SHORT-SALES CONSTRAINTS AND AFTERMARKET IPO PRICING*

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ABSTRACT

We use the IPO setting to provide new evidence on the surprisingly large and predictable mispricing that can result from short-sales constraints in equity markets. The IPOs that we predict to be most susceptible to mispricing have first-day returns of 44% and lockup expiration returns of -10%. These IPOs experience severe short-sales constraints that peak around the expiration of IPO share lockups, with average indicative lending fees topping 15%, average active utilization rates topping 75%, and average fails-to-deliver topping 20 times normal rates. While prior studies are inconclusive with respect to the importance of short-sales constraints, we provide direct evidence of severe short-sales constraints that are associated with extreme mispricing in equity markets.

Keywords: Short-Sales Constraints; Divergence of Opinion; IPO Pricing; IPO Share Lockups.
JEL Classification: G12, G14, M41.

I. INTRODUCTION

Equity markets are textbook examples of competitive markets that should reflect information efficiently. Yet academic research has discovered numerous pricing anomalies in equity markets that continue to defy satisfactory explanation. Popular explanations for these pricing anomalies include compensation for rationally priced risk (e.g., Fama and French 2015) and delegated portfolio management (e.g., Shleifer and Vishny 1997). These explanations, however, appear incomplete. Risk-based explanations fail to articulate fully the nature of the underlying risk. Explanations based on delegated portfolio management are undermined by the observation that many arbitrageurs do not rely on externally sourced capital. In this paper, we provide new evidence on the significant role of short-sales constraints in explaining equity market mispricing. Prior research on the role of short-sales constraints has been mixed and inconclusive (e.g., Geczy, Musto, and Reed 2002; Edwards and Hanley 2010). We isolate the conditions under which short-sales constraints are most severe and use new data on the magnitude of short-sales constraints to provide direct and compelling evidence on the importance of short-sales constraints in explaining equity market mispricing.

The setting that we use to illustrate the importance of short-sales constraints is the initial public offering (IPO) of securities. IPOs provide two of the greatest asset pricing puzzles. First, IPOs tend to experience positive first-day returns in that, on average, the closing price on the first trading day is substantially above the offer price (e.g., Logue 1973; Ibbotson 1975). Second, IPOs tend to have poor stock returns relative to seasoned securities in the years following the offering (e.g., Ritter 1991; Loughran and Ritter 1995), and especially around the expiration of IPO share lockups (e.g., Field and Hanka 2001; Brav and Gompers 2003).

A unified theory for explaining these phenomena is proposed in Miller (1977. Within the context of this theory, investors with relatively optimistic opinions buy the stock in the immediate aftermarket, while investors with relatively pessimistic opinions are unable to register their negative views due to short-sales constraints. The theory predicts that the aftermarket price will exceed the consensus valuation of the stock and the magnitude of this overpricing will be increasing in the combined effects of divergence of investor opinion and short-sales constraints. This theory also predicts that IPO firms will subsequently underperform seasoned firms. This is because the resolution of valuation uncertainty and the loosening of short-sales constraints will cause the stock price to revert toward the consensus valuation. This process is predicted to be accelerated at the expiration of IPO lockup agreements, as these expirations can lead to an increase in floating stock, thereby relaxing short-sales constraints (e.g., Ofek and Richardson 2003). This prediction distinguishes Miller's theory from a variety of theories of deliberate premarket discounting (e.g., Rock's [1986] "winner's curse" explanation), which presume that the immediate aftermarket price is an unbiased estimate of fundamental value and are silent with respect to long-term underperformance, especially around the lockup expiration. Duffie, Garleanu, and Pedersen (2002) formalize Miller's theory and extend it to a dynamic setting. The key insight of their model is that the anticipation of future lending fees can push the initial security price even higher than the valuation of the most optimistic buyer.

While Miller's theory provides an intuitive explanation for IPO price behavior, prior studies conclude that short-sales constraints do not appear to explain IPO returns. Geczy, Musto, and Reed (2002) find that while average borrowing costs are initially elevated for IPOs, they appear insufficient to explain the long-run underperformance of IPOs. Follow-up research by Edwards and Hanley (2010) finds evidence of active short selling in the first trading week of

IPOs, which they interpret as inconsistent with the notion that short-sales constraints are binding in the immediate aftermarket. Our paper, in contrast, provides direct evidence of a significant link between short-sales constraints and aftermarket IPO pricing.

Our research design incorporates three improvements over previous research. First, we analyze a comprehensive set of securities lending market data that allows us to assess the demand for shorting, the supply of lendable shares, and the cost of short selling. Second, we *ex ante* identify IPOs where divergence of investor opinion is expected to be high and floating stock is expected to be low. Miller's theory predicts that such IPOs are more likely to experience binding short-sales constraints and overvaluation. Third, we probe the dynamics of short-sales constraints around the IPO lockup expiration date, which should be the most opportune time for arbitrageurs to profit from the underperformance of overpriced IPOs.

To identify new issuers that are *ex ante* expected to have high divergence of opinion, we develop a composite measure of divergence of opinion (*DO Score*) using a parsimonious set of fundamental characteristics from the offering prospectus, including pre-IPO sales growth, operating earnings, and intangible intensity. The idea underlying the *DO Score* is that uncertainty about future operating performance and, therefore, divergence of investor opinion should be higher for high growth IPOs experiencing operating losses, while making larger intangible investments. To identify IPOs for which short-sales constraints are *ex ante* expected to be more binding in the aftermarket, we focus on offering size, measured as the number of shares offered in the IPO relative to the total number of shares outstanding in the company. Shares outstanding in the company that are not offered in the IPO are typically subject to lockup agreements that prohibit the sale or loan of the shares for 180 days following the offering. The combination of small offering size with lockup agreements on the remaining shares outstanding in the company

restricts the supply of lendable shares and makes short-sales constraints more binding prior to the lockup expiration.

In combination, *DO Score* and offering size provide a simple way to *ex ante* identify new issuers that are more likely to become overpriced in the immediate aftermarket. IPOs with a top *DO Score* and small offering size are IPOs for which both conditions of Miller's overvaluation theory are *simultaneously* satisfied. These IPOs should be more overpriced in the immediate aftermarket and should subsequently underperform, particularly around lockup expirations. On the flip side, IPOs with a bottom *DO Score* and large offering size should be the least susceptible to initial overpricing and subsequent underperformance.

Consistent with Miller's overvaluation theory, we find that IPOs with a combination of high *DO Score* and small offering size are associated with more positive first-day returns and more negative lockup expiration returns. The economic magnitudes of our results are striking. The average first-day return increases from 5.5% for IPOs with low *DO Score* and large offering size to 44.4% for IPOs with high *DO Score* and small offering size. Conversely, the average lockup expiration return decreases from effectively zero for IPOs with low *DO Score* and large offering size to -10.1% for IPOs with high *DO Score* and small offering size.

We next provide direct evidence on the role of short-sales constraints in aftermarket IPO pricing by analyzing detailed data from the securities lending market, including stock loan fees, supply and demand dynamics and fails-to-deliver. Our analysis centers on the window from ten trading days before to ten trading days after the lockup expiration date, since this should be the most opportune time for arbitrageurs to profit from short selling overpriced IPOs. We find that IPOs with high *DO Score* and small offering size are more difficult and costly to short sell. The

average stock loan fee increases from 0.8% per annum for IPOs with low *DO Score* and large offering size to 15.1% per annum for IPOs with high *DO Score* and small offering size. Similarly, the average utilization of active lending inventory increases from 25% for IPOs with low *DO Score* and large offering size to 76% for IPOs with high *DO Score* and small offering size. Moreover, a dynamic analysis shows that short-sales constraints for the high *DO Score*/small offering size subsample gradually rise to a peak at the lockup expiration date and then drop sharply thereafter. Lending fees, for example, gradually rise from around 8% in the three months leading to the lockup expiration to 17% immediately around expiration, and then fall to around 6% in three months after the lockup expiration. Similarly, fails-to-deliver on securities sales peak at over 20 times the normal levels around lockup expiration.

In contrast to Edwards and Hanley's (2010) conclusion that short-sales constraints are not binding in the immediate aftermarket, our results show that short selling is constrained—as indicated by the high stock loan fees, high active supply utilization and high fails-to-deliver—especially for new issuers that *ex ante* more likely to become overpriced. Overall, our evidence suggests that while short sellers attempt to actively arbitrage overpricing in the IPO aftermarket, short-sales constraints limit their ability to eliminate mispricing.[1]

[1] A representative example of new issuers with high *DO Score* and small offering size is Twitter Inc. (NYSE: TWTR). In the last fiscal year prior to its IPO that ended on December 31, 2012, TWTR reported sales growth of nearly 200%, an operating loss of $77 million, and an intangible intensity ratio of 38 cents in R&D and advertising per dollar of sales. TWTR offered 13% of its shares outstanding at its IPO, while the 87% of the shares outstanding that were not offered in the IPO were subject to a 180-day lockup agreement. Based on these characteristics, Twitter is classified as a top *DO Score* new issuer with small offering size. On November 7, 2013, trading opened at $45.10 and closed at $44.90, up 73 percent from the $26 offering price per share. First-day trading volume was 170% of the number of shares offered in the IPO. TWTR's lockup agreement expired on May 6, 2014, sending the stock price down by 18% and wiping out $4 billion of market value. Prior to the lockup expiration, short sellers were actively targeting TWTR with the active supply utilization peaking at 99% and stock loan fees hovering at 9%. At the same time, the five sell-side analysts covering TWTR were recommending the stock with a "Strong Buy" and a mean (median) consensus target price of $54.40 ($52.00).

To shed further light on the role of short-sales constraints and arbitrage costs in facilitating overpricing in the IPO aftermarket, we examine a hypothetical trading strategy that short sells IPOs around lockup expiration. We find that the strategy faces unique costs and risks, including the cost of borrowing, the cost of locating stock in the securities lending market, the idiosyncratic risk from targeting IPOs, the risk that stock loans are recalled, and the risk that stock loans become more expensive. Indeed, our analysis suggests that short selling around the lockup expiration is most costly and risky for IPOs with high *DO Score* and small offering size, which are precisely the stocks experiencing the most negative returns around lockup expirations. Our analysis illustrates the importance of short-sales constraints in limiting short sellers' effectiveness to arbitrage overpricing in the IPO aftermarket.

In summary, our paper provides evidence that the combination of heterogeneous investor opinions and short-sales constraints is key to explaining mispricing in the IPO aftermarket. More generally, our paper adds to the growing body of research on the importance of short-sales constraints in asset pricing (e.g., Jones and Lamont 2002; Cohen, Diether, and Malloy 2007; Kaplan, Moskowitz, and Sensoy 2013; Engelberg, Reed, and Ringgenberg 2018; Hong and Sraer 2016). The strength of our IPO setting is in isolating the conditions under which short-sales constraints are most binding, thus revealing the extreme nature of the resulting mispricing. Our findings also contribute to the debate on the merits of regulating short selling. Short selling is subject to a number of regulatory constraints and has been selectively banned.[2] Yet our findings add to the growing body of evidence that short selling promotes price efficiency and protects unsophisticated investors from buying overpriced securities (e.g., Beber and Pagano 2013).

[2] See for example, SEC's 2008 emergency order temporarily banning short selling of financial stocks https://www.sec.gov/news/press/2008/2008-211.htm.

II. BACKGROUND AND PREDICTIONS

The aftermarket pricing of IPOs provides two of the most enduring capital market puzzles. First, the closing price on the first trading day is usually significantly higher than the offer price. Second, the subsequent stock returns of IPOs are typically lower than the returns of seasoned securities. For example, Ritter (2016) reports an average first-day return of 17.9% and an average three-year buy-and-hold market-adjusted return of -17.8% for over 8,000 IPOs between 1980 and 2014. Prior research indicates that underperformance is particularly pronounced around the expiration of IPO share lockups. Lockup agreements prohibit pre-IPO shareholders from selling or lending their shares for a specified period. The typical lockup period lasts for 180 days and covers most of the shares that are not sold in the IPO. For example, Brav and Gompers (2003) examine a sample of 2,794 IPOs from 1988 to 1996 and find an average buy-and-hold market-adjusted return of -2% from ten trading days before to ten trading days after the lockup expiration.[3]

Miller's (1977) theory offers one of the earliest and most intuitive explanations for aftermarket IPO pricing. Miller's explanation hinges on the combination of heterogeneous investor opinions and short-sales constraints.[4] Divergence of investor opinion is expected to be

[3] Field and Hanka (2001) report that the fraction of new issuers with a 180-day lockup period increased from 43% in 1988 to 91% in 1996. Brav and Gompers (2003) find lockup agreements in 99% of new issuers.

