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Short selling in initial public offerings ☆

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ABSTRACT

Short sale constraints in the aftermarket of initial public offerings (IPOs) are often used to explain short-term underpricing that is subsequently reversed. This paper shows that short selling is integral to aftermarket trading and is higher in IPOs with greater underpricing. Perceived restrictions on borrowing shares are not systematically circumvented by "naked" short selling. Short sellers, on average, do not appear to earn abnormal profits in the near term and our findings are not driven by market makers. Short selling in IPOs is not as constrained as suggested by the literature, implying that other factors may be responsible for underpricing.

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1. Introduction

One of the longstanding puzzles in finance has been the pricing of initial public offerings. One explanation for underpricing in IPOs and their subsequent long-run performance was originally proposed by Miller (1977). He argues that restrictions on short selling immediately following an IPO contribute to pricing inefficiencies in the short-term, which are subsequently reversed in the long-term as these constraints are relaxed. In addition, the literature on the limits to arbitrage often uses underpricing in IPOs as an example of the impact of short sale constraints on pricing.[1]

The premise that short selling is difficult immediately after an IPO is based upon the perceived high cost of borrowing shares (Ljungqvist, Nanda, and Singh, 2006), limits on underwriters lending shares during the first month of trading (Houge, Loughran, Suchanek, and Yan, 2001), the lockup of insider shares which restrict supply (Ofek and Richardson, 2003), and difficulties in locating shares prior to the closing of the offer. By examining short selling in the context of IPOs, we are able to assess the speed with which short selling is available even in the shares of stocks that have no previous trading history. We test whether these potential constraints restrict short selling in the immediate aftermarket of IPOs by examining newly available data on actual short selling transactions.

Contrary to popular belief, we find that short selling is an integral part of the aftermarket trading of IPOs. Despite possible constraints on both the ability and cost of

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[1] See, for example, Scheinkman and Xiong (2003), Duffie, Garleanu, and Pedersen (2002), and Mitchell, Pulvino, and Stafford (2002).

borrowing shares for delivery, we show that short selling occurs simultaneously with the open of trading and without a delay, as previously thought. Short selling occurs on the offer day in 99.5% of the IPOs in our sample and the majority of first-day short sales occur at the open of trading. The average level of short sales on the offer day exceeds 7% of the shares offered and subsequently declines over the first month of trading. By the fifth trading day, the ratio of short selling to volume is only slightly lower than that shown by Diether, Lee, and Werner (2009a) for a large cross-section of stocks. We interpret this finding as an indication that the level of short selling in IPOs quickly approaches an "equilibrium" level.[2]

Miller (1977) suggests that investor divergence of opinion combined with the inability to short sell the security leads to higher initial returns than would otherwise occur. For example, the models of Derrien (2005) and Ljungqvist, Nanda, and Singh (2006) predict that underwriters and issuing firms take advantage of investor sentiment or irrational exuberance by pricing issues above their intrinsic value. In this case, investor sentiment combined with short selling constraints leads to greater underpricing and an aftermarket trading price that exceeds the "true" value of the security.

Our results indicate that the magnitude of short selling on the first trading day is positively and significantly related to variables that proxy for divergence of opinion: the change in offer price, the first-day return from the offer price to the open, and initial trading volume. These findings are consistent with Diether, Lee, and Werner (2009a) who find that short sellers are contrarians who "increase their trading following positive returns." However, our results do not support the role of short sale constraints in divergence of opinion models of IPO pricing, as short selling and first-day returns are positively related. Thus, short sellers do not appear to correct *observed* underpricing.[3]

We further examine the supposed difficulties in locating or borrowing shares by testing the hypothesis that short sellers are engaging in "naked" short selling activities. According to the Securities and Exchange Commission (SEC) Web site, "a "naked" short sale is a short sale where the seller does not borrow or arrange to borrow the securities in time to make delivery to the buyer within the standard three-day settlement period [and, as] a result, the short seller fails to deliver securities to the buyer when settlement is due (known as a "failure to deliver" or "fail to deliver")."[4] Failures to deliver, in practice, are often used as a measure for the presence of "naked" short selling.[5] Using a unique database, we examine whether short sales immediately following the IPO are positively correlated with failures to deliver. Such a test allows us to reconcile whether the observed level of short selling can be explained by an avoidance of significant constraints. To our knowledge, we are the first paper to examine the relationship between short selling transactions and failures to deliver in any context.

Like short selling, we find that failures to deliver are prevalent early in the aftermarket trading of IPOs. Approximately 61% of the IPOs in our sample have failures to deliver of at least 10,000 shares on *the first* standard settlement day.[6] In fact, almost one-third of IPOs have enough fails to deliver over the first five standard settlement days to qualify for the Regulation SHO threshold list on the first possible date and almost 40% appear on the list within the first month of trading.[7]

Contrary to the hypothesis that failures to deliver in IPOs are due to "naked" short selling, we find no relationship between the level of short selling and subsequent level of fails to deliver. Thus, 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.

We do show, however, that failures to deliver are more likely to occur in IPOs that are price supported. This suggests that failures to deliver in price supported IPOs may arise from the mechanics of the offering process. Underwriters generally allocate more shares in an IPO than are offered (e.g., Hanley, Lee, and Seguin, 1996; Aggarwal, 2000). If the first-day return is positive, the underwriter covers this overallocation by exercising the overallotment option.[8] In the case of IPOs needing price support, the underwriter will purchase shares in the open market to cover the overallocation.[9] These overallocated shares could result in fails to deliver if investors sell them before the

[2] While short selling is slightly below that shown by Diether, Lee, and Werner (2009a) by the fifth trading day, the level of short selling as a percentage of volume on the first trading day is lower than that reported for a typical stock. The difference in short selling on the first trading day in an IPO, as compared to seasoned stocks, may be due to the fact that the volume on the first trading day is extremely large.

[3] It could obviously be the case that the level of first-day return in these offers might have been higher if fewer short sales were able to be executed.

[4] http://www.sec.gov/spotlight/keyregshoissues.htm.

[5] The Commission has stated that fails to deliver can be indicative of abusive or manipulative naked short selling and can deprive shareholders of the benefits of ownership, such as voting and lending. See page 8 of the release proposing to amend Regulation SHO (SEC Release no. 34-54154, July 14, 2006).

[6] The first settlement date refers to 3 days after the issue starts trading in the stock market. This is also the first-day that a failure to deliver can occur.

[7] When a stock has a fail to deliver level of at least 10,000 shares and 0.5% of the shares outstanding for five consecutive settlement days, the trading venue listing the stock is required to place it on a list known as the Regulation SHO threshold list.

[8] Underwriters typically have an option to purchase additional shares from the issuer following the IPO. This option is called the overallotment option or the "green shoe" option.

[9] The creation of an uncovered short position by underwriters in connection with an offering is a permissible activity that facilitates an offering and is different from the delivery obligations relating to "uncovered short selling" of securities that is discussed in the Regulation SHO adopting release (SEC Release no. 34-50103, July 28, 2004 and 69 FR 48008, August 6, 2004). These are two distinctly different activities. Underwriters cover the overallocation either through the exercise of the overallotment option or through open market purchases (also known as "syndicate short covering"). Syndicate short covering, which is defined in Regulation M as "the placing of any bid or the effecting of any purchase on behalf of the sole distributor or the underwriting syndicate or group to reduce a short position created in connection with the offering," is regulated by Rule 104 of Regulation M, which governs certain aftermarket activities in connection with an offering. The

underwriter can purchase the shares in the open market. Therefore, underwriter price support activities could result in failures to deliver in the short-term and our findings provide an indication that failures to deliver may occur for reasons other than naked short selling.

We also examine the impact of borrowing costs on the level of short selling and find that loan fees on the first settlement day, $T+3$, are increasing in the level of short selling on the initial trading day, $T+0$. This finding calls into question the interpretation of prior studies that the higher cost of borrowing for IPOs, relative to other stocks, is an impediment to short selling.

We test whether short selling is related to subsequent returns over the first trading day and the first three months after the IPO. We find no relation in the near term but short selling on the offer day shows a weak negative relation to the cumulative return over the first three months of trading. However, even before considering lending fees, short selling profits are insignificantly related to short selling and greater than zero in only 34% of the IPOs with rebate rate data. Thus, the profitability of short selling, on average, over this 3-month horizon, is called into question.

We also examine whether potential market maker activity contributes to the findings above. Market makers are exempt from the locate requirement (see footnote 28) in Reg SHO and certain short sale execution rules and tend to be active participants in the early aftermarket (Krigman, Shaw, and Womack, 1999; Ellis, Michaely, and O'Hara, 2000; Ellis, 2006). Thus, our results may be driven not by short selling, in general, but market making, in particular. Using short sales marked as "exempt" that are executed on Nasdaq in Nasdaq IPOs as a proxy for potential market making activity, we find no evidence that the activity of market makers is responsible for our findings.

Finally, our results also contribute to the recent literature on short selling in IPOs and how quickly short selling markets begin to function in securities with no previous trading history. Both Geczy, Musto, and Reed (2002) and D'Avolio (2002) find that shares of most IPOs are available for borrowing as soon as the first settlement day. We add to their findings by presenting evidence on the magnitude and timing of short selling. We interpret our results as an indication that short selling in IPOs, at least in the time period considered here, is not as constrained as the literature has suggested. Further, the timing and magnitude of short selling in the aftermarket indicates that the short sales are an integral part of the IPO process. Overall, our results imply that factors such as the lack of short sale trading profits, rather than the type of short sale constraints frequently mentioned in the literature, may be responsible for the observed high level of initial returns in IPOs.[10]

The paper is organized as follows: A brief literature review is presented in Section 2, Section 3 describes the data and summary statistics, Section 4 examines the determinants of short selling, Section 5 investigates potential "naked" short selling, and Section 6 investigates the cost of borrowing shares and subsequent price movements. Section 7 examines the impact of potential market maker short selling. Section 8 provides a summary of the results and the conclusions.

2. Impact of short sale constraints on IPO pricing

Although a lack of short selling due to binding constraints early in the trading of IPOs is a commonly held belief, a number of theoretical papers have formally modeled the role of such short selling constraints. These papers suggest that divergence of opinion by investors, coupled with short sale constraints, is a potential explanation for the well-documented underpricing and subsequent overvaluation of IPOs (Miller, 1977; Derrien, 2005; Ljungqvist, Nanda, and Singh, 2006).[11] Miller (1977) argues that if underwriters price issues according to their own assessments of the "true" value of the security, then the offer price "will be below the appraisals of the most optimistic investors who actually constitute the market for the security." Derrien (2005) and Ljungqvist, Nanda, and Singh (2006) extend this argument with a theoretical framework and rely on restrictions prohibiting short sales in the secondary market for IPOs. By disallowing short sales, investor optimism drives the market price of IPOs far above the true value resulting in overvaluation in the secondary market.

Several papers find evidence consistent with the argument that divergence of opinion or investor optimism is related to IPO pricing. Houge, Loughran, Suchanek, and Yan (2001) present evidence that measures of divergence of opinion have predictive power in explaining the poor long-run returns shown by Ritter (1991), and they contend that regulatory rules place constraints on short sales. When examining carve-out IPOs, Lamont and Thaler (2003) find evidence of mispricing between the value of the 3Com Corp., and Palm Inc., and they argue that "the demand for certain shares by irrational investors is too large relative to the ability of the market to supply these shares via short sales, creating a price that is too high." They argue that "the short sale market works sluggishly." However, they find there is substantial short interest in carve-outs in the first month after the IPO. Mitchell, Pulvino, and Stafford (2002) provide additional evidence that carve-outs are overpriced due to short sale constraints, but introduce the risk of upward price movements as a significant impediment to the profitability of short sales. Finally, Ofek and Richardson (2003) contend that short sale constraints after the IPO are responsible for the Internet bubble. They argue that only upon lockup

(*footnote continued*)
Commission has proposed amendments to Rule 104 of Regulation M (see SEC Release no. 33-8511, December 9, 2004).

[10] We note that our tests are unable to determine whether all demand for short selling is fully satisfied. However, many of the papers referenced above assume that short selling is impossible during the first few trading days and our results indicate that this claim is untrue.

