Speculation, Price Limits and IPO Markets: Evidence from a Natural Experiment [*]

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Abstract

Motivated by theories on speculative trading, we examine how price variability affects speculative demand and the consequences of this effect for equity prices and corporate policy. Our study is based on a natural experiment, in which the price moves of newly-listed Initial Public Offering (IPO) stocks become exogenously restricted within a narrow range. Pursuant to the introduction of these restrictions, investors seeking to speculate reduce both their participation in IPOs and their net buying in the IPOs' aftermarket. The reduced aftermarket demand is followed by an increase in future 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 provide new insights into the role of speculative investors in IPO markets, suggesting that the participation of such investors increases the viability of IPO markets, which are generally afflicted by high asymmetric information problems.

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

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1. Introduction

The literature examining whether large price moves cater to investors' attitudes towards speculation and gambling, and the ramifications of such attitudes for economic activity, is vast and dates as far back as Keynes (1936) and Friedman and Savage (1948). One of the challenges to studying this area is that, while speculation may pursue high price variability, speculation itself may lead to wide swings in equity prices and affect the distributional properties of stock returns. Does high price variability attract trading? And does speculative trading affect equity prices and corporate policy? To address such questions, in this study, we exploit a natural experiment in the Indian initial public offerings (IPOs) market affected by regulatory changes. We use a customized, unique, and proprietary trading data extraction from the Bombay Stock Exchange (BSE) to examine how changes in the return distribution of stocks in their initial days of trading impact the demand for IPO stocks, the trading activity and prices of these stocks, and the supply of new IPOs.

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

[1] SEBI is the Indian counterpart of the U.S. 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).

Prices of IPO stocks are naturally uncertain. Firms issuing public equity for the very first time typically have limited availability of public information. The uncertainty is reflected in the high return variability of IPO stocks, especially in the initial days of trading. For instance, Miller and Reilly (1987) and Asquith, Jones, and Kieschnick (1998) find that return volatility and skewness are relatively high immediately after the IPO stocks' listing.[3]

Based on existing theories in financial economics, we propose that the high return volatility and skewness of IPO stocks during their initial trading days appeal to some market participants, especially those who tend to speculate. The high volatility provides traders with opportunities to speculate (Harrison and Kreps, 1978; Scheinkman and Xiong, 2003) and derive utility from an immediate realization of early profits while delaying early losses (Barberis and Xiong, 2012).[4] Moreover, individuals may buy shares in an IPO stock while expecting to quickly sell in the open market and directly derive utility from the highly skewed early returns of these stocks. This behavior is consistent with both standard utility theory (Arditti, 1967; Scott and Horvath, 1980) and cumulative prospect theory (Barberis and Huang, 2008).

Theoretical and empirical literature in finance focuses on the potential consequences of investor preferences for stocks with highly uncertain payoffs and lottery-like payoffs (i.e., payoffs that deliver a high return, albeit with a low probability). The literature, which we review in the following section of this manuscript, has reached the general conclusion that stocks catering to investor tendencies to speculate and gamble are priced at a premium, thus earning relatively low

[3] High return volatility during the initial days of trading after an IPO is also evident in our sample of Indian IPOs prior to regulation.

[4] In these models, speculation occurs when an investor buys the stock now with the sole objective of selling it later to other investors for more than its fundamental value.

subsequent returns.[5] In addition to validating this insight, empirical studies have also provided significant evidence that retail investors, when compared to other market participants, display a stronger tendency to speculate in financial markets.

The main findings presented in this study are summarized as follows. First, compared to the pre-regulation period, we find a pronounced decline in price variability of IPO stocks on their first day of trading post-regulation. Moreover, IPO stocks in the post-regulation period provided a significantly reduced upside potential relative to IPO stocks in the pre-regulation period. For instance, when we compare the daily high price to the daily open price, we find that one of five IPOs experienced an intraday price movement of 20 percent or higher in the pre-regulation period. In contrast, none of the IPO stocks in the post-regulation period experienced an intraday price movement greater than 20 percent due to the strict price controls. The decline in price variability and upside potential was accompanied by an overall decline in trading activity, consistent with a reduction in speculative trading.

Second, we find that the initial demand for IPO stocks, measured by investor subscription rates in the IPO, has declined significantly from before to after regulation. This decline in initial demand is evident for both retail and institutional investors. The decline in demand from retail investors is consistent with the reduced speculative appeal of IPO stocks after strict price controls are imposed. The decline in demand from institutional investors is consistent with prior literature, which documents that institutional investors also participate in speculation, as they seek to exploit the trading behavior of retail investors (e.g., Brunnermeier and Nagel, 2005).

[5] Short selling by sophisticated investors is often expected to (at least partially) correct overvaluation. However, we do not expect short-selling activity to affect our findings for at least two reasons. First, short selling in India was banned during the 2001-2008 period, which overlaps with the first three years of our pre-regulation sample. Second, naked short selling is not allowed while an inventory of lendable shares does not exist with brokers immediately after an IPO.

Third, we examine the buying and selling activities of different investor types on the first day of trading. We find that, since the new regulations came into effect, there has been a significant decline in post-IPO buying by retail investors, and an increase in post-IPO buying by institutional investors. Specifically, net buying (i.e., buying net of selling) by retail investors has declined by around 17 percent of the total trading volume; at the same time, net buying by institutional investors has increased by roughly the same amount. Moreover, we find evidence that retail investors used the pre-market call auction introduced in the post-regulation period to sell a disproportionate amount of their IPO allocations, participating in around 38 percent of the buy volume and in approximately 69 percent of the sell volume.[6] Since for every seller there has to be a buyer, we find that institutional investors and other non-individual investors used the pre-market call auction to buy shares in the IPO firms. These findings confirm that the new price restrictions reduced the demand for IPO stocks from exactly those investors that existing literature identifies as exhibiting a greater preference for speculation.

Our fourth set of results pertains to the returns on IPO stocks, where we examine both the first-day and subsequent one-year returns. Comparing the two regimes, we do not find a significant change in first-day returns, suggesting that the new rules did not affect investment bankers' ability to assess IPO demand, when determining offer prices.[7] However, we find significantly higher post-IPO one-year returns for IPOs conducted in the post-regulation period, compared to those conducted in 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, which corresponds to an

[6] We discuss the pre-market call auction and other details of the Indian IPO market in Section 3.

