Informed Short Selling, Fails-to-Deliver, and Abnormal Returns°

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ABSTRACT

We find that stocks with fails-to-deliver (FTDs) experience negative abnormal returns that are proportional to their FTD levels. These findings come from both an event study and a portfolio returns analysis using Fama-French factors. Using proprietary data on stock borrow costs, we also show that short sellers of low and high FTD stocks obtain positive estimated profits. Our findings support the hypothesis that FTDs reflect nonbinding short sale constraints which do not restrict informed short selling.

JEL Classification: G12; G14; G21; G28; K22

Keywords: abnormal returns; fail-to-deliver; Fama-French; event study; short selling

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1. Introduction

Short sale constraints may result from limited borrowable shares, high borrowing costs, or other factors. If short sale constraints are sufficiently high, then informed short sellers may not execute profitable trades and stocks may be overpriced. Alternatively, short sellers may sell short without borrowing stock and risk creating fails-to-deliver (FTDs). FTDs are net unsettled positions in brokerage firm accounts at the stock clearinghouse. If a short seller does not deliver shares to their broker by the end of the three day settlement cycle ("T+3"), then FTDs may occur.

We analyze the abnormal returns (ARs) of all Russell 3000 stocks that experienced significant FTDs during a period when SEC rules did not prevent settlement failures. With this broad sample, we show that stocks experience negative ARs that are proportional to their FTD levels. We follow Asquith et al. (2005) and group stocks according to common ratios of FTDs to shares outstanding. Using this methodology, we conduct an event study analysis and find strong evidence of negative and proportional ARs when stocks cross certain FTD thresholds. We find similar results for high FTD stocks in a portfolio returns analysis. Our results indicate that short sale constraints, as measured by FTDs, are not sufficiently binding to deter informed short selling. Our research findings are inconsistent with previous studies that find positive ARs in low FTD stocks (Autore et al., 2015; Boulton and Braga-Alves, 2012).

Using proprietary stock loan pricing data, we also show that short sellers of low and high FTD stocks obtain positive estimated economic profits. These results are consistent with the hypothesis that FTDs reflect nonbinding short sale constraints which, in turn, do not inhibit informed short selling. Moreover, we show that FTDs are highly correlated with short interest, put option open interest, and the cost to borrow stock. Our findings do not support claims that most FTDs result from clerical errors (SEC, 2005; DTCC, 2005).

Our analysis of FTDs and abnormal returns builds on three key findings from the academic short sale literature. The first empirical finding is that individual stocks with high short selling tend to experience negative abnormal returns (Desai et al., 2002; Angel et al., 2003; Christophe et al., 2007; Cohen et al., 2007; Boehmer et al., 2008; Boehmer at al., 2010), although this finding does not necessarily hold for the market in aggregate (Lamont and Stein, 2004). A related finding is that short sellers tend to be well informed about negative future events (Christophe et al., 2004; Christophe et al., 2010). Similarly, stock prices are more accurate when short sellers are more active (Boehmer and Wu, 2013).

A second empirical finding is that short sale constraints, or barriers to short selling, lead to stock overvaluation (Geczy et al., 2002; Jones and Lamont, 2002; Nagel, 2005, Boehme et al., 2006). Recent research has focused on regulations that impose short sale constraints and thus reduce liquidity or market quality (Boulton and Braga-Alves, 2010; Boehmer et al., 2013; Beber and Pagano, 2013). A short sale constraint is "binding" if shorting is too expensive or impossible.

Third, theoretical models predict that informed short selling may occur in stocks with nonbinding short sale constraints (Figlewski, 1981; Diamond and Verrecchia, 1987). A short sale constraint is nonbinding if it is expensive to short but not prohibitively so. Nonbinding short sale constraints may predict abnormal negative returns because informed short sellers are willing to pay extra to short whereas uninformed short sellers are not. The Diamond and Verrecchia (DV) model implies that short sale constraints that limit only "uninformed" trades may improve the informational efficiency of short selling. In other words, short sale constraints may not inhibit informed short selling. Aitken et al. (1998), Asquith et al. (2005), and Kolasinski et al. (2013a) provide empirical support for the DV model. Beneish et al. (2015) find that short selling is most profitable in hard-to-borrow stocks with nonbinding constraints.

Our research connects the short sale constraint literature with emergent research on short sale regulation, naked short selling, and trade settlement. Boni (2006), Evans et al. (2009), and Stratmann and Welborn (2013) find that market makers strategically fail-to-deliver when stock borrow costs are high and settlement regimes are permissive. Culp and Heaton (2008) develop a theoretical model in which short selling and naked short selling are economically equivalent. Devos et al. (2010) and Lecce et al. (2012) find that naked short selling predicts abnormal negative returns under special conditions. Conversely, Fotak et al. (2014) find that naked short selling reduces the volatility of stock price returns and leads to higher liquidity. Liu et al. (2016) use firm specific accounting data to show that FTDs reflect informed trading by short sellers.

Our research stands apart from recent findings on abnormal returns and FTDs. Boulton and Braga-Alves (2012) and Autore et al. (2015) both find evidence stocks which appear on the Regulation SHO Threshold List experience positive abnormal returns. They conclude that low FTDs indicate binding short sale constraints. Our research reaches the opposite conclusion and rejects the notion that stocks with FTDs are overpriced. By establishing that shorting low and high FTD stocks is profitable, we also fill a gap in the naked short sale literature which has heretofore assumed FTDs represent binding constraints that prevent informed short selling.

We do not resolve the more complex question of whether FTDs *cause* abnormal negative returns. For example, we do not test directly claims that FTDs depress stock prices (SEC, 2009a). This analysis would require us to disentangle the demand effects of company performance and the supply effects of FTDs on price, which exceeds the scope of this paper. In subsequent sections, we summarize modern trade settlement institutions and our hypotheses. We then present our data and empirical results for tests of whether FTDs reflect nonbinding short sale constraints and profitable short selling. We close with suggestions for future research.

2. Institutional Background

Physical stock certificates are an anachronism in modern stock markets. The trade in electronic securities via a central clearinghouse promotes liquidity and efficiency and reduces counterparty risk. This intermediation, however, negates the stock market's natural ability to self-regulate, and market participants' incentive to seek redress, when trades fail to settle as expected.

Settlement failures are documented as anonymous debits in broker-dealer (BD) accounts at the Depository Trust and Clearing Corporation (DTCC). Retail and institutional customers with accounts at BDs generally have no knowledge of settlement failures. Aggregate FTD data is published by the Securities and Exchange Commission (SEC) via the Freedom of Information Act (FOIA) at least one month after trade date (SEC, 2016a). Notably, FTD data are not broken down by BD as "The fails statistics of individual firms and customers is proprietary information" (SEC, 2016b).

Trade settlement is topical given SEC concerns about abusive short selling and FTDs (SEC, 2009a, 2013a). Short selling is legal and promotes liquidity and efficient price discovery. In a covered short sale, a short seller borrows stock from a lender in exchange for collateral, sells that stock, and then plans to buy back the same quantity of stock later, at a lower price. A naked short sale occurs when a short seller does not locate or borrow shares. If the naked short seller does not borrow the stock by trade date plus three days ("T+3"), then an FTD may occur.

The National Securities Clearing Corporation (NSCC), now part of the DTCC, was founded in 1976 to provide clearing, settlement, and central counterparty risk services (DTCC, 2012). While physical stock was held "immobilized" in the Depository Trust Company (DTC), the NSCC aggregated order flow and generated instructions for net changes in DTC accounts at the end of each trading day through a process known as "multilateral netting" (DTCC, 2014).

Today, NSCC aggregates trade data and provides settlement instructions to the DTC, where electronic stock transfers occur. The NSCC organizes this aggregation process through the Continuous Net Settlement (CNS) system. Through CNS, the NSCC effectively "steps in between two parties to a trade and nets each party's obligation to trade over multiple trades, so that each obligation to receive or deliver, and an obligation to deliver or receive, can be combined together into one" (Sirri, 2007).

CNS helps to provide liquidity when there are occasional or temporary problems with trade settlement. If a broker fails to deliver stock by T+3, the NSCC allocates that FTD to a different broker–dealer using a random distribution algorithm. The DTC account that did not receive securities because of this allocation will have a net fail-to-receive (FTR) position. The broker who has failed to receive will nonetheless credit the securities positions to his customer accounts. Additional liquidity comes from the Stock Borrow Program (SBP), which allows NSCC firms to loan shares automatically from DTC accounts in the event of a CNS fail. CNS and the SBP preclude identifying or tracking which specific brokers fail to deliver or receive (DTCC, 2016).

The anonymity of CNS, however, may open up the settlement system to abuse by preventing counterparties from self-regulating settlement failures. Pollack (1986) observed that, while CNS had substantially increased efficiency, the system insulated the brokers from the costs associated with FTDs and FTRs. Thus, CNS did not prevent FTDs and FTRs from increasing without limit and permitted some brokers to postpone delivery indefinitely. "The fact that there is no automatic mechanism preventing the substantial buildup of short positions at the clearing corporation and of fails to receive in brokerage firms carries the potential for serious problems, particularly in the event of crisis market conditions" (Pollack, 1986, p. 69).

CNS's inability to moderate FTDs became clear during the dot-com bust of the early 2000s. In 2003, the SEC requested comment on proposed regulations "to address the problem of 'naked' short selling" (SEC, 2003a and 2003b). The final short sale rule, Regulation SHO, was passed in August 2004 and became effective in January 2005. Under the new rule, exchanges such as the NYSE and Nasdaq publish daily Regulation SHO Threshold Lists of stocks with persistent CNS FTDs of 10,000 shares or more and 0.5% of shares outstanding (SEC, 2005).

Regulation SHO updated short sale regulations and established "uniform 'locate' and 'close-out' requirements in order to address problems associated with failures to deliver" (SEC, 2005). Regulation SHO required close-out of unsettled positions by trade date plus 13 days ("T+13"). Despite these requirements, however, FTDs actually increased from 2005 through 2008, in part due to a grandfather clause and a market maker exception (OEA, 2008 and 2009).

During this era, some regulators maintained that intentional naked short selling that led to delivery failures was rare. According to the SEC Division of Market Regulation, "naked short selling is not necessarily a violation of the federal securities laws or the Commission's rules" unless it is intentional (SEC, 2005). The DTCC stated that factors such as customer delays, short sale constraints, and title transfer delays may prevent timely settlement. The DTCC also claimed that inaccurate use of FTD data "reflects a conscious attempt to mislead the investing public and undermine confidence in the workings of our capital markets" (DTCC, 2006).

These positions were challenged by a series of regulatory actions that revealed widespread and unlawful naked short selling and fails-to-deliver (AMEX, 2007a, b, and c; CBOE, 2007; SEC, 2009b, 2012a, 2012b). In 2008, the SEC imposed a temporary pre-borrow requirement for short selling the stock of the 19 primary dealers' out of concern that naked short selling would exacerbate a burgeoning financial crisis (SEC, 2008a).

> [Short] sellers sometimes intentionally fail to deliver securities as part of a scheme to manipulate the price of a security, or possibly to avoid borrowing costs associated with short sales, especially when the costs of borrowing stock are high…[L]arge and persistent fails to deliver may deprive shareholders of the benefits of ownership, such as voting and lending…Moreover, sellers that fail to deliver securities on settlement date may attempt to use this additional freedom to engage in trading activities to improperly depress the price of a security (SEC, 2009a, pp. 5–7).

As a result of these concerns, the SEC amended Regulation SHO in 2008 and 2009 to impose stricter settlement standards and eliminate important loopholes. SEC Rule 204, finalized in 2009, shortened the mandatory close-out period for fail to deliver positions from T+13 days to T+4 days. For market makers, the standard become T+6 days (SEC, 2009a).