[11] In this paper, we will assume that divergence of opinion, investor sentiment, and over-optimism refer to the same general phenomenon.

expiration did sufficient shares become available for shorting.

More recently, a number of papers question the assumption of short sale constraints in IPOs. Dorn (2009), Aussenegg, Pichler, and Stomper (2006) and Cornelli, Goldreich, and Ljungqvist (2006) examine pre-IPO markets that allow short selling and still find evidence that investor divergence of opinion is correlated with underpricing in the trading of IPOs.[12]

Direct evidence on the costs of short selling is presented by D'Avolio (2002) and Geczy, Musto, and Reed (2002). In particular, the Geczy, Musto, and Reed (2002) results indicate that although IPOs are initially more expensive to short in the first month of trading, the overall cost of shorting is fairly small at around 3% at issuance and this value declines to approximately 1.5% per year. They also conclude, contrary to Ofek and Richardson (2003), that the cost of short selling around lockups does not appear to be an impediment. Their evidence is the first to suggest that short selling may be available earlier in the IPO process than previously thought.

The literature remains inconclusive on the presence or impact of short selling on the pricing of IPOs because the measures of short selling immediately after the IPO must be inferred by other means such as proxies for divergence of opinion, price support, and rebate rates. Further, data on short interest are often not available close to the IPO offer date and such data cannot shed light on how quickly short sellers enter the market. Thus, it is only recently that we are able to ascertain whether short sale constraints are a plausible explanation for underpricing and comment on theories regarding the pricing of IPOs that rely on short selling constraints.

3. Data and summary statistics

3.1. IPO sample

The sample of IPOs and their offering characteristics is from Securities Data Corp. (SDC) from January 1, 2005 through December 31, 2006. The sample period, beginning January 2005, is chosen because it begins after the implementation of Regulation SHO and is associated with the public release of the Regulation SHO Pilot data which contain short selling transaction information. In order for an IPO to be included in the final sample, we require that the IPO have prices on CRSP, preliminary offer prices in SDC, and no prior trading history.[13] After excluding closed-end funds, the final number of IPOs in the sample is 388.[14]

[12] Grey market trading involves some sort of short position (usually by an institution) that is sold to investors (usually retail). Short sales are covered by allocations in the IPO.

[13] CRSP®, Center for Research in Security Prices. Graduate School of Business, The University of Chicago. Used with permission. All rights reserved. crsp.chicago.edu

[14] We did remove one IPO with an excessively high level of both short selling and failures to deliver, because it appears to be an outlier.

Table 1
Summary statistics on IPOs.

The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. Short sales are from Regulation SHO Pilot data compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx. Offer amounts, offer prices, and shares offered are from SDC and exclude the exercise of the overallotment option. Change in offer price is the percent difference between the final offer price and the midpoint of the preliminary offer price range in the prospectus. Opening and closing prices for the calculation of first-day or offer day (T+0) returns are from CRSP. Volume is the daily number of shares traded. Both volume and shares outstanding are from CRSP.

Variable	Mean	Median
Panel A: Offering statistics		
Offer price	$14.82	$14.50
Offer amount (in $m)	$188.53	$114.23
Change in offer price	−4.18%	0.00%
Panel B: Offer day trading statistics		
First-day return from offer price to open	9.07%	2.84%
First-day return from open to close	0.62%	0.00%
First-day return from offer price to close	9.58%	4.17%
Trading volume/shares offered	58.94%	53.80%
Panel C: Offer day short selling		
Short sales$_{T+0}$/shares offered	7.26%	5.56%
Short sales$_{T+0}$/trading volume$_{T+0}$	12.02%	10.36%
Short sales$_{T+0}$/shares outstanding	3.02%	1.94%

Table 1, Panel A presents initial statistics on the IPO sample. On average, the mean offer amount is $188.53 million. The sample has a negative change in offer price of −4.18% indicating a relatively conservative IPO market. The change in offer price is defined as the percent difference between the offer price and the midpoint of the original preliminary offer price filing range noted in SDC (Hanley, 1993). Approximately 39% of IPOs have offer prices above the midpoint of the preliminary offer price range and 48% have offer prices below the midpoint.

Panel B of Table 1 presents summary statistics on the first-day return and trading volume. Like Aggarwal and Conroy (2000), most of the first-day return occurs at the open. The mean first-day return is 9.07% and the time period covered by this study is characterized by somewhat lower levels of average first-day returns than other studies on short sale constraints which focus on periods during the tech bubble. Trading volume on the offer date is over 50% of the shares offered similar to that found in Ellis, Michaely, and O'Hara (2000) and Corwin, Harris, and Lipson (2004) which is much greater than the average trading volume on a given day for an individual stock.

3.2. Short selling

To examine whether short selling is present in the immediate aftermarket of trading in IPOs, we collect information on transactions involving short sales for the first month of trading from the Regulation SHO Pilot data. The data are compiled from the following exchanges

(*footnote continued*)
This IPO had twice the level of short selling and fails to deliver as the next highest IPO. The inclusion of this one outlier affects the results.

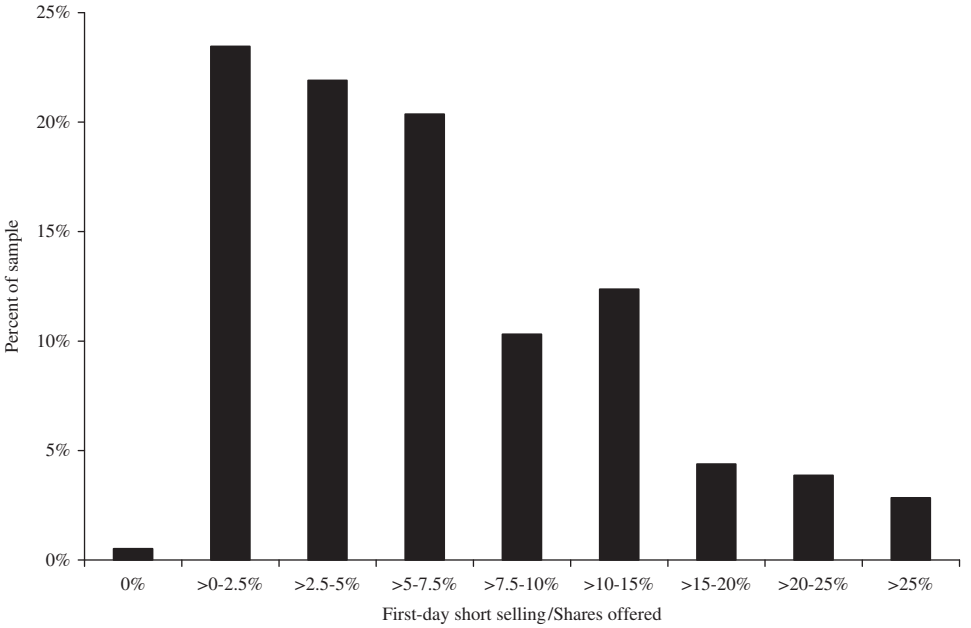

Fig. 1. Distribution of short selling on the offer day. The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. Short sales are from Regulation SHO Pilot data and compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx. First-day short selling is as a percent of shares offered. Shares offered are from SDC and exclude the exercise of the overallotment option.

and Self-Regulatory Organizations (SROs): Amex, Arca Exchange (ArcaEx), Boston Stock Exchange, Chicago Stock Exchange, NASD, Nasdaq, National Stock Exchange, NYSE, and Philadelphia Stock Exchange (Phlx). The data include ticker, time and date of trade, quantity, and price, but do not include trader identity. Individual short sale transactions are then aggregated into daily short sales for each IPO.[15]

All but two IPOs in our sample have short sales on the offer day. As shown in Table 1, Panel C, short sales comprise over 7% of the shares offered and 12% of the trading volume.[16] Fig. 1 presents the distribution across IPOs of short selling on the offer day as a percent of the shares offered. While the majority of IPOs have short selling between zero and 10% of shares offered, a quarter of the IPOs in the sample have short selling in excess of 10% with a maximum of over 34%. These findings clearly indicate that short selling is both non-trivial and an integral part of the IPO price process on the first trading day.[17]

Fig. 2 shows the time distribution of short sales on the offer day by trading market. Thirty-six percent of the IPOs in the sample trade on the NYSE or Amex while 64% trade on the Nasdaq. Because IPO trading does not always open at 9:30 a.m., as noted by Aggarwal and Conroy (2000), we measure the volume in 15-minute increments from the time that trading actually opens and through the first four hours.

In all markets, the largest amount of short selling occurs close to the open. On average, 42% of the short sale volume in NYSE/Amex IPOs occurs in the first 15 minutes of actual trading and this percentage is the maximum for the day. Likewise, almost 40% of the the Nasdaq short sale volume occurs in the first 15 minutes. This pattern is similar to the intraday pattern for all trading volume, with the Nasdaq trading volume in the first 15 minutes accounting for almost 50% of daily volume and the NYSE/Amex volume accounting for 43%. Our findings on volume are consistent with Krigman, Shaw, and Womack (1999) who find that over 50% of the first trading day volume in IPOs occurs in the first hour of trading. Overall, these results suggest that short selling is an integral part of the price formation process at the opening of trade despite the supposed impediments to short selling.

Fig. 3 presents short selling as a percent of shares offered, trading volume, and daily returns over the first month of trading. As can be seen in the graph, the initial trading day has the highest proportion of return, volume, and short sales. Short selling continues to occur over the first month of trading although the levels are quite small in relation to the first few trading days. The volume of trading and daily returns exhibit similar time-series properties with a rapid decline after the IPO and a leveling off for the remainder of the first trading month.

[15] The short selling data used in this paper do not include any overallocation or overallotment of shares by the underwriter (or syndicate members) in connection with an offering. Only market short sale transactions are included in the data.

[16] There is no adjustment to volume between NYSE and Nasdaq IPOs.

[17] Note that some of this short selling may be investors who are allocated IPO shares that are "shorting against the box" to circumvent restrictions on flipping such as penalty bids. However, this strategy is indistinguishable from other short sales in its execution. Although the investor may be long the shares of the IPO because of their allocation, she must still borrow the shares for delivery and thus, faces the same constraint on availability and cost of borrowing shares as any other short seller. If the investor were to use allocated shares for delivery on $T+3$, this would constitute a long sale.

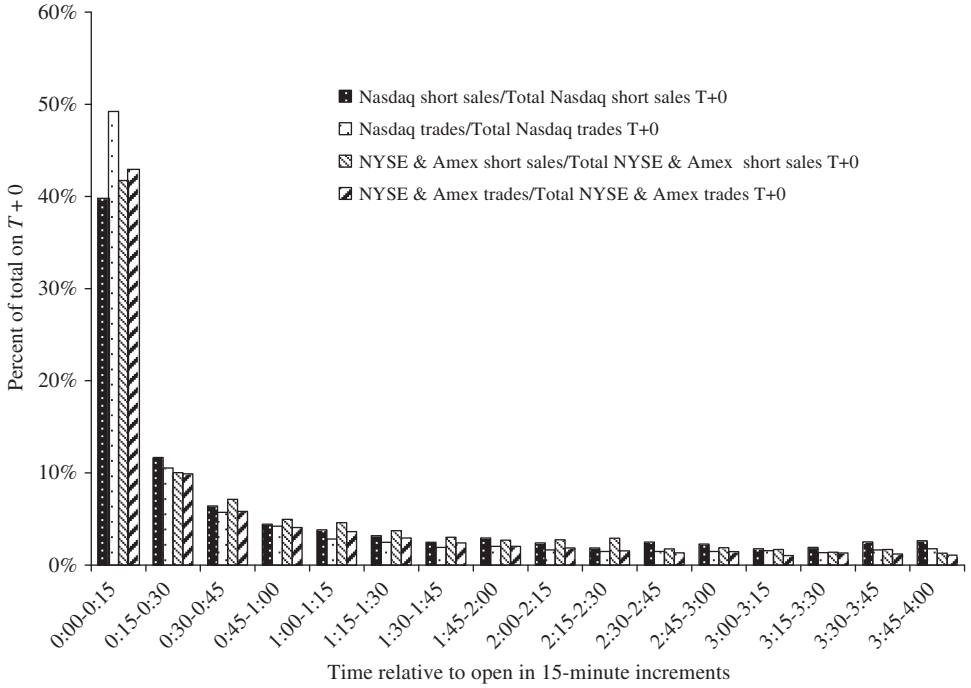

Fig. 2. Intraday short selling. The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. Short sales are from Regulation SHO Pilot data and compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx. Exchange listing information is from CRSP. Short selling is a percent of total shares shorted on the offer day. Trades are a percent of total shares traded on the offer day. Because all IPOs do not open at 9:30 a.m. opening times are aligned and the first four hours of actual trading are captured in 15-minute increments (e.g., if trading opens at 11 a.m., this chart captures 11:00 a.m.–3:00 p.m.).