[7] Major theories relate IPO underpricing to ex-ante uncertainty and asymmetric information (see, among many others, Rock, 1986; Beatty and Ritter, 1986; and Benveniste and Spindt, 1989). Because there are no clear reasons to expect that the new rules had a material effect on uncertainty or on the distribution of information across investors, the similar underpricing between the two regimes is to be expected.

excess return of around -13.5 percent per year. In stark contrast to the underperformance of IPO stocks in the pre-regulation period, IPO stocks in the post-regulation period earn an excess return of around 1.5 percent per month, or around 19.5 percent per year after IPO. These findings are consistent with the idea that a reduction in the demand for IPO stocks from speculative traders has a significant effect on the price of these stocks, as evidenced by their future returns.

For our fifth and final analysis, we examine the supply of IPOs of different 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. Pre regulation, around 80 percent of all IPOs had issue proceeds below INR 2.5 billion. The corresponding proportion has since declined to 20 percent by the later part of the post-regulation period. These findings provide an important insight into the role of speculative investors in equity markets, suggesting that the participation of such investors increases equity prices, which in turn increases the incentives of private firms to go public. Moreover, because IPO markets are subject to substantial asymmetric information, and thus to potential market failure (Akerlof, 1970), the participation of speculative investors may be critical for the viability of these markets, especially for the relatively riskier firms.

In additional tests, we explore whether our findings could be driven by an overall decline in the supply of smaller firms' IPOs or are due to an overall decline in the demand for speculative stocks. We do not find evidence for either of these two conjectures. For example, 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 listed on the SME exchange during the post-

regulation sample period.[8] Further analysis based on all stocks traded on India's main stock exchanges shows that demand for speculative stocks, while exhibiting variation over time, has not declined in the post-regulation period.

Our study contributes to several strands of related literature. We contribute to the literature originating from Keynes (1936) and Friedman and Savage (1948) that is concerned with individual attitudes towards speculation and gambling. In this regard, we provide direct evidence of how changes in the distributional properties of stock returns affect investor demand and trading behavior while distinguishing between retail and institutional investor demand. 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 extends a strand of literature that examines the ability of financial regulators to curb speculation by imposing price limits (e.g., 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 focuses on the general population of stocks. Our paper further contributes to the literature examining the activity of IPO 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 the literature examining the importance of investor speculation and gambling preferences for their participation in financial markets (e.g., Dorn, Dorn, and Sengmueller, 2015; Gao and Lin, 2015; Cookson, 2018).

[8] 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.

The rest of the paper is organized as follows. Section 2 reviews relevant literature and develops our testable hypotheses. Section 3 describes the institutional setting. Section 4 provides a description of the sample and variables used in the analysis and outlines our empirical approach. Section 5 presents our findings while Section 6 concludes the paper.

2. Literature review and hypotheses development

2.1. Speculation and equity prices

Economists have long proposed that individual attitudes towards speculation and gambling may have important ramifications for financial markets (e.g., Keynes, 1936; Friedman and Savage, 1948; Markowitz, 1952). Following these early ideas, a large and growing theoretical and empirical literature in finance examines investor preferences for stocks with return properties that cater to these attitudes as well as the consequences of such preferences for asset prices.

Several, theoretical models propose why speculators are attracted to volatile stocks. Harrison and Kreps (1978) and Scheinkman and Xiong (2003) show how investor overconfidence and heterogeneous beliefs can lead to speculative trading, where an investor buys the stock now with the sole objective of selling it later to other investors for more than its fundamental value. In that framework, as fundamental volatility increases so does heterogeneity in beliefs and thus speculation. However, speculation also leads to an increase in stock volatility, which highlights the complex relation between speculation and volatility.

Besides overconfidence, other behavioral attitudes of individual investors may also lead to a preferences for volatile stocks. For example, 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 provides 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.[9] Moreover, the volatility of IPO stocks may attract sensation seeking investors. IPOs are usually conducted by relatively young firms, with an element of novelty, and as such may appeal to sensation-seeking investors (Grinblatt and Keloharju, 2009). The high volatility of the prices of IPO firms should further stimulate sensation seeking behavior.

Existing literature also examines investor preferences for lottery-type assets (i.e., assets 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 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) also explore a model based on cumulative prospect theory and derive a novel equilibrium wherein a security's skewness is priced, so that an increase in skewness reduces expected returns.

Empirical studies provide substantive evidence that some investors, especially retail investors, display a preference for speculative stocks and lottery-type stocks. Further, there is

[9] 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).

empirical evidence that speculation and gambling preferences increase investor participation in financial markets. Finally, there is evidence that speculative and lottery-type stocks tend to earn relatively low subsequent returns. With regards to investor preferences, Kumar (2009) finds that retail investors, as compared to institutional investors, exhibit a greater preference for low-priced stocks and stocks with high idiosyncratic volatility and skewness. Dorn and Huberman (2010) provide evidence that some retail investors exhibit a preference for stocks with high volatilities. 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-type characteristics.[10]

Other studies based on natural experiments, 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-type stocks declines significantly. Cookson (2018) examines the introduction of prize-linked savings accounts in Nebraska and finds a concurrent reduction in gambling in casinos in the affected counties. Examining fund flows in mutual funds, Akbas and

[10] In a recent study, Kumar, Nguyen, and Putnins (2021) use data from 38 countries and provide evidence of significant gambling activity in stock markets.

Genc (2020) find that future fund flows are positively related with the respective funds' high maximum monthly returns.

With regards to asset prices, empirical research provides extensive evidence that stocks that cater to investors' tendencies to speculate and gamble earn relatively low future returns. Ang et al. (2006, 2009) examine the cross-section of stock returns in the U.S. as well as in international markets and find that idiosyncratic volatility is negatively related to future returns. Bali, Cakici, and Whitelaw (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.[11] Fong and Toh (2014) show that the Bali, Cakici, and Whitelaw (2011) effect depends on investor sentiment, defined as investors' propensity to speculate.[12] Asness et al. (2020) examine whether the negative relation between risk, as measured by return volatility and extreme returns, and future alphas is due to leverage constraints or due to investor sentiment. They find significant evidence that the documented relation between measures of risk and future returns is, at least in part, due to investor sentiment.

Prior research has also pointed out that 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 speculation. 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 return skewness is positively related with the fraction of small-sized trades on the first day of trading, evidence

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

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

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 offerings 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.[13] This is perhaps not surprising because, under the efficient market hypothesis, restricting prices within pre-determined bands is not necessary. If markets are efficient, price limits not only provide no benefit but they also impose trading frictions that may hinder price discovery and may reduce stock market liquidity, thus detracting from the value of the firm.[14]

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

[13] 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 examine 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.

[14] 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.

volatility.[15] In a recent study of China's warrants market, Li, Subrahmanyam, and Yang (2021) find that price bands could serve to effectively constrain speculative trading frenzies.

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, our findings show that the effects of price limits on price variability depend on the market setting. More importantly, our unique setting allows us to explore the ramifications of price limits for assets with highly uncertain payoffs in the presence of investors with a tendency to speculate.