Regulatory actions from 2007 onward indicate that, for some traders, short sale constraints were nonbinding during the 2004 to 2008 period (Stratmann and Welborn, 2013). Subsequent SEC rule changes describe widespread misuse of a market making exception to SEC rules that governed short selling and trade close-out (SEC, 2008b and c). The so-called Options Market Maker (OMM) Exception to SEC Regulation SHO allowed market makers to delay settlement in connection with bona fide market making. Unlawful abuse of this exception allowed informed short sellers a source of loanable stock when borrow costs were high.

The SEC eliminated the OMM Exception on evidence that OMMs engaged in unlawful naked short selling that led to large and persistent FTD positions (SEC, 2008b, 2008c, 2009a). In one of several enforcement actions against options market makers, the SEC found that OMMs illegally supplied hard-to-borrow optionable securities to prime brokerage firms (SEC, 2012a):

> "The brokerage firm could then loan out the shares of the threshold securities and received fees from the borrowers. Those loan fees can be quite significant when the stock is a threshold security, because threshold securities are generally hard to borrow and therefore command large fees in the stock loan market" (SEC, 2012a, pp. 4–5).

The first OMM case, *In the Matter of Scott H. Arenstein and SBA Trading, LLC*, concerned trading in Overstock.com (Remond, 2007). Overstock.com was on the Threshold List for 825 days and had a peak FTD ratio of 19.55% (Nasdaq, 2016; SEC, 2016a). In January 2007, Overstock.com sued 10 prime brokers in California State Court for unfair business practices related to "intentional" FTDs (San Fran., 2007). The case was later amended to focus on The Goldman Sachs Group, Inc., and Merrill Lynch, Pierce, Fenner & Smith, Inc. (San Fran., 2011).

In 2015, a California Appeals Court dismissed the complaint against Goldman Sachs on jurisdictional grounds. Nevertheless, the Appeals Court wrote that,

> "[T]here is evidence Goldman Brokerage acted as Arenstein's agent in executing conversion trades with itself, and acknowledged Arenstein could provide the firm a supply of shares it could not obtain "in the pits." In an e-mail, for example, Goldman acknowledged such conversion trades "create inventory to allow customers to short." In another email, it acknowledged a general goal of its Hedging Strategies Group was "to create supply and perpetuate selling in stocks with a large amount of short interest." In sum, there is substantial evidence Goldman Brokerage was, itself, a beneficial purchaser of one species of the exotic trades in which Hazan and Arenstein engaged to circumvent Regulation SHO." (1st Appellate District, 2014a, p. 36).

Goldman and Merrill argued that their actions did not violate Regulation SHO. In 2015, Overstock.com settled separately with both defendants for undisclosed sums (Economist, 2015).

A 2013 Risk Alert issued by the SEC Office of Compliance Inspections and Examinations (OCIE) suggests that Rule 204 did not eliminate the behavior described above:

> "This Risk Alert highlights observed trading strategies that could be designed to circumvent certain requirements of Reg SHO … [T]he purchased shares in question are often times not delivered because of subsequent options trading used to re-establish or otherwise extend the broker-dealer's fail position without any demonstrable legitimate economic purpose." (SEC, 2013b, p. 2).

Research by Stratmann and Welborn (2012) shows that, while common stock FTDs declined after Rule 204, FTDs in exchange traded funds (ETFs) have increased significantly.

2. Hypotheses

Absent from the naked short selling literature is a rigorous analysis of abnormal returns in stocks in the highest percentiles of FTDs as well as estimated profits from shorting those stocks. Our research distinguishes between high and low FTD stocks and challenges the notion that FTDs reflect binding short sale constraints (Boulton and Braga-Alves, 2012; Autore et al., 2015).

Hypothesis 1: *FTDs predict proportionally negative abnormal returns.*

Intuitively, FTDs indicate that a short sale constraint is non-binding because significant short positions have been realized. We predict that FTDs occur when shorting is costly, but these costs primarily deter uninformed shorting. Thus, where profitable, informed market participants execute short sales and incur FTDs. The resulting short positions, and prices, incorporate information from informed short sellers irrespective of the short sale constraint. We therefore predict that stocks with FTDs will experience negative abnormal returns that are consistent with short interest levels. We define low FTD stocks as those that are on the Regulation SHO Threshold List. High FTD stocks are either in the 99^{th} percentile or exceed a 2.5% FTD ratio.

Hypothesis 1 is consistent with research which shows that short sale constraints may improve the information content of short sales (Diamond and Verrecchia, 1987; Kolasinski et al., 2013a). Our hypothesis is also supported by regulatory actions that indicate informed short sellers are willing to accept the high cost of hard-to-borrow (HTB) securities and the regulatory risk associated with FTDs (SEC, 2008 and 2012b). Thus, FTDs indicate informed short selling in the presence of a nonbinding short sale constraint, and stocks with FTDs will experience abnormal negative returns comparable to stocks with high levels of short selling.

Hypothesis 2: *FTDs predict proportional short sale profits.*

Our second hypothesis concerns the nature of the stock lending business itself. Beneish et al. (2015) show that HTB stocks are the most profitable to short, but these profits may be offset by high stock loan fees. In contrast, we posit that estimated short sale profits increase with FTD levels. This is because FTDs reflect informed short selling as well as risks from regulatory actions or buy-ins by a clearing broker, and returns must be proportional to those risks.

It may seem counterintuitive that a short sale related to an FTD position is costly. This is because a naked short sale that results in an FTD implies a failure to borrow. Naked short sales that result in large and persistent FTDs, however, are not necessarily executed in order to establish short position by avoiding stock borrow costs. Rather, recent regulatory actions and academic research indicate that naked short sales that result in large FTD positions are effected in order to create supply of loanable inventory for informed short sellers (AMEX, 2007c; SEC, 2009a, 2009b, 2012a and 2012b; Stratmann and Welborn, 2013; SEC, 2013a and 2013b).

In fact, short sellers are rarely aware of the source of borrowable shares. Most institutional traders execute short sales via a prime broker and an executing broker. In a typical short sale, the prime broker locates the stock for the short seller, and the executing broker accepts the short sale order. The prime broker often acts as clearing broker for clients and is responsible for ensuring that trades settle. Some prime brokers consider the risk of FTDs worthwhile, as securities lending is a profitable business and hard-to-borrow stock are desirable to hold and lend to short seller clients. Moreover, the securities lending market is notoriously opaque and search costs are high, particularly when there is high demand to short, and "the magnitude of the lending fee … is increasing in lenders' bargaining power" (Kolasinski et al., 2013b, p. 562).

3. Data

Table 1 shows daily summary statistics for the 4,149 equity issues from the Russell 3000 Index for the period from April 1, 2004 through June 30, 2008. Our data start in April 2004 because that is the beginning of the SEC FOIA FTD data set. The SEC initiated discussion of amendments to Regulation SHO in 2008:Q3. Thus, to ensure that no results are influenced by perhaps anticipated changes to Regulation SHO, our data set ends on June 30, 2008.

Table 1 shows daily summary statistics for the Russell 3000 Index tickers. Panel A provides daily average results for the full sample, and Panel B provides daily averages for stocks in the 99th percentile of FTDs. We obtained FTD data from the SEC FOIA Office, Threshold List data from the SROs, and short interest, options open interest (OI), and daily trading data from the Center for Research in Security Prices (CRSP) via Wharton Research Data Services (WRDS). We shift all FTD data backward in time by three trading days to account for T+3 settlement.

Panel A shows the full sample descriptive statistics. Here the mean daily FTDs are $690 thousand with a standard deviation of $9.88 million. Maximum daily FTDs are $7.91 billion. Most tickers have zero FTDs on any given date. Similarly, the average stock is on the Threshold List for 2 percent of the days in the sample, and this statistic has a standard deviation of 13 percent and a maximum of 100 percent. These descriptive statistics imply that most Russell 3000 Index tickers do not appear on the Regulation SHO Threshold List.

Panel B shows that 99th percentile sample statistics. Here, the mean daily FTDs are $29.10 million, with a standard deviation of $89.9 million. The average stock in this sample is on the Threshold List for 74 percent of the total period with a standard deviation of 44 percent. The summary statistics suggest that there is substantial variation with the 99th FTD percentile insofar as only a few several stocks have large and persistent FTDs relative to the mean.

Mean daily market capitalization is $5.34 billion for the full sample and $895 million for the 99th FTD percentile. The summary statistics show that FTDs are concentrated in small cap stocks. Average daily volume for high FTD stocks is higher than in the full sample, but the maximum dollar value of volume is lower. This suggests that high FTD stocks experience more trading and price volatility than the average equity issue.

The mean ratio of short interest (SI) to shares outstanding is 6 percent for the full sample and 25 percent for the 99th percentile. The maximum SI ratio is 250 percent. An SI ratio greater than 100 percent may be explained by a timing mismatch between short interest reporting periods (monthly or bi-monthly) and shares outstanding reporting (monthly or quarterly). Alternatively, "chained lending" through repeated short selling of the same quantity of stock may create more ownership claims than issued shares, a scenario which is likely with high FTDs.

Mean daily put option open interest (OI) is higher in the 99th percentile than in the full sample. For high FTD stocks, mean daily put OI is 61.31 thousand, or put contracts on 6.131 million shares, compared 29.76 thousand for the full sample. The full sample has higher maximum put option OI because these stocks tend to have higher market cap and float.

The cost to borrow stocks is quoted as a "rebate" rate. Short sellers are generally required to post loan collateral equal to or greater than the marked-to-market value of a short position. This collateral is usually invested in liquid, low risk assets. The rebate is the percentage of the collateral investment return that is rebated to the short seller. Very hard to borrow stocks may have a negative rebate rate, in which case the short seller must pay the stock lender a percentage of the annualized short position value in addition to surrendering all of the collateral investment return. Per convention in the short sale literature, we estimate the cost to borrow as the spread between the daily federal funds rate and the rebate rate (Evans et al., 2009).

We are the first to analyze daily rebate data from SunGard Astec Analytics, a unique data aggregator that collects loan prices from both the wholesale and retail sides of the market. Spreads are the difference between SunGard daily mean rebates and the Federal Funds rate. Mean rebates are 2.99% for the full sample and -7.53 for the 99th FTD ratio percentile. This means that, to borrow high FTD stocks, short sellers must pay the lender 7.53% of the position value in addition to posting collateral. Note that negative rebate rates can be as high as 90%.

Table 2 presents the 51 Russell 3000 stocks with the highest mean daily ratio of FTDs to shares outstanding for the period from 2004:Q2 through 2008:Q3. Of these, 34 are small cap firms with a market cap between $250m and $5b. Many of these firms were on the Threshold List for several hundred trading days and have highly negative rebate rates, which are both indirect measurements of high short sale demand. Alternatively, some firms were never on the Threshold List, as CNS FTDs must persist at the DTCC for at least 5 days for a stock to qualify.

Figure 1 compares the aggregate daily dollar value of FTDs and volume for Russell 3000 Index stocks during the sample period. Even though FTDs are a stock variable and volume is a flow variable, aggregate volume and FTDs are highly correlated. At the end of 2008:Q3, aggregate Russell 3000 FTDs were roughly $5 billion dollars on any given day. These FTDs are 2.5 percent of $200 billion in aggregate daily Russell 3000 volume.

Figure 2 illustrates the trajectory of the Russell 3000 stocks on the Regulation SHO Threshold List. Between January 2005 and June 2008, the number of Russell 3000 stocks on the Threshold List grew from roughly 100 per day to between 200 and 300. As discussed before, these are stocks with FTDs that persist for five days at the clearing corporation. Given the T+3 settlement cycle, a stock with persistent FTDs will appear on the list seven days after trade date.