[4] Diether, Malloy, and Scherbina (2002) note that Miller's theory implicitly assumes bounded rationality in the sense that investors are either over-confident about their own valuation estimates or they make inaccurate inferences about others' valuation estimates. Miller's overvaluation would disappear if investors learned to perfectly discount their valuations to account for the possibility that they ended up holding stock largely because others did not want it, as in Diamond and Verrecchia's (1987) rational expectations framework. Cornelli and Yilmaz (2015) extend Diamond and Verrecchia's (1987) rational expectations framework to include uncertainty about the number of informed investors in the market and show that, as long as the signal observed by the informed investors is not too precise, significant short-sales constraints will not allow prices to converge to the fundamental value.

particularly pronounced for IPOs because they are often high growth companies with a limited operating history for which it is difficult to forecast future cash flows and valuation uncertainty is high (e.g., Miller 1977; Kim and Ritter 1999). With divergent investor opinions about fundamental value and a limited supply of floating shares, the stock price will reflect the valuation estimates of the most optimistic investors who participate in the immediate aftermarket, which will be above the consensus stock valuation. As the stock becomes more seasoned, the reduction in valuation uncertainty along with the increase in the supply of floating shares should cause its price to fall toward the consensus valuation.

Miller explicitly identifies IPOs as a prime setting for overvaluation, stating that "*the prices of new issues, as of all securities, are set not by the appraisal of the typical investor, but by the small minority who think highly enough of the investment merits of the new issue to include it in their portfolio.*" Miller also suggests a non-strategic explanation for the underpricing of new issues by underwriters based on the marginal investor viewpoint: "*...if underwriters…price new issues on the basis of their own best estimates of the prices of comparable seasoned securities, they will typically underprice new issues. The mean of their appraisals will resemble the mean appraisal of the typical investor, and this will be below the appraisals of the most optimistic investors who actually constitute the market for the security.*"

The key requirement of Miller's overvaluation theory is that short-sales constraints are sufficiently binding to prevent pessimistic investors from registering their views via short sales in the immediate IPO aftermarket. Such short sales would effectively increase the stock supply, causing price to fall toward the consensus valuation.

Evidence related to short-sales constraints for IPOs is sparse and the existing evidence is inconclusive with respect to the importance of such constraints in explaining aftermarket IPO pricing. Geczy, Musto, and Reed (2002) examine short-selling activity for a sample of 311 IPOs between October 28, 1998 and October 26, 1999 using a proprietary database provided by a large securities lender. They find that investors with good access to specials can short most IPOs in the immediate aftermarket, but investors without that access cannot short any IPOs initially and they only gradually gain access to a few. Building on this evidence, Edwards and Hanley (2010) examine short-selling activity for 388 IPOs from January 1, 2005 to December 31, 2006 using Regulation SHO pilot data. They find that short selling is prevalent in the immediate aftermarket and that IPOs with more positive first-day returns experience a greater volume of short selling. In addition, they argue that during their sample period there is no evidence that short sellers systematically engage in "naked" short selling in IPOs and, therefore, no indication that too few shares are available to be borrowed in time for settlement. Overall, Edwards and Hanley (2010) conclude that short sellers are active in IPO aftermarket trading and that short-sales constraints are not binding in the immediate aftermarket, as had been assumed in some previous research (e.g., Cornelli, Goldreich, and Ljungqvist 2006). However, Edwards and Hanley (2010) concede that their evidence does not address whether all demand for short selling is satisfied.

While prior evidence confirms the existence of short selling around IPOs, it does not directly address the question of whether the combination of heterogeneous investor opinions with short-sales constraints can explain variation in first-day returns and subsequent underperformance, especially around the lockup expiration. We use a comprehensive database from the securities lending market to examine the role of short-sales constraints in aftermarket IPO pricing. We begin by testing the basic prediction of Miller's (1977) hypothesis that

divergence of investor opinion about fundamental value combined with a limited supply of lendable shares lead to positive first-day returns:

Prediction 1: *IPOs with a combination of high divergence of investor opinion and more limited supply of lendable shares experience more positive first-day returns.*

Miller's explanation also predicts that IPOs with high divergence of investor opinion and more limited supply of shares will subsequently underperform. This is because the resolution of valuation uncertainty and the loosening of short-sales constraints will cause the stock price to drop toward the consensus valuation. This process should be accelerated at the expiration of IPO lockup agreements, as these expirations result in a dramatic increase in floating stock, thereby significantly relaxing short-sales constraints. This discussion leads to our second prediction:

Prediction 2: *IPOs with a combination of high divergence of investor opinion and more limited supply of lendable shares experience more negative returns around the lockup expiration.*

It should be noted that Prediction 2 is made even though the lockup parameters, i.e., the lockup period length and the number of locked-up shares, are known at the time of the IPO. It therefore requires that either (i) the optimistic investors do not anticipate downward price pressure from the additional short selling of pessimistic investors after the lockup expiration; and/or (ii) the lending fees received by the optimistic investors through the lockup period are sufficient to compensate for the downward price pressure from additional short selling.

Prediction 2 distinguishes Miller's theory from a variety of theories, which presume that the immediate aftermarket price is an unbiased estimate of fundamental value and attribute evidence of positive first-day returns to premarket discounting (see Ritter 1998 for a

comprehensive review). For example, an important rationale for evidence of positive first-day returns is Rock's (1986) winner's curse explanation. Rock (1986) presents a model with two groups of investors: the informed investors, who have perfect information about the value of the offering, and the uninformed investors, who have homogeneous expectations about the distribution of the value of the offering. If the new shares are priced at their expected value, the informed investors crowd out the uninformed investors when good issues are offered and withdraw when bad issues are offered. The new issuer must price the shares at a discount in order to guarantee that the uninformed investors are sufficiently compensated for this adverse selection problem. Rock's (1986) model presumes that the immediate aftermarket price is an unbiased estimate of fundamental value and predicts that premarket discounting is more pronounced for IPOs with high information asymmetry. Rock's (1986) model, however, is silent with respect to the long-run underperformance of IPOs, especially around the lockup expiration.

Relatedly, Benveniste and Spindt (1989) view premarket discounting as compensation to investors for revealing information about the IPO valuation to the underwriters during the book-building procedure, which is then used to assist in pricing the issue. This market-feedback hypothesis is geared towards explaining deliberate discounting in the underwriting process and while it generates predictions with respect to variation in first-day returns, it is silent with respect to the long-run underperformance of IPOs, especially around the lockup expiration. Aggarwal, Krigman, and Womack (2002) develop a model in which managers strategically underprice IPOs to maximize personal wealth from selling shares at lockup expiration. Their model predicts that more positive first-day returns generate information momentum, which leads to a higher stock price at the lockup expiration. Their model, however, is silent with respect to the implications of heterogeneous investor opinions and short-sales constraints on aftermarket IPO pricing.

We next examine variation in short-selling costs across IPOs. Specifically, we predict that divergence of investor opinion combined with a limited stock supply available for lending lead to a higher cost of borrowing in the securities lending market. Our prediction is consistent with the model of Duffie, Garleanu, and Pedersen (2002). In particular, Duffie, Garleanu, and Pedersen (2002) build a dynamic model of the determinants of stock prices, stock loan fees, and short interest where agents trade because of differences of opinion and would-be short sellers must search for security lenders and bargain over the stock loan fees. Within the context of their model, Duffie, Garleanu, and Pedersen (2002) find that stock loan fees increase when there is a high degree of divergence of investor opinion and a limited float, i.e., a small number of tradeable shares, as in the case of IPOs offering a small fraction of their number of shares outstanding. Our third prediction is summarized as follows:

Prediction 3: *IPOs with a combination of high divergence of investor opinion and more limited supply of lendable shares are more difficult and costly to short sell.*

We employ a detailed database on stock loan fees and supply utilization in the securities lending market to test this prediction. We anticipate that the difficulty and cost of short selling will peak in the days immediately around the lockup expiration. This is because the lockup expiration is expected to cause a systematic increase in supply of securities, thus relaxing short-sales constraints and causing a drop in overpricing. If short-sales constraints explain IPO overpricing and the associated negative returns around IPO lockup expiration, the costs of short selling should be greatest immediately prior to the realization of the negative returns.

III. SAMPLE AND RESEARCH DESIGN

III.A. Sample Selection

Our sample period begins in 2007 because this is the first year in which we have detailed securities lending data available on a daily basis from Markit Securities Finance Data (formerly known as Data Explorers). We start with an initial sample of 910 domestic IPOs listed on NYSE, NASDAQ, and AMEX over the period from 2007 to 2015 obtained from the Securities Data Company (SDC) database that have Markit coverage. Following prior research (e.g., Ritter and Welch 2002), our initial sample excludes IPOs with an offering price below $5 per share and IPOs by American depository receipts (ADRs), unit offerings, real estate investment trusts (REITs), special purpose acquisition companies (SPACs), and closed-end funds.[5] We reviewed all cases with missing pre-IPO financial accounting data from Compustat and hand-collected data directly from the offering prospectuses available from the SEC's EDGAR database.[6] To obtain our final sample, we exclude 33 IPOs with no lockup agreements and 36 IPOs whose first lockup agreements do not expire 180 days after the IPO day.[7] We further exclude 132 new issuers with zero pre-IPO sales.

[5] We thank Jay Ritter for providing a list of corrections to the SDC database, all of which we have incorporated in this study. The corrections are located at http://site.warrington.ufl.edu/ritter/ipo-data/.

[6] A company undertaking an IPO discloses required information in the registration statement, typically on Form S-1. Form S-1 and its amendments are filed with the SEC and are publicly available through the SEC's EDGAR database. Most of the Form S-1 is comprised of the offering prospectus, which contains at least two years of audited financial statements. After a company's IPO registration has been declared effective, the company will typically file a final prospectus, which is usually identified as a 424B3 or 424B4 filing in the EDGAR database. For the average new issuer, the last fiscal year prior to the IPO ended 191 calendar days prior to the IPO day.

[7] Our results are not sensitive when we include the 36 IPOs with lockup agreements that do not expire 180 days after the IPO day. Our analysis and presentation of results is simplified, however, by focusing on IPOs with 180-day long lockup agreements (see, e.g., Figures 1 and 2).

Our final sample includes 709 IPOs from 2007 to 2015 with aggregate proceeds of $156.3 billion. Our sample ends in 2015 because this is the last year for which we can track new issuers for at least 180 days after the IPO as of the data analysis date. Table 1, Panel A, reports the sample distribution by year. The number of new issuers ranges from a minimum of 15 for 2008 to a maximum of 149 for 2014, which was the most active year since 2000.

III.B. *Ex ante* Determinants of Divergence of Opinion and Short-Sales Constraints

Miller (1977) emphasizes valuation uncertainty as the key determinant of divergent investor opinions since "*the very concept of uncertainty implies that reasonable men may differ in their forecasts*." Miller also identifies IPOs as a prime setting for valuation uncertainty, stating "*the divergence of opinion about a new issue are [sic] greatest when the stock is issued.*" Miller goes on to identify "*uncertainty about the success of new products or the profitability of a major business expansion*" as key sources of valuation uncertainty for IPOs and argues that "*over time this uncertainty is reduced as the company acquires a history of earnings or lack of them, and the market indicates how it will value these earnings*."

We measure *ex ante* divergence of investor opinion due to valuation uncertainty using three pre-IPO characteristics based on financial accounting data in the offering prospectus. These three characteristics are (i) sales growth, (ii) the sign of operating earnings, and (iii) the level of R&D and advertising spending per dollar of sales—a measure of new product uncertainty. The idea underlying this parsimonious set of variables is simple. Uncertainty about future operating performance and, therefore, divergence of investor opinion should be higher for high growth new issuers experiencing operating losses, while making larger intangible investments. Consistent with this idea, prior research provides evidence from the general population that uncertainty over

fundamental value is higher for fast-growing firms, firms with high intangible intensity and firms experiencing losses (e.g., Lakonishok, Shleifer, and Vishny 1994; Chan, Lakonishok, and Sougiannis 2001; Darrough and Ye 2007; Balakrishnan, Bartov, and Faurel 2010).

Next, we introduce a composite score, which we refer to as the *DO Score*, that captures variation in the *ex ante* determinants of divergence of opinion. Specifically, an IPO scores one point for each of the following criteria: (i) it has above median sales growth, (ii) it reports an operating loss, and (iii) it has above median intangible intensity. All three inputs are measured as of the most recent fiscal year prior to the IPO. We obtain the composite *DO Score* by summing up the points and dividing by three to standardize the score to range between zero (low) and one (high). The possible intermediate values of our composite score are 0.33 and 0.66. Note that while high-score IPOs are *ex ante* expected to have the highest divergence of investor opinion, a low-score IPO does not imply the absence of valuation uncertainty.