2.3. Testable hypotheses

Building on prior literature, we develop six 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 a stock's trading after its IPO, we expect a lower variability in the stock's prices in periods when price bands are in effect, relative to periods when price bands are not in effect. As an auxiliary hypothesis, we expect the upside return potential of IPO stocks on the first day of trading to be lower when price bands are in effect, relative to periods when price bands are not in effect.*

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

To derive our second hypothesis, we rely on prior literature documenting retail investors' tendency to speculate in markets with high uncertainty. When IPO prices are allowed to vary without constraints, IPO stocks exhibit relatively high price variability, making them attractive to retail investors. Given that the new rules substantially reduce the upside return potential, IPO stocks further lose their lottery-like skewed 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.*

Price limits restrict the upside potential, thereby reducing the incentive for speculative 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 speculative 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 (i.e., underpricing) can be realized. Since demand from investors (such as institutional investors) without a preference for speculative stocks is not sensitive to the reduced speculative potential of IPO stocks, and because for every seller there is a buyer, the opposite expectation holds for such investors. This line of reasoning gives rise to our third hypothesis.

Hypothesis 3: *In the IPO aftermarket, on the first day of trading, we expect reduced net buying by retail investors in periods when price bands are in effect, relative to periods when price bands are not in effect. As an auxiliary hypothesis, 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 and fifth hypotheses relate the presence of price limits to equity prices, where we consider both IPO underpricing and long-run returns. To form our expectations about changes in IPO underpricing, we consider existing theories of underpricing. It is a well-established fact that IPO stocks are underpriced, on average; that is, IPO offer prices are typically lower than post-IPO market prices. IPO underpricing is typically positively related with uncertainty regarding the value of the firm (e.g., Beatty and Ritter, 1986). In bookbuilding theories (e.g., Benveniste and Spindt, 1989), investment banks underprice IPOs in order to reward investors for revealing favorable information.[16] Other theories (e.g., Rock, 1986), show how IPO underpricing is a result of asymmetric information across different investors. The new rules are not expected to have affected fundamental uncertainty, the distribution of information across market participants, or the ability of banks to extract favorable information from investors. Consequently, and as stated in Hypothesis 4 below, we do not expect underpricing to have changed between the two regimes.

Hypothesis 4: *We expect IPO underpricing to be similar in periods when price bands are in effect, relative to periods when price bands are not in effect.*

Hypothesis 5 makes predictions related to the long-run returns of IPO stocks. We derive this hypothesis based on prior studies, discussed in Section 2.1, which find that stocks with speculative characteristics experience inferior future returns. If IPO stocks lose their appeal as opportunities for speculation when price limits are imposed, we expect reduced valuations and increased future returns. These arguments give rise to our fifth hypothesis.

[16] While the bookbuilding method used in India provides no share allocation discretion to investment banks, it provides substantial discretion in pricing each IPO.

Hypothesis 5: *We expect lower market prices, and thus higher future returns, of newly listed IPO stocks in periods when price bands are in effect, relative to periods when price bands are not in effect.*

The five hypotheses derived above focus on investor demand for IPO stocks and on firm values 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 go public. 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 6: *We expect fewer IPOs by firms that are most affected by the new price band rules in periods when price bands are in effect, relative to periods when price bands are not in effect.*

3. Institutional setting

The Indian IPO setting provides a unique opportunity to examine the hypotheses proposed in the previous section. In January 2012, the Securities Exchange Board of India (SEBI) imposed trading controls for IPO firms listing on the two main exchanges: 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. A wider price band of ±20 percent is set 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, so that the new rules permit trading at the price limits.

To provide an example of the price limits discussed above, Figure 1 plots the daily prices of two observations 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 price bands, discussed above, were in effect. As is evident from the figure in Panel A, the stock price of the first IPO was unconstrained throughout the day. In Panel B, in contrast, the price of the second IPO reached its 20 percent price limit early in the trading day, thus limiting further price increases.

[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.[17] 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

[17] 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.

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.

4. Sample description and empirical approach

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.[18] 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 a 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: institutional investors, individual investors, and non-individual investors. Institutional investors are mainly

[18] 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.

banks, mutual funds, and foreign institutional investors, while non-individual investors are mainly corporations, partnerships, and joint family (Hindu undivided families) accounts.[19]

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 the number of shares outstanding post-IPO. 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: 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 collect 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

[19] 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.

following the IPO are obtained from the Bombay Stock Exchange (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.[20] 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 National Stock Exchange (NSE), to measure the market conditions at the time of each IPO.

In further tests we examine how trading activity is related to the return properties of stocks for the full sample of firms traded on the NSE and BSE. For this analysis, we gather daily returns, prices, and shares outstanding from the CMIE *Prowess* database.

4.2. Descriptive statistics

Table 1 provides descriptive statistics for 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.[21] 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 firm 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 per share.

[Insert Table 1 about here]

[20] 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/.

[21] 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.

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 total assets. The *Q* ratio for the average firm is around 2.4, indicating that Indian IPO firms are expected to take advantage of significant growth opportunities in the future. The majority of firms in our sample have existed for at least a decade before going public. For example, the first quartile of firm age is 17 years, with the average firm operating 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 the 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 market timing effect is modest.

4.3. Empirical approach

Part of 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. These results are broadly consistent with Hypothesis 6, which predicts a post-regulation decline in the frequency of relatively small IPOs, which also tend to have low offer prices, low VC backing, and low underwriter reputation. The propensity score matching approach allows us to identify matches based on these multiple relevant dimensions.

To create matched subsamples 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.[22] For nine 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 their matched pre-regulation observations. We find that for all but one of the variables, the two samples are indistinguishable from each other. The only

[22] 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 the 2008-2009 financial crisis period leads to similar findings. The findings from these alternative specifications are available from the authors.

difference in the pre-regulation versus the post-regulation samples, which 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 in the pre-regulation period. However, 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 between the post-regulation and the pre-regulation samples is calculated as $\Delta_X = \left(\bar{X}_{POST} - \bar{X}_{PRE}\right) \Big/ \sqrt{SD_{POST}^2 + SD_{PRE}^2}$, 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.

5. 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- 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.

5.1. 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 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.[23]

In interpreting these findings as being consistent with lower price variability, one potential concern arises due to 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 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.[24] 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

[23] We note that the return is capped at 5 percent for IPOs with proceeds below INR 2.5 billion.

[24] For brevity, we do not tabulate these numbers.

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 should also decline substantially.

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. These findings confirm that price volatility is significantly higher in the initial days of trading in IPO stocks.