To qualify for the list, FTDs must exceed with 10,000 shares or 0.5 percent of shares issued and outstanding. We discuss later why this Threshold is relatively low and many Russell 3000 stocks appeared on the Threshold List at least once during this period. Note that a number of Threshold List stocks are not part of the Russell 3000 Index, and we do not include them in the totals in Figure 2. These include stocks on Pink Sheets and OTC Bulletin Boards.

Figure 3a shows daily 50^{th}, 90^{th}, 95^{th}, and 99^{th} percentiles for FTD to shares outstanding ratios for Russell 3000 stocks. The 50^{th} percentile is zero everywhere. The 99^{th} percentile grows from an FTD ratio of 1 percent to 2.5 percent in 2008:Q3. The 90^{th} and 95^{th} percentiles are closer to zero than they are to the 99^{th} percentile. Figure 3b present daily portfolio counts for stocks with FTD ratios of 2.5%, 5% and 10%, respectively. Of the Russell 3000 stocks we examine during the sample period, the number of stocks with an FTD ratio exceeding 2.5% ranges from 0 to just over 40. The 5% and 10% FTD ratio portfolios had maximum daily counts of 17 and 12, respectively. Together with Figures 1 and 2, these data illustrate that FTDs are highly concentrated in a few Russell 3000 stocks, and those FTDs positions are large and persistent.

4. Empirical results

We test Hypothesis 1 in two ways. First, we use an event study to test whether stocks that cross a given FTD ratio threshold experience negative CARs. We focus on stocks that cross and remain above the relevant FTD threshold for 1, 2, and 3 consecutive days. Second, we follow Asquith et al. (2005) and calculate concurrent and future portfolio abnormal returns using a Fama-French regression model. We use daily and monthly data to calculate returns for five FTD ratio portfolios: "≥2.5% & <5%," "≥5% & <10%," ">10%," "≥95^{th} percentile & <99^{th} percentile," and ">99^{th} percentile." The factor returns are provided by Kenneth R. French (2016). Concurrent (future) returns are calculated in period t ($t+1$) using a portfolio sorted in t.

4.1 Event study of abnormal returns

To establish a baseline for our event study, we estimate normal firm performance in two ways. First, we follow the market model suggested by Brown and Warner (1980, 1985) and Campbell et al. (1997). For each Russell 3000 ticker that crosses an FTD threshold, we estimate normal performance during the 30 period that ends 60 days prior to the FTD event [-90, -61].

$$R_{it} = \alpha_i + \beta_i \, Russell_{mt} + \varepsilon_{it} \quad (1)$$

In equation (1), R_{it} are daily returns for security i on date t and $Russell_{mt}$ are daily returns for the Russell 3000 Index. For each ticker i, we obtain β_i, which is the portion of daily returns that are "normal" relative to market returns. We consider only the first FTD event for each firm, as "(f)irms move on and off the threshold lists with great regularity" (Autore et al., 2015, p. 149)

Second, for robustness, we estimate normal firm performance using the four-factor model suggested by Fama and French (1993) and Carhart (1997):

$$R_{it} - RF_t = \alpha_i + \beta_{1i} \, (Russell_t - RF_t) + \beta_{2i} \, SMB_t + \beta_{3i} \, HML_t + \beta_{4i} \, UMD_t + \varepsilon_{it} \quad (2)$$

In equation (2), the dependent variable, $R_{it} - RF_t$, represents daily returns for ticker i minus the risk free rate. Similar to the market model, we obtain β_{1i} which captures the normal performance of firm i relative to the Russell 3000 Index minus the risk free rate, $Russell_t - RF_t$.

SMB_t is the return on a portfolio of small cap stocks minus the return on a portfolio of large cap stocks on day t. HML_t is the return on a portfolio of high book-to-market value stocks, or "growth" stocks, minus the return on a portfolio of low book-to-market value stocks, or "value" stocks. UMD_t is a momentum factor based on the return on a portfolio of "winners" minus the return on a portfolio of "losers" as calculated by Kenneth R. French (2016).

We use a shortened estimation window of 30 days, [-90, -61], as a longer period would result in asymmetric data for recent IPO stocks. This procedure also avoids capturing previous and unconnected short selling that may complicate estimation of normal firm performance. "The risk of adopting a long [estimation] interval…is that information and short-selling unrelated to the [event] might be accidentally incorporated into the testing" (Christophe et al., 2004, p. 1853).

We report results for key FTD ratio events in Table 3. Panel A shows mean CARs for FTD ratio event stocks for which we estimate normal performance using the market model. Panel B shows mean CARs when we use a Fama-French four-factor model. We report CARs for stocks that remain above a given FTD ratio for 1, 2, and 3 consecutive days.

There are five event categories. "SHO" are stocks that appear on the Regulation SHO Threshold List, "⩾2.5%" are stocks for which the FTD ratio exceeds 2.5 percent, and "⩾5%" and "⩾10%" are similarly defined. "⩾99th" represents stocks in the highest FTD ratio percentile. These are the same short interest ratio thresholds used by Asquith et al. (2005). We use cumulative and not truncated samples because only a few stocks achieve very high FTD ratios and truncation would reduce statistical power. Thus, successive FTD ratio events may include the same stocks. For example, the 5% FTD ratio group contains 10% FTD ratio stocks.

For some FTD ratio categories, sample sizes for the 2 and 3 day estimations are smaller than the 1 day estimations. This is because FTD are not necessarily persistent. Also, as noted above, for each ticker we consider only the first FTD event during the period from 2004 through 2008. This controls for the fact that, once a stock experiences significant FTDs, estimating normal performance may be subjective. Thus, these CAR estimates are conservative because the same small sample of stocks may experience repeated FTD events.

Table 3 illustrates three important trends among FTD event stocks. First, stocks that cross a significant FTD ratio threshold have proportionally negative CARs during the event period. For example, stocks that cross the 2.5 percent ratio have CARs over -2.120 percent. Similarly, stocks that cross the 10 percent FTD ratio have mean CARs of between -7.867 percent and -10.18 percent. The 99th percentile has mean CARs of between -0.77 percent and -0.945 percent. In most cases, mean CARs are significant at the 5 and 10 percent level.

Second, stocks that appear on the Regulation SHO Threshold List experience negative and statistically significant CARs of roughly -1%. Figure 4c provides additional visual support for this result. These findings are inconsistent with Autore et al. (2015) and Bolton and Braga-Alves (2012), who find that Threshold stocks experience overvaluation. Our results may differ because we consider only the first FTD ratio event for each stock, whereas the other studies consider all Threshold events for the stocks in their sample. Our methodology reflects a belief that most information from informed short selling is incorporated during the initial FTD event.

Third, Table 3 indicates that the ARs associated with FTDs may decline after 3 days. For FTD event stocks in SHO, 2.5 percent, and 5 percent groups, mean CARs are not statistically significant from zero after two days. For the 99th percentile and 10 percent group, mean CARs are negative but less statistically significant at 3 days. This supports our belief that markets quickly incorporate new information associated with high short selling, both naked and covered.

Figure 4 shows daily mean FTD ratios and abnormal returns for each group in the event study. For each stock that crosses a given FTD ratio, we calculate averages across the common days in the 30-day event window [-10,20]. Consistent with Hypothesis 1, all figures show a negative AR spike concurrent with a positive FTD spike at the time of the event. Furthermore, the magnitude of mean ARs is increasing with mean FTD ratio levels.

4.2. Estimated profits from shorting low and high FTD stocks

In this section, we test Hypothesis 2 and again use an event study methodology to estimate profits from shorting low and high FTD stocks. For each stock *i* in the data set, we use the CARs subsequent to a FTD event from Table 3, and then subtract the cost of borrowing stock and maintaining a short position for a period of five trading days prior to the event:

$$\Pi_{i,t} = -\left[CAR_{i,t} - \sum_{t=-4}^{0}\left(\frac{rebate_{i,t}}{360}\right)\right] \quad (3)$$

We de-annualize the rebate data by dividing by 360. We then sum over the holding period to estimate the cost of maintaining a marked-to-marked short position for 5 trading days. While 5 days is an assumption, the results change little if we vary the holding period from 0 to 20 days.

We report results for our estimated profit event study in Table 4. The coefficients on the FTD threshold buckets are very similar to the CARs reported in Table 3. For example, the mean estimated profit from holding a short position in a 10% FTD ratio stock until 2 days after the event is 9.728 percent. This is compared to cumulative abnormal returns of -9.584 percent from Table 3. Thus, the cost of holding this position for five trading days is 144 basis points. On an annualized basis, this is a negative rebate rate of 51.84 percent, which is proportional to the summary statistics in Table 1. This result is statistically significant at the 10 percent level.

We compare the results from Tables 3 and 4 in Figure 5. The horizontal axis measures CARs as reported in Table 3. The vertical axis measures estimated short sale profits as reported in Table 4. The 45 degree line indicates that mean CARs and mean estimated profits are proportional. For example, stocks with FTD rations of 10% or greater experience negative CARs and profits of between 8 and 10 percent, respectively. Stocks with lower FTD ratios experience proportionally smaller negative CARs and, therefore, lower short sale profits.

In general, the estimated profit coefficients in Table 4 are less statistically significant than their corresponding CAR coefficients in Table 3. For example, few of the coefficients for the estimated profits 3 days after an FTD event are statistically significant. This is partly due to the fact that not all Russell 3000 stocks have quoted rebates on these particular dates from our data supplier, SunGard. Nevertheless, the coefficients' signs are proportional to their FTD ratios, which is consistent with our hypothesis that FTDs represent a non-binding short sale constraint that does not inhibit informed short selling. We note also that estimated profits on the SHO portfolios are positive and statistically significant. This further challenges previous research which suggests that moderate FTD levels represent a binding short sale constraint that leads to overpricing (Autore et al., 2015; Boulton and Braga-Alves, 2012).

The results in Table 4 are based on strong assumptions about the homogeneity and length of short position holding periods, and we do not wish to overemphasize the precision of these findings. Nevertheless, the results demonstrate that, on average, the CARs achieved by low and high FTD stocks exceed the borrow costs, at least in the period immediately following a high FTD threshold event. From this we conclude that informed short sellers of stocks with FTDs tend to earn positive economic profits proportional to borrow rates.

Table 5 supplements the results in Table 4 with a list of the 55 Russell 3000 stocks that cross the 10% FTD ratio. This list is sorted in descending order by the total number of days a stock is above the 10% FTD ratio threshold. Other data in Table 5 reflect stock specific information on the date of the event. This list exhibits a wide range of market capitalizations and includes household names such as Martha Stewart Living (NYSE: MSO; $250 million), Netflix (Nasdaq: NFLX; $611 million), and NYSE Euronext (NYSE: NYX; $15 billion).

4.3 Portfolio analysis of low and high FTD ratio stocks using Fama-French factors

In this section we revisit Hypothesis 1 and, following Asquith et al. (2005), calculate daily and monthly concurrent portfolio returns using the four-factor model discussed above:

$$Port_{it} - RF_t = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{it} \quad (4)$$

The dependent variable, $Port_{it} - RF_t$, is the return on a portfolio *i* on date *t*. In equation (4), the variable of interest is the intercept, α_{it}, which represents the abnormal return on portfolio *i* during period *t*. We employ the four-factor model differently in the portfolio analysis as compared to the event study. In the event study, we used the four-factor model to obtain a more accurate estimate of normal firm performance relative to the market, or β_1. In contrast, we use a four-factor model in the portfolio analysis to estimate abnormal returns through time.

Portfolios are defined as in the event study but are truncated so that no stocks are counted twice. On a given day, the "SHO" portfolio contains only those stocks on the Regulation SHO Threshold List. Similarly, the "⩾2.5% & <5%" portfolio contains only those stocks whose FTD ratio is greater than or equal to 2.5 percent and less than 5 percent. The portfolios labeled "⩾5% & <10%," "⩾10%," "⩾95th & <99th percentile" and "⩾99th percentile" are similarly defined. This conservative approach helps to reduce the risk that results are skewed by outliers.