Prior research has used analyst forecast dispersion as a measure of divergence of investor opinion for the general population of stocks (e.g., Diether, Malloy, and Scherbina 2002; Nagel 2005; Boehme, Danielsen, and Sorescu 2006). Analyst coverage of IPOs, however, typically starts forty calendar days following the IPO date, which coincides with the end of the quiet period (e.g., Bradley, Jordan, and Ritter 2003). As a result, analyst forecast dispersion is determined endogenously and simultaneously with IPO pricing. By focusing on *ex ante*

determinants of divergence of investor opinion using information from the offering prospectus, we alleviate issues of simultaneity and endogeneity in our empirical tests.[8]

With respect to the securities lending market, a key determinant of the supply of lendable shares in the immediate aftermarket is the offering size, i.e., the number of shares offered in the IPO relative to the number of shares outstanding in the company. Shares outstanding that are *not* offered in the IPO are typically subject to lockup agreements that prohibit the sale or loan of the shares for 180 days following the offering. The combination of small offering size with lockup agreements on the remaining shares outstanding in the company restricts the supply of lendable shares in the securities lending market. It follows that new issuers with small offering size are more likely to experience binding short-sales constraints due to a limited supply of lendable shares in the immediate IPO aftermarket and a greater loosening of this constraint around the IPO lockup expiration. Conversely, new issuers with large offering size are less likely to face binding restrictions on the supply of lendable shares in the IPO aftermarket. Given that all new issuers in our sample have a lockup agreement, we identify the number of shares offered in the IPO relative to the total number of shares outstanding in the company as the key *ex ante* determinant of short-sales constraints.

III.C. Timeline of Research Design

Figure I illustrates the timeline of our research design. We measure the *ex ante* determinants of divergence of investor opinion, including sales growth, the operating loss

[8] In additional analysis, we find consistent evidence of lockup return predictability when we stratify IPOs based on analyst forecast dispersion rather than our *DO Score*. This is consistent with evidence of a significantly positive association between analyst forecast dispersion and *DO Score* (see Table 1, Panel E).

indicator, and intangible intensity, using financial accounting data from the offering prospectus as of the most recent fiscal year prior to the IPO. From the offering prospectus, we also measure the offering size as the number of shares offered in the IPO (excluding the exercise of the overallotment option) divided by the number of shares outstanding in the company immediately after the IPO.[9] At the end of the first day of trading, we measure the return from the IPO offering price per share to the closing price per share, and offer turnover as the number of shares traded on the first trading day divided by the number of shares offered in the IPO. Around the lockup expiration, we measure buy-and-hold market-adjusted returns from the CRSP database as well as stock loan fees, and active supply utilization using daily values available from Markit's securities lending market database. Our primary tests focus on the window from ten trading days before to ten trading days after the lockup expiration date.

III.D. Descriptive Statistics

Before presenting our empirical results, we discuss the descriptive statistics. Appendix I details variable definitions. Table I, Panel B, summarizes the empirical distributions of key variables. The average new issuer reports sales growth of 85.3% in the year prior to the offering and invests nearly 90 cents in R&D and advertising per dollar of reported sales. Operating losses are reported by 37.7% of our sample. The average offering size accounts for nearly 29% of the number of shares outstanding. It follows that the average fraction of locked-up shares is 71%. The average offering price is $15.52 per share, while 73% of IPOs

[9] For new issuers with dual-class ownership structure (60 cases), we measure the offering size as the number of Class A shares offered in the IPO divided by the number of shares outstanding in the company immediately after the IPO. This is because Class B shares typically do not enter the supply of tradeable shares prior to the IPO lockup expiration.

in our sample have offering prices between $10 and $20, which is in line with prior evidence on the distribution of IPO prices (e.g., Ritter and Welch 2002).[10]

Consistent with prior research dating back to Logue (1973), we find evidence of positive first-day returns. The average first-day return is 17.4% with a standard deviation in excess of 27%. Consistent with prior research (e.g., Field and Hanka 2001; Brav and Gompers 2003; Ofek and Richardson 2003), we also find evidence of negative returns around the lockup expiration. The average market-adjusted return cumulated from ten trading days before to ten trading days after the lockup expiration is −3.41% with a standard deviation in excess of 15%.

Turning to the securities lending market, we measure the active lendable quantity of shares, the lender quantity of shares on loan, and stock loan fees using daily data available from Markit. Markit sources its data from a consortium of institutional lenders that collectively account for the vast majority of lendable inventory of shares in the U.S. Markit provides the expected daily value of stock loan fees using rates between agent lenders and prime brokers as well as rates from hedge funds to produce an indication of the current market rate. We measure active supply utilization as the ratio of lender quantity of loan divided by the active lendable quantity of shares.

[10] Under the book-building method used in the U.S., IPO underwriters first come up with a suggested offering price range. After setting the offering price range, the underwriters collect investors' indications of interest during the book-building process and determine the final offering price. For a description of the book-building procedure, see Cornelli and Goldreich (2001, 2003). In additional analysis, we find that IPOs with high *DO Score* are associated with a wider offering price range relative to the final offering price. When compared to the offering price range, our *DO Score* offers a more appealing *ex ante* measure of divergence of investor opinion about fundamental value. This is because the *DO Score* inputs hew closely to Miller's (1977) theory of the determinants of valuation uncertainty, while the offering price range is a function of various other factors, including market conditions that may affect institutional client demand for the offering.

Table I, Panel C, compares the securities lending market characteristics around the lockup expiration of IPOs in our sample to the general population.[11] When compared to the average firm in the general population, the average IPO is significantly more constrained in the securities lending market as indicated by the significantly smaller lendable quantity of shares and the significantly higher utilization rates. Around the lockup expiration of the average IPO the stock loan fee is 4.27% per annum, while the average active supply utilization is nearly 43%. In contrast, for the average firm in the general population the stock loan fee is 0.98% per annum, while the active supply utilization is below 19%. These comparisons are even more striking when we consider value-weighted averages for the general population. On a value-weighted basis, the average stock loan fee is 0.44% per annum with active supply utilization of 6.85%.

Table I, Panel D, shows evidence of higher optimism for new issuers relative to the general population. Focusing on the average new issuer, we find that the sell-side analysts' consensus target price is 31% higher than the prevailing stock price prior to IPO lockup expirations and 24% above the one-year-out stock price. Turning to the average firm in the general population, the sell-side analysts' consensus target price is 18.5% higher than the prevailing stock price and 8.9% above the one-year-out stock price. Consistent with the idea that valuation uncertainty is elevated in the IPO setting, we find that analyst forecast dispersion—a measure of divergence of investor opinion that has been used for the general population of stocks (e.g., Diether, Malloy, and Scherbina 2002; Nagel 2005; Boehme,

[11] The general population includes U.S. firms listed on NYSE, AMEX, and NASDAQ, excluding IPOs, penny stocks, micro-cap stocks, ADRs, unit stocks, closed-end funds, and REITs.

Danielsen, and Sorescu 2006)—is significantly higher for new issuers relative to the general population.

Table I, Panel E, explores variation in analyst forecast dispersion with our composite *DO Score*. Consistent with the notion that *DO Score* captures variation in *ex ante* determinants of divergence of investor opinion, we find that analyst forecast dispersion is significantly higher for high *DO Score* IPOs relative to low *DO Score* IPOs. Consistent with long-standing evidence of a positive link between trading volume and investor disagreement due to valuation uncertainty (e.g., Comiskey, Walkling, and Weeks 1987), we find evidence of a positive association between *DO Score* and first-day turnover measured as the number of shares traded on the first day of trading divided by the number of shares offered in the IPO.

Table I, Panel F explores variation in the active lendable quantity of shares as a function of offer size. For this panel, we want to see how offer size impacts the lendable quantity before lockup expiration. We therefore use the average active lendable quantity of shares as a percentage of the number of shares outstanding in the company from the IPO day to ten trading days before lockup expiration. The average active lendable quantity is 4.81% for IPOs with a small offering size and 8.24% for IPOs with a large offering size. The evidence is consistent with the notion that small offering size restricts the supply of lendable shares prior to lockup expiration, thus increasing short-sales constraints.

The correlation matrix in Table I, Panel G confirms that our *DO Score* is positively correlated with analyst forecast dispersion (*Analyst Dispersion*). One key advantage of our *DO Score* is that it is based on pre-IPO characteristics and so is not endogenously determined in the IPO aftermarket. The correlation matrix also shows that offering size is positively related to the

active supply of lendable shares and negatively related to the utilization rate and stock loan fees. These correlations are consistent with offering size being a key *ex ante* determinant of supply constraints in the securities lending market. The -21% correlation between *DO Score* and offering size suggests that hard-to-value new issuers are more likely to have lower offering size and therefore are more likely to be constrained in the securities lending market. The correlation between *DO Score* and offering size is far from perfect, however, allowing us to intersect partitions of low and high *DO Score* with partitions of small and large offering size.

Table I, Panel H, presents the sample distribution across partitions formed based on *DO Score* and independent sorts based on offering size. We stratify our sample of new issuers into three portfolios of small, medium, and large offering size using the first and third quartile cutoffs of the empirical distribution of offering size. The two key portfolios of interest are (i) new issuers with high *DO Score* and small offering size, which is the group that Miller's theory predicts to be most susceptible to overpricing in the immediate IPO aftermarket due to the combination of higher *ex ante* dispersion of investor opinions with more binding short-sales constraints; and (ii) new issuers with low *DO Score* and large offering size, which are predicted to be least susceptible to overpricing.

IV. EMPIRICAL RESULTS

IV.A. Evidence from the First Trading Day

Table II examines variation in first-day returns across partitions formed based on the *DO Score*, our *ex ante* measure of differences of investor opinion about fundamental value, and offering size, a key determinant of limits on the supply of lendable shares in the immediate IPO aftermarket. Consistent with our first prediction in Section II, the portfolio results in Table II,

Panel A, provide evidence that first-day returns are more positive for IPOs that are *ex ante* expected to have high divergence of investor opinion and more limited supply of lendable shares. The average first-day return is 44.36% for new issuers with high *DO Score* and small offering size (top portfolio), while the average first-day return is 5.53% for new issuers with low *DO Score* and large offering size (bottom portfolio). Table II, Panel B, shows that the first-day return spread of 38.84% across the top and bottom portfolios is not only economically large but also statistically significant. The spread in first-day returns from the bivariate sort based on *DO Score* and offering size is more than two times that from the univariate sort based on *DO Score* alone. We hasten to note that a high *DO Score* alone does not necessarily result in significantly positive first-day returns. The average first-day return for new issuers with a combination of *high DO Score* and *large* offering size is not significantly different from zero. While consistent with Miller's theory, this result is inconsistent with theories of deliberate premarket discounting based on information asymmetry alone (e.g., Rock 1986).

The regression results in Table II, Panel C provide consistent evidence of a significantly positive interaction effect between high *DO Score* and the indicator for small offering size on first-day returns, after controlling for year fixed effects and industry fixed effects. Evidence of a significantly positive coefficient on $DO\ \ Score \times Small\ \ Offer$ is not sensitive to including other determinants of first-day returns explored in prior research (e.g., Lowry and Schwert 2002; Lowry, Officer, and Schwert 2010). These other determinants include the natural logarithm of the IPO value measured as the offering price multiplied by the number of shares outstanding in the company ($IPO\ \ Value$), an indicator variable for new issuers listed on NASDAQ, the natural logarithm of firm age measured from the founding year (Age), the number of shares offered by selling shareholders divided by the number of shares offered in the IPO

(*Selling Shareholders* %), and the cumulative market return over the fifteen trading days before the first IPO trading day (*Market Return*). The evidence is also not sensitive to the inclusion of indicator variables for prestigious underwriters, Big-Four auditors, and prestigious advising law firms.[12] In fact, we find that none of these indicators has incremental explanatory power for first-day returns.

Overall, the evidence supports our first prediction that IPOs with a combination of high divergence of investor opinion and a limited supply of lendable shares experience more positive first-day returns. Our evidence extends prior studies on the relation between heterogeneous investor opinions due to valuation uncertainty and first-day returns (e.g., Beatty and Ritter 1986; Houge et al. 2001; Cook, Kieschnick, and Van Ness 2006; Gao, Mao, and Zhong 2006). To be clear, while the evidence is consistent with Miller's overvaluation theory, our results do not preclude deliberate premarket discounting as a non-mutually exclusive explanation for positive first-day returns. Theories of deliberate premarket discounting, however, presume that the immediate aftermarket price is an unbiased estimate of fundamental value and are silent with respect to long-term underperformance, especially around the IPO share lockup expiration. Next, we search for predictability in stock returns around IPO lockup expirations.

IV.B. Evidence from IPO Share Lockups

IPO lockup agreements are intended to keep pre-IPO shareholders from immediately selling their stock when a company raises public capital, thereby creating unique supply

[12] The indicator variable for prestigious underwriters $= 1$ if Loughran and Ritter's (2004) underwriter rank score is equal to 9; $= 0$ otherwise. The indicator variable for prestigious law firms$= 1$ if the law firm advising the issuer is included in the Legal 500 top-four tiers; $= 0$ otherwise. The indicator variable for Big-Four auditors $= 1$ if the issuer's auditor is Deloitte & Touche, Ernst & Young, KPMG, or PwC; $= 0$ otherwise.

constraints in the securities lending market. A key prediction based on Miller's (1977) theory is that new issuers with high valuation uncertainty and a restricted supply of lendable shares are more likely to become overpriced in the immediate IPO aftermarket and to experience a price correction around the lockup expiration when an increased stock supply comes to the market. As we explain in Section II, this prediction distinguishes Miller's overvaluation theory from theories that attribute positive first-day returns to deliberate premarket discounting and make no predictions concerning abnormal return performance around the lockup expiration (e.g., Rock's [1986] winner's curse explanation).