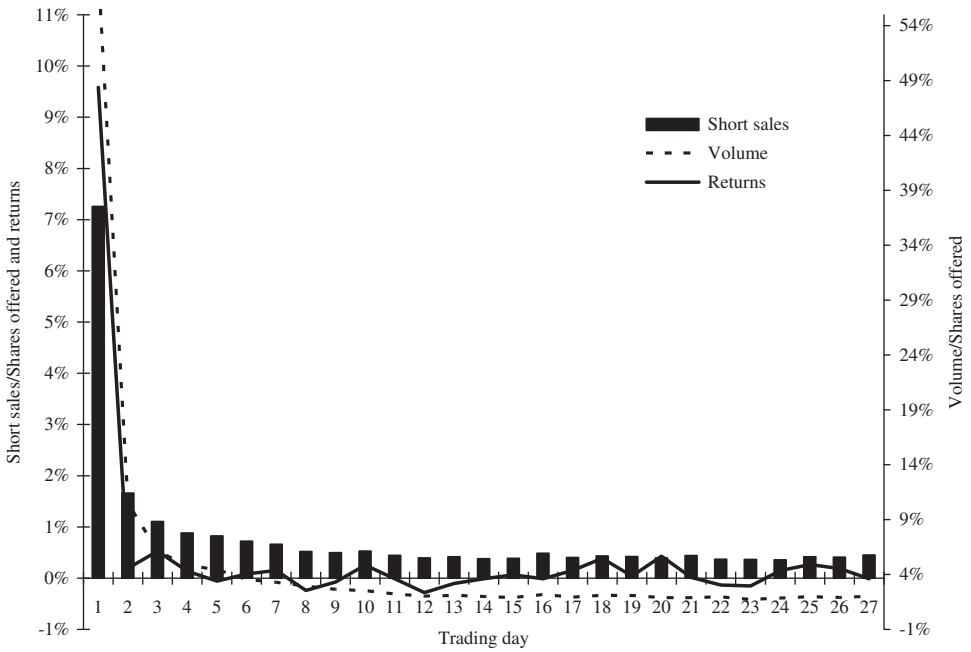

Fig. 3. Short selling, returns and trading volume. The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. Short sales are from Regulation SHO Pilot data and compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx. Short selling is a percent of shares offered. Shares offered are from SDC and exclude the exercise of the overallotment option. The first-day return is from the offer price from SDC to the first trading day closing price on CRSP. Daily returns after the offer date are from CRSP. Volume is the daily number of shares traded from CRSP scaled by the number of shares offered.

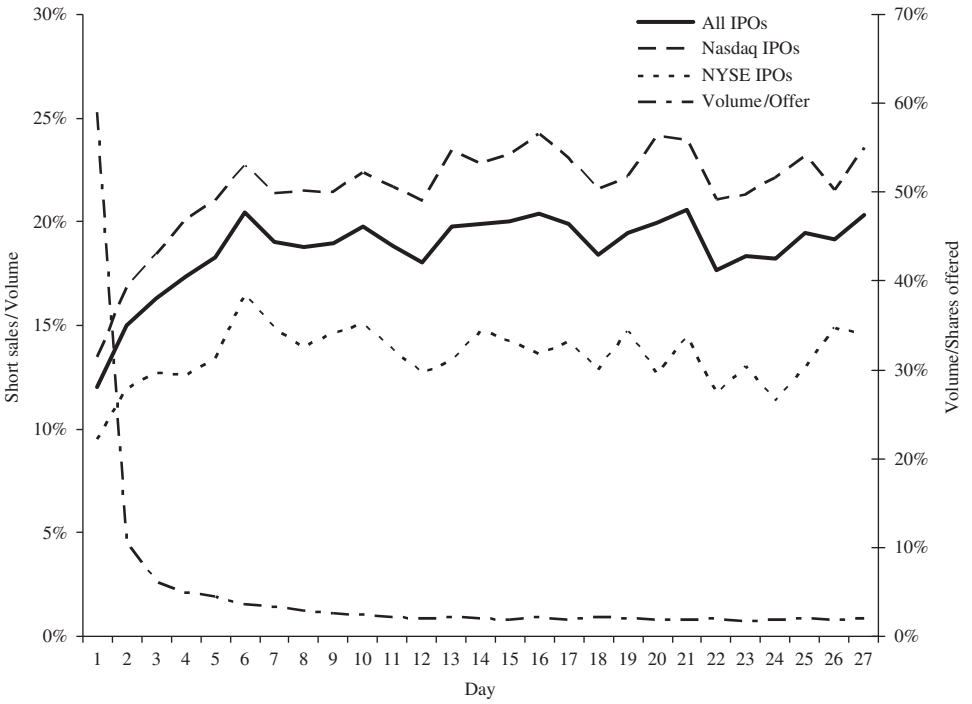

Fig. 4. Short selling as a percent of volume. The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. Short sales are from Regulation SHO Pilot data and compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx. Volume is the daily number of shares traded from CRSP scaled by the number of shares offered.

Fig. 4 presents the time-series pattern of short selling as a percent of volume over the first month of trading, by exchange. Recent studies that also use the Regulation SHO Pilot data such as Diether, Lee, and Werner (2009a), find that short sales constitute approximately 24% of the daily trading volume in NYSE-listed stocks and 31% of volume in Nasdaq-listed stocks. As shown in Fig. 4, the level of short selling quickly levels off by the fifth or sixth trading day.[18] Although the magnitude of short sales as a percent of volume remains lower for NYSE IPOs (15%) and Nasdaq IPOs (25%), than that found by Diether, Lee, and Werner (2009a), it appears from Fig. 4 that short selling as a percent of volume begins to approach average levels very quickly.

4. Determinants of short selling

The findings of the previous section indicate that short selling is prevalent early in the trading process. Thus, it appears as if perceived short sale constraints may not be as binding as commonly thought. To better understand the implications of this for theories of IPO pricing, this section examines the types of IPOs that are likely to be attractive to short sellers. Miller (1977) argues that "the prices of new issues… 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. The divergence of opinion about a new issue [is] greatest when the stock is issued." Those with pessimistic appraisals will prefer to short the stock. Therefore, it is an open question as to whether short sale constraints affect the ability to short sell in offers with greater divergence of opinion, as proxied by greater changes in the offer price and higher first-day returns.[19]

Table 2 presents univariate statistics on the level of short selling by classifying the sample of IPOs into quartiles based upon the first-day return. IPOs in the two lowest quartiles have low first-day returns. We suggest that IPOs in the highest two quartiles, those with significantly positive first-day returns, are more likely to be associated with offers that have a higher potential for divergence of opinion.[20]

Consistent with the divergence of opinion hypothesis, the greatest amount of short selling as a percent of shares offered is in IPOs in the highest two quartiles. IPOs in the highest two quartiles have significantly greater average

[18] While Diether, Lee, and Werner (2009a) find a much higher level of short sales relative to volume than the average short sale on the first trading day reported in our study, the amount of trading volume on the offer day for IPOs is substantially larger than the average daily trading volume for an individual stock, making an exact comparison difficult.

[19] Note that this hypothesis is based on one component of the Miller (1977) theory and we do not directly test theories of investor sentiment or divergence of opinion. These theories are used only as examples of the perceptions regarding the role of short selling and thus, our results can only speak to the role of binding short sale constraints but not on the role of investor sentiment in IPO pricing.

[20] We consider only ex ante measures of divergence of opinion or uncertainty. For an examination of ex post measures, see Falconieri, Murphy, and Weaver (2009).

Table 2
Comparison of first-day trading and short selling by quartiles of first-day returns.

The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. Short sales are from Regulation SHO Pilot data and compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx, and are scaled by shares offered, trading volume on the offer day, and shares outstanding after the offer. Offer amount, offer price and shares offered are from SDC and exclude the exercise of the overallotment option. Opening and closing prices for the calculation of first-day (T+0) returns are from CRSP. Change in offer price is the percent difference of the final offer price from the midpoint of the preliminary offer price range in the prospectus. The percent positive (negative) change in offer price is the percent of IPOs whose final offer price exceeds the midpoint of the offer price in the preliminary price range. Volume is the daily number of shares traded. Both volume and shares outstanding are from CRSP. Medians are in parentheses.

	First-day return			
	Lowest	Quartile 2	Quartile 3	Highest
Number of IPOs	85	109	97	97
Offer amount (in $m)	$181.24	$173.53	$200.07	$200.25
First-day return from offer price to open	0.04%	1.56%	9.41%	25.11%
	(0.00%)	(0.29%)	(7.14%)	(21.58%)
First-day return from open to close	−4.70%	−0.31%	0.72%	6.20%
	(−3.57%)	(0.00%)	(1.43%)	(5.60%)
First-day return from offer price to close	−4.78%	1.11%	9.72%	31.54%
	(−3.53%)	(0.48%)	(9.70%)	(26.20%)
Change in offer price	−12.55%	−13.51%	0.08%	9.38%
Percent with positive change in offer price	9.41%	12.84%	58.76%	76.29%
Percent with negative change in offer price	76.47%	66.97%	30.93%	17.53%
Volume$_{T+0}$/shares offered	48.49%	46.56%	60.41%	80.53%
	(46.39%)	(37.88%)	(59.57%)	(74.63)
Short sales$_{T+0}$/shares offered	5.48%	5.20%	7.37%	11.00%
	(4.07%)	(3.44%)	(5.67%)	(7.80%)
Short sales$_{T+0}$/trading volume$_{T+0}$	11.47%	10.17%	13.50%	13.12%
	(8.77%)	(9.91%)	(10.61%)	(10.69%)
Short sales$_{T+0}$/shares outstanding	2.39%	2.07%	3.15%	4.49%
	(1.35%)	(1.21%)	(2.26%)	(2.93%)
Cumulative short sales$_{T+0}$ to $_{T+21}$/shares offered	12.83%	13.27%	18.94%	33.38%
	(10.57%)	(9.97%)	(14.13%)	(20.55%)

short selling relative to shares offered both on the offer day and over the first month of trading as compared to the lowest two quartiles. (Indeed, there are no significant differences in the level of short selling between the two lowest quartiles.) This table indicates a dichotomy in the amount of short selling with the level of short selling increasing in positive first-day returns but relatively constant in low or negative first-day returns.

We further analyze the determinants of short selling using a regression analysis with short selling on the offer day as a percent of shares offered as the dependent variable. Independent variables that proxy for divergence of opinion include the first-day return at the open measured from the offer price to the opening price (*First-day return from offer price to open*), the change in offer price measured as the percentage difference of the offer price from the midpoint of the preliminary offer price range (*Change in offer price*), and the first-day trading volume as a percent of shares offered (*Volume$_{T+0}$/shares offered*).[21]

Prior research in IPOs has found that trading volume and first-day return are related and significantly correlated (see Aggarwal, 2003; Krigman, Shaw, and Womack, 1999). Although not presented, we also find a high degree of correlation between short selling as a percent of shares offered, trading volume as a percent of shares offered, and first-day return. The change in offer price is not as highly correlated with the other variables but is still significantly so. Therefore, caution must be used when including all of these variables in a regression analysis as they may capture the same economic effect. In order to limit the effect of multicollinearity, each of these variables is included individually in the regressions.

Price support may also be related to the amount of short selling as it is only economically viable for underwriters to engage in such activities if they can constrain both short and long sales.[22] Under this scenario, if underwriters are successful in limiting the amount of selling that occurs immediately in the aftermarket, short selling should be negatively related to price support. Alternatively, in the absence of constraints, it is possible that price supported IPOs may attract short sellers because, as Ellis (2006) suggests "demand for shorting is likely to be higher in stabilized IPOs as well as IPOs with high first-day returns, as investors are more likely to believe these prices are inflated." Thus, the predicted relation between price support and short selling is ambiguous.