We estimate equation (4) using daily and monthly data. We calculate equal-weighted (EW) and value-weighted (VW) concurrent period returns for daily and monthly portfolios, and we report time series regression results in Tables 6 and 7 for daily and monthly data, respectively. In all tables, the variable of interest is the Intercept, which indicates the mean abnormal return for a given portfolio of across time.

Table 6 contains four-factor model results for our daily data set. Equal-weighted (EW) and value-weighted (VW) portfolio abnormal returns are increasingly negative and statistically significant as FTD ratios are higher. For EW portfolios of stocks with a 10% FTD ratio, the coefficient on the intercept indicates that mean daily abnormal returns are -0.244 percent. For VW portfolios at or above the ten percent threshold, the mean daily abnormal returns are -0.335 percent. Both intercepts are statistically significant at the 1 percent level. For other portfolios, the coefficients on the intercepts are negative in almost all cases except for the "$\geqslant$95th & <99th percentile" portfolio, which has relatively low FTDs compared to the 99th percentile and above.

In all specification in Table 6, the coefficient on the market return is positive and statistically significant at the 1 percent level, which indicates the Fama-French factors fit the data well. The Fama-French factor that represents the return for small cap stocks is positive and statistically significant at the 1 percent level in all specifications, as FTDs are concentrated in small cap stocks. In all specifications, the momentum factor is negative and statistically significant, as high FTD stocks experience returns that are going in the opposite direction of returns in a basket of momentum stocks. The coefficient on the book-to-market ratio factor is positive and of low statistical significance, as high FTD stocks are generally not "value" stocks.

We report results for monthly concurrent portfolio returns in Table 7. As with the daily data, we calculate EW and VW portfolio returns for high FTD ratio stocks. We include a stock in the monthly FTD ratio portfolio when its maximum FTDs are within the portfolio bounds during the same month. For example, we include a stock whose maximum FTDs are between 5 percent and 10 percent during a given month in the "$\geqslant$5% & <10%" portfolio. We sort stocks into FTD threshold portfolios and calculate portfolio returns using the same month because we believe that the abnormal returns realized by high FTD stocks are realized quickly.

Table 7 shows that monthly portfolios of high FTD stocks subsequently experience negative abnormal returns. While most of the coefficients are negative, the 10 percent and 99th percentile FTD ratio portfolios are statistically significant at the one and five percent levels. The monthly 10 percent FTD ratio portfolio show between -7.284 percent and -8.249 percent abnormal negative returns for EW and VW portfolios. Similarly, the monthly 99th percentile FTD ratio portfolios show between -1.929 percent and -2.049 percent abnormal negative returns.

Table 7 also shows that the Fama-French monthly factors explain the monthly portfolio returns. The coefficients on the market return factor are positive and statistically significant at the one percent level in all specifications except for the 5 percent and 10 percent FTD ratio portfolios. For those portfolios, the market return factor is statistically significant for the EW portfolio but not the VW portfolio. Similar to the daily data, the small market cap factor is everywhere positive and the momentum factor is everywhere negative.

One potential concern regarding our results is the fact that R-squared statistics in Tables 6 and 7 decline as portfolio FTD ratios increase. For example, in the daily and monthly portfolio returns, we obtain R-squared in the daily 10 percent FTD ratio portfolio analysis of roughly 0.25. In contrast, R-squared statistics are generally much higher in the adjacent columns.

The declining R-squared statistics for high FTD ratio portfolios may be explained by the design of the Fama-French model. The Fama-French factors are calculated by using historical portfolio returns. Stocks with extremely high FTD ratios are likely subject to frequent shocks, and these shocks produced daily returns that are well outside of historical means. Thus the factors computed by Fama and French will do a poorer job of explaining variation in high FTD portfolios, as opposed to portfolios with very small shocks. Therefore, the R-squared statistics are lower as FTD ratios are higher.

4.4 Persistence of portfolio abnormal returns in low and high FTD ratio stocks

Following Asquith et al. (2005), we continue our testing of Hypothesis 1 and calculate the persistence of portfolio abnormal returns for the FTD ratios discussed above. This procedure provides indirect evidence of the success of short selling strategies in low and high FTD stocks through time. For daily data, we build portfolios with stocks that have appeared in a given FTD ratio portfolio at least once in the previous 12 days.

Table 8 reports the 12-day persistence of daily four-factor portfolio returns. The coefficients on the intercepts are increasingly negative and statistically significant as FTD ratios increase. Daily portfolios of stocks that have experienced an FTD ratio higher than 10 percent at least once in the previous 12 days experience persistent abnormal negative returns of between -0.172 percent and -0.205 percent. This result is statistically significant at the one percent level. The coefficients on the market return factor and small cap stock factors are everywhere positive and statistically significant at the one percent level. The coefficients on the momentum factor are negative in all specifications and statistically significant at the one percent level. For robustness, we also generate monthly and weekly portfolios using stocks that have crossed a given FTD threshold at least once in the previous 12 months or weeks. We report results in Appendix A.

4.3 Future portfolio abnormal returns in low and high FTD ratio stocks.

Our final test of Hypothesis 1 examines future portfolio returns of low and high FTD stocks using. In equation (5), we modify our Fama-French four-factor model to look at the relationship between future portfolio returns for portfolio sort in the present period:

$$Port_{it+1} - RF_{t+1} = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{it} \qquad (5)$$

In equation (5), the dependent variable is the return on portfolio *i* in period *t+1*. We report results in for daily portfolio returns in Tables 9. High FTD portfolios experience abnormal returns of between -0.204% and -0.258% on the following day. Moderate FTD ratio portfolios of between 2.5% and 5% abnormal returns of between -0.142% and -0.145%. Other FTD ratio portfolios experience negative abnormal returns that are not statistically significant. We also test for future abnormal returns in FTD ratio portfolios sorted monthly. Results are discussed in Appendix A.

5. Determinants of FTDs

We supplement our findings above with a brief analysis of the determinants of FTDs. FTDs are primarily a product of short sale demand, which we measure in three ways using monthly short interest, daily put option open interest, and daily short sale borrow costs. Here we report results for daily data. Results for monthly and weekly data are available in Appendix B.

Previous research has demonstrated a strong relationship between short sale demand, FTDs, and the options market when stock borrow costs are high (Boni, 2006; Evans et al., 2009, Welborn and Stratmann, 2013). When shortable stock is expensive or scarce, short sellers can trade options to create synthetic short positions that are economically equivalent to short sales. As noted above, regulatory proceedings indicate that options market makers violated short sale locate and close-out requirements to sell put options on hard-to-borrow stocks, short sell an equivalent amount of the underlying equity to hedge the risk associated with the options sale, and then fail to deliver to avoid borrow costs. The purpose of these "conversion" transactions was to increase the loanable supply of hard-to-borrow stocks and circumvent nonbinding short sale constraints (SEC, 2012a).

We also predict a positive relationship between FTDs and stock loan spreads. While short interest and put option open interest measure the quantity component of short sale demand, the stock loan rate is the price component of short sale demand. If FTDs reflect some kind of short sale constraint, then we expect spreads to increase with FTDs.

Finally, we predict that FTDs vary inversely with market capitalization. D'Avolio (2002) demonstrates that stock borrow costs decline as firm size increases. This is because firms with smaller market capitalization, and therefore a smaller equity float, have less liquid markets than large cap firms. This constraint affects prices in the stock lending market. For example, Kolasinski et al. (2013b) find that specialness varies inversely with firm size.

Additionally, small cap stocks experience higher levels of short selling. Asquith et al. (2005) find that stocks in the 99th percentile of short interest are small-cap. Furthermore, Boulton and Braga-Alves (2012) find that firms that appear on the Threshold List multiple times tend to have smaller market capitalization, and lower per-share prices, than firms that appear on the Threshold List just once. In other words, smaller firms experience more persistent FTDs.

We test these predictions individually and jointly by estimating the following equation:

$$FTD_{it} = \beta_1 \, Short\ Int_{it} + \beta_2 \, Put\ OI_{it} + \beta_2 \, Spread_{it} + \beta_3 \, Market\ Cap_{it} + \beta_4 \, Volume_{it} + \gamma_i + \varepsilon_{it} \quad (6)$$

For all specifications, we measure the dependent variable in three ways. First, we use the logarithm of daily FTD dollar values. Second, we use the ratio of FTDs to shares outstanding. Third, we use an indicator variable equal to one when stock *i* is on the Regulation SHO Threshold List during time period *t*. We test equation (6) using daily data, weekly averages, and monthly averages. We shift FTDs backward three days in time to account for T+3 settlement.

Short Interest$_{it}$ is the net aggregate short position for ticker *i* on date *t*. Until June 30, 2008, short interest was reported monthly by broker-dealers to the SROs. Thus, with the daily and weekly data, short interest for ticker *i* will remain the same within months. Since then, short interest has been reported and published on a bi-weekly basis (FINRA, 2016). We use both the log of daily short interest and the ratio of short interest to shares outstanding.

Put OI$_{it}$ represents the total outstanding put options contracts for ticker *i* on date *t*. This variable is a proxy for short sale demand insofar as put options are an economic substitute for short sales. Like short interest, open interest is a stock variable and not a flow variable. Thus daily changes to open interest obscure the magnitude of opening and closing volume.

The variable *Spread*$_{it}$ represents the difference between the Federal Funds rate and the rebate rate for stock *i* on day *t* as reported by SunGard. We use SunGard's composite retail rebate rate, which is weighted average of various retail rates that prime brokers charge clients to borrow stock (FIS Securities Finance, 2016). *Market Cap*$_{it}$ represents stock *i*'s market capitalization during time period *t*.

In the full specification, we include the variable *Volume*$_{it}$, which is the value of shares traded in stock *i* on during time period *t* and which controls for the possibility that FTDs may increase with volume. Depending on the dependent variable, *Volume*$_{it,}$ either represents log volume or the ratio of volume to shares outstanding. Equation (6) includes indicators γ_i, which are fixed effects that capture the unique properties of stock *i* that are constant over time. In all specifications, we use a panel OLS model and cluster standard errors by ticker *i*.

5.1 FTD vary positively with short interest.

Table 10 shows the results when we test the prediction above using daily data. In specification (1), the coefficient on Log Short Interest indicates that 100 percent increase in short interest corresponds to a 35.8 percent increase in FTDs. When we regress all variables jointly on Log FTDs, as in Table 10, column 5, the coefficient on Log SI shows that daily Log FTDs are 30.9 percent higher when daily short interest doubles.

In Table 10, columns 6 through 10, the dependent variable is the ratio of FTDs to shares outstanding. When the ratio of short interest to shares outstanding doubles, the FTD ratio increases by 3.82 percent. In the joint specification, a doubling of the SI ratio produces a 2.49 percent increase in the FTD ratio.

In the last five specifications in Table 10, the dependent variable is an indicator equal to 1 when ticker *i* is on the Threshold List on day *t*. We shift this indicator backward seven days to account for the T+3 settlement cycle plus the Regulation SHO requirement that FTDs persist for five days before a stock may appear on the Threshold List. Table 15, column 11 indicates that, when SI doubles, a ticker is 4.1 percentage points more likely to appear on the Threshold List. In the joint specification, the increase is 3.38 percentage points. In all specifications in Table 15, the coefficient on $Short\ Interest_{it}$ is statistically significant at the 1 percent level.

5.2 FTD vary positively with put option open interest.

In Table 10, column 2, the coefficient on Log Put Option OI indicates the FTDs are 47.4 percent higher when put OI doubles. The same coefficient in the joint specification shows that FTDs increase by 27.3 percent when put OI doubles. Table 15, column 7, shows that the FTD ratio increases by 0.049 percentage points when put OI doubles. Table 15, columns 12 and 15

show that a stock is 0.9 to 1.25 percentage points more likely to appear on the Threshold List when put OI doubles. This indicates that higher put option OI predicts greater FTD persistence.