Table III examines variation in stock returns around IPO lockup expirations. We measure market-adjusted buy-and-hold returns over the window from ten trading days before to ten trading days after the lockup expiration. We use the CRSP value-weighted index including distributions to proxy for the stock market portfolio. Consistent with prior research, we find that the average new issuer experiences negative abnormal returns around the IPO lockup expiration. Importantly, we uncover predictable variation in lockup returns with *ex ante* determinants of divergence of investor opinion and short-sales constraints.

Specifically, the portfolio results in Table III, Panel A, provide evidence that lockup returns are more negative for new issuers with a combination of high divergence of investor opinion and a limited supply of lendable shares. The average market-adjusted lockup return is -10.11% for new issuers with high *DO Score* and small offering size (top portfolio), while the average lockup return is -0.68% for new issuers with low *DO Score* and large offering size (bottom portfolio). Table III, Panel B, shows that the lockup return spread of -9.43% across the top and bottom portfolios is both economically large and statistically significant. The regression results in Table III, Panel C, provide consistent evidence of a significantly negative

interaction effect between high *DO Score* and the indicator for small offering size on lockup returns, after controlling for year and industry fixed effects as well as other new issuer characteristics. In addition, we find that the indicator variables for prestigious underwriters and advising law firms, as well as the presence of a Big-Four auditor have no explanatory power for IPO lockup returns.

Taken together, the evidence in Tables II and III is consistent with Miller's overvaluation theory and highlights the importance of the interaction of divergence of investor opinions and short-sales constraints. Indeed, we find the strongest evidence of overpricing—as indicated by evidence of positive first-day returns followed by significantly negative lockup returns—among new issuers with high *DO Score* and small offering size, i.e., new issuers that are *ex ante* more likely to have a combination of high divergence of investor opinion with more limited supply of lendable shares. Conversely, we do not find evidence of significant overpricing among new issuers with low *DO Score* and large offering size—as indicated by the lack of evidence of significantly negative lockup returns. We also do not find evidence of significant overpricing among new issuers with high *DO Score* and large offering size or new issuers with low *DO Score* and small offering size.

Figure II provides additional evidence with respect to variation in the aftermarket performance of IPOs. The figure plots average market-adjusted stock returns cumulated forward starting from the IPO day (day 0) to 270 calendar days after the trading debut of (i) all IPOs (solid black line), (ii) IPOs with top *DO Score* and small offering size (dotted red line), and (iii) IPOs with a zero *DO Score* and large offering size (dashed green line). The vertical line indicates the lockup expiration on the 180th calendar day after the IPO day. Starting with our full sample of new issuers, Figure II shows a price jump relative to the offering price on the first trading day,

which is consistent with longstanding evidence of positive first-day returns. A price drop follows about six months later, which is consistent with Brav and Gompers' (2003) evidence of negative abnormal lockup returns. When we stratify new issuers by *DO Score* and offering size, IPOs with a combination of high *DO Score* and small offering size have more positive first-day returns and more negative lockup returns, while new issuers with a combination of low *DO Score* and large offering size exhibit no evidence of abnormal returns around the lockup expiration.

Focusing on new issuers with a combination of high *DO Score* and small offering size, we also find evidence of negative abnormal returns over the trading month leading to the lockup expiration. This finding is consistent with increased short-selling activity leading up to the lockup expiration (we provide direct evidence in Section IV.D). In addition, we find evidence of a downward post-lockup drift, which is consistent with a gradual incorporation of the views of more pessimistic investors and a gradual reversion toward the consensus valuation.

Taken together, the evidence supports our second prediction that new issuers that are *ex ante* expected to have high divergence of investor opinion and more limited supply of lendable shares are more likely to become overpriced in the immediate aftermarket and experience more negative returns around the lockup expiration. Although consistent with Miller's overvaluation theory, our evidence of predictably negative lockup returns for new issuers with a combination of high *DO Score* and small offering size is actually inconsistent with predictions based on rational expectations models with frictionless trading. Within the context of such models, on average, investors should correctly anticipate the number of shares sold around the lockup expiration and abnormal lockup returns should be zero (e.g., Allen and Postlewaite 1984).

IV.C. Evidence from the Securities Lending Market

Our findings so far provide evidence that new issuers with a combination of high divergence of investor opinion and limited supply of lendable shares become overpriced in the immediate IPO aftermarket and experience a significant price correction around the IPO lockup expiration. Next, we analyze detailed data from the securities lending market to test whether such IPOs are also more difficult and costly to short sell. Our analysis provides direct evidence on the constraints faced by short sellers in arbitraging overpricing in the IPO aftermarket.

1. Variation in Stock Loan Fees and Utilization Rates. Stock loan fees are determined by the available supply of lendable shares and demand in the securities lending market and reveal how much investors must pay to gain short exposure (e.g., Reed 2013). Prior research has focused on the level of short interest, measured as the ratio of shares shorted to shares outstanding. The problem with short interest is that a low value can reflect either low demand or low supply in the securities lending market. In fact, a low value of short interest may simply indicate that a stock is difficult or costly to borrow and sell short (e.g., Chen, Hong, and Stein 2002). In contrast, stock loan fees provide a direct measure of the cost of short selling.

Table IV examines variation in stock loan fees around the IPO lockup expiration across new issuers stratified based on *DO Score* and offering size. Table IV, Panel A, provides evidence that new issuers with a combination of high *DO Score* and small offering size are more costly to short. The average stock loan fee (per annum) is 15.08% for new issuers with high *DO Score* and small offering size, while the average stock loan fee is 0.83% for new issuers with low *DO Score* and large offering size. Table IV, Panel B, shows that the stock loan spread of 14.26% across the top and bottom portfolios is both economically large and statistically significant. The

regression results in Table IV, Panel C, provide consistent evidence of a significantly positive effect on stock loan fees from the interaction between high *DO Score* and small offering size, after controlling for year and industry fixed effects and other new issuer characteristics.

Next, we examine variation in active supply utilization prior to the IPO lockup expiration measured as the lender quantity on loan divided by the quantity of current inventory available from beneficial owners net of shares temporarily restricted from lending. Beneish, Lee, and Nichols (2015) argue that active supply utilization—effectively the percentage of lendable shares that are actually on loan—measures the "supply slack" in the securities lending market, thereby offering a good instrumental variable for the otherwise unobservable "marginal" cost of borrowing in the securities lending market.

Table V, Panel A, provides evidence that new issuers with a combination of high *DO Score* and small offering size are associated with higher active supply utilization, which is indicative of higher marginal cost of borrowing in the securities lending market. The average utilization is 76.3% for new issuers with a combination of high *DO Score* and small offering size, while the average utilization is 24.61% for new issuers with a combination of low *DO Score* and large offering size. Table V, Panel B, shows that the utilization spread of 51.69% across the top and bottom portfolios is both economically large and statistically significant. The regression results in Table V, Panel C, provide consistent evidence of a significantly positive effect on utilization from the interaction between high *DO Score* and small offering size after controlling for year and industry fixed effects as well as other new issuer characteristics.

Overall, the evidence supports our third prediction that new issuers with a combination of high divergence of investor opinion and a more limited supply of lendable shares are both more

likely to become overpriced in the immediate IPO aftermarket and also more costly and difficult to short, as indicated by the higher stock loan fees and active supply utilization. Next, we examine the dynamics of the securities lending market in the IPO aftermarket.

2. Securities Lending Market Dynamics. Figure III provides evidence with respect to the dynamics of stock loan fees. The figure plots average stock loan fees starting from the IPO day (day 0) to 270 calendar days after the trading debut of (i) all IPOs (solid black line), (ii) IPOs with top *DO Score* and small offering size (dotted red line), and (iii) IPOs with a zero *DO Score* and large offering size (dashed green line). The vertical line indicates the lockup expiration on the 180th calendar day after the IPO day. Starting with our full sample of new issuers, stock loan fees range between 3% and 4% in the IPO aftermarket, which is significantly higher than the 0.98% average stock loan fees for the general population. Stratifying new issuers based on *DO Score* and offering size, we uncover important variations in the securities lending market.

With respect to new issuers with a combination of high *DO Score* and small offering size, we find that stock loan fees (per annum) range between 8% and 10% over the first three months of trading, trend upwards for the subsequent three months reaching a peak at 17% at the IPO lockup expiration, and experience a rapid drop to 6% in the three months following the lockup expiration. Evidence of a sharp increase in stock loan fees just prior to the lockup expiration is consistent with increased short-selling demand to exploit the negative lockup expiration returns. In addition, evidence of a sharp decline in stock loan fees after the IPO lockup expiration is consistent with a relaxation of short-sale constraints in the securities lending market. In contrast, the average stock loan fees for IPOs with a combination of low *DO Score*

and large offering size fluctuate around 1% per annum, which is close to the average stock loan fees for the general population, and do not exhibit significant variability in the IPO aftermarket.

Figure IV illustrates the dynamics of the securities lending market by tracking the behavior of the active lendable quantity of shares as well as the lender quantity on loan in the IPO aftermarket. Starting with Figure IV, Panel A, it is immediately evident that the availability of lendable shares is much lower for IPOs relative to the general population, though the availability of lendable shares gradually increases as the new issuers become more seasoned. Analyzing variation within IPOs, it is also evident that the availability of lendable shares is more limited for new issuers with a combination of high *DO Score* and small offering size. Turning to the dynamics of lender quantity on loan in Figure IV, Panel B, we find that quantity on loan starts out low for the average IPO and gradually converges toward the population. When we separate IPOs, we find that quantity on loan is significantly higher for IPOs with high *DO Score* and small offering size relative to IPOs with low *DO Score* and small offering size. This is particularly evident around the IPO lockup expiration date. Moreover, new issuers with a combination of high *DO Score* and small offering size is the only portfolio for which quantity on loan approaches lendable quantity.

We next look at fails to deliver on securities sales (FTDs). After the implementation of SEC Regulation SHO (effective January 3, 2005), a short seller has to locate shares she intends to borrow prior to executing a trade. Three days later, the short seller must borrow the shares to deliver them to the buyer. Failing to do so within the three-day settlement period is termed a fail-to-deliver (FTD). Existing research on FTDs finds that FTDs facilitate price discovery, but that high levels of FTDs are associated of equity overvaluation, accounting-related pricing anomalies and binding short sales constraints (see Autore, Boulton and Braga-Alves, 2015;

Fotak, Raman and Yadav 2014; and Liu, McGuire and Swanson, 2017). We obtain the daily values of total FTD for each issuer in our sample from the SEC's website and measure FTD activity as a percentage of shares outstanding.[13]

Figure V examines the dynamics of FTD activity in the IPO aftermarket. Higher FTD activity reflects the difficulty faced by short sellers in locating shares to borrow. Starting with the average IPO (black solid line), we find that FTD activity spikes at 0.2% by the end of the second trading week, subsequently normalizes at 0.02% close to the average level for the general population (black dashed line), before rising to 0.08% in the trading week after the lockup expiration and dropping back to 0.02% within the next week. Our evidence for the average IPO in the immediate aftermarket is broadly consistent with Edwards and Hanley's (2010) evidence of increased FTD activity. In their paper, however, they do not find a relation between FTD activity and short-selling activity and argue that FTD activity is unrelated to short-sales constraints. Our evidence of variation in the level of FTD activity across portfolios of new issuers stratified based on *DO Score* and offering size contradicts this argument.

Specifically, we document that while the level of FTD activity across portfolios is consistent with that of the average IPO in the first two trading months, FTD activity is higher and more volatile during the subsequent period for new issuers with a combination of high *DO Score* and small offering size. Focusing on this group, FTD activity rises dramatically leading to the lockup expiration, peaking at 0.40% (or 20 times normal levels) in the trading week after the

[13] The FTD data is available at https://www.sec.gov/data/foiadocsfailsdatahtm. We thank Ed Swanson for pointing out the availability of this data to us. Prior to September 16, 2008, the FTD data include only securities with a balance of total fails-to-deliver of at least 10,000 shares as of a particular settlement date. After September 16, 2008, the FTD data include all securities with a balance of total fails-to-deliver as of a particular settlement date. We set the level of missing FTD values to zero. As a robustness check, we find consistent results when we set the FTD values to zero for observations with less than 10,000 shares in the later data.

lockup expiration and rapidly converges to the general population average within the next two weeks. Turning to the group of issuers with a combination of low *DO Score* and large offering size, we observe that FTD activity quickly normalizes and stays close to the FTD activity of the general population after the first two trading weeks in the aftermarket. The pattern of sharply increased FTDs for high *DO Score* and small offer size IPOs around lockup expiration mirrors the sharp rise in stock lean fees in Figure IV and is consistent with significant short-sales constraints.