Another potential concern we address is that the types of IPOs have changed over time. To take into account a possible systematic shift in the types of firms going public on the main exchanges, we use the matched subsamples described in Section 4.3. In Table 3, we compare several measures of price variability between the matched subsamples of pre-regulation and post-regulation IPOs. As one of our measures, we calculate the standard deviation of stock returns over 5-minute intervals.[25] 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%.[26]

[25] 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.

[26] 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.

[Insert Table 3 about here]

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 post-regulation, 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. The percentage difference between the first-day high price and the first-day low price for pre-regulation 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.

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 investors' opportunities to speculate in search of high returns on the first day of trading.

5.2. 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. In this section we evaluate the validity of the hypothesis, by examining how investor demand for IPO stocks differs between the two regulatory regimes.

In Table 4 we compare subscription rates and allocation rates of different investor types between the pre-regulation and post-regulation periods. Examining subscription rates, we find a decline in the subscription rate of retail investors. In the pre-regulation period, retail investors subscribed, on average, for almost 9.0 times the shares originally allotted to them. In other words, for each share originally allotted to retail investors, these investors subscribed for 9.0 shares.[27] The times subscribed ratio for retail investors in the post-regulation period declined to 4.7 times, where the decline is statistically 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]

We also find a decline in the subscription rate by qualified institutional investors (QIBs), for which the times subscribed ratio drops from around 36.1 times pre regulation to approximately 12.6 times post regulation. The difference between the two subscription rates is also significant at

[27] As long as IPOs 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. By regulation, the quota set aside for retail investors is 35% of the shares offered in the IPO. The quota set aside for the qualified institutional buyers (QIBs) is 50% of the shares in the offering. Allocations in excess of the prescribed ratios are made only if the retail investor group declines to pick up the shares allocated to them. If the retail subscription is below the shares allotted to them, the remaining shares can be offered to QIBs. The reverse is not permitted. If the QIBs demand is below the allotted 50%, the deal is not allowed to go through, until the QIBs' subscription reaches their allotted level.

the 0.01 level. The decline in demand from institutional investors is consistent with prior literature, which documents that institutional investors also participate in speculation. For example, Brunnermeier and Nagel (2005) show that hedge funds trade during speculative episodes, to exploit the suboptimal trading behavior of retail investors.

In contrast to retail investors and qualified institutional investor, 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.

Allocation rates, which are presented in the bottom half of Table 4, are relatively stable across the two regimes. We compare the two regimes and do not find significant differences in the allocations to retail investors. In both regimes, retail investors were allocated around 30% to 31% of IPO shares, on average. Qualified institutional investors also received similar allocations between the two regimes, at around 54% to 55%, on average. 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 discussed in footnote#26)

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 noted 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.

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 a large decline in the demand by qualified institutional investors, a decline which is not directly predicted by the decline in price variability. As discussed above, it is possible that the demand by institutional investors is influenced, at least in part, by retail investors' demand.

5.3. 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 for every seller there is a 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's trading because IPO stocks are most volatile during their initial trading. As shown in Section 5.1, price variability declines steadily and significantly in subsequent days, especially in 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 IPO's first day. 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 a 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 the pre-regulation period; this number declines to around 247 trades per minute in the post-regulation period. The drop in trading activity by half is both economically and statistically significant (at the 0.01 level). 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 the 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 the 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 here on the buy and sell volume, as reported in Panel B of Table 5.

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 selling volume accountable to individual investors, from around 49.1 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 buy volume and the percentage of sell volume ascribed to individual investors were approximately equal, leading to a stable net position by such investors. In contrast, post regulation, individual investors were net sellers, where their sell volume was around 16.1 percentage points higher than their buy volume. These findings are supportive of Hypothesis 3, which predicts a decline in net buying by retail investors in the post-regulation period.

For institutional investors, we find that around 8.5 percent of all buy volume pre regulation is attributable to institutions, whereas 24.2 percent of all post-regulation buy-volume is attributable to institutions. The increase of around 15.7 percentage points is statistically significant at the 0.01 level. Selling activity of institutional investors has remained relatively stable between the two regimes, at around 16.2 to 14.9 percent. Comparing buy and sell 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.

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 containing 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 volume and the sell volume measures as well as the number of buy trades and the number of 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 the number of trades, while the other three types of investors were net buyers.

[Insert Table 6 about here]

The findings presented in this section show that investor sentiment for IPOs, as measured by trading activity, has declined significantly from pre- to the post-regulation period. In addition, our findings 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 opportunity provided by the pre-market auction to sell their IPO allocations. The net selling by individual investors was met by a net buying by institutional and non-individual investors. The overall findings in this section are consistent with the proposition 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.

5.4. IPO first-day returns

To test Hypothesis 4, in Table 7 we compare the first-day returns for our samples of pre-regulation IPOs and post-regulation IPOs. While we follow existing literature and examine offer-to-close returns, we also examine offer-to-open returns. This allows us to understand the effects on IPO first-day returns while excluding the returns incurred during the first day of trading (i.e., from opening price to closing price).

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. Even

though 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 find that the difference is statistically insignificant.

The overall findings in this section show no discernable changes in IPO underpricing between the two regimes. These findings provide support for Hypothesis 4 and are consistent with the premise that the information environment in IPOs has remained unchanged from pre regulation to post regulation.

5.5. One-year returns

In this section, we examine whether the reduced demand for IPO stocks has led to longer term valuation effects.[28] For example, speculation during the first days of trading should lead to increased market prices and reduced expected future returns. On the other hand, as proposed in Hypothesis 5, a decline in speculative activity after the regulation should lead to reduced stock prices and increased expected returns. To test the hypothesis, in this section we examine IPO returns over the following year, again focusing on our matched sample of IPOs as discussed in Section 4.3.

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

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.

[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). We estimate the following portfolio regression model:

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

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 a comparison of factor sensitivities between the two regimes, we estimate the model within 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, delivering to investors 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).[29] In stark contrast to the underperformance of IPO stocks in the pre-regulation period, IPO stocks in the post-regulation 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 5, which predicts that a reduction in post-regulation speculative demand has led to a decline in the prices of IPO stocks, and thus an increase in their future 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.[30]

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

[30] Viewed in light of Asness et al. (2020), these findings provide further confirmation that our overall results are due to investor sentiment and not risk considerations.

5.6. A disappearance of medium-sized IPOs

To test Hypothesis 6, we examine in greater detail the supply of IPOs with different sizes between the two regimes. According to the proposed hypothesis, we expect a lower incidence of IPOs, which are most affected by the new rules. In this section, we analyze the Indian IPO market in its totality by complementing our sample with additional IPOs that list on the SME exchange (see also footnote 8).