Other than the joint specification in column 10, all coefficients on Log Put OI are statistically significant at the one percent level. The coefficient in column 10 may not be statistically significant because of interaction effects with the Log Market Cap variable. Higher market cap stocks will have higher options open interest.

5.3 FTDs vary positively with stock borrow spreads.

We calculate $Spread_t$ by subtracting retail rebate rates as reported by SunGard from the daily NY Federal Funds rate. All coefficients on $Spread_t$ are positive and statistically significant at the one percent level. We conclude that stocks with higher borrow costs have higher FTDs.

Table 10, column 3, shows that FTDs are 59.3 percent higher spreads increase by 100 basis points. This effect is similar in the joint specification in column 5, a 48.6 percent increase. Table 10, column 8, shows that the FTD ratio is 0.145 percentage points higher when spreads doubles. In the joint specification, the coefficient on similar, positive, and statistically significant. Table 10, columns 13 and 15, indicate that stocks are roughly 3.5 percent more likely to appear on the Threshold List when spreads double. Thus, higher stock borrow spreads predict greater FTD persistence.

These results are consistent with the hypothesis that hard-to-borrow stocks are short sale constrained. At the same time, our data indicate that the short sale constraints are not necessarily binding. SunGard reports historical prices of transactions that occurred, as opposed to those prices that were just quoted. Thus, despite the high cost to borrow high FTD stocks, the abnormal negative returns earned by those stocks suggest that the transactions were profitable.

5.4 FTDs vary inversely with market capitalization.

In almost all specifications in Table 10, the coefficient on Log Market Cap is positive and statistically significant at the one percent level. Table 10, column 4, indicates that a 100 percent increase in market cap corresponds to a 110 percent decline in FTDs. The coefficient in the joint specification in column 5 indicates that FTDs are 290 percent lower when market cap doubles. The results demonstrate that FTDs vary inversely with market capitalization as predicted.

Table 10, columns 14 and 15, show that a stock is between 3.89 and 4.2 percent less likely to appear on the Threshold List when its market cap doubles. The only specification in which market cap does not vary statistically significantly with FTDs is the joint specification in column 10 in which the dependent variable is the FTD ratio. As discussed above, this is likely because market cap is positively correlated with put option OI in the regression specification.

These results mirror the findings in the portfolio abnormal returns analysis in Tables 6 through 9. In those tables, we report that the coefficient on the Fama-French factor for small cap stocks was generally positive and statistically significant at the one percent level. This means that high FTDs are more concentrated in smaller cap stocks.

6. Conclusions

We present evidence that FTDs reflect nonbinding short sale constraints that do not inhibit informed short selling. In an event study framework, we show that stocks earn negative abnormal returns that are proportional to their FTD levels. Next, using proprietary data on stock borrow rates, we show that estimated short sale profits are positive and proportional to FTD levels. These findings indicate that informed short sellers are not necessarily deterred from trading when stock borrow costs are high or borrowable stock inventory is limited.

We supplement our FTD ratio event study with an analysis of daily and monthly portfolio returns in stocks with comparable FTD ratios using a Fama-French four-factor model. High FTD portfolios achieve statistically significant negative ARs, especially those with FTD ratios of 5% or 10% or in the 99th FTD percentile. Results are similar for future daily portfolios and the persistence of daily portfolios. Our portfolio returns analysis supports the findings in the event study, but primarily in high FTD portfolios. This may be because, in the event study analysis, we only consider the first date a stock crosses a given FTD threshold. Conversely, the daily and monthly portfolios include all stocks that have a high FTD ratio. Our results suggest abnormal returns are primarily realized during an initial FTD event, unless those FTDs are especially high.

Finally, we establish that FTDs are positively correlated with short sale demand as measured by short interest, put option open interest, and stock borrow costs. In our sample period, a doubling in short interest results in a 35.8 percent increase in FTDs for certain stocks. Put Option OI and stock loan spread have a proportionally positive and statistically significant relationship with FTDs. Finally, FTDs are concentrated in small cap stocks, even when we control for other factors such as borrow cost and market volume.

A topical question for policy makers is whether FTDs *cause* abnormal negative returns. According to the SEC, "sellers that fail to deliver securities on settlement date may attempt to use this additional freedom to engage in trading activities to improperly depress the price of a security" (SEC, 2009a, pp. 5-7). While our results point to the possibility that FTDs depress prices, correlation does not constitute causation. Furthermore, it is difficult to disentangle the predictive properties of informed short selling from the possibly manipulative effects of naked short selling. Further research is needed to identify the causal effects of FTDs on returns.

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Table 1

Summary Statistics for Russell 3000 Index Stocks

The sample is defined by 4,149 tickers that are or were part of the Russell 3000 Index. Daily data begin on April 1, 2004, the start of fail-to-deliver (FTD) data from the SEC Freedom of Information Act (FOIA) office (sec.gov/foia/docs/failsdata.htm). The data end on June 30, 2008, when the SEC began to consider major changes to Regulation SHO. Threshold Lists are posted daily by the NYSE, NASDAQ, NYSE ARCA, NYSE AMEX and Chicago Stock Exchange (CHX). Stock price, volume, short interest, shares outstanding, and options open interest data are from the Center for Research in Security Prices (CRSP) via Wharton Research Data Services (WRDS). Stock rebate data are from SunGard. Spread is the daily difference between the NY Federal Funds rate and rebate. All dollar amounts are in real 2010 dollars.

Variable	*N*	Mean	Std. Dev	Min	Max
	Panel A - Full Sample				
Fails-to-Deliver ($; millions)	3,192,840	0.69	9.88	0	7,910.00
Ratio of FTDs to Shares Outstanding	3,192,840	0.00	0.006	0	0.63
Frequency on the Regulation SHO Threshold List	3,188,967	0.02	0.13	0	1.000
Market Capitalization ($; millions)	3,195,747	5,340.00	20,100.00	0.91	548,000.00
Volume ($; millions)	3,195,747	42.30	163.00	0	18,000.00
Ratio of Volume to Shares Outstanding	3,195,747	0.01	0.02	0	3.04
Short Interest ($; millions)	3,173,703	142.00	275.00	0	6,690.00
Ratio of SI to Shares Outstanding	3,173,703	0.06	0.06	0	2.50
Put Option Open Interest (thousands)	2,126,577	29.76	99.55	0	2,925.64
Rebate	2,471,110	2.99	2.62	-90.40	6.90
Spread	2,471,110	1.18	2.38	-2.22	92.87
	Panel B - 99th FTD Percentile				
Fails-to-Deliver ($; millions)	32,417	29.10	89.90	0	7,910.00
Ratio of FTDs to Shares Outstanding	32,417	0.03	0.042	0	0.63
Frequency on the Regulation SHO Threshold List	32,257	0.74	0.44	0	1.000
Market Capitalization ($; millions)	32,417	895.00	1,980.00	1.07	99,600.00
Volume ($; millions)	32,417	36.40	138.00	0	7,230.00
Ratio of Volume to Shares Outstanding	32,417	0.04	0.09	0	3.04
Short Interest ($; millions)	32,141	198.00	288.00	0	3,850.00
Ratio of SI to Shares Outstanding	32,141	0.25	0.16	0	2.50
Put Option Open Interest (thousands)	26,783	61.31	108.91	0	981.92
Rebate	24,906	-7.53	8.86	-86.98	5.16
Spread	24,906	11.68	8.80	-0.48	88.97

Table 2

Russell 3000 stocks with highest mean FTDs to shares outstanding ratio

Data are for the 51 Russell 3000 tickers with the highest average ratio FTDs to shares outstanding for the period from April 1, 2004 through June 30, 2008. FTDs are mean fails-to-deliver. Data are sorted by FTDs/SH, the mean daily ratio of fails to shares outstanding. SI/SH is the mean ratio of short interest to shares outstanding. Where available, rebate is the mean daily stock loan rate from SunGard. SHO is the sum of the days on the Regulation SHO Threshold List and First SHO is the first date on the List. All values are in January 2010 dollars.

#	Ticker	Name	FTDs (m)	MktCap (m)	FTDs/SH	SI/SH	Rebate	SHO	First SHO
1	NFI	NOVASTAR FINANCIAL INC	$ 44.10	$ 900.00	10.83%	41.79%	-66.33	700	1/7/05
2	PWEI	PW EAGLE INC	$ 31.30	$ 414.00	7.49%	48.28%		215	7/12/06
3	MSO	MARTHA STEWART LVNG OMNIMEDIA IN	$ 29.00	$ 449.00	5.64%	25.44%	2.16	457	1/7/05
4	CMG	CHIPOTLE MEXICAN GRILL INC	$ 67.10	$ 1,200.00	5.10%	12.15%	-7.69	440	9/19/06
5	DAL	DELTA AIR LINES INC	$ 32.40	$ 672.00	4.74%	35.69%		171	1/7/05
6	OSTK	OVERSTOCK COM INC DEL	$ 24.70	$ 640.00	4.27%	27.20%	-2.40	825	1/27/05
7	IDRA	IDERA PHARMACEUTICALS INC	$ 11.90	$ 329.00	3.61%	4.51%	0.05	0	
8	LULU	LULULEMON ATHLETICA INC	$ 44.40	$ 1,490.00	3.08%	23.40%	-18.72	109	1/3/08
9	AKNS	WESTINGHOUSE SOLAR INC	$ 4.75	$ 157.00	3.03%	14.41%	-6.21	1	6/30/08
10	MDTL	MEDIS TECHNOLOGIES LTD	$ 16.40	$ 517.00	3.03%	21.80%	-32.90	783	3/29/05
11	IIG	CREXENDO INC	$ 6.42	$ 188.00	3.00%	39.54%	-24.74	248	6/29/07
12	CSR	CHINA SECURITY & SURVEILL TECH	$ 16.40	$ 572.00	2.87%	14.58%	-5.25	1	6/30/08
13	MAXM	MAXIM PHARMACEUTICALS INC	$ 4.27	$ 142.00	2.74%	15.76%		15	1/11/05
14	USNA	USANA HEALTH SCIENCES INC	$ 15.80	$ 765.00	2.71%	20.57%	-20.93	304	5/30/06
15	NTRI	NUTRISYSTEM INC	$ 25.50	$ 1,600.00	2.63%	35.40%	-19.64	319	2/21/07
16	FEED	AGFEED INDUSTRIES INC	$ 12.60	$ 491.00	2.56%	8.23%	-6.25	0	
17	TASR	TASER INTERNATIONAL INC	$ 28.70	$ 788.00	2.54%	30.93%	-1.24	549	1/7/05
18	JOSB	JOS A BANK CLOTHIERS INC	$ 11.60	$ 562.00	2.46%	43.62%	-6.87	201	6/19/06
19	VMW	VMWARE INC	$ 126.00	$ 5,250.00	2.40%	22.00%	-13.61	126	12/31/07
20	SPWR	SUNPOWER CORP	$ 30.90	$ 1,860.00	2.27%	28.01%	-2.23	454	1/30/06
21	KAZ	B M B MUNAI INC	$ 5.99	$ 263.00	2.27%	0.77%	0.05	0	
22	CALM	CAL MAINE FOODS INC	$ 8.29	$ 302.00	2.26%	18.90%	-1.71	305	1/7/05
23	MWA	MUELLER WATER PRODUCTS INC	$ 7.49	$ 385.00	2.10%	12.96%	-5.48	310	7/3/06
24	AGIX	ATHEROGENICS INC	$ 6.48	$ 649.00	2.08%	28.80%		318	1/3/06
25	MEA	METALICO INC	$ 13.00	$ 623.00	2.08%	12.87%	-2.25	1	6/30/08
26	BCON	BEACON POWER CORP	$ 3.73	$ 183.00	2.04%	5.35%	-5.78	0	
27	HOM	HOME SOLUTIONS OF AMERICA INC	$ 4.00	$ 232.00	2.03%	30.36%	-24.89	276	7/10/06
28	FNLC	FIRST BANCORP INC ME	$ 2.61	$ 131.00	1.99%	0.32%	0.05	0	
29	HNSN	HANSEN MEDICAL INC	$ 11.30	$ 473.00	1.98%	14.64%	-6.73	218	3/22/07
30	FTEK	FUEL TECH INC	$ 10.00	$ 552.00	1.97%	29.65%	-11.02	200	6/29/07
31	NFLD	NORTHFIELD LABORATORIES INC	$ 5.41	$ 321.00	1.92%	19.18%		340	1/7/05
32	PEIX	PACIFIC ETHANOL INC	$ 12.70	$ 499.00	1.88%	12.80%	-8.78	613	6/30/05
33	CFX	COLFAX CORP	$ 20.30	$ 1,090.00	1.86%	4.43%	1.85	0	
34	TOWN	TOWNEBANK	$ 6.67	$ 362.00	1.84%	0.49%	1.85	0	
35	NFLX	NETFLIX INC	$ 20.00	$ 1,470.00	1.80%	26.66%	-6.09	586	1/7/05
36	KKD	KRISPY KREME DOUGHNUTS INC	$ 11.00	$ 599.00	1.74%	31.86%	0.16	633	1/7/05
37	WPL	STEWART W P & CO LTD	$ 6.75	$ 281.00	1.60%	6.85%	-14.28	159	6/29/07
38	BIDZ	BIDZ COM INC	$ 3.24	$ 204.00	1.59%	14.29%	-36.50	1	6/30/08
39	BRLC	SYNTAX BRILLIAN CORP	$ 4.85	$ 288.00	1.56%	18.67%	-28.53	240	6/29/07
40	NYX	N Y S E EURONEXT	$ 242.00	$ 17,900.00	1.56%	8.59%	3.37	172	7/6/06
41	DNDN	DENDREON CORP	$ 11.40	$ 512.00	1.53%	25.50%	-17.37	309	3/21/07
42	DHIL	DIAMOND HILL INVESTMENT GRP INC	$ 2.95	$ 199.00	1.48%	0.98%	0.05	0	
43	AEZ	AMERICAN OIL & GAS INC	$ 2.56	$ 180.00	1.42%	3.64%	-4.00	0	
44	ZOLT	ZOLTEK COMPANIES INC	$ 11.50	$ 793.00	1.41%	16.35%	-4.98	491	11/15/05
45	BBI	BLOCKBUSTER INC	$ 6.63	$ 674.00	1.39%	28.80%	1.36	42	8/15/07
46	RNN	REXAHN PHARMACEUTICALS INC	$ 2.46	$ 179.00	1.37%	0.01%	0.05	0	
47	WCI	W C I COMMUNITIES INC	$ 5.38	$ 952.00	1.37%	25.24%	-27.78	393	8/14/06
48	KPPC	KAPSTONE PAPER & PACKAGING CORP	$ 2.30	$ 168.00	1.37%		-11.25	0	
49	HEV	ENER1 INC	$ 10.20	$ 769.00	1.33%	3.55%	-7.62	0	
50	CFSG	CHINA FIRE & SECURITY GROUP INC	$ 2.90	$ 220.00	1.32%	6.95%	-4.75	0	
51	PPD	PRE PAID LEGAL SERVICES INC	$ 7.03	$ 633.00	1.30%	28.04%	2.52	139	1/7/05