In order to determine if price support may affect the level of short selling, we define an IPO to be price

[21] Our results are robust to removing short sales at the open from the total number of short sales.

[22] See Hanley, Lee, and Seguin (1996) for a discussion on the economics of price stabilization.

supported (*Price supported IPO*) using a dummy variable equal to one if: (a) the first-day return is equal to zero, or (b) the IPO is in the bottom quartile of the percent of the overallotment option exercised (as collected from Bloomberg), or (c) in the top quartile for the percent of trades, using Trades and Quotes (TAQ), executed at the offer price on the first trading day. We use a combination of the three measures because a number of IPOs may have price support even if the first-day return is not zero.[23] Aggarwal (2000), Ellis, Michaely, and O'Hara (2000), and Lewellen (2006) find that underwriters exercise less of the overallotment option when they engage in price support activities in the market. In addition, we expect that IPOs that have no change in price on the offer day or more trades at the offer price, regardless of the first-day return, are more likely to have underwriter price support.

We also include two variables that control for less onerous short sale constraints. First, the percentage float (*Float*) has been used in previous literature as a measure of borrowing constraints (Ofek and Richardson, 2003; Cook, Kieschnick, and VanNess, 2006). As the percentage float decreases, the amount of lendable shares may decline which increases the cost of borrowing. Thus, the smaller is the public float, as measured by the ratio of shares offered to shares outstanding from CRSP, the greater are the supposed short sale constraints. The percentage float is the ratio of shares offered to shares outstanding from CRSP and averages 47% in our sample.

Second, regulatory constraints such as the Uptick Rule and Nasdaq Bid Test Rule (*Ability to execute*$_{T+0}$) could also affect the level of short selling by restricting the ability to trade on the offer day.[24] For the Nasdaq Bid Test, we measure the percentage of the trading day when the rule allows short sales to execute against the bid price. For the Uptick Rule, we add the percentage of trades on upticks during periods when the rule does not allow short sales to execute against the bid price.

The rationale for treating execution constraints in this manner is as follows: If a short sale can execute against the bid price, then it can be executed without delay and this occurs much more often for the Bid Test than for the Uptick Rule. Note, however, that a short sale can still execute even if it cannot execute against the bid. Instead, the short sale must wait for a buy order willing to pay a price at which the short sale can execute. For the Uptick Rule, this is any price greater than the previous one. Therefore, the adjustment in the calculation for the Uptick Rule helps capture the ease of short selling.

Finally, we include a dummy variable equal to one for IPOs listed on the Nasdaq (*Nasdaq*) to control for differences in market structure. Indeed, several recent studies note a difference between the level of short selling in the NYSE- or Amex-listed IPOs and in Nasdaq-listed IPOs (Alexander and Peterson, 2008; Diether, Lee, and Werner, 2009a, 2009b; and the Pilot Report by the Office of Economic Analysis of the US Securities and Exchange Commission) that may be due to market structure, regulation, or selection bias.[25]

The results of the various regression models in Table 3 show that short selling is related to proxies for divergence of opinion. Both the first-day return at the open and the change in offer price are positively and significantly related to short sales indicating that short selling is more prevalent in IPOs that are expected to experience significant price increases rather than price declines.[26]

Trading volume as a percent of shares offered is also positively and significantly related to the short sales as a percent of shares offered. If volume is measuring the degree of the divergence of opinion, this result provides additional support for that hypothesis. However, greater trading volume could also signal that it is easier for short sellers to locate shares for lending. Note that the greater the amount of short selling, the higher may be the trading volume. However, adjusting volume for the level of short selling or using raw volume and raw short sales has no effect on the regression results.

Short sales are either unrelated to or significantly lower in price supported IPOs.[27] Although our findings are consistent with underwriters constraining short sales, possibly through the supply of lendable shares in order to provide price support, the literature has also provided mixed results on the potential profitability of shorting price supported IPOs (e.g., Aggarwal, 2000; Lewellen, 2006). Thus, we cannot determine whether short sellers are either unable (because of potential underwriter constraints on supply) or unwilling (due to profitability) to short price supported IPOs.

The coefficients on the variables that capture other potential constraints on short selling, i.e., the percentage float and the ability to execute short sales, are also generally insignificant. The negative and occasionally significant coefficient on percentage float is counter to the use of this variable as a measure of short sale constraints. The result on the ability to execute short

[23] While each of these measures is correlated, they are not perfect substitutes. Our results are robust to using alternate definitions such as IPOs that did not fully exercise the overallotment option.

[24] See "Economic analysis of the short sale price restrictions under the Regulation SHO Pilot," by the Office of Economic Analysis, for more information. The pilot report is available at http://www.sec.gov/news/studies/2007/regshopilot020607.pdf.

[25] While the sample IPOs are listed on NYSE, Amex, and Nasdaq, they trade on many different exchanges and trading platforms. The dummy variable refers to the listing exchange, which matters for market structure during the sample period.

[26] This result is robust to a number of alternative specifications. Including other IPO characteristics in the regression, such as issuer age, venture capital backing, proceeds, and secondary shares, does not alter the results and none of the coefficients on these variables are significant. Winsorizing the data to the 99th and 95th percentile or taking logs of (1+variable) does not affect the results. Including change in offer price, first-day return, and volume in the same regression results in only volume being significant.

[27] We also examined whether short selling in price supported IPOs increases toward the typical end of the price support period (around 10 days after the IPO date). In order to do so, we examine the level of short selling over the first month of trading by whether or not the IPO was price supported (not shown). On each day, the level of short selling in price supported IPOs is lower than in other IPOs and this difference is statistically significant for all but a few days. At no time during the first 27 trading days did we observe an increase in the level of short selling of price supported IPOs.

Table 3
Regression analysis on offer day short sales.

The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. The dependent variable is the offer day short sales as a percent of the offer amount. Short sales are from Regulation SHO Pilot data and compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx, aggregated and then scaled by offer amount. Shares offered are from SDC and exclude the exercise of the overallotment option. The first-day return is from the offer price from SDC to the first trading day (T+0) opening price on CRSP. Change in offer price is the percent difference of the final offer price from the midpoint of the preliminary offer price range in the prospectus. Volume is the daily number of shares traded from CRSP. Price supported IPO is a dummy variable equal to one if the first-day return is equal to zero, or the IPO is in the bottom quartile of the percent of the overallotment option exercised collected from Bloomberg, or in the top quartile of the percent of trades, using TAQ, executed at the offer price on the first trading day. Percent float is the ratio of shares offered from SDC to shares outstanding from CRSP. The ability to execute is estimated using TAQ and measures the extent to which the Uptick Rule or Nasdaq Bid Test allows short sales to execute. Nasdaq is a dummy variable equal to one if the IPO trades on either the Nasdaq, zero if it trades on the NYSE or the Amex. t-Values are in parentheses. ***, **, and * indicate significance at the 1%, 5%, or 10% levels.

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	0.056	0.073	−0.016	0.075
	(4.70)***	(6.41)***	(−1.67)*	(5.87)***
First-day return from offer price to open	0.188			
	(8.88)***			
Change in offer price		0.173		
		(9.90)***		
Volume $_{T+0}$/shares offered			0.150	
			(21.49)***	
Price supported IPO	0.008	0.004	−0.002	−0.023
	(1.17)	(0.55)	(−0.50)	(−3.40)***
Float	−0.005	−0.008	0.0004	−0.005
	(−1.37)	(−2.30)**	(0.15)	(−1.41)
Ability to execute$_{T+0}$	−0.029	−0.022	−0.025	−0.016
	(−1.84)*	(−1.43)	(−2.09)**	(−0.91)
Nasdaq	0.022	0.033	0.023	0.028
	(3.57)***	(5.41)***	(5.05)***	(4.05)***
Adjusted R^2	0.23	0.25	0.58	0.07

sales suggests that price test restrictions are not a significant deterrent to short selling.

Consistent with recent literature (Alexander and Peterson, 2008; Diether, Lee, and Werner, 2009a, 2009b), the coefficient on the Nasdaq dummy is highly significant and positive. This finding indicates that IPOs on non-specialist markets have higher short selling than IPOs on specialist markets. It is not clear, however, whether this is related to the structure and regulation of the market or the types of companies that choose to go public on the NYSE/Amex or Nasdaq (Corwin and Harris, 2001).

Collectively, our findings suggest that IPOs that are more underpriced have greater short selling than other IPOs. Although Miller (1977) and others argue that informed investors may be precluded from taking advantage of divergence of opinion because of short sale constraints, our results indicate that at least some investors are able to engage in short selling.

5. Are short sellers in IPOs engaged in naked short selling?

The observed high level of short selling, coupled with the presumed difficulty in borrowing shares and the potentially high cost of lending (Ljungqvist, Nanda, and Singh, 2006), begs the question of whether short sellers avoid those constraints by engaging in naked short selling. According to the SEC Web site, "a "naked" short sale is a short sale where the seller does not borrow or arrange to borrow the securities in time to make delivery to the buyer within the standard 3-day settlement period [and, as] a result, the short seller fails to deliver securities to the buyer when settlement is due (known as a "failure to deliver" or "fail to deliver")."[28] Thus, failures to deliver are often used as a measure for "naked" short selling.[29]

In this section, we attempt to distinguish whether short sellers are avoiding borrowing constraints by

[28] Regulation SHO or Reg SHO, for short, was adopted in 2004 and provides regulations, among others, that govern locating shares prior to a short sale as well as the delivery of shares. Under Rule 203 of Regulation SHO, the broker facilitating a short sale must "locate" the stock prior to the trade. "Locate" refers to the requirement under Regulation SHO that a broker-dealer have reasonable grounds to believe that the security can be borrowed for delivery on the T+3 settlement date. Note that the locate requirement is not the same as actually borrowing the security. The broker may locate these shares in its own inventory, from a prime broker, or large institutional investors through a custodial bank. The broker-dealer can rely on "easy to borrow" lists for a locate if they satisfy the "reasonable grounds" standards of Regulation SHO Rule 203. Brokers may satisfy the reasonable grounds requirement if they rely on easy to borrow lists so long as those lists are less than 24-hours old, and the securities on the list are readily available such that it would be unlikely that a failure to deliver would occur. These standards are described in Section V.A. of release number 34-50103. See http://www.sec.gov/spotlight/keyreg-shoissues.htm for more information.

[29] See, for example, Angel (2006) and press articles such as "Games Short Sellers Play," by Bob Drummond, Bloomberg Markets, September 2006, and "Failed Trades" by Liz Moyer, *Forbes*, August 18, 2006. The media has referred to the Regulation SHO threshold list as the "naked short selling" list.

analyzing whether IPOs with large short selling have subsequent failures to deliver. To our knowledge, ours is the first analysis of the relationship between short selling and failures to deliver in any context.[30] Failures to deliver are examined both on a daily aggregate level and by whether the IPO has persistent delivery failures. We use data on failures to deliver sent to the SEC from the National Securities Clearing Corporation's (NSCC) Continuous Net Settlement (CNS). The NSCC reports the level of failures to deliver to the SEC and several SROs daily for stocks that have aggregate failures of at least 10,000 shares. The data contain the balance of fails to deliver as of a given day.[31]

5.1. Level of failures to deliver

Fig. 5 presents daily fails to deliver as a percent of the shares offered in addition to daily short selling. Fails to deliver are shown on the graph 3 days earlier ($N-3$) than short sales to account for the standard settlement process. Note that fails to deliver, unlike short sales, represent a balance outstanding rather than new transactions. Consistent with the pattern of short sales, the initial settlement day has the highest proportion of fails to deliver with a decline over time. While some fails to deliver are resolved after the first settlement date, many appear to persist beyond the first few days.