Taken together, our results have important implications for the interpretation of results in prior research, particularly those in Edwards and Hanley (2010). This prior research concludes that short selling does not appear to be constrained for new issuers because short sellers are active in the immediate aftermarket. However, our evidence indicates that around lockup expiration, short selling is severely constrained for IPOs with a combination of high *DO Score* and small offering size. Next, we provide evidence that while short sellers actively target the lockup expirations of these IPOs, they weigh the anticipated gains from the correction of overpricing against the significant costs of short selling. Because of the high costs of short selling, some mispricing remains in equilibrium.

3. Short Selling IPO Lockups in Practice: A Risky Business. The evidence above suggests that short sellers do not completely arbitrage mispricing in the IPO aftermarket due to short-sales constraints. Prior research often rules out short-sales constraints as a complete explanation for IPO mispricing through comparisons of the lending fees to the predictable returns from short selling (e.g., Geczy, Musto, and Reed 2002). Such comparisons do not fully account for the unique costs and risks associated with a strategy of short selling IPOs. To provide a more thorough analysis of this explanation, we examine the performance of a short-selling

investment strategy that systematically targets IPO lockup expirations. Our hypothetical trading strategy involves constructing a portfolio in calendar time throughout our sample period that borrows at the risk free rate, takes a long position in the stock market index, and an offsetting short position that equal-weights across available IPO share lockup periods, i.e., IPOs that are within ten trading days before and after each lockup expiration.[14] This strategy yields a payoff approximating the market-adjusted lockup return minus the stock loan fee.

Table VI, Panel A, reports the mean and standard deviation of the daily returns to our hypothetical trading strategy, along with the corresponding annualized Sharpe ratios. As a passive benchmark, we also report the mean and standard deviation of the daily stock market index return in excess of the risk free rate, which corresponds to the payoff from a trading strategy that takes a long position in the stock market index and is financed by borrowing at the risk free rate. We use the CRSP value-weighted index including distributions to proxy for the market portfolio and the one-month T-bill rate to proxy for the risk free return.

We find that the average daily payoffs to short sellers are higher for IPOs with a combination of high *DO Score* and small offering size. The average daily payoff is 0.55% or 298% per annum, and comes with an annualized Sharpe ratio of 2.51. In comparison, the passive strategy that buys the stock market index and is financed by borrowing at the risk free yields an average daily payoff of 0.03% or 8% per annum, corresponding to an annualized Sharpe ratio of 0.33. The difference in Sharpe ratios suggests that there is a premium for short

[14] On trading days with multiple overlapping lockup expiration windows, we measure the equal-weighted payoff across overlapping IPO lockups. On trading days that are not spanned by any IPO lockup windows, we set the payoff to zero. We also considered a trading strategy that takes a short position in IPO lockups but does not hedge out the market return. This strategy results in lower Sharpe ratios.

selling IPO lockups.[15] The premium for targeting IPO lockups, however, is unlikely to be fully attainable in practice. This is because our payoff calculation ignores (i) the possibility that short sellers are unable to locate shares to borrow at the rates quoted on Markit; (ii) the possibility that a stock loan is recalled and that another loan cannot be located to replace it; and (iii) the requirement that short sellers post additional collateral if prices rise. As discussed in Lamont and Thaler (2003) and Mitchell, Pulvino, and Stafford (2002), the stock lending market is a fragmented over-the-counter market and, therefore, the existence of an indicative lending fee on Markit does not imply a liquid market at that rate. In addition, the combination of small active supply with high utilization, especially for IPOs with low *DO Score* and small offering size, implies that the stock lending market may be too thin for large-scale short-selling operations.

Recall risk is a particularly pernicious risk of short selling. Most institutional lenders in the U.S. maintain the right to terminate a stock loan at any time. If the lender recalls the borrower's loan, it is the borrower's responsibility to return shares to the lender by either buying shares in the market or borrowing shares from another lender. If the borrower fails to return the shares, the lender can institute a "buy-in" using the borrower's collateral to buy shares to cover the loan. Loan recalls can force borrowers to unwind their trading positions sub-optimally and can expose borrowers to the possibility of being "squeezed" at an unattractive price.[16] With respect to the risk that stock loans become more expensive, D'Avolio (2002) proposes that a short seller is concerned not only with the level of fees, but also with the variance of fees. More

[15] In additional analysis, we find that the premium for targeting IPO lockups is not explained by variation in risk-factor loadings based on Fama and French' (1993, 2015) three- and five-factor model.

[16] Mitchell, Pulvino, and Stafford (2002) empirically examine arbitrage activity for situations in which the market value of a company is less than its subsidiary and find that short-selling risk can limit arbitrage activity. They specifically discuss recall risk, noting "*the possibility of being bought-in at an unattractive price provides a disincentive for arbitrageurs to take a large position*."

recently, Engelberg, Reed, and Ringgenberg (2018) interpret a stock loan recall as an extremely high loan fee and argue that recall risk and fee changes are manifestations of the same underlying event, namely changes in lending conditions, and therefore are not independent risks. Engelberg, Reed, and Ringgenberg (2018) introduce the variance of stock loan fees as proxies for short-selling risk and find evidence that stocks with high short-selling risk have lower future returns, decreased price efficiency, and lower short-selling activity by arbitrageurs.

Table VI, Panel B, explores variation in short-selling risk. Following Engelberg, Reed, and Ringgenberg (2018), we measure short-selling risk as the standard deviation of stock loan fees and stock returns. Focusing on the window from ten trading days before to ten trading days after the IPO lockup expiration, we find that short-selling risk is higher for new issuers that are more likely to become overpriced in the IPO aftermarket. Arranging our sample based on high *DO Score* and small offering size effectively separates new issuers with higher variance in stock loan fees and more volatile stock returns.

Table VI, Panel C, reports the frequency distribution of the number of new issuers with overlapping IPO lockup windows on any given trading day across portfolios. The evidence highlights the lack of diversification for short sellers targeting IPO lockups. Focusing on new issuers with a combination of high *DO Score* and small offering size, the evidence shows that arbitrageurs would have been able to target more than three overlapping IPO lockups for only

2% of the 2,251 trading days in our sample period. Clearly, targeting IPO lockups entails poorly diversified portfolios with substantial idiosyncratic risk.[17]

Overall, we conclude that the premium for short selling IPO share lockups likely reflects compensation for the unique costs and risks facing short sellers. Indeed, our analysis provides evidence that short selling IPO lockups is costly and risky especially when targeting new issuers that are *ex ante* expected to become overpriced in the immediate IPO aftermarket.[18] Our hypothetical trading strategy illustrates the importance of short-sales constraints and limits to arbitrage in constraining short sellers' ability to arbitrage overpricing the IPO aftermarket.

V. CONCLUSION

Focusing on a parsimonious set of characteristics available from the offering prospectus, we find evidence that IPOs that are *ex ante* expected to have high divergence of investor opinion about fundamental value and more limited supply of lendable shares become overpriced in the immediate aftermarket and experience a significant price correction around lockup expiration. Using detailed data from the securities lending market, we document that such IPOs are more difficult and expensive to short sell. While prior research is inconclusive with respect to the

[17] We note that arbitrageurs' ability to construct synthetic short positions in the options market by buying puts and writing calls is limited when targeting IPO lockups. This is because several IPOs do not have tradable options prior to lockup expiration. In addition, because the cost of buying puts depends on the put writers' cost of hedging their synthetic long positions by shorting the stock, the cost of synthetic shorts moves hand-in-hand with the cost of borrowing the stock in the securities lending market (see, e.g., Grundy, Lim, and Verwijmeren 2012; Reed 2013). Relatedly, Li and Zhu (2016) argue that arbitrageurs may use exchange-traded funds (ETFs) to create synthetic short positions. We are aware of only one ETF offering exposure to a portfolio of new issuers listed in the U.S. throughout our sample period: the First Trust U.S. IPO Index Fund (NYSE ARCA: FPX), which was incepted on 04/12/2006. Short selling the FPX, however, would not offer a close substitute for short-selling IPOs with high *DO Score* and small offer size.

[18] Our evidence of a shorting premium for targeting IPO lockups complements Drechsler and Drechsler's (2016) evidence of positive abnormal returns for their cheap-minus-expensive-to-short portfolio of stocks in the general population, which they interpret as compensation for the costs and risks associated with short selling.

importance of short-sales constraints in the IPO setting, we provide strong evidence that the combination of heterogeneous investor opinions with binding short-sales constraints is key to explaining aftermarket IPO pricing.

Recent research suggests that restrictions on short selling have the potential to explain a broader set of anomalous returns (e.g., Drechsler and Drechsler 2016; Beneish, Lee, and Nichols 2015). Restrictions on short selling can be severe in the IPO setting, since new issuers are subject to significant valuation uncertainty and a limited supply of lendable shares. More generally, we expect restrictions on short selling to explain overpricing in other settings where divergence of investor opinion is high and the supply of lendable shares is limited. One such setting is the subset of firms that have Fama and French's (2015) "lethal combination" of small size, high investment, and low profitability. These stocks appear to be overpriced, as they experience abnormally low returns that cannot be explained by existing asset pricing models.

Our findings also have implications for the debate on the merits of regulating short selling in equity markets. Short selling is subject to a number of regulatory constraints and has been selectively banned on the grounds that manipulative short selling temporarily depresses security prices.[19] In contrast, our findings add to the growing body of evidence that short selling promotes price efficiency and protects unsophisticated investors from buying overpriced securities (e.g., Beber and Pagano 2013). Our IPO findings are particularly salient because prior research suggests that institutional investors sell the most overpriced IPOs to retail investors in the aftermarket (e.g., Field and Lowry 2009). As such, short-sales constraints result in market

[19] See for example, the SEC's 2008 emergency order temporarily banning short selling of financial stocks https://www.sec.gov/news/press/2008/2008-211.htm.

inefficiencies that permit institutional investors to exploit retail investors, thus compromising regulators' objectives of maintaining efficient markets and protecting retail investors.

Finally, our findings support arguments that the development of more centralized and accessible markets for short selling should enhance the informational efficiency of prices and hence improve the allocative efficiency of capital markets. The current stock lending system is dominated by a small number of large global banks and operates as an opaque over-the-counter market that has been subject to allegations of anticompetitive behavior.[20]

[20] See "Pension Funds Sue Six Banks, Claiming Stock-Lending Abuses" Katy Burne, *Wall Street Journal* 8/17/2017 and "Big Banks Accused of Stifling Competition in Stock Lending" Gretchen Morgenson, *Wall Street Journal* 2/1/2018.

APPENDIX I
VARIABLE DEFINITIONS

IPO Characteristics	
Offer Price	Offer price per share.
Proceeds	Amount of proceeds in millions of U.S. dollars from the initial offering.
IPO Value	IPO value in millions of U.S. dollars measured as the offering price multiplied by the number of shares outstanding in the company.
Sales Level	Sales in millions of U.S. dollars reported as of the last fiscal year prior to the IPO.
Total Assets	Total assets in millions of U.S. dollars reported as of the last fiscal year prior to the IPO.
Age	Firm age measured from the founding year.
NASDAQ	Indicator variable $= 1$ if the firm is listed on the Nasdaq Stock Market; $= 0$ otherwise.
Selling Shareholders %	Number of shares offered by selling shareholders divided by the number of shares offered in the IPO.
Market Return	Cumulative equal-weighted market return over the fifteen trading days before the first IPO trading day.
Sales Growth	Percentage year-over-year growth in sales measured as of the last fiscal year prior to the IPO.
Operating Loss	Indicator variable $= 1$ for negative earnings before interest and tax expenses reported as of the last fiscal year prior to IPO; $= 0$ otherwise.
Intangible Intensity	R&D plus advertising expenses divided by sales as of the last fiscal year prior to the IPO. We set missing values for R&D or advertising expenses to zero.
DO Score	Our composite divergence of investor opinion score using pre-IPO characteristics. A new issuer scores one point for each of the three criteria: (i) it has above median pre-IPO sales growth, (ii) it reports a pre-IPO loss, and (iii) it has above median intangible intensity. To obtain a standardized score, we sum up the points and divide by three.
Offering Size	Number of shares offered in the IPO divided by the number of shares outstanding in the aftermarket.
Small Offer	Indicator variable $= 1$ if the new issuer's offering size is below the 25^{th} percentile; $= 0$ otherwise.
IPO Aftermarket Characteristics	
First Day Return	First trading day return measured from the IPO offering price per share to the closing price per share on the first trading day.
Lockup Return	Buy-and-hold market adjusted stock return from ten trading days before to ten trading days after the IPO lockup expiration.
First Day Turnover	Number of shares traded on the first trading day divided by the number of shares offered in the IPO.