Table 3

Daily event study for low and high FTD Russell 3000 stocks

This table reports mean cumulative abnormal returns (CARs) for stocks whose ratio of FTDs to shares outstanding crosses a percentage threshold. In Panel A, the dependent variable is Rit, the daily returns for security i on date t. Russellt is the daily return for the Russell 3000 Index on date t. For each Russell 3000 ticker i, we estimate normal ticker performance using the market model with a 30 day estimation window 30-days prior to the event. We obtain βi, which is the portion of daily returns that are "normal" relative to market returns. We consider only the first FTD "event" for each firm. Daily Russell 3000 ticker data are for the period from April 1, 2004 through June 30, 2008. In Panel B, the dependent variable is Rit -RFt, the daily excess return of portfolio i over the risk-free rate in period t. The market risk premium in period t is Russellt -RFt. In Panel B, we estimate βi using the Fama-French four factor model. The daily factor return realizations for book-to-market value, firm size, and momentum are provided by Kenneth French. The SHO portfolio is composed of stocks that appear on the Regulation SHO Threshold List for the first time. The ≥2.5% portfolio is composed of all Russell 3000 Index stocks whose ratio of FTDs to shares outstanding exceeds for the first time. The ≥5%, ≥10%, and ≥99th percentile portfolios are similarly defined. Standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1.

Panel A: $R_{it} = \alpha_i + \beta_i \, Russell_t + \varepsilon_{it}$

Panel B: $R_{it} - RF_t = \alpha_i + \beta_{1i} (Russell_t - RF_t) + \beta_{2i} SMB_t + \beta_{3i} HML_t + \beta_{4i} UMD_t + \varepsilon_{it}$

	1 Day ARs		2 Day CARs		3 Day CARs	
Portfolio	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**
			Panel A - Estimation using the market model			
SHO	-1.089***	779	-0.908**	774	-0.617	756
	(0.353)		(0.439)		(0.497)	
≥99th	-0.779**	1082	-0.875**	1081	-0.823**	1080
	(0.360)		(0.373)		(0.411)	
≥2.5%	-2.120**	464	-2.209**	462	-0.998	456
	(0.842)		(0.859)		(0.980)	
≥5%	-3.899**	160	-3.851**	160	-2.48	160
	(1.588)		(1.685)		(1.849)	
≥10%	-7.867**	55	-9.584**	55	-8.403*	54
	(3.779)		(4.109)		(4.641)	
			Panel B - Estimation using a Fama-French Four Factor Model			
SHO	-1.168***	779	-1.068**	774	-0.841*	743
	(0.359)		(0.448)		(0.506)	
≥99th	-0.827**	1082	-0.945**	1081	-0.776*	1080
	(0.363)		(0.381)		(0.413)	
≥2.5%	-2.288***	464	-2.509***	462	-1.288	456
	(0.848)		(0.872)		(0.993)	
≥5%	-4.201***	160	-4.120**	160	-2.579	160
	(1.604)		(1.733)		(1.889)	
≥10%	-8.251**	55	-10.18**	55	-9.053*	54
	(3.835)		(4.220)		(4.729)	

Table 4

Profitability of shorting low and high FTD Russell 3000 stocks

This table reports mean estimated profit for shorting stocks whose ratio of FTDs to shares outstanding crosses a percentage threshold. In both panels, the dependent variable is Πi , the estimated profit from shorting security *i* on event date *t* . CAR*it* is the cumulative abnormal return for stock i on date t, as reported in Table 3A. Panels A and B use CARs derived from the market model and a Fama-French four factor model, respectively. Rebate*i* is the composite daily short sale rebate rate as reported by SunGard Astec. We normalize the SunGard rebate data, which are annualized, to a daily rebate rate by dividing by 360. We estimate the cost of shorting by summing the daily marked-to-market cost of paying a negative rebate over the five trading days prior to an FTD event. The SHO portfolio is composed of stocks that appear on the Regulation SHO Threshold List for the first time. The ≥2.5% portfolio is composed of all Russell 3000 Index stocks whose ratio of FTDs to shares outstanding exceeds for the first time. The ≥5%, ≥10%, and ≥99th percentile portfolios are similarly defined. Standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1.

$$\Pi_{i,t} = -\left[CAR_{i,t} - \sum_{t=-4}^{0}\left(\frac{rebate_{i,t}}{360}\right)\right]$$

	1 Day Profit		2 Day Mean Profit		3 Day Mean Profit	
Portfolio	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**
			Panel A - Estimation using the market model			
SHO	0.949***	689	0.690	684	0.418	666
	(0.367)		(0.427)		(0.506)	
≥99th	0.830**	721	0.966**	720	0.883*	719
	(0.389)		(0.413)		(0.450)	
≥2.5%	1.417	347	1.759*	345	0.736	339
	(0.992)		(1.022)		(1.068)	
≥5%	4.022**	117	4.128*	117	2.128	117
	(1.991)		(2.176)		(2.187)	
≥10%	7.887	40	9.728*	40	7.257	39
	(4.706)		(5.301)		(6.123)	
			Panel B - Estimation using a Fama-French Four Factor Model			
SHO	0.981***	689	0.803*	684	0.600	666
	(0.374)		(0.441)		(0.516)	
≥99th	0.849**	721	1.024**	720	0.865*	719
	(0.395)		(0.428)		(0.463)	
≥2.5%	1.542	347	2.093**	345	1.149	339
	(1.000)		(1.040)		(1.083)	
≥5%	4.421**	117	4.444*	117	2.338	117
	(2.027)		(2.255)		(2.268)	
≥10%	8.604*	40	10.61*	40	8.122	39
	(4.806)		(5.462)		(6.222)	

Table 5

Russell 3000 stocks that crossed the 10% FTDs/shares outstanding threshold

Data are for the 55 Russell 3000 tickers that exceeded a 10% ratio of FTDs to shares outstanding between April 1, 2004 and June 30, 2008. All values are for the 30 day event study period when the ticker crossed the 10% threshold. FTDs/shares is the ratio of FTDs to shares outstanding. CARs are cumulative abnormal returns. SunGard is the stock loan rebate rate. FTDs and MktCap are in millions (January 2010 dollars). Data are sorted by FTD10, which is the total number of days the FTD ratio exceeded 10% during the data period.