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 (i.e., there is a decline in the supply of smaller firms). To examine this possibility, we collect a sample of IPOs that listed on the SME exchange over the 2012-2017 period. The SME exchange was highly active over that period, with 327 IPOs, or around 54 IPOs per year on average. We

find that all these IPOs raised proceeds lower than INR 2.5 billion. These findings demonstrate that there is no shortage of small firms that sought to go public in the more recent years.

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 for this part of the analysis we are interested in a comprehensive set of IPO firms, 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 less than INR 2.5 billion and who list on the main exchanges. This finding is consistent with Hypothesis 6. 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 that list 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) have proceeds 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.

5.7. Has demand for stocks with speculative payoffs declined over time?

One could reasonably ask whether our findings are due to a general decline in the demand for speculative stocks in the Indian stock market. It is possible, for example, that investors' propensity to speculate in the stock market has declined over time. If indeed that is the case, then the documented decline in investor demand for riskier IPOs, as well as the decline in the number of relatively smaller and riskier IPOs on the main exchanges, could both be as a consequence of a more general trend.

To investigate the possibility of a systemic shift in attitudes towards speculation, in this section we examine investor trading activity over time and how such activity relates to the return properties of stocks. Our empirical analysis is motivated by several studies, which show that trading by speculators has a discernable effect on trading activity, both buying and selling, in individual stocks (Dorn, Dorn, and Sengmueller, 2015; Gao and Lin, 2015). Following these studies, a decline in demand for speculative stocks should also lead to a decline in the trading activity in such stocks, relative to the trading activity in non-speculative stocks. Our empirical approach is further motivated by the theoretical model of Tkac (1999), where anomalous trading activity is derived in relation to a benchmark.

For every month in our sample, we estimate a cross-sectional regression model that relates each stock's trading activity to the stock's return properties, focusing on return properties that existing literature has identified as being related to speculative demand. Every month, we estimate the following cross-sectional regression model:

$$\ln\left(Turnover_{it}\right) = \alpha_t + \beta_t \ln\left(Mcap_{it}\right) + \gamma_t X_{it} + \varepsilon_{it}. \quad (2)$$

The dependent variable in Equation (2) is our measure of trading activity: the average daily share turnover of stock *i* over month *t*. As explanatory variables, we use the average market

capitalization of each firm over month *t* as well as measures of stock return properties (*X*), which the existing literature has identified as appealing to speculators.[31] We use the stock's standard deviation of daily returns over the month, the stock's maximum daily return over the month, the stock's average of the five highest daily returns over the month, and an indicator variable which equals 1 if the stock's maximum daily return over the month is greater than 10 percent, else equals zero. The last variable allows for a non-linear relation between MAX and the trading activity. This variable is motivated by Fong and Toh (2014), who find that the MAX effect documented by Bali, Cakici and Whitelaw (2011) is mainly due to underperformance of stocks with the highest maximum returns rather than the overperformance of stocks with the lowest maximum returns.

We use the monthly estimates of γ_t and their variation over time to capture variations in demand for stocks with speculative properties. The estimated γ_t should increase when the propensity to trade in speculative stocks increases, and it should decrease when this propensity decreases. The γ_t estimates from the four specifications are plotted in Figure 5. Based on our analysis, we do not find a decline in the estimated γ_t coefficients in more recent years. Although all four estimated γ_t coefficients decline in 2013, they revert back to historic levels by 2014. In additional tests (untabulated), we find that, with the exception of 2013, all post-regulation γ_t estimates are either similar or even higher than pre-regulation estimates. These findings do not indicate a systemic decline in the demand for speculative stocks in the Indian stock market.[32]

[Insert Figure 5 about here]

[31] The relevant literature is reviewed in Section 2.1.

[32] In additional tests, we replicate all our other results while excluding IPOs conducted during 2013. In these tests, which are available upon request, we reach similar conclusions.

To ensure the robustness of our findings, we perform several additional tests. First, in the set of explanatory variables we also include measures of the respective return properties as of month *t*-1. The inclusion of one-month lags is motivated by Barberis, Mukherjee, and Wang (2016), who find evidence that investors look at the distribution of past returns when trading. We then examine both the estimated coefficients on the lagged variables as well as the sum of lagged and contemporaneous coefficients. Second, when measuring trading activity, we distinguish between total trading volume and deliverable quantities. To the extent that speculative trading is short-term, the use of total share turnover in excess of share turnover from deliverable quantities should capture speculative trading better than simply using total share turnover. Third, instead of estimating regressions, we compare the average share turnover of stocks with high and stocks with low levels of the explanatory variables. We do not find evidence of a general decline in the demand for speculative stocks in more recent years, in any of the robustness tests.

6. Concluding remarks

We position this paper amidst a large and growing literature, which documents that some investors, particularly retail investors, exhibit a strong tendency to speculate and gamble in stocks that have the potential for extreme returns, thus affecting prices of these stocks.

To examine several important features of IPO markets, we conduct our empirical analysis using a unique and proprietary trading data provided by the Bombay Stock Exchange (BSE) while relying on a natural experiment. 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 after they get listed on India's national stock exchanges, namely the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE). Under the new rules, the IPOs' 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 speculate on wide price variations.

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 stocks 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 IPO subscription rates and the post-IPO net buying by retail investors. While there is no discernable change in IPO underpricing post regulation, we do find significant evidence of higher future 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 from the Indian equity markets. As a result, IPO sizes follow a bimodal distribution post regulation, where large-sized IPOs list exclusively on the main exchanges while small-sized IPOs list exclusively on the SME exchange. Since medium-sized IPOs are the most affected by the new rules, their disappearance could be explained by such firms facing lower valuations, and hence their choice to remain private.

Overall, our findings shed new light on the role of speculative investors in IPO markets, suggesting that the participation of such investors increases prices in a market generally considered to face significant asymmetric information problems. Restricting the participation of these investors, either directly or indirectly, could lead to a significant increase in some firms' cost of capital and to a reduction in their incentives to sell equity to public investors. Our findings suggest

that, at least for relatively risky firms, speculative investors may play a critical role in the viability of their IPO markets.