Securities Lending Market Characteristics	
$Active\ Lendable\ Quantity$	The quantity of current inventory of lendable shares available from beneficial owners minus shares temporarily restricted from lending divided by the number of shares outstanding.
$Lender\ Quantity\ on\ Loan$	The quantity of current inventory on loan from beneficial owners divided by the number of shares outstanding.
$Active\ Utilization$	Active supply utilization measured as ratio of lender quantity on loan divided by active lendable quantity.
$Stock\ Loan\ Fee$	Indicative stock loan fees from Markit expressed in per annum percentages.
Fixed Effect Indicators	
$Prestigious\ Underwriter$	Indicator variable $= 1$ if Loughran and Ritter's (2004) underwriter rank score is equal to 9; $= 0$ otherwise.
$Prestigious\ Law\ Firm$	Indicator variable $= 1$ if the law firm advising the issuer is included in the Legal 500 top-four tiers; $= 0$ otherwise.
$Big\ Four\ Auditor$	Indicator variable $= 1$ if the issuer's auditor is Deloitte & Touche, Ernst & Young, KPMG, or PwC; $= 0$ otherwise.
Sell-Side Analyst Characteristics	
$Target\ Price/Offer\ Price - 1$	The percentage deviation of sell-side analysts' median consensus target price from the offer price available as of ten trading days prior to the IPO lockup expiration.
$1YR\ Out\ Price/Target\ Price - 1$	The percentage deviation of the one-year-out stock price (including cumulated distributions) from the sell-side analysts' median consensus target price available as of ten trading days prior to the IPO lockup expiration.
$Analyst\ Dispersion$	Sell-side analyst forecast dispersion measured as the standard deviation of one-year-out EPS forecasts scaled by total assets per share. To measure dispersion, we require coverage by at least three sell-side analysts as of ten trading days prior to the lockup expiration and use the most recent individual analyst forecasts.

Note: Firm and year subscripts are omitted for brevity.

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Table I
Descriptive Statistics

Panel A: Sample Distribution by Year.

Offer year	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
# of IPOs	114	15	34	66	52	68	121	149	90	709
Proceeds ($BN)	21.6	4.2	9.6	10.4	15.6	12.8	28.5	35.1	18.4	156.3

Panel B: Empirical Distributions of Key Variables.

Variable	*Mean*	*Std. Dev.*	*Percentiles*		
			25^{th}	50^{th}	75^{th}
Offer Price ($)	15.52	6.38	12.00	15.00	18.00
Proceeds ($MN)	220.40	348.59	75.00	113.90	223.12
IPO Value ($MN)	1,027.46	1,866.11	271.49	489.84	1,012.35
Sales Level ($MN)	644.81	1,947.99	48.50	110.88	362.02
Total Assets ($MN)	1,549.40	8,232.31	54.74	142.81	836.40
Age	8.88	8.57	1.00	7.00	12.00
NASDAQ	55.71%	49.71%	0.00%	100.00%	100.00%
Selling Shareholder %	11.08%	24.10%	0.00%	0.00%	7.35%
Market Return	0.59%	3.68%	-1.99%	0.64%	2.99%
Sales Growth	85.29%	214.11%	11.03%	32.06%	71.61%
Operating Loss	37.66%	48.49%	0.00%	0.00%	100.00%
Intangible Intensity	90.31%	350.58%	0.03%	5.75%	25.03%
DO Score	45.93%	37.26%	0.00%	33.33%	66.67%
Offering Size	28.89%	18.83%	18.10%	24.39%	32.99%
First Day Return	17.36%	27.04%	0.00%	10.00%	26.67%
Lockup Return	-3.41%	15.29%	-11.49%	-2.90%	5.06%
Prestigious Underwriter	43.44%	49.60%	0.00%	0.00%	100.00%
Prestigious Law Firm	50.92%	50.03%	0.00%	100.00%	100.00%
Big Four Auditor	79.97%	40.05%	100.00%	100.00%	100.00%

Panel C: Securities Lending Market Characteristics around IPO Lockup Expirations.

Mean Values	(1) IPO Sample (709 firms)	(2) General Population (3,552 firms)	(1) – (2)	*t-stat.*
Active Lendable Quantity	7.55%	21.68%	-14.13%	*-45.94*
Lender Quantity on Loan	2.60%	3.48%	-0.88%	*-6.28*
Active Utilization	42.91%	18.78%	24.13%	*18.94*
Stock Loan Fee	4.27%	0.98%	3.28%	*7.47*

Panel D: Securities Analysts' Characteristics around IPO Lockups.

Mean Values	(1) IPO Sample (709 firms)	(2) General Population (3,552 firms)	(1) – (2)	*t-stat.*
$Target\ Price/Current\ Price - 1$	30.97%	18.45%	12.53%	*6.55*
$1YR\ Out\ Price/Target\ Price - 1$	-23.52%	-8.88%	-14.64%	*-10.81*
Analyst Dispersion	13.8%	0.83%	12.97%	*7.55*

Panel E: Variation in Proxies for Investor Disagreement with *DO Score*.

DO Score	*N*	*Analyst Dispersion*	*First Day Turnover*
0 (Low)	206	2.33%	68.99%
0.33	182	3.63%	66.18%
0.66	168	23.54%	77.42%
1 $(High)$	153	31.58%	88.78%
$High - Low$		29.24%	19.79%
t-statistic		*4.75*	*3.23*

Panel F: Variation in Lendable Quantity Prior to Lockup Expiration with Offering Size.

Offering Size	*N*	*Active Lendable Quantity*
Small	177	4.81%
Medium	355	5.03%
Large	177	8.24%
$Small - Large$		-3.42%
t-statistic		*-5.07*

Panel G: Pairwise Pearson (Spearman) Correlations above (below) Main Diagonal.

	Variable	(1)	(2)	(3)	(4)	(5)	(6)
(1)	*DO Score*		-0.21	0.27	-0.15	0.41	0.23
(2)	*Offering Size*	-0.20		0.00§	0.29	-0.22	-0.13
(3)	*Analyst Dispersion*	0.59	-0.01§		-0.10	0.13	0.01§
(4)	*Active Lendable Quantity*	-0.22	0.27	-0.23		-0.23	-0.07
(5)	*Active Utilization*	0.43	-0.27	0.31	-0.32		0.46
(6)	*Stock Loan Fees*	0.42	-0.26	0.31	-0.44	0.76	

Note: All pairwise correlations are significantly different from zero at the 10% level or better, except for those indicated by §.

Panel H: Sample Distribution across DO Score and Offering Size Partitions.

DO Score	All IPOs	*Offering Size*		
		Small	*Medium*	*Large*
0 (*Low*)	206	37	97	72
0.33	182	45	86	51
0.66	168	43	88	37
1 (*High*)	153	52	84	17
All IPOs	709	177	355	177

Panels A through H of this table report descriptive statistics for key variables. Our sample includes 709 IPOs over the period from 2007 to 2015. Appendix I provides detailed variable definitions.

Table II
IPO First-Day Returns

Panel A: Portfolio Results.

DO Score	All IPOs	*Offering Size*		
		Small	*Medium*	*Large*
0 (*Low*)	10.82%	11.47%	14.50%	5.53%
t-statistic	*8.24*	*4.83*	*5.97*	*4.70*
0.33	13.59%	16.90%	14.20%	9.64%
t-statistic	*7.93*	*4.56*	*6.44*	*2.69*
0.66	19.85%	31.90%	17.54%	11.35%
t-statistic	*9.57*	*6.30*	*7.05*	*3.13*
1 (*High*)	27.92%	44.36%	22.11%	6.37%
t-statistic	*9.57*	*7.35*	*6.99*	*1.27*
High − Low	17.11%	32.90%	7.61%	0.84%
t-statistic	*5.35*	*5.07*	*1.91*	*0.16*

Panel B: Top and Bottom Portfolio Results.

	First Day Return
Low DO Score & Large Offer	5.53%
t-statistic	*4.70*
High DO Score & Small Offer	44.36%
t-statistic	*7.35*
Spread	**38.84%**
t-statistic	*6.32*

Panel C: Regression Results.

	Dependent Variable $= First\ Day\ Return$		
	(1)	(2)	(3)
$Intercept$	0.210	0.218	-0.058
	2.63	*2.78*	*-0.37*
$DO\ Score$	0.198	0.123	0.125
	8.39	*3.23*	*3.01*
$Small\ Offer$	.	-0.028	-0.060
		-1.06	*-2.66*
$\boldsymbol{DO\ Score \times Small\ Offer}$	.	**0.250**	**0.247**
		3.07	***2.85***
$Prestigious\ Underwriter$	.	.	-0.005
			-0.27
$Big\ Four\ Audit\ Firm$	.	.	-0.045
			-0.86
$Prestigious\ Law\ Firm$	.	.	0.001
			0.06
$log(IPO\ Value)$	.	.	0.044
			2.67
$NASDAQ$	.	.	0.029
			1.96
$log(Age)$	.	.	0.020
			1.94
$Selling\ Shareholders\ \%$	.	.	-0.050
			-2.48
$Market\ Return$	.	.	0.727
			3.29
Year fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Adjusted R^2	12.9%	17.1%	19.4%

This table reports evidence of variation in first-day returns with pre-IPO characteristics. We measure the first-day return as the return from the IPO offering price per share to the closing price per share on the first trading day. Panel A reports portfolio mean values of first-day returns across partitions formed based on *DO Score* and *Offering Size*. Panel B reports the spread of first-day returns between the portfolio with a combination of low *DO Score* and large offering size and the portfolio with a combination of high *DO Score* and small offering size. Panel C reports results from OLS regressions of first-day returns on *DO Score*, the indicator for small offering size (*Small Offer*), and their interaction, along with other new issuer characteristics, as well as year and industry fixed effects. Industry fixed effects are based on Fama and French's (1997) 12-industry classification. The t-statistics are based on standard errors clustered by year. Our sample includes 709 IPOs over the period from 2007 to 2015. Appendix I provides detailed variable definitions.

Table III
IPO Lockup Returns

Panel A: Portfolio Results

DO Score	All IPOs	*Offering Size*		
		Small	*Medium*	*Large*
0 (*Low*)	0.16%	2.72%	-0.18%	-0.68%
t-statistic	*0.21*	*1.62*	*-0.22*	*-0.42*
0.33	-1.59%	-0.31%	-3.14%	-0.13%
t-statistic	*-1.45*	*-0.14*	*-1.98*	*-0.06*
0.66	-5.55%	-6.07%	-5.13%	-5.95%
t-statistic	*-3.85*	*-2.11*	*-2.61*	*-1.85*
1 (*High*)	-8.01%	-10.11%	-8.10%	-1.13%
t-statistic	*-6.44*	*-4.49*	*-5.01*	*-0.33*
High − Low	-8.17%	-12.83%	-7.92%	-0.45%
t-statistic	*-5.61*	*-4.57*	*-4.33*	*-0.12*

Panel B: Top and Bottom Portfolio Results.

	Average Lockup Return
Low DO Score & Large Offer	-0.68%
t-statistic	*-0.42*
High DO Score & Small Offer	-10.11%
t-statistic	*-4.49*
Spread	**-9.43%**
t-statistic	*-3.39*

Panel C: Regression Results.

	Dependent Variable $= Lockup\ Return$		
	(1)	(2)	(3)
$Intercept$	-0.012	-0.022	0.054
	-0.61	*-1.11*	*1.08*
$DO\ Score$	-0.065	-0.050	-0.049
	-3.97	*-3.08*	*-2.68*
$Small\ Offer$	.	0.038	0.047
		2.46	*2.40*
$\boldsymbol{DO\ Score \times Small\ Offer}$	.	**-0.060**	**-0.065**
		-2.57	***-2.97***
$Prestigious\ Underwriter$	.	.	-0.001
			-0.11
$Big\ Four\ Audit\ Firm$	.	.	0.003
			0.11
$Prestigious\ Law\ Firm$	.	.	0.004
			0.52
$log(IPO\ Value)$	.	.	-0.009
			-1.49
$NASDAQ$	.	.	-0.016
			-1.84
$log(Age)$	.	.	-0.008
			-1.58
$Selling\ Shareholders\ \%$	.	.	-0.014
			-0.86
$Market\ Return$	.	.	-0.182
			-1.50
Year fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Adjusted R^2	6.4%	6.5%	6.3%

This table reports evidence of variation in lockup returns with pre-IPO characteristics. We measure the lockup return as the buy-and-hold market adjusted return over the window from ten trading days before to ten trading days after the lockup expiration. We use the CRSP value-weighted index including distributions to proxy for the market portfolio. Panel A reports portfolio mean values of lockup returns across partitions formed based on *DO Score* and *Offering Size*. Panel B reports the spread of lockup returns between the portfolio with a combination of low *DO Score* and large offering size and the portfolio with a combination of high *DO Score* and small offering size. Panel C reports results from OLS regressions of lockup returns on *DO Score*, the indicator for small offering size (*Small Offer*), and their interaction, along with other new issuer characteristics, as well as year and industry fixed effects. Industry fixed effects are based on Fama and French's (1997) 12-industry classification. The t-statistics are based on standard errors clustered by year. Our sample includes 709 IPOs over the period from 2007 to 2015. Appendix I provides detailed variable definitions.