Table 4 presents statistics on aggregate fails to deliver in excess of 10,000 shares on the first settlement day ($T+3$). If an IPO is not in the data on the first settlement day, the number of fails to deliver is set to zero although technically the IPO may not be in the data because the level of fails is less than 10,000 shares. The average fails to deliver, relative to shares offered, is 4.23% which is lower than the average level of short sales shown in Table 1. Compared to short sales, fails to deliver, on average, are over ten times greater. This average, however, may be misleading because of skewness in the ratio due to some IPOs with small short sales but large fails. However, it is interesting to note that some IPOs have fails on $T+3$ that far exceed their short selling. (The two IPOs without short sales are not included.) We find that the median fails to deliver to short sales on the first trading day is approximately 30%.

In Table 4, we further split the sample of IPOs with failures to deliver between those that have fails on the first settlement day (Panel B) and those that have fails anytime between $T+4$ and $T+24$ (Panel C). The vast majority of IPOs in our sample have fails to deliver sometime during the first 21 trading days. Of the sample, 237 (61%) have fails to deliver on $T+3$, 134 IPOs have fails to deliver between $T+4$ and $T+24$, and 17 IPOs either have no fails to deliver or fails to deliver below 10,000 during the entire first month of trading. The percentage of IPOs in our sample that have a failure to deliver in excess of 10,000 shares at any time during the first month of trading (96%) is larger than that found by Fotak, Raman, and Yadav (2009) who find that 91% of NYSE and 71% of Nasdaq stocks have at least one failure to deliver in excess of 10,000 shares over their 6-month sample period.

There is a difference between the two samples with IPOs with fails to deliver on the first settlement day having a slightly lower mean first-day return and a higher average fails to deliver as a percent of either the shares offered or short sales. When fails to deliver do not occur on $T+3$, most IPOs have fails not long after $T+3$ as the sample has a median first fail date of $T+5$.

5.2. Determinants of failures to deliver

In this section, we further examine the relation between short selling and both transitory and persistent fails to deliver. We define an IPO as having persistent fails to deliver if the IPO is on the Regulation SHO threshold list on the first possible date ($T+7$).

When a stock has fails to deliver level of at least 10,000 shares and 0.5% of the shares outstanding for five consecutive settlement days, the trading venue listing the stock is required to place it on a list known as the Regulation SHO threshold list.[32] The earliest an IPO can be on the list is eight days after the issue date ($T+7$) in order to allow three days for the first settlement and five days of high fails to deliver. Threshold list information is collected from daily Regulation SHO lists on the NYSE, Amex, and Nasdaq.

In Panel A, of Table 5, we regress the level of fails to deliver on $T+3$ on short sales on the offer day using a Tobit specification to accommodate the large number of IPOs with zero fails to deliver. We include the same independent variables as in the previous short selling regressions. We hypothesize that if short selling, at the time of the IPO, is due to the failure to locate the shares or naked short selling, regressing failures to

[30] There is no empirical evidence that failures to deliver affect prices despite the potential for buying pressure when the failures are closed-out under Regulation SHO and concerns about the impact of naked short selling (see e.g., Boulton and Braga-Alves, 2009; Fotak, Raman, and Yadav, 2009; Gjerde, 2009). In addition to potential naked short selling, failures to deliver may also occur on long sales and possibly around other corporate actions such as follow-on offers and proxy voting. However, these events are not likely to occur within 3 months after the IPO and thus, should have little impact on our findings. Further, any potential counterparty risk from failures to deliver are managed by a central clearing agency such that the incremental risk and economic consequence from failures to deliver should be minimal. Since the sample period, the regulations regarding failures to deliver have changed (see http://www.sec.gov/rules/other/2008/34-58572.pdf, http://www.sec.gov/rules/final/2008/34-58775.pdf, and http://www.sec.gov/rules/final/2009/34-60388.pdf). For further discussion on some of the economics and mechanics of failures to deliver, see Evans, Geczy, Musto, and Reed (2009) and Boni (2006).

[31] Note that the CNS data are a net failure to deliver. Therefore, the balance is not related to any individual transaction but to the net position of the clearing member. Our data are not as comprehensive as the data studied by Boni (2006) as they do not also include failures to receive, but our data do contain a much longer time series. Some data on aggregated failures to deliver are available at http://www.sec.gov/foia/docs/failsdata.htm.

[32] Once a stock is placed on the threshold list, Regulation SHO includes additional delivery requirements. For more information on Regulation SHO and the requirements described in this section, see the rules (17 CFR 242.203) and adopting release for Regulation SHO (SEC Release no. 34-50103, July 28, 2004).

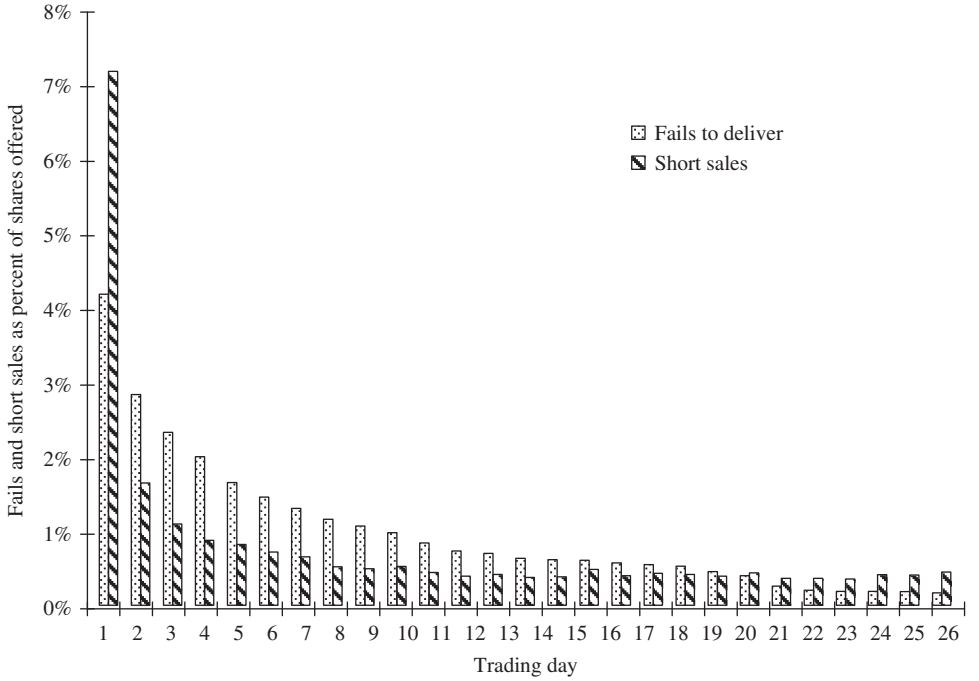

Fig. 5. Short selling and failures to deliver. The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. Short sales are from Regulation SHO Pilot data and compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx. Daily fails to deliver for IPOs are from NSCC's Continuous Net Settlement which include stocks with aggregate fails to deliver of at least 10,000 shares. Fails to deliver on $T+N$ are shown three trading days prior ($N-3$). Short sales and fails to deliver are a percent of shares offered. Shares offered are from SDC and exclude the exercise of the overallotment option.

deliver on the same variables as in the short selling regressions in Table 3 should result in similar relationships.

Our results indicate that the factors that influence short selling are *not* related to fails to deliver, as the coefficient on the level of shorts sales is insignificant in each regression. This finding suggests that fails to deliver on the first settlement date ($T+3$) are not related to short sales on the offer date ($T+0$). Further, the coefficients on the first-day return, change in offer price, and volume are also insignificant.[33]

In Panel B of Table 5, we test whether persistent or long-lived fails to deliver are related to the level of short selling by conducting a probit analysis using a dummy variable for whether the IPO is on the threshold list on $T+7$. There are 113 IPOs (almost 30% of the sample) on the threshold list on the first possible date ($T+7$) which indicates that many IPOs have persistent fails to deliver. This seems particularly high when considering that only

Table 4
Summary statistics on fails to deliver.

The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. Daily fails to deliver are from NSCC's Continuous Net Settlement which includes stocks with aggregate fails to deliver of at least 10,000 shares. Short sales are from Regulation SHO Pilot data and compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx, aggregated. Shares offered are from SDC and exclude the exercise of the overallotment option. The first-day return is from the offer price from SDC to the first trading day ($T+0$) closing price on CRSP.

Variable	Mean	Median
Panel A: All IPOs first settlement day (T+3)		
Fails to deliver/shares offered	4.23%	2.29%
Fails to deliver/short sales$_{T+0}$	1,083.37%	30.32%
Panel B: 237 IPOs with first fail on first settlement day (T+3)		
First-day return from offer price to close	9.14%	3.67%
Fails to deliver/shares offered	6.92%	5.73%
Fails to deliver/short sales$_{T+0}$	1,779.50%	99.70%
Panel C: 134 IPOs with first fail later than first settlement day (T+4 to T+24)		
First-day return from offer price to close	10.88%	5.44%
First fails to deliver/shares offered	0.86%	0.46%
First fails to deliver/short sales$_{T+0}$	31.47%	7.99%
Day of first fails to deliver	6.14	5.00

[33] An alternative explanation for fails to deliver in IPOs is the possibility that some investors, for whom brokers are unable to locate shares or who would otherwise be unable to short sell because of regulatory restrictions, cause their brokers to mark the short trades as long. There is evidence that such marking of short sales as long have occurred in follow-on equity offers. (See "SEC and NYSE settle enforcement actions against Goldman Sachs unit for its role in customers' illegal trading scheme" Release 2007-41.) However, absent actual evidence of such conduct, our data cannot confirm this explanation. It is a violation of Regulation SHO Rules 200 and 203 (17 CFR 242.200 and 242.203) for a broker to mark a short sale as a long sale, or to lend securities for delivery on a long sale or fail to deliver on a long sale unless the broker had been reasonably informed by the seller that it owns the securities and could deliver them in time for settlement.

Table 5
Analysis on fails to deliver and probability of being on threshold list on $T+7$.

The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. Dependent variables are first settlement day fails as a percent of shares offered and a dummy variable if the IPO is on the threshold list on day $T+7$. Daily fails to deliver are from NSCC's Continuous Net Settlement which includes stocks with aggregate fails to deliver of at least 10,000 shares. Information is collected from daily threshold lists on the NYSE, Amex, and Nasdaq. Short sales are from Regulation SHO Pilot data and compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx, aggregated and then scaled by offer amount (excluding the exercise of the overallotment option). The first-day return is from the offer price from SDC to the first trading day ($T+0$) closing price on CRSP. Change in offer price is the percent difference of the final offer price from the midpoint of the preliminary offer price range in the prospectus. Volume is the daily number of shares traded from CRSP. Price supported IPO is a dummy variable equal to one if the first-day return is equal to zero, or the IPO is in the bottom quartile of the percent of the overallotment option exercised collected from Bloomberg, or in the top quartile of the percent of trades, using TAQ, executed at the offer price on the first trading day. Percent float is the ratio of shares offered from SDC to shares outstanding from CRSP. The ability to execute is estimated using TAQ and measures the extent to which the Uptick Rule or Nasdaq Bid Test allows short sales to execute. Nasdaq is a dummy variable equal to one if the IPO trades on the Nasdaq, zero if it trades on the NYSE or the Amex. t-Values are in parentheses for Tobit regressions and χ^2 for probit analysis. ***, **, and * indicate significance at the 1%, 5%, or 10% levels.