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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. If several prices lead to the same minimum order imbalance, then the equilibrium price is the price closest to the base price. In cases where the base price is the mid-value of the pair of prices closest to it, 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

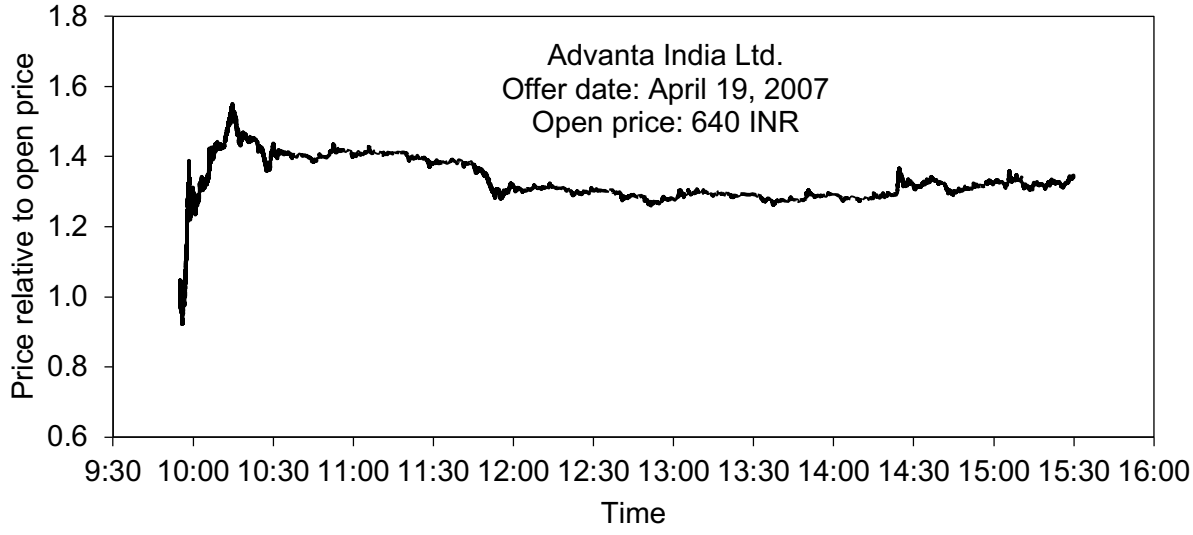
Variable	Description	Data Source
Buy (sell) trades by investor type (%)	Number of buy (sell) trades for a given investor type as a percent of all buy (sell) trades on the first day of trading after IPO.	BSE
Buy (sell) volume by investor type (%)	Number of shares bought (sold) for a given investor type 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/

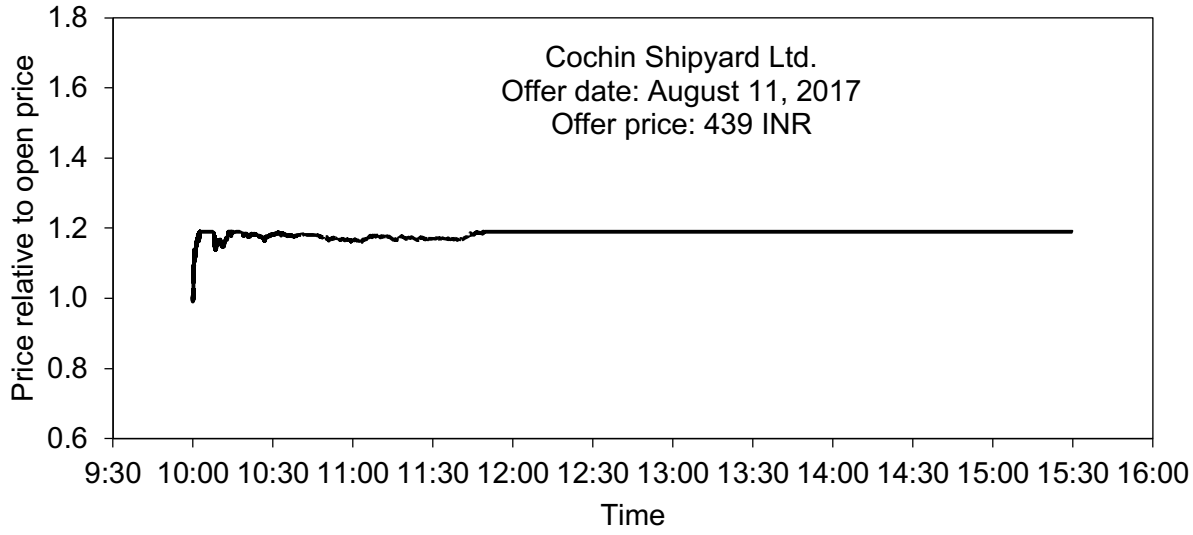
Appendix C: Client categories in the intra-day data

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

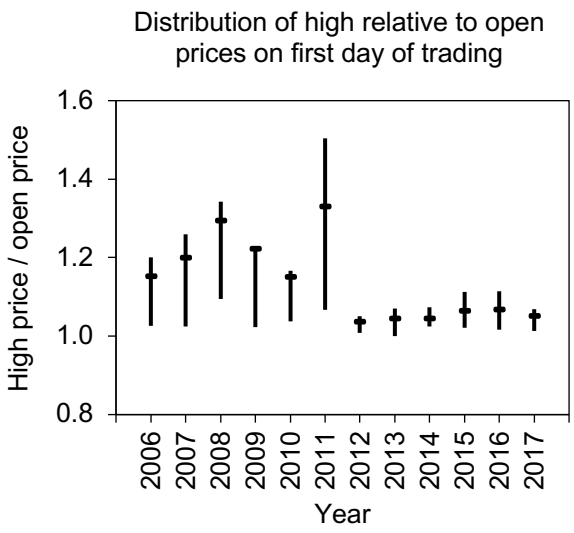


Panel A

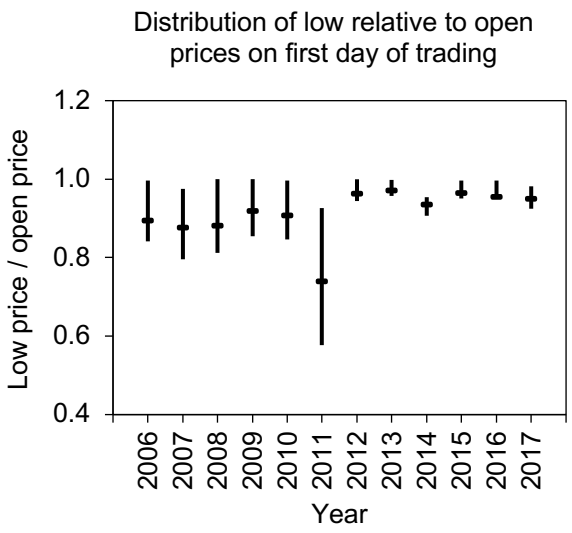


Panel B

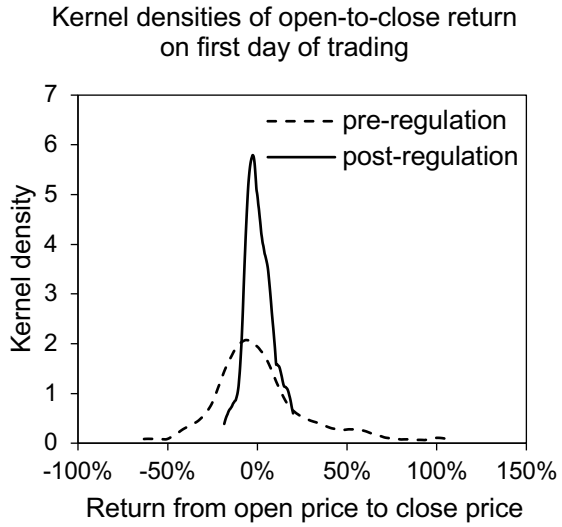
Fig. 1.: The figures plot the intraday prices on the first day of trading for two IPOs in our sample. The first IPO, plotted in Panel A, was conducted in 2007 by Advanta India Ltd and was not subject to price bounds. The second IPO, plotted in Panel B, was conducted in 2017 by Cochin Shipyard Ltd and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