#	Ticker	Name	Price	FTDs/SH	Date	CARs	SunGard	FTDs (m)	MktCap (m)	FTD10
1	MSO	MARTHA STEWART LIVING OMNIMD	$ 10.99	12.30%	4/1/04	-16.27	-8.09	30.74	$ 249.94	315
2	NFI	NOVASTAR FINANCIAL INC	$ 174.32	10.80%	10/19/04	0.29	-22.79	133.54	$ 1,236.33	259
3	OSTK	OVERSTOCK.COM INC	$ 40.84	10.04%	9/26/05	-24.29	-10.23	83.59	$ 832.20	185
4	USNA	USANA HEALTH SCIENCES INC	$ 29.48	11.20%	8/9/07	-0.94	-4.61	55.96	$ 499.71	127
5	JOSB	JOS A BANK CLOTHIERS INC	$ 14.84	10.39%	1/16/08	15.69	0.06	43.16	$ 415.41	95
6	PWEI	PW EAGLE INC	$ 37.31	10.22%	11/22/06	10.82	-7.29	49.09	$ 480.22	85
7	TASR	TASER INTERNATIONAL INC	$ 20.69	10.95%	4/1/04	-42.74	-5.62	146.27	$ 1,335.44	80
8	DNDN	DENDREON CORP	$ 5.22	11.21%	3/28/07	153.32	-3.62	50.91	$ 454.07	59
9	AGIX	ATHEROGENICS INC	$ 11.69	10.30%	2/7/07	33.43	-0.73	50.57	$ 491.09	56
10	DAL	DELTA AIR LINES INC	$ 3.51	13.49%	8/12/04	-64.50	-14.01	67.39	$ 499.76	50
11	CMG	CHIPOTLE MEXICAN GRILL INC	$ 49.60	10.24%	9/28/06	24.27	-4.30	74.96	$ 732.21	50
12	CALM	CAL-MAINE FOODS INC	$ 14.67	10.46%	12/22/04	19.66	-2.56	37.28	$ 356.55	32
13	BBI	BB LIQUIDATING INC	$ 7.48	13.53%	9/9/04	-21.79	2.06	42.87	$ 316.77	31
14	NTRI	NUTRISYSTEM INC	$ 32.10	11.01%	10/5/07	-21.39	-4.28	126.64	$ 1,150.21	31
15	WCI	WCI COMMUNITIES INC	$ 6.17	10.49%	9/25/07	-3.10	-5.84	28.29	$ 269.79	26
16	LEND	ACCREDITED HOME LENDERS HLDG	$ 11.40	16.11%	3/12/07	-0.16	0.89	48.51	$ 301.05	25
17	MAXM	MAXIM PHARMACEUTICALS INC	$ 6.89	10.59%	9/8/04	-79.79	-2.04	23.78	$ 224.54	22
18	ARTC	ARTHROCARE CORP	$ 46.37	10.39%	1/15/08	-8.10	1.38	132.55	$ 1,276.11	22
19	NFLD	NORTHFIELD LABORATORIES INC	$ 4.12	14.05%	12/21/06	-85.17	-6.69	16.66	$ 118.62	18
20	NYX	NYSE EURONEXT	$ 93.60	11.25%	2/21/07	-19.58	3.31	1,751.26	$ 15,571.02	18
21	UA	UNDER ARMOUR INC	$ 15.65	10.14%	1/22/08	19.69	-1.38	115.09	$ 1,135.45	13
22	JRCC	JAMES RIVER COAL CO	$ 5.00	13.80%	8/8/07	-41.93	-1.84	11.95	$ 86.57	12
23	WBMD	WEBMD HEALTH CORP -OLD	$ 34.20	11.54%	6/5/08	-16.13	-1.31	37.00	$ 320.58	12
24	SFCC	PHARMANET DEVELOPMENT GROUP	$ 15.78	14.55%	12/15/05	-19.06	3.66	46.64	$ 320.51	11
25	NILE	BLUE NILE INC	$ 49.41	10.77%	4/4/08	41.72	-2.99	80.52	$ 747.84	11
26	GNTA	GENTA INC	$ 98.10	10.68%	4/27/04	-105.39		156.47	$ 1,464.66	8
27	HNSN	HANSEN MEDICAL INC	$ 38.77	10.74%	10/25/07	-28.34	-4.51	94.00	$ 875.32	8
28	KBR	KBR INC	$ 20.72	11.07%	3/29/07	-0.78	2.67	405.63	$ 3,665.33	8
29	AVNR	AVANIR PHARMACEUTICALS INC	$ 3.98	17.06%	10/31/06	-90.72	-1.48	23.12	$ 135.51	7
30	PARL	PARLUX FRAGRANCES INC	$ 10.24	13.56%	6/14/06	-34.89	-7.17	26.56	$ 195.82	4
31	ESCL	SPECTRUM GROUP INTL INC	$ 9.45	10.85%	5/15/06	-16.99	-22.98	30.81	$ 283.98	4
32	IMB	INDYMAC BANCORP INC	$ 21.39	10.11%	8/7/07	1.76	-1.71	166.03	$ 1,642.25	4
33	NFLX	NETFLIX INC	$ 10.30	13.21%	10/15/04	2.63	-5.71	80.76	$ 611.49	4
34	INPC	INPHONIC INC	$ 0.49	10.23%	10/16/07	-283.29	-1.83	1.90	$ 18.57	3
35	ABRX	ABLE LABORATORIES INC	$ 5.05	10.25%	5/23/05	-145.81	0.52	10.69	$ 104.25	3
36	PEIX	PACIFIC ETHANOL INC	$ 196.07	10.14%	6/2/06	-90.87	-11.63	95.43	$ 940.71	3
37	BSC	BEAR STEARNS COMPANIES INC	$ 4.81	11.68%	3/17/08	-68.73		67.31	$ 576.42	3
38	HERO	HERCULES OFFSHORE INC	$ 33.54	11.20%	7/11/07	-38.32	2.72	125.95	$ 1,124.48	3
39	ENWV	ENDWAVE CORP	$ 12.82	11.06%	12/8/05	112.50	-6.50	17.66	$ 159.69	3
40	FED	FIRSTFED FINANCIAL CORP/CA	$ 10.83	10.98%	6/11/08	-2.03	1.01	16.12	$ 146.76	2
41	BRNC	BRONCO DRILLING CO	$ 18.44	14.22%	11/29/06	17.34	3.76	70.34	$ 494.56	2
42	DECK	DECKERS OUTDOOR CORP	$ 5.99	11.93%	10/28/05	21.91	1.50	28.83	$ 241.61	2
43	NEW	NEW CENTURY FINANCIAL CORP	$ 5.16	10.03%	3/7/07	-162.65	2.72	30.28	$ 302.03	1
44	LUM	LUMINENT MORTGAGE CAPITAL	$ 1.08	10.10%	8/7/07	-74.61	0.14	5.32	$ 52.70	1
45	TMA	THORNBURG MORTGAGE INC	$ 12.90	11.27%	4/2/08	-59.39	-22.61	25.16	$ 223.20	1
46	BWLD	BUFFALO WILD WINGS INC	$ 14.58	10.28%	5/21/04	-37.41	3.15	27.59	$ 268.49	1
47	MWA	MUELLER WATER PRODUCTS INC	$ 14.49	10.04%	8/6/07	-26.00	-0.75	43.85	$ 436.74	1
48	IMA	ALERE INC	$ 24.20	10.82%	12/13/04	-24.20	3.47	60.67	$ 560.48	1
49	CLNE	CLEAN ENERGY FUELS CORP	$ 13.21	37.30%	4/2/08	-6.61	2.18	220.14	$ 590.20	1
50	RCNI	RCN CORP	$ 12.73	13.34%	8/16/07	1.31	3.72	67.05	$ 502.49	1
51	MOVI	MOVIE GALLERY INC	$ 2.65	10.11%	3/17/06	5.04	-0.37	9.30	$ 92.01	1
52	LULU	LULULEMON ATHLETICA INC	$ 14.92	10.20%	6/27/08	5.36	-15.69	142.18	$ 1,393.51	1
53	KIRK	KIRKLAND'S INC	$ 8.28	14.66%	7/21/05	7.73	1.23	25.97	$ 177.22	1
54	PCYC	PHARMACYCLICS INC	$ 3.30	14.37%	12/19/05	19.44	1.64	10.36	$ 72.10	1
55	TARR	TARRAGON CORP	$ 0.94	12.38%	8/9/07	91.27	-3.20	3.50	$ 28.25	1

Table 6

Four-factor model parameters for daily portfolios of low and high FTD Russell 3000 stocks

The dependent variable is Portit - RFt, the daily excess return of portfolio i over the risk-free rate, on either an equal-weighted (EW) or value-weighted (VW) basis, on day t. The market risk premium in period t is Russellt - RFt. The daily factor return realizations are provided by Kenneth French. SMB is the daily return on a portfolio of small stocks minus the daily return on a portfolio of big stocks. HML is the daily return on a portfolio of high book-to-market (value) minus low book-to-market (growth) stocks. UMD is the daily return on a portfolio of prior winners minus the return on a portfolio of prior losers. For April 1, 2004 through June 30, 2008, 1048 daily returns are used in all regressions except the SHO portfolio. The SHO portfolio, which begins in 2005, is composed of all Regulation SHO Threshold Stocks on a given date. The ≥2.5% & <5% portfolio is composed of all Russell 3000 Index stocks with a ratio of FTDs to shares outstanding greater than 2.5% but less than 5%. The ≥5% & <10%, ≥10%, ≥95th & <99th percentile, and ≥99th percentile portfolios are similarly defined, and portfolios are updated daily. Robust standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1.

$$Port_{it} - RF_t = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{it}$$

Sample	Intercept	Russell-RF	SMB	HML	UMD	*N*	*R*-squared
Panel A: Daily EW Russell 3000 Portfolios, April 1, 2004– June 30, 2008							
SHO	-0.04	1.236***	1.042***	0.291**	-0.469***	867	0.70
	(0.030)	(0.034)	(0.073)	(0.113)	(0.049)		
≥2.5% & <5%	-0.0631	1.364***	1.114***	0.581**	-0.427***	1047	0.30
	(0.07)	(0.09)	(0.18)	(0.28)	(0.13)		
≥5% & <10%	-0.189***	1.253***	1.332***	0.352	-0.467***	1046	0.30
	(0.07)	(0.10)	(0.16)	(0.22)	(0.10)		
≥10%	-0.244***	1.512***	1.067***	0.35	-0.339***	1047	0.27
	(0.08)	(0.10)	(0.19)	(0.24)	(0.12)		
≥95th & <99th	0.0516***	1.240***	1.177***	0.153**	-0.424***	1047	0.87
	(0.02)	(0.02)	(0.05)	(0.06)	(0.03)		
≥99th	-0.0664	1.326***	1.024***	0.472***	-0.556***	1048	0.52
	(0.04)	(0.05)	(0.11)	(0.18)	(0.09)		
Panel B: Daily VW Russell 3000 Portfolios, April 1, 2004– June 30, 2008							
SHO	-0.0248	1.200***	0.949***	0.201	-0.411***	867	0.65
	(0.032)	(0.039)	(0.080)	(0.126)	(0.054)		
≥2.5% & <5%	-0.102*	1.374***	1.109***	0.443**	-0.563***	1047	0.37
	(0.06)	(0.07)	(0.15)	(0.21)	(0.10)		
≥5% & <10%	-0.156**	1.168***	1.156***	0.168	-0.384***	1046	0.25
	(0.07)	(0.09)	(0.17)	(0.24)	(0.10)		
≥10%	-0.335***	1.516***	1.285***	0.423	-0.480***	1047	0.24
	(0.09)	(0.11)	(0.19)	(0.30)	(0.14)		
≥95th & <99th	0.0387*	1.216***	0.904***	0.238**	-0.353***	1047	0.76
	(0.02)	(0.03)	(0.06)	(0.10)	(0.05)		
≥99th	-0.0633	1.277***	0.966***	0.370**	-0.476***	1047	0.47
	(0.04)	(0.06)	(0.10)	(0.18)	(0.09)		

Table 7

Four-factor model parameters for monthly portfolios of low and high FTD Russell 3000 stocks

The dependent variable is Portit - RFt, the monthly excess return of portfolio i over the risk-free rate, on either an equal-weighted (EW) or value-weighted (VW) basis, in month t. The market risk premium in period t is Russellt - RFt. The monthly factor return realizations are provided by Kenneth French. SMB is the return on a portfolio of small stocks minus the return on a portfolio of big stocks. HML is the return on a portfolio of high book-to-market (value) minus low book-to-market (growth) stocks. UMD is the return on a portfolio of prior winners minus the return on a portfolio of prior losers. For April 1, 2004 through June 30, 2008, 49 monthly returns are used in all regressions except the SHO portfolio. The SHO portfolio, which begins in 2005, is composed of all stocks that have appeared on the Regulation SHO Threshold List at least once in a given month. The ≥2.5% & <5% portfolio is composed of all Russell 3000 Index stocks with a ratio of FTDs to shares outstanding greater than 2.5% but less than 5%. The ≥5% & <10%, ≥10%, ≥95th & <99th percentile, and ≥99th percentile portfolios are similarly defined, and portfolios are updated monthly. Robust standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1.