	Panel A Tobit regression Dependent variable: level of fails				*Panel B* Probit analysis Class variable: on threshold list at $T+7$			
Variable	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Intercept	0.056	0.056	0.059	0.054	−0.405	−0.322	−0.373	−0.314
	(3.40)***	(3.44)***	(3.70)***	(3.04)***	(2.16)	(1.43)	(2.00)	(1.12)
Short sales$_{T+0}$/shares offered	0.039				0.430			
	(0.62)				(0.15)			
First-day return		0.029				−0.495		
		(1.06)				(0.92)		
Change in offer price			0.004				−0.398	
			(0.17)				(0.88)	
Volume$_{T+0}$/shares offered				0.009				−0. 101
				(0.74)				(0.20)
Price supported IPO	0.038	0.040	0.037	0.038	0.571	0.483	0.502	0.548
	(4.53)***	(4.55)***	(4.16)***	(4.55)***	(15.39)***	(8.58)***	(10.23)***	(13.98)***
Float	−0.008	−0.008	−0.008	−0.008	0.038	0.035	0.041	0.032
	(−0.81)	(−0.85)	(−0.84)	(−0.80)	(0.20)	(0.17)	(0.25)	(0.14)
Ability to execute$_{T+0}$	−0.043	−0.045	−0.044	−0.045	−0.240	−0.214	−0.22/	−0.238
	(−2.05)**	(−2.11)**	(−2.08)**	(−2.11)**	(0.43)	(0.34)	(−0.39)	(0.43)
Nasdaq	−0.038	−0.037	−0.036	−0.037	−0.483	−0.463	−0.487	−0.471
	(−4.40)***	(−4.41)***	(−4.33)***	(−4.39)***	(10.65)***	(10.11)***	(11.13)***	(10.53)***
Log likelihood	169.58	169.95	169.40	169.66	221.11	220.73	220.75	221.09

about 2% of NYSE, Amex, and Nasdaq stocks qualified for the threshold list per day in May 2006.[34] An additional 42 IPOs are on the threshold list sometime during the first 30 trading days. Although not shown, when an IPO is on the threshold list on day $T+7$, it remains on the threshold list for a median of 12 settlement days. In general, the results in Panel B are consistent with the results in Panel A in which we find no evidence that the first trading day level of short sales is related to persistent failures to deliver.[35]

The most striking result of Panels A and B is that price supported IPOs are significantly more likely to have high levels of fails to deliver and to be on the threshold list. We explore how this may occur in the next section. Overall, these findings suggest that fails to deliver in IPOs are not due to short selling, in general, or naked short selling, in particular.

5.3. Could failures to deliver be due to underwriter price support?

The results in Table 5 indicate that IPOs that may have underwriter price support are more likely to have failures to deliver. In this section, we give a possible explanation of how the mechanics of underwriter price support may result in failures to deliver.

Underwriters typically oversell the number of shares in the IPO (Aggarwal, 2000; Jenkinson and Jones, 2007) and must cover this overallocation either with the exercise of the overallotment option or by purchases in the open market. Generally, the underwriter will cover its shares in the open market when the market trading price is near or less than the offer price in order to provide price support. Aggarwal (2000) finds that underwriter purchases in the open market, in order to cover its overallocation, occur for 10–15 days after the IPO. In addition, she finds that underwriters may oversell the issue by more than the 15% overallotment option which would necessitate the purchase of shares in the open market. Therefore, any shares that are overallocated in the offer but not covered either through the immediate exercise of the overallotment

[34] See "Fails to Deliver Pre- and Post-Regulation SHO," http://www.sec.gov/spotlight/failstodeliver082106.pdf.

[35] Using cumulative short sales over the first five days of trading does not alter the results.

option or underwriter market purchases on $T+0$, cannot settle on $T+3$.[36] (For the purposes of this discussion, we will term the shares oversold and allocated by the underwriter but not yet delivered as "uncovered" until the underwriter transfers shares to the investor either through the exercise of the overallotment option or by buying in the open market.)

There may be investors, however, who are unaware that they were allocated uncovered shares and who may wish to sell. The sale of these uncovered shares will then result in fails to deliver until such time as the underwriter either purchases the shares in the open market or exercises the overallotment option and subsequently transfers the shares to the investor (technically, the broker's clearing member).

Table 5 also shows that an IPO has higher fails to deliver on day $T+3$ if it is traded on the NYSE or Amex. This finding may also be related to price support in that underwriters on a specialist market may find it more difficult to provide price support through open market purchases. Ellis, Michaely, and O'Hara (2000) reports that the lead underwriter is always a market maker for Nasdaq-listed IPOs. In contrast, for NYSE/Amex IPOs, it is unlikely that the specialist and the underwriter will be affiliated (Corwin, Harris, and Lipson, 2004). The underwriter acting as a market maker improves its ability to directly cover the overallocated position. In the case of a specialist market, frictions may exist which preclude an underwriter directly purchasing shares in the open market to cover the overallocation which may result in more fails to deliver in specialist markets.

6. The cost of borrowing and return predictability

In this section, we further analyze the nature of short selling constraints by examining whether borrowing costs, which we measure as direct stock loan fees, are a detriment to short selling. For example, Ljungqvist, Nanda, and Singh (2006) suggest that short selling is constrained by the high cost of borrowing by interpreting the findings of Geczy, Musto, and Reed (2002) as an indication "that borrowing IPO stock in the early aftermarket is *extremely* (italics added) expensive in general, the more so, the higher was the initial day return." In addition, we test whether short selling is related to subsequent price movements over the first three months of trading.

We obtain information on stock loan fees, over the first month of trading, from a data set of rebate rates provided by an anonymous data source. A total of 259 out of 388 IPOs (67%) have rebate rate data available. Note that we are unable to determine whether a missing value in the data may be due to the absence of rebate rates for all security lenders or only for our source, in particular.

[36] $T+3$ is almost always the closing day for the IPO and we find that if the overallotment option is to be exercised, it is often exercised upon closing of the IPO. Our data cannot directly measure the number of overallocated shares that do not settle.

We first conduct a probit analysis to determine whether a bias may exist in the type of stocks covered by our data. As shown in Panel A of Table 6, the differences between the IPOs that are covered by our data source and those that are not appear to be related to the level of short selling and the trading market. We are more likely to observe rebate rates for IPOs that have high short selling and are traded on the NYSE or Amex.

Panel B of Table 6 presents the determinants of the cost of borrowing. For the IPOs for which data are available, the daily loan fee is calculated as the annualized Federal funds rate minus the rebate rate. We then calculate the weighted average loan fee over the first month of trading ($T+3$ to $T+24$) using the number of shares in our vendor's data. The average level of the loan fee in our sample is just slightly lower than Geczy, Musto, and Reed (2002), most likely due to the weighted averaging of the loan fees over the first trading month. The fact that our rebate rates are within the range shown in Geczy, Musto, and Reed (2002) is surprising given that our sample exhibits much lower first-day returns than their sample, which is within the bubble period.

If the expected cost of borrowing deters short sellers from entering the market on $T+0$, then the relationship between the level of short selling on the offer day and loan fees should be negative. On the contrary, we find that higher loan fees are related to higher, not lower, levels of short selling, and our results provide additional insight into the Geczy, Musto, and Reed (2002) finding that loan fees are greatest for IPOs with high first-day returns. We show that the high level of short selling on the first trading day is a good predictor of the level of loan fees and interpret these results as an indication that loan fees appear not to be an impediment to short selling in IPOs but are likely determined, in part, by the level of short selling.

Although Geczy, Musto, and Reed (2002) show a significant relation between loan fees and IPOs that have zero or negative returns, we find only weak evidence that potential price support is related to the loan fee. For the sample of IPOs studied here, the lack of consistent relation between loan fees and price support is consistent with the insignificant relation between price support and short selling. Interestingly, we find a significant relation between failures to deliver and loan fees even though the level of failures to deliver and short selling are unrelated.

To further examine the cost of borrowing and subsequent returns, Table 7 presents univariate statistics for IPOs without rebate rates in our data, for the full sample of IPOs with rebate rates and by quartiles of the subsequent 3-month return (adjusted for the return on the Nasdaq index). There is a U-shaped relation between subsequent returns and the cost of borrowing. Both the lowest and highest quartiles of 3-month adjusted returns have the highest loan fees and they are statistically different from Quartiles 2 and 3 but not different from each other.

Short sales on the offer day are highest (and significantly different from the first and third quartiles) in the quartile with the lowest 3-month return, while

Table 6
Determinants of loan fees.

The dependent variables are for (1) the probit model: the probability the IPO will have a rebate rate from the anonymous data source during the month of trading, and (2) for the regression model: the weighted average loan fee (by loan amount) which is equal to the rebate rate minus the Fed funds rate over the first month of trading and is collected from an anonymous data source. The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. Short sales are from Regulation SHO Pilot data and compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx, aggregated and then scaled by offer amount (excluding the exercise of the overallotment option). Daily fails to deliver are from NSCC's Continuous Net Settlement which includes stocks with aggregate fails to deliver of at least 10,000 shares. Price supported IPO is a dummy variable equal to one if the first-day return is equal to zero, or the IPO is in the bottom quartile of the percent of the overallotment option exercised collected from Bloomberg, or in the top quartile of the percent of trades, using TAQ, executed at the offer price on the first trading day. Percent float is the ratio of shares offered from SDC to shares outstanding from CRSP. The ability to execute is estimated using TAQ and measures the extent to which the Uptick Rule or Nasdaq Bid Test allows short sales to execute. Nasdaq is a dummy variable equal to one if the IPO trades on the Nasdaq, zero if it trades on the NYSE or the Amex. χ^2 for the probit analysis and t-values for the ordinary least squares (OLS) regressions are in parentheses. ***, **, and * indicate significance at the 1%, 5%, or 10% levels.

	Panel A Probit analysis Dependent variable: Probability of observing IPO in rebate rate data			*Panel B* Regression analysis Dependent variable: Average weighted loan fee From T+3 to T+24		
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	0.429	0.444	0.014	0.013	0.019	0.023
	(2.25)	(2.44)	(2.49)**	(2.73)***	(3.13)***	(4.05)***
Short sales$_{T+0}$/shares offered	3.620		0.120			
	(9.49)***		(5.59)***			
Cumulative short sales$_{T+0}$ to $_{T+21}$/shares offered		1.437		0.049		
		(10.02)***		(10.65)***		
Fails to deliver$_{T+3}$/shares offered					0.068	
					(2.14)**	
Price supported IPO	−0.151	−0.130	0.003	0.005	−0.0007	0.001
	(1.11)	(0.81)	(1.13)	(2.04)**	(−0.21)	(0.28)
Float	0.083	0.082	0.0003	0.0006	−0.0004	−0.0005
	(0.51)	(0.51)	(0.21)	(0.49)	(−0.27)	(−0.31)
Ability to execute$_{T+0}$	0.168	0.134	−0.008	−0.010	−0.007	−0.009
	(0.21)	(0.13)	(−1.11)	(−1.47)	(−0.94)	(−1.15)
Nasdaq	−0.482	−0.494	−0.003	−0.003	0.003	0.001
	(10.10)***	(10.55)***	(−0.76)	(−1.23)	(0.93)	(0.38)
χ^2/Adj. R^2	235.81	234.38	0.10	0.30	0.01	0.00
N	388	388	259	259	259	259

cumulative short sales are fairly constant over the quartiles. This provides evidence that short sales on the first trading day may be informed as IPOs with the lowest subsequent returns have slightly more short selling. Failures to deliver are also relatively constant in the level of the 3-month Nasdaq-adjusted return. However, we find that failures to deliver are not indicative of future returns, and short sales after the first-day are not correlated with their contemporaneous return.

We define the potential profits of short sales as the buy-and-hold Nasdaq Composite Index-adjusted return over the first three months of trading excluding the first-day return plus the loan fee (measured over the first month of trading and multiplied by three).[37] A comparison of monthly loan fees and subsequent price movements over the first and third months indicates that loan fees are relatively small in comparison to returns. Even taking the cost of borrowing into account, there is little difference between the 3-month adjusted return and the 3-month profit, indicating that loan fees appear not to be a significant factor. More importantly is the near split between positive and negative returns over the first three months of trading.

In focusing on the potential short selling profits, the results indicate that those who sold short the IPOs in the lowest two quartiles profited from the short selling. However, the average potential short selling profits are negative even before adjusting for lending fees, revealing several interesting implications. First, short sellers are not so informed that they can profit without risk. Once lending fees are considered, only 34% of the IPOs with rebate rate data have profits greater than zero (not shown). Second, as in Mitchell, Pulvino, and Stafford (2002), the risk of upward price movements may be a bigger deterrent to additional short selling in IPOs than other short selling constraints.

Table 8 provides further evidence on the return predictability of short selling over the first month and the first three months of trading. Prior studies on short selling, for example, Diether, Lee, and Werner (2009a) and Boehmer, Jones, and Zhang (2008), find that the level of

[37] We do not have rebate rates over the entire 3-month period, so for the current tests we use the weighted average loan fee only over the first month of trading and multiply the monthly loan rate by three as an estimate of the 3-month loan rate. Since the cost of borrowing is likely to be highest in the first month of trading, we believe this is a conservative estimate of the cost of borrowing.

Table 7
Univariate statistics on loan fees and profitability.