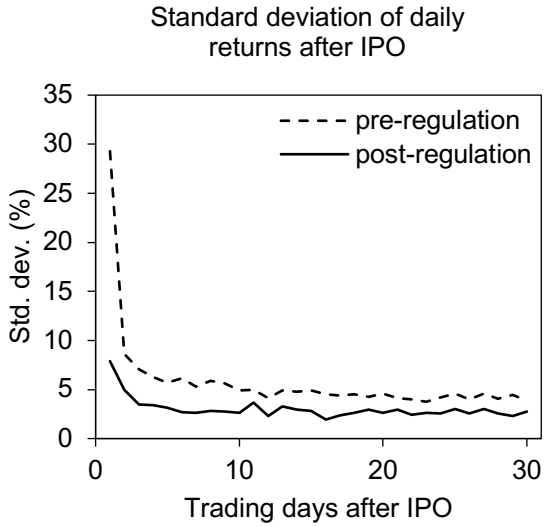
Panel A



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.

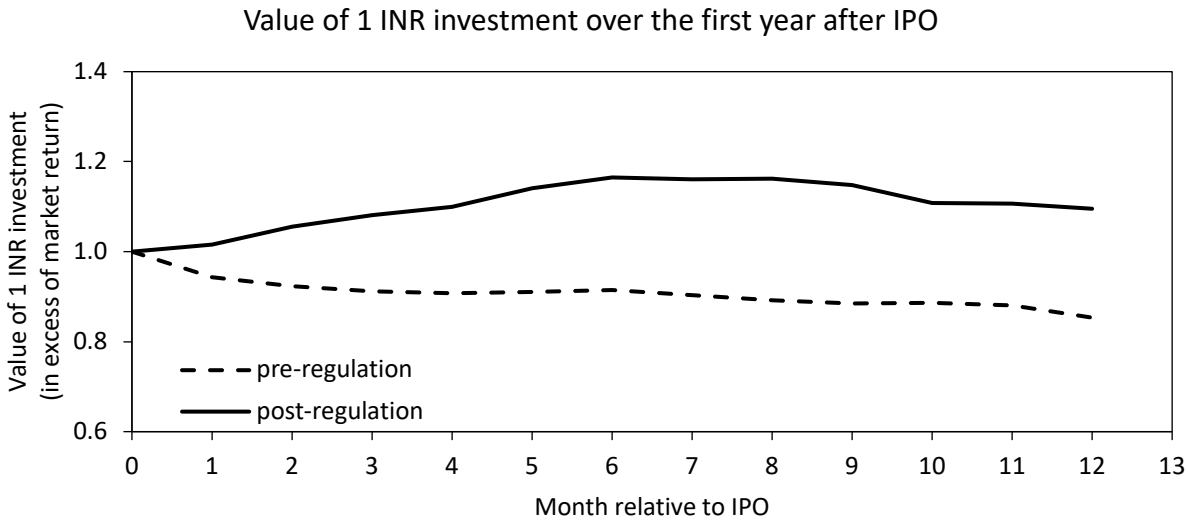
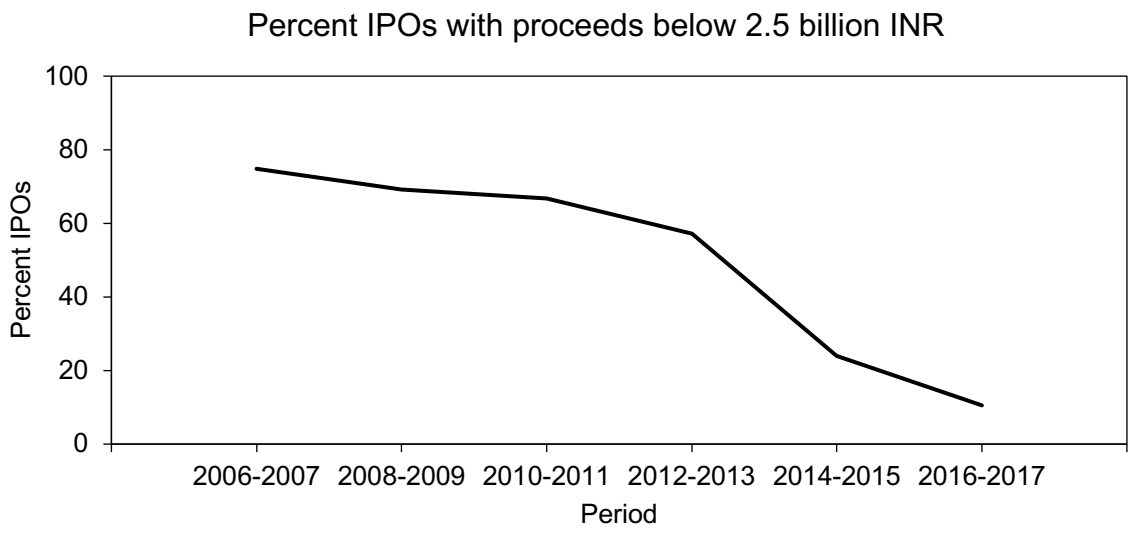
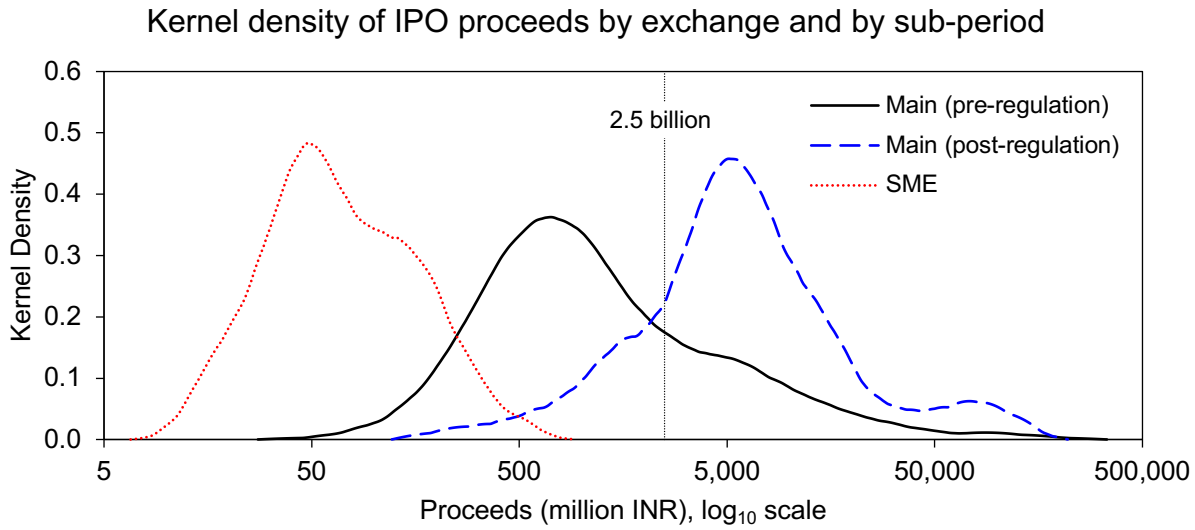


