) to IPOs in the post-regulation period (from 2012 to 2017 when IPO stock returns were limited by price bands). The table further reports differences between the means of the first-day returns measures, with t-statistics and p-values (in parenthesis). In the unmatched sample analysis, we compare 297 bookbuilt IPOs conducted in the pre-regulation period to 96 bookbuilt IPOs conducted in the post-regulation period. In the matched sample analysis, an IPO in the post-regulation period is matched to one IPO in the pre-regulation period. We construct the matched samples based on the propensity scores estimated from the probit model reported in Table 2, Panel A. To identify matches, we use the nearest propensity score and impose a caliper of 0.2 standard deviations. This procedure results in a sample of 87 IPOs from the post-regulation period and their matched IPOs from the pre-regulation period.

	Pre-regulation (N=297)	Post-regulation (N=96)	Difference	t-statistic	p-value
Unmatched samples					
Open price / Offer price – 1 (%)	15.041	11.528	– 3.513	– 1.358	(0.175)
Close price / Offer price – 1 (%)	19.511	12.483	– 7.028	– 1.522	(0.129)
Matched samples					
Open price / Offer price – 1 (%)	14.205	10.900	– 3.305	– 1.080	(0.282)
Close price / Offer price – 1 (%)	12.714	11.956	– 0.758	– 0.190	(0.852)

Table 8
Four-factor model estimates

The table reports coefficient estimates (t-statistics in parenthesis) from the following regression model:

$$R_{p,t} - R_{rf} = \alpha + \beta_{MKT}\left(R_{m,t} - R_{rf}\right) + \beta_{SMB}R_{SMB,t} + \beta_{HML}R_{HML,t} + \beta_{MOM}R_{MOM,t} + u_{i,t}\,.$$

In this model, the dependent variable is the monthly return of an equally-weighted portfolio of IPO stocks in excess of the return on a risk-free investment. To be included in the IPO portfolio, a stock must have conducted its IPO at most one year prior to the examined month. As explanatory variables, we use the returns of the three Fama-French factors and the momentum factor, calculated for the Indian equity market using data available from CMIE Prowess. The factors are adjusted for survivorship bias and include the market (MKT) factor, the small-minus-big (SMB) factor, the high-minus-low (HML) factor, and the momentum (MOM) factor. For details of the methodology used to calculate the four factors, see Agarwalla, Jacob, and Varma (2013). We estimate the model separately for IPOs in the pre-regulation period (from 2007 to 2011. when IPO stock returns were not limited by price bands) and for IPOs in the post-regulation period (from 2012 to 2017. when IPO stock returns were limited by price bands). The last column of the table reports the difference in coefficient estimates between the two sub-periods. The t-statistics of the differences in estimates are estimated using simultaneous equations estimation.

	Pre-regulation	Post-regulation	Difference
α	– 0.012**	0.015*	0.027***
	(– 2.577)	(1.736)	(2.802)
β_{MKT}	1.033***	1.127***	0.094
	(15.926)	(4.930)	(0.453)
β_{SMB}	0.842***	0.507**	– 0.335
	(6.890)	(2.243)	(– 1.329)
β_{HML}	0.296***	0.060	– 0.236
	(3.324)	(0.360)	(– 1.269)
β_{MOM}	– 0.194***	– 0.115	0.079
	(– 2.666)	(– 0.653)	(0.446)
Observations	82	80	
Adjusted R-squared (%)	86.88	30.33	

Table 9
Percent of IPOs on the main exchanges with proceeds below INR 2.5 billion
The table reports the number of bookbuilt IPOs by year. The table further reports the number of IPOs with proceeds below INR 2.5 billion, the number of IPOs with proceeds above INR 2.5 billion, and the number of IPOs with proceeds below INR 2.5 billion as a percent of total number of IPOs.

Period	All IPOs	IPOs (proceeds < INR 2.5bill)	IPOs (proceeds ≥ INR 2.5bill)	Percent IPOs (proceeds < INR 2.5bill)
2006	57	43	14	75%
2007	86	64	22	74%
2008	36	28	8	78%
2009	16	8	8	50%
2010	65	35	30	54%
2011	37	33	4	89%
2012	11	7	4	64%
2013	3	1	2	33%
2014	5	3	2	60%
2015	20	3	17	15%
2016	27	3	24	11%
2017	30	3	27	10%
All	393	231	162	59%