The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. The weighted average loan fee (by loan amount) is equal to the rebate rate minus the Fed funds rate over the first month of trading and is collected from an anonymous data source. The first-day return is from the offer price from SDC to the first trading day (T+0) closing price on CRSP. Short sales are from Regulation SHO Pilot data and compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx, aggregated and then scaled by offer amount (excluding the exercise of the overallotment option). Daily fails to deliver are from NSCC's Continuous Net Settlement which includes stocks with aggregate fails to deliver of at least 10,000 shares. First-month and three-month returns are the buy-and-hold return minus the return on the Nasdaq Composite Index. Three-month profit is the Nasdaq Composite Index-adjusted return over the first three months of trading excluding the first-day return plus the loan fee (measured over the first month of trading and multiplied by three). Price supported IPO is a dummy variable equal to one if the first-day return is equal to zero, or the IPO is in the bottom quartile of the percent of the overallotment option exercised collected from Bloomberg, or in the top quartile of the percent of trades, using TAQ, executed at the offer price on the first trading day. Nasdaq is a dummy variable equal to one if the IPO trades on the Nasdaq, zero if it trades on the NYSE or the Amex. Information is collected from daily threshold lists on the NYSE, Amex, and Nasdaq. Medians are in parentheses. ***, **, and * indicate returns/profits are significantly different from zero at the 1%, 5%, or 10% levels.

	IPOs without rebate rate	IPOs with rebate rate	Three-month Nasdaq-adjusted return			
			Lowest	Quartile 2	Quartile 3	Highest
Number of IPOs	129	259	69	61	65	64
Annual weighted loan fee from T+3 to T+24	NA	1.88%	2.19%	1.35%	1.88%	2.05%
		(1.17%)	(1.47%)	(0.62%)	(0.96%)	(1.21%)
Month weighted loan fee from T+3 to T+24	NA	0.15%	0.17%	0.11%	0.15%	0.17%
		(0.10%)	(0.12%)	(0.05%)	(0.08%)	(0.10%)
First-day return from offer to close	5.14%***	11.80%***	8.08%***	6.92%***	13.02%***	10.31%***
	(1.00%)	(6.52%)	(1.76%)	(1.92%)	(10.00%)	(7.50%)
Short sales$_{T+0}$/shares offered	6.07%	7.85%	8.38%	7.06%	7.05%	6.53%
	(4.32%)	(5.76%)	(6.42%)	(5.32%)	(5.03%)	(5.42%)
Cumulative short sales$_{T+0}$ to $_{T+21}$/shares offered	14.83%	22.00%	19.98%	18.25%	20.92%	19.34%
	(11.72%)	(15.26%)	(14.99%)	(11.72%)	(13.11%)	(13.74%)
Fails to deliver$_{T+3}$/shares offered	4.37%	4.16%	4.52%	4.73%	3.56%	4.10%
	(1.40%)	(2.66%)	(2.48%)	(1.59%)	(2.20%)	(2.10%)
One-month Nasdaq-adjusted return	−0.34%	1.06%**	−9.86%***	−1.94%**	4.43%***	9.74%***
	(−0.59%)	(−0.31%)	(−9.34%)	(−2.21%)	(3.89%)	(7.67%)
Three-month Nasdaq-adjusted return	1.69%	2.70%*	−26.34%***	−6.71***%	7.43%***	36.30%***
	(−0.17%)	(−0.67%)	(−22.03%)	(−6.83%)	(7.61%)	(27.87%)
Three-month profit	NA	−3.62%***	23.09%***	6.30%***	−7.78%***	−37.64%***
		(0.24%)	(20.80%)	(6.69%)	(−7.74%)	(−29.45%)
Percent price supported IPOs	45%	35%	48%	51%	26%	28%
Percent Nasdaq IPOs	74%	59%	69%	61%	58%	68%
Percent on threshold list T+7	34%	27%	34%	33%	28%	22%

short sales is negatively related to subsequent returns. As our dependent variable, we calculate buy-and-hold returns adjusted for the Nasdaq Composite Index over three different time periods: the offer day intraday return from the open to the close, the 1-month return from the close of the offer day to the end of the first month, and the return over the first three months of trading. We adjust standard errors for clustering by month of the IPO.

In Panel A, we find no evidence that the level of short selling is related to the intraday return on the offer day. Although short sellers are attracted to IPOs that open at a high return, the level of short selling is not related to changes in the price after trading begins. The only independent variable that is related to intraday returns is the price support dummy variable, which is negative as expected.

Panels B–D examine the effect of the level of short sales over a longer time horizon. The level of short selling, whether on the offer day or cumulatively over the first month of trading, has no relation to returns over a 1-month or 3-month time period.[38]

Finally, in Panel D, we examine whether short selling is profitable only for the sample of IPOs that have rebate rate data. After the cost of borrowing is taken into account and controlling for only IPOs that have lending activity in our data, the level of short selling on the first trading day is still unrelated to subsequent returns.[39] Thus, we conclude that short sellers are unlikely candidates to substantially mitigate any overvaluation.

7. Potential effects of market maker activity

A natural question arises as to whether the results, thus far, are due to market making activity rather than the short selling of others. A number of papers have shown the importance of market making activity in the after-market trading of IPOs, particularly on the Nasdaq (Krigman, Shaw, and Womack, 1999; Ellis, Michaely, and O'Hara, 2000; Ellis, 2006). Further, market makers are

[38] The 3-month return and profitability are significantly and negatively related to the level of short selling on the first trading day if clustering is not used.

[39] A preliminary test of whether a long/short portfolio of shorting IPOs with high short selling and going long IPOs with low short selling using quintiles in each offer month generates zero 3-month abnormal returns (Diether, Lee, and Werner, 2009a). Given the small sample size and short time series, this test is admittedly crude but is consistent with the low level of profitability shown by our other tests.

Table 8
Short-term price effects.

The dependent variables are the first-day return from the open to the close (Panel A), the Nasdaq Composite Index-adjusted return over the first month of trading (Panel B), the first three months of trading (Panel C), and the 3-month return adjusted for loan fees (Panel D). Three-month return adjusted for loan fees is the Nasdaq Composite Index-adjusted return over the first three months of trading excluding the first-day return plus the loan fee (measured over the first month of trading and multiplied by three). The sample includes 388 IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. Short sales are from Regulation SHO Pilot data and compiled from the following exchanges and SROs: Amex, ArcaEx, Boston, Chicago, NASD, Nasdaq, National, NYSE, and Phlx, aggregated and then scaled by offer amount (excluding the exercise of the overallotment option). Price supported IPO is a dummy variable equal to one if the first-day return is equal to zero, or the IPO is in the bottom quartile of the percent of the overallotment option exercised collected from Bloomberg, or in the top quartile of the percent of trades, using TAQ, executed at the offer price on the first trading day. Percent float is the ratio of shares offered from SDC to shares outstanding from CRSP. The ability to execute is estimated using TAQ and measures the extent to which the Uptick Rule or Nasdaq Bid Test allows short sales to execute. Nasdaq is a dummy variable equal to one if the IPO trades on the Nasdaq, zero if it trades on the NYSE or the Amex. *t*-Values are in parentheses for ordinary least squares (OLS) regressions and standard errors are adjusted for monthly clustering. ***, **, and * indicate significance at the 1%, 5%, or 10% levels.

	Panel A First-day return from open to close	*Panel B* One-month return from first-day close		*Panel C* Three-month return from first-day close		*Panel D* Three-month return adjusted for loan fees (N=259)	
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	−0.007	0.083	0.057	0.119	0.087	0.108	0.076
	(−0.69)	(3.43)***	(2.99)***	(2.51)**	(2.21)**	(2.33)**	(1.87)*
Short sales$_{T+0}$/shares offered	−0.044	−0.215		−0.500		−0.491	
	(−0.58)	(−1.35)		(−1.67)		(−1.67)	
Cumulative short sales$_{T+0\ to\ T+21}$/ shares offered			0.050		−0.031		−0.027
			(1.33)		(−0.60)		(−0.69)
Price supported IPO	−0.043	−0.079	−0.070	−0.099	−0.091	−0.107	−0.099
	(−6.37)***	(−5.63)***	(−4.78)***	(−3.34)***	(−3.10)***	(−2.97)***	(−2.78)***
Float	−0.006	0.006	0.008	0.006	0.008	0.007	0.010
	(−3.12)***	(1.46)	(2.06)**	(0.94)	(1.36)	(0.97)	(1.41)
Ability to execute$_{T+0}$	0.044	−0.070	(−0.067)	−0.066	−0.058	−0.027	−0.023
	(3.28)***	(−2.47)**	(−2.45)**	(−1.30)	(−1.17)	(−0.47)	(−0.39)
Nasdaq	0.017	0.009	−0.001	0.025	0.013	0.027	0.015
	(2.40)**	(0.67)	(−0.10)	(0.80)	(0.46)	(0.77)	(0.49)
Adj. R^2	0.10	0.09	0.09	0.04	0.03	0.05	0.03

expected to short when prices are rising and can do so even when other short sellers are constrained as they are exempt from the locate requirement in Reg SHO and some execution rules on short sales. Although the short selling transaction data do not indicate the identity of the trader or whether or not the short sale was done by a market maker, the data do contain an indicator if the short sale is "exempt."

During our sample period, Regulation SHO required a broker to mark an order as "short sale exempt" if it is not subject to a short selling price restriction such as the Uptick Rule or the Bid Test. The rules on which short sales are "exempt" depend on both the exchange listing the stock and the location of the trade. For trades on Nasdaq in Nasdaq stocks, some (although not all) of these exempt short sales are likely to be market maker short sales and thus, the indicator provides a proxy (albeit a noisy one) to test whether market makers may be responsible for the preceding results.[40] Approximately 40% of all first-day short sales executed on Nasdaq in Nasdaq IPOs are marked as exempt. For Nasdaq IPOs, exempt short sales are 3.25% of shares offered compared to 5% for the remaining short sales.

Table 9 presents the impact of potential market maker activity on the level of short selling (Panel A), failures to deliver (Panel B), and subsequent returns (Panels C and D) for Nasdaq IPOs only. Shorts sales that are non-exempt in Nasdaq IPOs and all short sales in Nasdaq IPOs in all markets are defined as "all other short sales."[41]

In Panel A, both the level of potential market maker short sales and all other short sales are increasing in the first-day return from the offer price to the opening price. Although not shown, the positive relation on the level of potential market maker short sales and all other short sales is similar if the first-day return independent variable is replaced by either the change in the offer price or volume.

In Panel B, failures to deliver are unaffected by either potential market making activity or other short sales. This confirms our finding that failures to deliver in IPOs are

[40] For example, market makers trading Nasdaq stocks on Nasdaq were never subject to the Bid Test, thus, "exempt," but other market centers that trade Nasdaq stocks did not apply the Bid Test at all and so the exempt/non-exempt indicator cannot proxy for market maker short sales in this trading. Thus, we restrict our definition of market maker short sales to only short sales marked exempt that are executed on Nasdaq and compare this to all other short sales in Nasdaq stocks in any market. It is possible that some market making short selling in Nasdaq IPOs on non-Nasdaq markets are included in our definition of "all other short sales" but because of data limitations, we are unable to provide any additional information. Market makers trading NYSE stocks anywhere were subject to the Uptick Rule, except in narrow circumstances and are, therefore, not exempt (and not included in the analysis).

[41] Similar results are obtained if short sales in NYSE IPOs are included in the "all other short sales" category.

Table 9
Potential effects of market making activity for Nasdaq IPOs only.