Fig. 3.: The figure plots in event time the value of a 1.0 INR investment in an equally-weighted portfolio of IPOs for two sub-periods. We track the value of the investment over the 12 months after the IPO. The value is calculated in excess of the return on a market portfolio of Indian equities obtained from CMIE Prowess and adjusted for survivorship bias. We divide the IPO sample into two sub-periods: pre-regulation period (solid) and post-regulation period (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 period (solid, black) and post-regulation period (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.

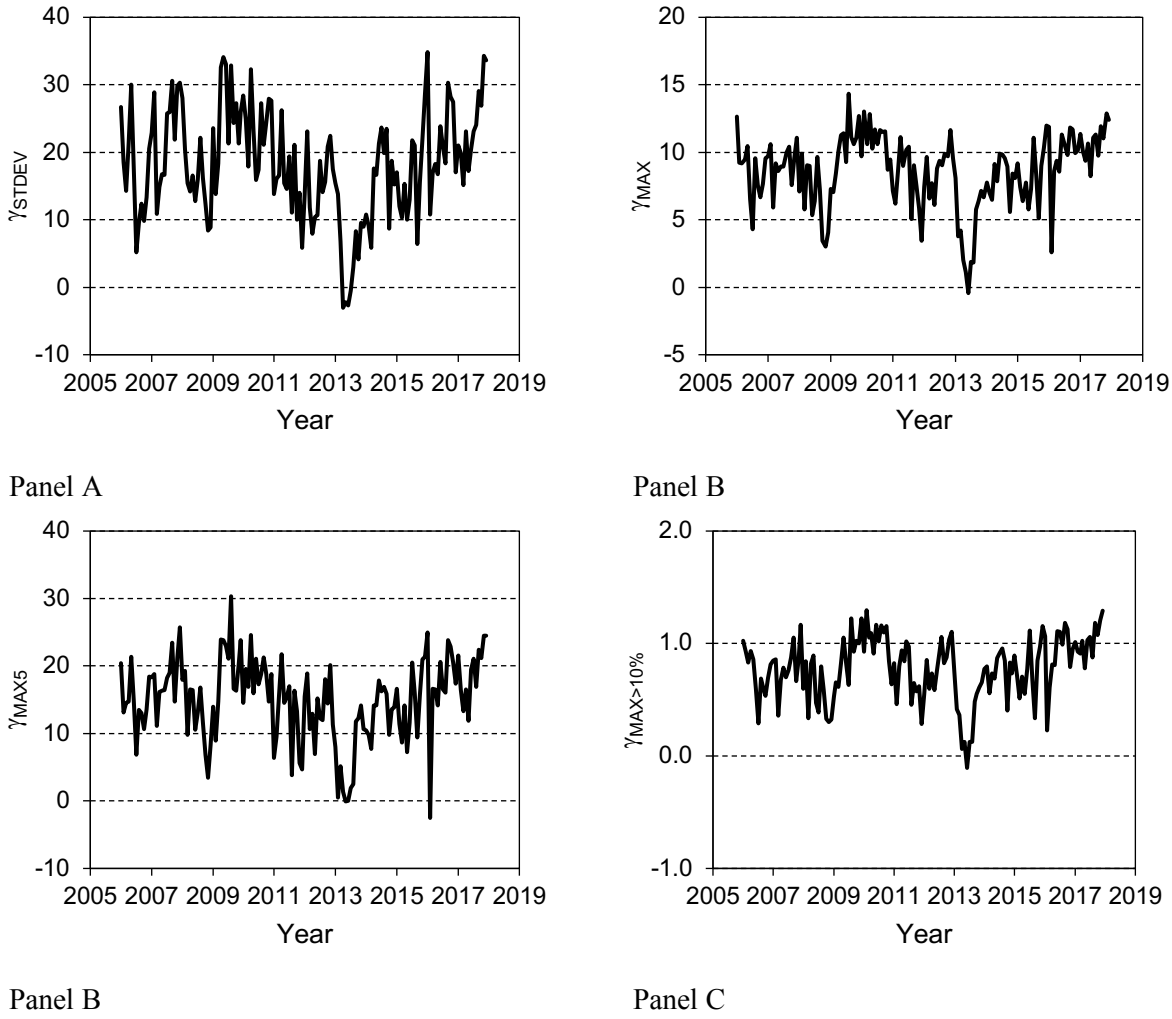


Fig. 5.: The figures plot monthly coefficient estimates of γ from the following cross-sectional regression model:

$$\ln\left(Turnover_{it}\right) = \alpha_t + \beta_t \ln\left(Mcap_{it}\right) + \gamma_t X_{it} + \varepsilon_{it}.$$

The dependent variable is the average daily share turnover of stock *i* over month *t* and as explanatory variables we use firm market capitalization and measures of stock return properties (*X*) that existing literature has identified as attracting speculators. To measure speculative stock returns for each stock *i* in month *t*, we use the stock's standard deviation of daily returns over the month (Panel A), the stock's maximum daily return over the month (Panel B), the stock's average of the five highest daily returns over the month (Panel C), and a dummy of whether the stock's maximum daily return over the month is higher than 10 percent. Regressions are estimated separately for each month *t*, thus producing monthly estimates of γ. The sample covers all NSE and BSE stocks with available daily data for at least 10 trading days in a given month. The average number of stocks per month is 2,697, with a minimum of 2,121 in August of 2013 and a maximum of 3,080 in October of 2010.

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 of total 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 (sell – buy, % 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 of total 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 (sell – buy, % 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 (sells–buys)	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%