Table IV
IPO Short-Sales Constraints: Variation in Stock Loan Fees

Panel A: Portfolio Results

DO Score	All IPOs	*Offering Size*		
		Small	*Medium*	*Large*
0 (*Low*)	1.31%	1.40%	1.64%	0.83%
t-statistic	*6.97*	*3.58*	*4.03*	*6.16*
0.33	2.99%	3.44%	2.02%	4.22%
t-statistic	*3.97*	*3.67*	*3.13*	*1.82*
0.66	5.15%	10.67%	3.78%	1.98%
t-statistic	*5.35*	*4.26*	*2.97*	*3.61*
1 (*High*)	8.81%	15.08%	4.92%	8.83%
t-statistic	*6.34*	*4.95*	*3.84*	*1.95*
High − Low	7.50%	13.68%	3.29%	8.00%
t-statistic	*5.33*	*4.45*	*2.45*	*1.77*

Panel B: Top and Bottom Portfolio Results.

	Average Stock Loan Fee
Low DO Score & Large Offer	0.83%
t-statistic	*6.16*
High DO Score & Small Offer	15.08%
t-statistic	*4.95*
Spread	**14.26%**
t-statistic	*4.67*

Panel C: Regression Results.

	Dependent Variable = $Stock\ Loan\ Fee$		
	(1)	(2)	(3)
$Intercept$	0.009	0.015	0.048
	0.26	*0.40*	*1.01*
$DO\ Score$	0.083	0.050	0.047
	4.65	*4.21*	*5.27*
$Small\ Offer$	.	-0.020	-0.015
		-1.46	*-1.55*
$\boldsymbol{DO\ Score \times Small\ Offer}$	.	**0.112**	**0.108**
		2.85	***2.83***
$Prestigious\ Underwriter$	.	.	-0.002
			-0.19
$Big\ Four\ Audit\ Firm$	.	.	-0.003
			-0.25
$Prestigious\ Law\ Firm$	.	.	-0.006
			-1.19
$log(IPO\ Value)$	.	.	-0.002
			-0.21
$NASDAQ$	.	.	-0.002
			-0.14
$log(Age)$	.	.	-0.004
			-0.80
$Selling\ Shareholders\ \%$	.	.	-0.024
			-2.52
$Market\ Return$	.	.	0.107
			1.21
Year fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Adjusted R^2	9.2%	13.0%	12.5%

This table reports evidence of variation in stock loan fees with pre-IPO characteristics. We measure stock loan fees as the average daily stock loan fees over the window from ten trading days before to ten trading days after the lockup expiration. Panel A reports portfolio mean values of stock loan fees across partitions formed based on *DO Score* and *Offering Size*. Panel B reports the spread of stock loan fees between the portfolio with a combination of low *DO Score* and large offering size and the portfolio with a combination of high *DO Score* and small offering size. Panel C reports results from OLS regressions of stock loan fees on *DO Score*, the indicator for small offering size (*Small Offer*), and their interaction, along with other new issuer characteristics, as well as year and industry fixed effects. Industry fixed effects are based on Fama and French's (1997) 12-industry classification. The t-statistics are based on standard errors clustered by year. Our sample includes 709 IPOs over the period from 2007 to 2015. Appendix I provides detailed variable definitions.

Table V
IPO Short-Sales Constraints: Variation in Active Supply Utilization

Panel A: Portfolio Results

DO Score	All IPOs	*Offering Size*		
		Small	*Medium*	*Large*
0 (*Low*)	26.32%	27.57%	27.11%	24.61%
t-statistic	*13.62*	*5.91*	*9.61*	*7.56*
0.33	38.11%	48.70%	34.98%	34.04%
t-statistic	*16.09*	*9.38*	*10.60*	*8.10*
0.66	49.65%	62.79%	48.20%	37.84%
t-statistic	*19.56*	*11.47*	*14.27*	*8.49*
1 (*High*)	63.55%	76.30%	59.83%	42.93%
t-statistic	*25.29*	*22.41*	*17.85*	*4.89*
High − Low	37.23%	48.73%	32.72%	18.31%
t-statistic	*11.74*	*8.44*	*7.47*	*1.96*

Panel B: Top and Bottom Portfolio Results.

	Average Active Utilization
Low DO Score & Large Offer	24.61%
t-statistic	*7.56*
High DO Score & Small Offer	76.30%
t-statistic	*22.41*
Spread	**51.69%**
t-statistic	*10.97*

Panel C: Regression Results.

	Dependent Variable = *Active Utilization*		
	(1)	(2)	(3)
Intercept	0.478	0.470	0.358
	4.82	*4.74*	*2.40*
DO Score	0.398	0.344	0.329
	10.97	*7.92*	*7.68*
Small Offer	.	0.035	0.016
		0.67	*0.29*
DO Score* × *Small Offer	.	**0.164**	**0.170**
		2.93	***3.02***
Prestigious Underwriter	.	.	0.010
			0.69
Big Four Audit Firm	.	.	-0.051
			-1.54
Prestigious Law Firm	.	.	-0.011
			-0.46
log(IPO Value)	.	.	0.021
			2.48
NASDAQ	.	.	0.050
			1.82
log(Age)	.	.	0.005
			0.58
Selling Shareholders %	.	.	-0.079
			-1.21
Market Return	.	.	-0.307
			-0.57
Year fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Adjusted R^2	22.7%	25.2%	25.6%

This table reports evidence of variation in active supply utilization with pre-IPO characteristics. We measure active supply utilization as the current inventory on loan from beneficial owners divided by the current inventory of lendable shares available from beneficial owners net of shares temporarily restricted from lending. We take the average daily utilization over the window from ten trading days before to ten trading days after the lockup expiration. Panel A reports portfolio mean values of active supply utilization across partitions formed based on *DO Score* and *Offering Size*. Panel B reports the spread of active supply utilization between the portfolio with a combination of low *DO Score* and large offering size and the portfolio with a combination of high *DO Score* and small offering size. Panel C reports results from OLS regressions of active supply utilization on *DO Score*, the indicator for small offering size (*Small Offer*), and their interaction, along with other new issuer characteristics, as well as year and industry fixed effects. Industry fixed effects are based on Fama and French's (1997) 12-industry classification. The t-statistics are based on standard errors clustered by year. Our sample includes 709 IPOs over the period from 2007 to 2015. Appendix I provides detailed variable definitions.

Table VI

Short Selling IPO Lockups: A Risky Business

Panel A: Sharpe Ratios from Short Selling IPO Lockups.

	Portfolio Payoffs			
	# of Days	*Mean*	*Std.Dev.*	*Sharpe Ratio*
Low DO Score & Large Offer	2,251	-0.06%	2.73%	-0.36
High DO Score & Small Offer	2,251	0.55%	3.49%	2.51
All IPOs	2,251	0.10%	1.99%	0.76
Stock Market	2,251	0.03%	1.37%	0.33

Panel B: Variation in Short-Selling Risk.

	Average standard deviations		
	# of IPOs/firms	*Stock loan fee*	*Stock return*
Low DO Score & Large Offer	72	0.22%	2.84%
High DO Score & Small Offer	52	2.56%	3.74%
All IPOs	709	0.76%	3.32%

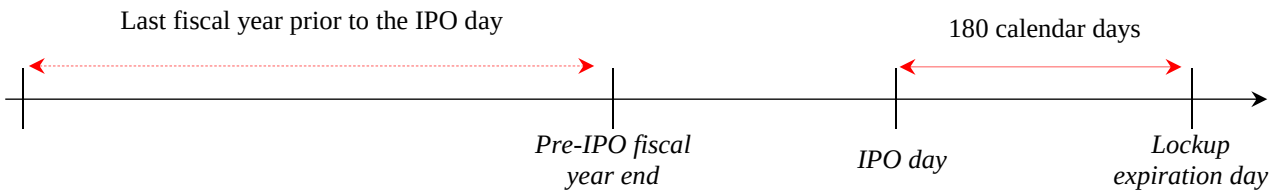
Panel C: Portfolio Diversification Restrictions.

	# of IPOs on any given trading day							
	0	1	2	3	4	5	>5	>20
Low DO Score & Large Offer	59%	25%	8%	4%	2%	1%	0%	0%
High DO Score & Small Offer	68%	20%	10%	2%	0%	0%	0%	0%
All IPOs	10%	8%	14%	6%	5%	7%	51%	2%

This table examines the payoffs to short sellers from targeting IPO lockups over the window from ten trading days before to ten trading days after the lockup expiration. Panel A reports the mean, standard deviation, and annualized Sharpe ratio from a trading strategy financed by borrowing at the risk free rate that takes a long position in the stock market index and a short position in IPO lockups. We measure the payoff to this trading strategy at daily frequency as the stock loan rebate rate minus the market adjusted stock return minus the risk free rate. On trading days with multiple overlapping lockup expiration windows, we measure the equal-weighted payoff across the overlapping IPO lockups. On trading days that are not overlapping with any IPO lockup windows, we set the payoff equal to zero. We proxy for the stock market portfolio using the CRSP value-weighted index including distributions. We proxy for the daily risk free rate using the one-month T-bill rate. We implement the strategy across the portfolio of new issuers with a combination of low *DO Score* and large offering size and the portfolio of new issuers with a combination of high *DO Score* and small offering size. For comparison purposes, we report the mean and standard deviation of the daily stock market index return in excess of the risk free rate along with the

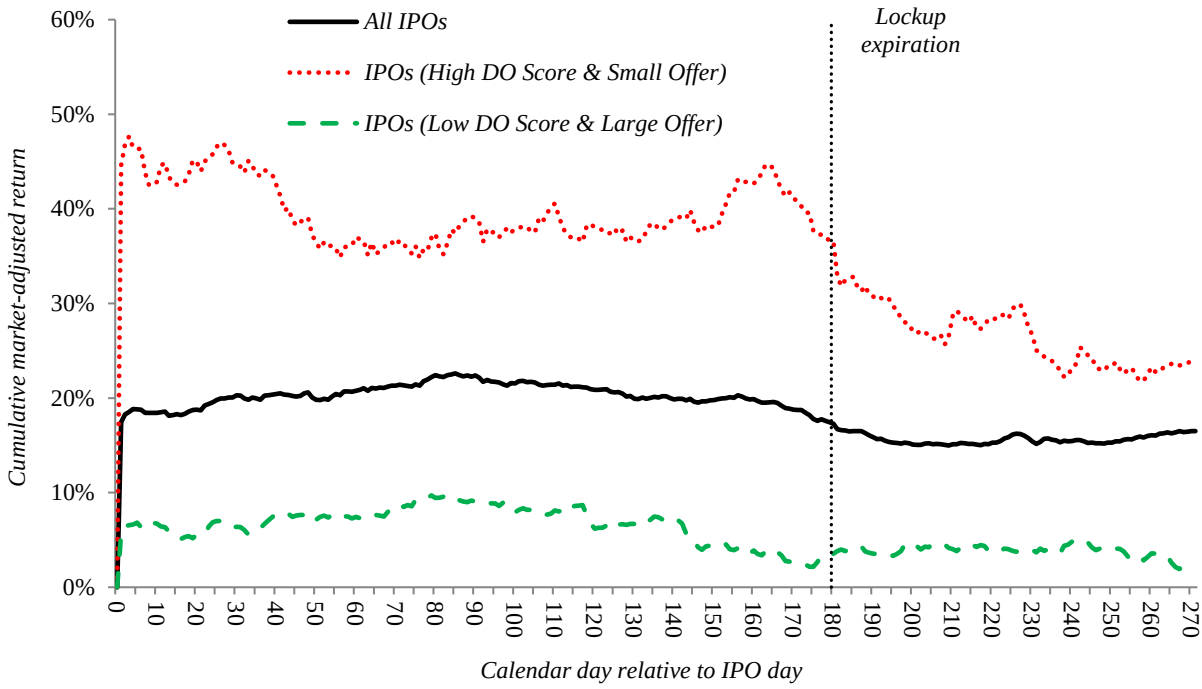
corresponding annualized Sharpe ratio. We measure the annualized Sharpe ratio as the ratio of the mean value of payoffs to the standard deviation of payoffs multiplied by the square root of 252, which corresponds to the number of trading days per year. Panel B reports the average standard deviation of stock loan fees and daily stock returns. We measure the standard deviation of stock loan fees and daily stock returns for each IPO over the window from ten trading days before to ten trading days after the lockup expiration, and then we report the average standard deviation across all IPOs, IPOs with a combination of low *DO Score* and large offering size, and IPOs with a combination of high *DO Score* and small offering size. Panel C reports the average frequency distribution of the number of IPOs with overlapping lockup windows on any given trading day. Our sample includes 709 IPOs and 2,251 trading days over the period from 2007 to 2015.