The sample includes 248 Nasdaq IPOs issued between January 1, 2005 and December 31, 2006 excluding closed-end funds. Tests are conducted using two different short selling samples: (1) Exempt short sales: short sales executed on Nasdaq in Nasdaq IPOs that are marked as "exempt" as a proxy for market maker activity, and (2) All other short sales: short sales excluding exempt. In Panel A, the dependent variable in the regression is the offer day short sales (as defined above) as a percent of the offer amount. In Panel B, the dependent variable in the Tobit regression is the first settlement day failure to deliver (FTD), as a percent of shares offered. The independent variable of interest is offer day short sales (as defined above) as a percent of the offer amount. In Panel C, the dependent variable in the regression is the 3-month return adjusted for loan fees. Three-month return adjusted for loan fees is the Nasdaq Composite Index-adjusted return over the first three months of trading excluding the first-day return plus the loan fee (measured over the first month of trading and multiplied by three). The first-day return is from the offer price from SDC to the first trading day closing price on CRSP. Change in offer price is the percent difference of the final offer price from the midpoint of the preliminary offer price range in the prospectus. Volume is the daily number of shares traded from CRSP. Price supported IPO is a dummy variable equal to one if the first-day return is equal to zero, or the IPO is in the bottom quartile of the percent of the overallotment option exercised collected from Bloomberg, or in the top quartile of the percent of trades, using TAQ, executed at the offer price on the first trading day. Percent float is the ratio of shares offered from SDC to shares outstanding from CRSP. The ability to execute is estimated using TAQ and measures the extent to which the Uptick Rule or Nasdaq Bid Test allows short sales to execute. Nasdaq is a dummy variable equal to one if the IPO trades on the Nasdaq, zero if it trades on the NYSE or the Amex. *t*-Values are in parentheses and standard errors are clustered by IPO month in Panel C. ***, **, and * indicate significance at the 1%, 5%, or 10% levels.

	Panel A Level of short selling Dependent variable: Short selling			*Panel B* Level of FTDs Dependent variable: Level of failures to deliver		*Panel C* Short-term price effects Dependent variable: One-month Nasdaq return		*Panel D* Short-term price effects Dependent variable: Three-month Nasdaq return	
	Dep. var: Exempt short sales	Dep. var: All other short sales		Indep. var: Exempt short sales	Indep. var: All other short sales	Indep. var: Exempt short sales	Indep. var: All other short sales	Indep. var: Exempt short sales	Indep. var: All other short sales
Variable	Model 1	Model 2	Variable	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Intercept	0.054 (7.03)***	0.050 (3.75)***	Intercept	0.055 (2.31)**	0.069 (2.99)**	0.134 (3.42)***	0.148 (3.90)***	0.234 (3.94)***	0.228 (4.43)***
First-day return from offer price to open	0.059 (4.99)***	0.106 (5.14)***	Short sales$_{T+0}$/ shares offered	0.214 (1.30)	−0.040 (−0.43)	−0.257 (−0.74)	−0.399 (−1.97)*	−0.897 (−1.32)	−0.766 (−2.17)**
Price supported IPO	−0.00002 (−0.01)	−0.005 (−0.72)	Price supported IPO	0.029 (2.86)***	0.027 (2.64)***	−0.079 (−4.17)***	−0.084 (−4.88)***	−0.098 (−2.74)**	−0.105 (−3.05)***
Float	−0.001 (−0.78)	−0.003 (−1.13)	Float	−0.048 (−2.23)**	−0.046 (−2.15)**	0.0042 (2.08)**	0.003 (1.74)*	−0.005 (−1.30)	0.004 (1.00)
Ability to execute$_{T+0}$	−0.049 (−3.87)***	−0.012 (−0.52)	Ability to execute$_{T+0}$	−0.081 (−2.35)***	−0.090 (−2.64)***	−0.178 (−3.11)***	−0.170 (−3.35)***	−0.263 (−3.66)***	−0.226 (−2.72)**
Adj. R^2	0.12	0.11	Log likelihood/ Adj. R^2	99.87	99.12	0.09	0.11	0.04	0.05

not due to "naked" short sales, even those of market makers.

Finally, in Panel C, the exclusion of potential market maker short selling on the first trading day results in weak positive statistical significance on the relation between short selling and future short-term returns. Although not shown, there is still no relation between either market maker short selling or other short selling and the 3-month profitability. Overall, the results of Table 9 indicate that our findings are not attributable to market making activity but to short selling by others.

8. Summary and conclusions

Using short sale transactions data recently made publicly available, we explore the nature of short selling in initial public offerings. Many academic papers rely on the assumption that short selling is constrained early in the IPO process and that such constraints contribute to the high level of underpricing of some IPOs. In contrast, we find that short selling is prevalent on the initial trading day and many short sales occur close to the open.

Tests of whether short selling is related to divergence of opinion (Miller, 1977; Derrien, 2005; Cornelli, Goldreich, and Ljungqvist, 2006; Ljungqvist, Nanda, and Singh, 2006) indicate that short selling is increasing in the level of the first-day return. While our results are consistent with the hypothesis that short sellers are attracted to IPOs with more divergence of opinion and hence, higher first-day returns, they are inconsistent with the notion that short selling constraints are the reason for high underpricing.

The perceived inability of short sellers to borrow securities for settlement is one of the primary reasons cited by others for constraints on short selling in IPOs. We test whether short sellers are avoiding regulatory constraints on locating and borrowing shares for shorting (i.e., engaging in "naked" short selling) by examining whether IPOs with greater short selling are also more likely to have failures to deliver. While we show that most IPOs have failures to deliver on the first settlement date and approximately 30% of IPOs in the sample qualify for the Regulation SHO threshold list

on the first possible date, our findings do not indicate that the level of short selling on the offer date is related to fails to deliver or to the qualification for the threshold list. In fact, the factors that are correlated with increased short selling are uncorrelated with fails to deliver.

Instead, we argue that fails to deliver are potentially related to underwriter price support activities and present evidence that the level of failures to deliver are related to a variable indicating a high probability of underwriter price support. Thus, we conclude that the observed short selling is not due to an avoidance of short selling constraints and therefore, short selling constraints might not be as onerous as presumed.

Prior literature has shown a significant role of market makers in the aftermarket trading of IPOs. Using the "exempt" indicator on the short sale transaction as a proxy for potential market making activity, we test whether our results may be due to the presence of market makers and find no evidence that market makers are the primary driver of our findings.

Finally, we present evidence that the magnitude of short selling (after removing market maker activity) on the offer day has a weakly negative statistical relation to subsequent price movements. Once loan fees are considered, however, there is no relation between short selling and profitability. While it appears that a small fraction of short sellers make substantial profits, the average short sale loses almost 4% in the first three months of trading. Therefore, short sellers are unlikely to significantly mitigate the magnitude of the underpricing.

Our results may have implications for the argument that the loosening of short sale constraints due to the expiration of lockups led to an increase in the supply of shares resulting in the collapse of internet stocks (e.g., Ofek and Richardson, 2003). Even though the period studied here does not include the tech bubble because of data availability, our findings on rebate rates are surprisingly similar to those found by Geczy, Musto, and Reed (2002) during the bubble period. Thus, our findings complement Schultz (2008) regarding the impact of lockup expirations on short sale constraints during the tech bubble as we show that short selling is prevalent early in IPO aftermarkets long before such lockups expire.

References

Aggarwal, R., Conroy, P., 2000. Price discovery in initial public offerings and the role of the lead underwriter. Journal of Finance 55, 2903–2922.

Aggarwal, R., 2000. Stabilization activities by underwriters after initial public offerings. Journal of Finance 55, 1075–1103.

Aggarwal, R., 2003. Allocation of initial public offerings and flipping activity. Journal of Financial Economics 62, 111–135.

Alexander, G., Peterson, M., 2008. The effect of price tests on trader behavior and market quality: an analysis of Reg SHO. Journal of Financial Markets 11, 84–111.

Angel, J., 2006. Naked short selling. Unpublished working paper, Georgetown University.

Aussenegg, W., Pichler, P., Stomper, A., 2006. IPO pricing with bookbuilding and a when-issued market. Journal of Financial and Quantitative Analysis 41, 829–862.

Boehmer, E., Jones, C., Zhang, X., 2008. Which shorts are informed? Journal of Finance 63, 491–527.

Boni, L., 2006. Strategic delivery failures in US equity markets. Journal of Financial Markets 9, 1–26.

Boulton, T., Braga-Alves, M., 2009. Naked short selling and market returns. Unpublished working paper, Miami University and Marquette University.

Cook, D., Kieschnick, R., Van Ness, R., 2006. On the marketing of IPOs. Journal of Financial Economics 82, 35–61.

Cornelli, F., Goldreich, D., Ljungqvist, A., 2006. Investor sentiment and pre-IPO markets. Journal of Finance 61, 1187–1216.

Corwin, S., Harris, J., 2001. The initial listing decisions of firms that go public. Financial Management 30, 35–55.

Corwin, S., Harris, J., Lipson, M., 2004. The development of secondary market liquidity for NYSE-listed IPOs. Journal of Finance 59, 2339–2373.

D'Avolio, G., 2002. The market for borrowing stock. Journal of Financial Economics 66, 271–306.

Derrien, F., 2005. IPO pricing in "hot" market conditions: who leaves money on the table? Journal of Finance 60, 487–521.

Diether, K., Lee, K., Werner, M., 2009a. Short-sale strategies and return predictability. Review of Financial Studies 22, 575–607.

Diether, K., Lee, K., Werner, M., 2009b. It's SHO time! Short-sale price tests and market quality. Journal of Finance 64, 37–73.

Dorn, D., 2009. Does sentiment drive the retail demand for IPOs? Journal of Financial and Quantitative Analysis 44, 85–108.

Duffie, D., Garleanu, N., Pedersen, L., 2002. Securities lending, shorting and pricing. Journal of Financial Economics 66, 307–339.

Ellis, K., Michaely, R., O'Hara, M., 2000. When the underwriter is the market maker: an examination of trading in the IPO aftermarket. Journal of Finance 55, 1039–1074.

Ellis, K., 2006. Who trades IPOs? A close look at the first day of trading. Journal of Financial Economics 79, 339–363.

Evans, R., Geczy, C., Musto, D., Reed, A., 2009. Failure is an option: impediments to short selling and options prices. Review of Financial Studies 22, 1955–1980.

Falconieri, S., Murphy, A., Weaver, D., 2009. Underpricing and ex post value uncertainty. Financial Management 38, 295–300.

Fotak, V., Raman, V., Yadav, P., 2009. Naked short selling: good, bad or ugly? Unpublished working paper, University of Oklahoma.

Geczy, C., Musto, D., Reed, A., 2002. Stocks are special too: an analysis of the equity lending market. Journal of Financial Economics 66, 241–269.

Gjerde, T., 2009. Liquidity, fundamentals and delivery failure. Unpublished working paper, Butler University.

Hanley, K., 1993. The underpricing of initial public offerings and the partial adjustment phenomenon. Journal of Financial Economics 34, 231–250.

Hanley, K., Lee, C., Seguin, P., 1996. The marketing of closed-end fund IPOs: evidence from transactions data. Journal of Financial Intermediation 5, 127–159.

Houge, T., Loughran, T., Suchanek, G., Yan, X., 2001. Divergence of opinion, uncertainty, and the quality of initial public offerings. Financial Management 30, 5–23.

Jenkinson, T., Jones, H., 2007. The economics of IPO stabilization, syndicates and naked shorts. European Financial Management 13, 616–642.

Krigman, L., Shaw, W., Womack, K., 1999. The persistence of IPO mispricing and the predictive power of flipping. Journal of Finance 54, 1015–1044.

Lamont, O., Thaler, R., 2003. Can the stock market add and subtract? Mispricing in tech stock carve-outs. Journal of Political Economy 111, 227–268.

Lewellen, K., 2006. Risk, reputation and IPO price support. Journal of Finance 61, 613–653.

Ljungqvist, A., Nanda, V., Singh, R., 2006. Hot markets, investor sentiment, and IPO pricing. Journal of Business 79, 1667–1702.

Miller, E., 1977. Risk, uncertainty and divergence of opinion. Journal of Finance 32, 1151–1168.

Mitchell, M., Pulvino, T., Stafford, E., 2002. Limited arbitrage in equity markets. Journal of Finance 57, 551–584.

Ofek, E., Richardson, M., 2003. DotCom mania: the rise and fall of internet stock prices. Journal of Finance 58, 1113–1138.

Ritter, J., 1991. The long-run performance of initial public offerings. Journal of Finance 46, 3–27.

Scheinkman, J., Xiong, W., 2003. Overconfidence and speculative bubbles. Journal of Political Economy 111, 1183–1219.

Schultz, P., 2008. Downward sloping demand curves, the supply of shares, and the collapse of internet stock prices. Journal of Finance 63, 351–378.