Figure I
Timeline of Research Design



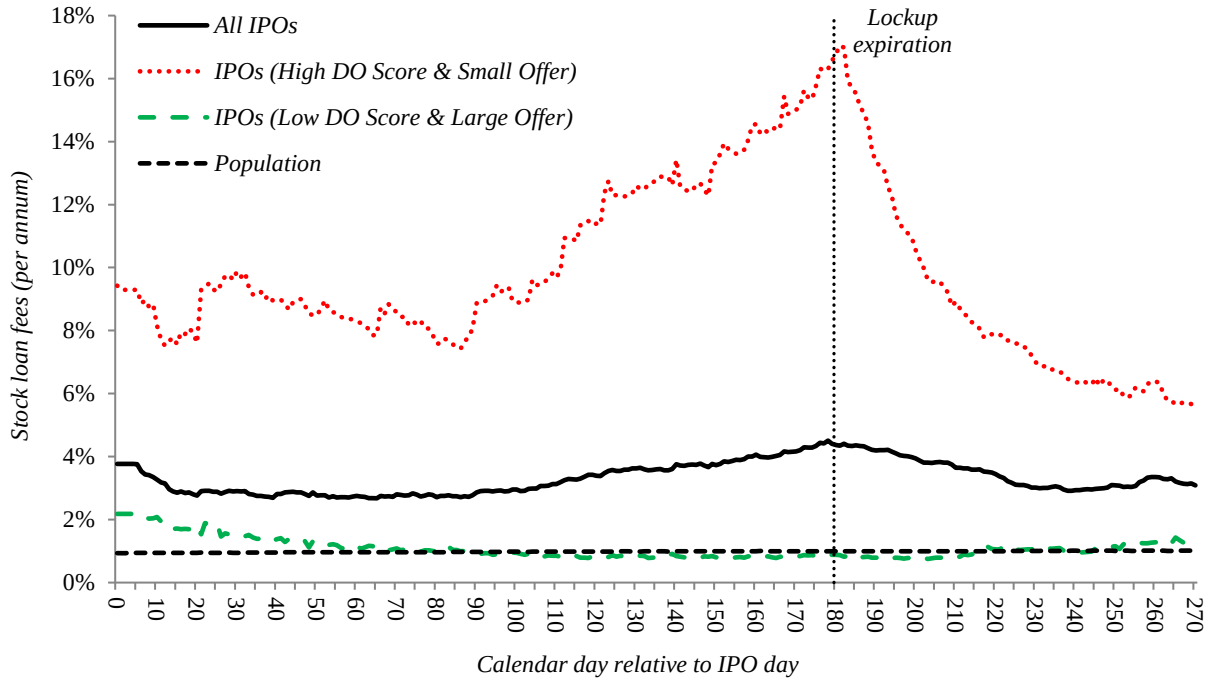
Note: This figure describes our research design timeline. The mean (median) distance in calendar days between the pre-IPO fiscal year end and the IPO day is 191 (197) days.

Figure II
Aftermarket Stock Returns



This figure reports mean cumulative market-adjusted stock returns from the IPO day (day zero) onwards for (i) all IPOs (solid black line), (ii) IPOs with a combination of high *DO Score* and small offering size (dotted red line), and (iii) IPOs with a combination of low *DO Score* and large offering size (dashed green line). We use the CRSP value-weighted index including distributions to proxy for the market portfolio. The day zero return is the market-adjusted return from the IPO offering price per share to the closing price per share on the first trading day. The vertical line indicates the lockup expiration on the 180th calendar day after the IPO day. Our sample includes 709 IPOs over the period from 2007 to 2015.

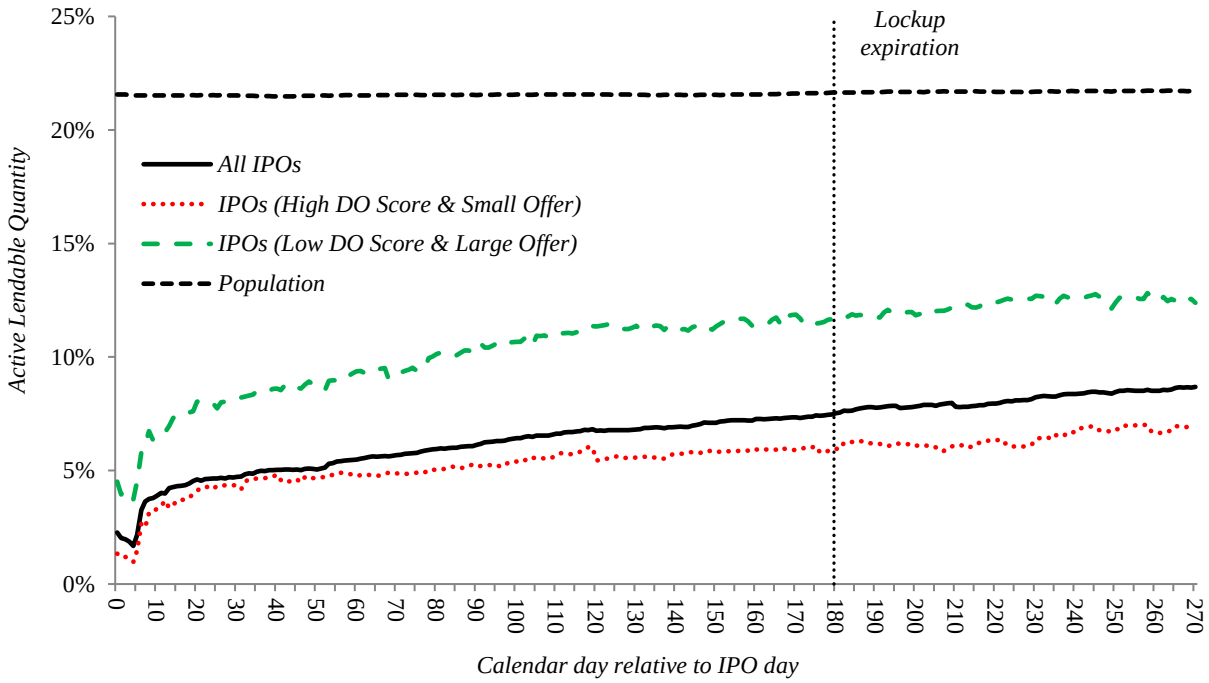
Figure III
Stock Loan Fee Dynamics



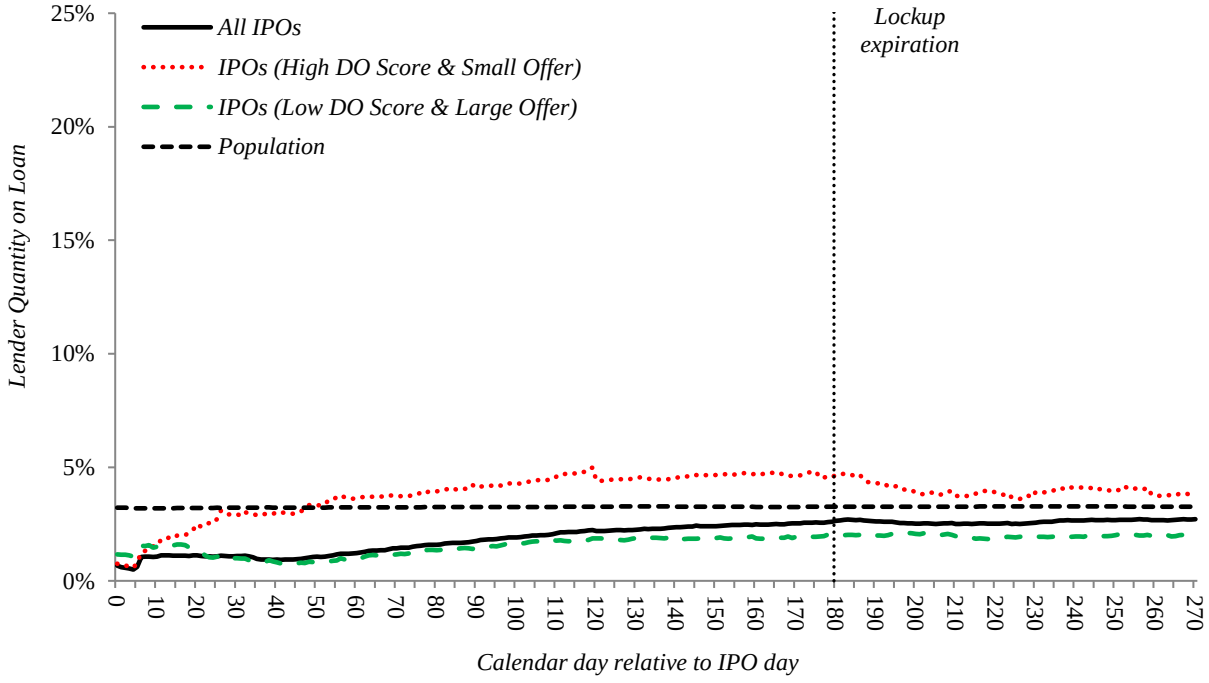
This figure reports mean values of stock loan fees from the IPO day (day zero) onwards for (i) all IPOs (solid black line), (ii) IPOs with a combination of high *DO Score* and small offering size (dotted red line), (iii) IPOs with a combination of low *DO Score* and large offering size (dashed green line), and (iv) the population equal-weighted average stock loan fees (black dashed line). The vertical line indicates the IPO lockup expiration on the 180th calendar day after the IPO day. Our sample includes 709 IPOs over the period from 2007 to 2015.

Figure IV
Securities Lending Market Dynamics

Panel A: Active Lendable Quantity.

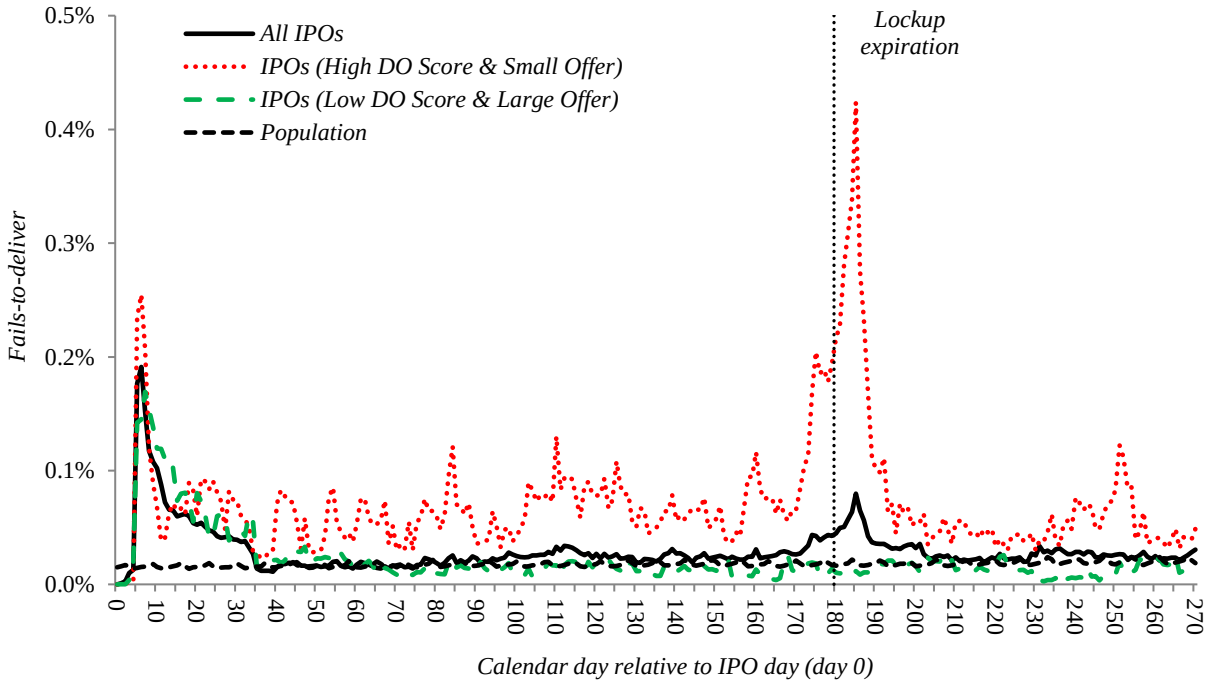


Panel B: Lender Quantity on Loan.



This figure reports mean values of active lendable quantity (Panel A) and lender quantity on loan (Panel C) from the IPO day (day zero) onwards for (i) all IPOs (solid black line), (ii) IPOs with a combination of high *DO Score* and small offering size (dotted red line), (iii) IPOs with a combination of low *DO Score* and large offering size (dashed green line), and (iv) the population equal-weighted average values (black dashed line). The vertical line indicates the IPO lockup expiration on the 180th calendar day after the IPO day. Our sample includes 709 IPOs over the period from 2007 to 2015.

Figure V
Fail-to-Deliver Dynamics



This figure reports mean values of fails-to-deliver activity from the IPO day (day zero) onwards for (i) all IPOs (solid black line), (ii) IPOs with a combination of high *DO Score* and small offering size (dotted red line), (iii) IPOs with a combination of low *DO Score* and large offering size (dashed green line), and (iv) the population equal-weighted average stock loan fees (black dashed line). Fails-to-deliver activity is measured as the total fails-to-deliver shares as of a particular settlement date divided by the number of shares outstanding. The fails-to-deliver data is available from the SEC's website. The vertical line indicates the IPO lockup expiration on the 180th calendar day after the IPO day. Our sample includes 709 IPOs over the period from 2007 to 2015.