$$Port_{it} - RF_t = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{it}$$

Sample	Intercept	Russell-RF	SMB	HML	UMD	*N*	*R*-squared
Panel A: Monthly EW Russell 3000 Portfolios, April 1, 2004– June 30, 2008							
SHO	-0.0887	1.403***	1.260***	-0.316	-0.824**	40	0.68
	(0.803)	(0.358)	(0.406)	(0.322)	(0.388)		
≥2.5% & <5%	-1.427	1.225***	0.818	0.836	-0.702	49	0.27
	(1.01)	(0.40)	(0.62)	(0.72)	(0.45)		
≥5% & <10%	2.224	1.317*	2.935***	-0.549	-1.933***	48	0.37
	(1.93)	(0.72)	(0.79)	(0.92)	(0.57)		
≥10%	-7.284***	2.225**	2.029	0.969	-0.107	49	0.26
	(2.26)	(1.02)	(1.27)	(1.27)	(0.79)		
≥95th & <99th	-0.222	1.213***	1.472***	0.181	-0.390*	49	0.75
	(0.51)	(0.26)	(0.33)	(0.27)	(0.22)		
≥99th	-1.929**	1.653***	0.944*	1.325**	-0.979***	49	0.54
	(0.82)	(0.40)	(0.53)	(0.52)	(0.32)		
Panel B: Monthly VW Russell 3000 Portfolios, April 1, 2004– June 30, 2008							
SHO	0.0285	1.317***	1.118**	-0.289	-0.562**	40	0.61
	(0.736)	(0.296)	(0.460)	(0.365)	(0.274)		
≥2.5% & <5%	-1.044	1.368***	1.351**	0.59	-0.889*	49	0.34
	(1.18)	(0.38)	(0.56)	(0.76)	(0.50)		
≥5% & <10%	1.739	0.66	3.079***	-0.977	-1.333**	48	0.31
	(1.97)	(0.65)	(0.68)	(0.98)	(0.56)		
≥10%	-8.249***	1.879	3.262**	0.35	-0.0558	49	0.25
	(2.72)	(1.24)	(1.38)	(1.27)	(1.00)		
≥95th & <99th	-0.756	1.331***	1.414***	0.458	-0.635**	49	0.67
	(0.54)	(0.26)	(0.37)	(0.36)	(0.26)		
≥99th	-2.049***	1.529***	1.284***	0.859*	-0.562*	49	0.56
	(0.72)	(0.34)	(0.40)	(0.44)	(0.29)		

Table 8

Persistence of four-factor model parameter estimates for daily portfolios of low and high FTD Russell 3000 stocks

The dependent variable is Portit - RFt, the daily excess return of portfolio i over the risk-free rate, on either an equal-weighted (EW) or value-weighted (VW) basis, for the period from April 1, 2004 through June 30, 2008. The market risk premium on day t is Russellt - RFt. The daily factor return realizations for book-to-market value, firm size, and momentum are provided by Kenneth French. The SHO portfolio, which begins in 2005, is composed of all stocks that have appeared on the Regulation SHO Threshold List at least once in the previous 12 days. The ≥2.5% & <5% portfolio is composed of all Russell 3000 Index stocks that have experienced an FTDs to shares outstanding ratio greater than 2.5% but less than 5% at any point in the previous 12 days. The ≥5% & <10%, ≥10%, ≥95th & <99th percentile, and ≥99th percentile portfolios are similarly defined, and portfolios are updated daily. Robust standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1.

$$Port_{it} - RF_t = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{it}$$

Sample	Intercept	Russell-RF	SMB	HML	UMD	*N*	*R*-squared
			Panel A: Daily EW Russell 3000 Portfolios, April 1, 2004– June 30, 2008				
SHO	-0.0601**	1.216***	1.069***	0.259**	-0.466***	868	0.77
	(0.025)	(0.030)	(0.065)	(0.103)	(0.045)		
≥2.5% & <5%	-0.110***	1.277***	1.219***	0.311***	-0.463***	1048	0.66
	(0.03)	(0.04)	(0.08)	(0.12)	(0.06)		
≥5% & <10%	-0.128***	1.245***	1.308***	0.181	-0.467***	1048	0.50
	(0.04)	(0.06)	(0.12)	(0.15)	(0.08)		
≥10%	-0.172***	1.407***	1.195***	0.248	-0.414***	1048	0.44
	(0.05)	(0.07)	(0.14)	(0.18)	(0.09)		
≥95th & <99th	-0.011	1.191***	1.077***	0.146***	-0.356***	1048	0.93
	(0.01)	(0.02)	(0.04)	(0.05)	(0.03)		
≥99th	-0.0425*	1.267***	1.034***	0.344***	-0.494***	1048	0.73
	(0.03)	(0.04)	(0.07)	(0.12)	(0.06)		
			Panel B: Daily VW Russell 3000 Portfolios, April 1, 2004– June 30, 2008				
SHO	-0.0424	1.181***	0.951***	0.213*	-0.396***	868	0.72
	(0.027)	(0.033)	(0.069)	(0.114)	(0.048)		
≥2.5% & <5%	-0.116***	1.274***	1.059***	0.422**	-0.360***	1048	0.55
	(0.04)	(0.05)	(0.11)	(0.17)	(0.08)		
≥5% & <10%	-0.193***	1.220***	1.247***	0.228	-0.403***	1048	0.48
	(0.04)	(0.05)	(0.11)	(0.17)	(0.07)		
≥10%	-0.205***	1.415***	1.260***	0.370*	-0.543***	1048	0.44
	(0.05)	(0.07)	(0.13)	(0.20)	(0.09)		
≥95th & <99th	-0.0199	1.186***	0.739***	0.196***	-0.288***	1048	0.90
	(0.01)	(0.02)	(0.04)	(0.06)	(0.03)		
≥99th	-0.0780***	1.251***	0.843***	0.308***	-0.383***	1048	0.67
	(0.03)	(0.04)	(0.07)	(0.11)	(0.06)		

Table 9

Four-factor model parameters for future daily portfolios of low and high FTD Russell 3000 stocks

The dependent variable is Portit+1 - RFt+1, the daily excess return of portfolio i over the risk-free rate, on either an equal-weighted (EW) or value-weighted (VW) basis, on day t+1. The market risk premium in period t+1 is Russellt+1 - RFt+1. The daily factor return realizations are provided by Kenneth French. SMB is the daily return on a portfolio of small stocks minus the daily return on a portfolio of big stocks. HML is the daily return on a portfolio of high book-to-market (value) minus low book-to-market (growth) stocks. UMD is the daily return on a portfolio of prior winners minus the return on a portfolio of prior losers. For April 1, 2004 through June 30, 2008, 1037 daily returns are used in all regressions except the SHO portfolio. The SHO portfolio, which begins in 2005, is composed of all Regulation SHO Threshold Stocks on date t. The ≥2.5% & <5% portfolio is composed of all Russell 3000 Index stocks with a ratio of FTDs to shares outstanding greater than 2.5% but less than 5% in period t. The ≥5% & <10%, ≥10%, ≥95th & <99th percentile, and ≥99th percentile portfolios are similarly defined, and portfolios are updated daily. Robust standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1.

$$Port_{it+1} - RF_{t+1} = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{it}$$

Sample	Intercept	Russell-RF	SMB	HML	UMD	*N*	*R*-squared
Panel A: Future Daily EW Russell 3000 Portfolios, April 1, 2004– June 30, 2008							
SHO	-0.0090	1.248***	1.074***	0.331***	-0.494***	860	0.73
	(0.028)	(0.033)	(0.071)	(0.109)	(0.048)		
≥2.5% & <5%	-0.142***	1.246***	1.303***	0.362**	-0.532***	1,035	0.48
	(0.045)	(0.055)	(0.117)	(0.167)	(0.073)		
≥5% & <10%	-0.0999	1.231***	1.020***	0.328	-0.564***	1,035	0.27
	(0.068)	(0.078)	(0.187)	(0.218)	(0.130)		
≥10%	-0.204***	1.446***	1.213***	0.279	-0.279**	1,035	0.33
	(0.067)	(0.094)	(0.161)	(0.220)	(0.110)		
≥95th & <99th	-0.0056	1.202***	1.147***	0.220***	-0.438***	1,035	0.88
	(0.015)	(0.021)	(0.042)	(0.064)	(0.028)		
≥99th	-0.039	1.274***	1.157***	0.567***	-0.574***	1,035	0.62
	(0.034)	(0.052)	(0.095)	(0.154)	(0.085)		
Panel B: Future Daily VW Russell 3000 Portfolios, April 1, 2004– June 30, 2008							
SHO	-0.0106	1.199***	0.950***	0.215*	-0.410***	860	0.65
	(0.032)	(0.038)	(0.080)	(0.127)	(0.054)		
≥2.5% & <5%	-0.145**	1.227***	1.108***	0.347	-0.475***	1,035	0.34
	(0.057)	(0.068)	(0.138)	(0.240)	(0.107)		
≥5% & <10%	-0.0965	1.092***	0.997***	0.11	-0.456***	1,035	0.24
	(0.067)	(0.077)	(0.158)	(0.253)	(0.111)		
≥10%	-0.258***	1.437***	1.329***	0.651**	-0.402***	1,035	0.27
	(0.080)	(0.086)	(0.171)	(0.278)	(0.143)		
≥95th & <99th	-0.0216	1.174***	0.905***	0.382***	-0.347***	1,035	0.80
	(0.019)	(0.027)	(0.055)	(0.079)	(0.036)		
≥99th	-0.0579	1.229***	0.953***	0.446***	-0.412***	1,035	0.52
	(0.038)	(0.046)	(0.095)	(0.164)	(0.083)		

Table 10

The Determinants of FTDs using Daily Data

In specifications (1) through (3), the dependent variable is the log dollar value of net CNS fails-to-deliver (FTDs) for stock i on date t. In specifications (4) through (6), the dependent variable is the ratio of FTDs to shares outstanding. In specifications (7) through (9), the dependent variable is the likelihood that a ticker will appear on the Regulation SHO Threshold List. Data are for the period from April 1, 2004 through June 30, 2008. All regressions include stock fixed effects and in all regressions standard errors are clustered by ticker. Standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1. All dollar values are in real 2010 dollars.

$$FTD_{it} = \beta_1 \, Short\ Int_{it} + \beta_2 \, Put\ OI_{it} + \beta_2 \, Spread_{it} + \beta_3 \, Market\ Cap_{it} + \beta 4 \;\; Volume_{it} + \gamma_i + \varepsilon_{it}$$

	Log FTDs ($)					FTDs / Shares Outstanding					Regulation SHO Threshold List				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Log Short Interest	0.358***				0.309***						0.00410***				0.00338***
	(0.033)				(0.050)						(0.001)				(0.001)
Short Interest / Shares Outstanding						0.0382***				0.0249***					
						(0.006)				(0.004)					
Log Put Option IO		0.474***			0.273***		0.000491***			-0.0000363		0.0125***			0.00917***
		(0.023)			(0.020)		(0.000)			(0.000)		(0.001)			(0.001)
Spread			0.593***		0.486***			0.00145***		0.00120***			0.0332***		0.0344***
			(0.043)		(0.040)			(0.000)		(0.000)			(0.002)		(0.002)
Log Market Cap				-1.101***	-2.907***				-0.00126***	0.000265				-0.0389***	-0.0422***
				(0.084)	(0.099)				(0.000)	(0.000)				(0.004)	(0.005)
Log Volume ($)					1.374***										0.0102***
					(0.023)										(0.001)
Volume / Shares Outstanding										0.0427***					
										(0.007)					
Constant	-3.459***	-0.507***	2.200***	25.93***	34.28***	-0.00167***	-0.00318***	-0.00102***	0.0271***	-0.00835*	-0.0536***	-0.0788***	-0.0166***	0.835***	0.585***
	(0.587)	(0.185)	(0.051)	(1.759)	(1.815)	(0.000)	(0.001)	(0.000)	(0.009)	(0.005)	(0.011)	(0.009)	(0.003)	(0.083)	(0.090)
N	3,171,240	2,124,937	2,468,694	3,192,840	1,705,305	3,171,240	2,124,937	2,468,694	3,192,840	1,705,305	3,167,672	2,122,732	2,465,457	3,188,967	1,703,551
R- squared	0.28	0.27	0.31	0.28	0.32	0.40	0.34	0.47	0.33	0.51	0.30	0.36	0.43	0.30	0.50

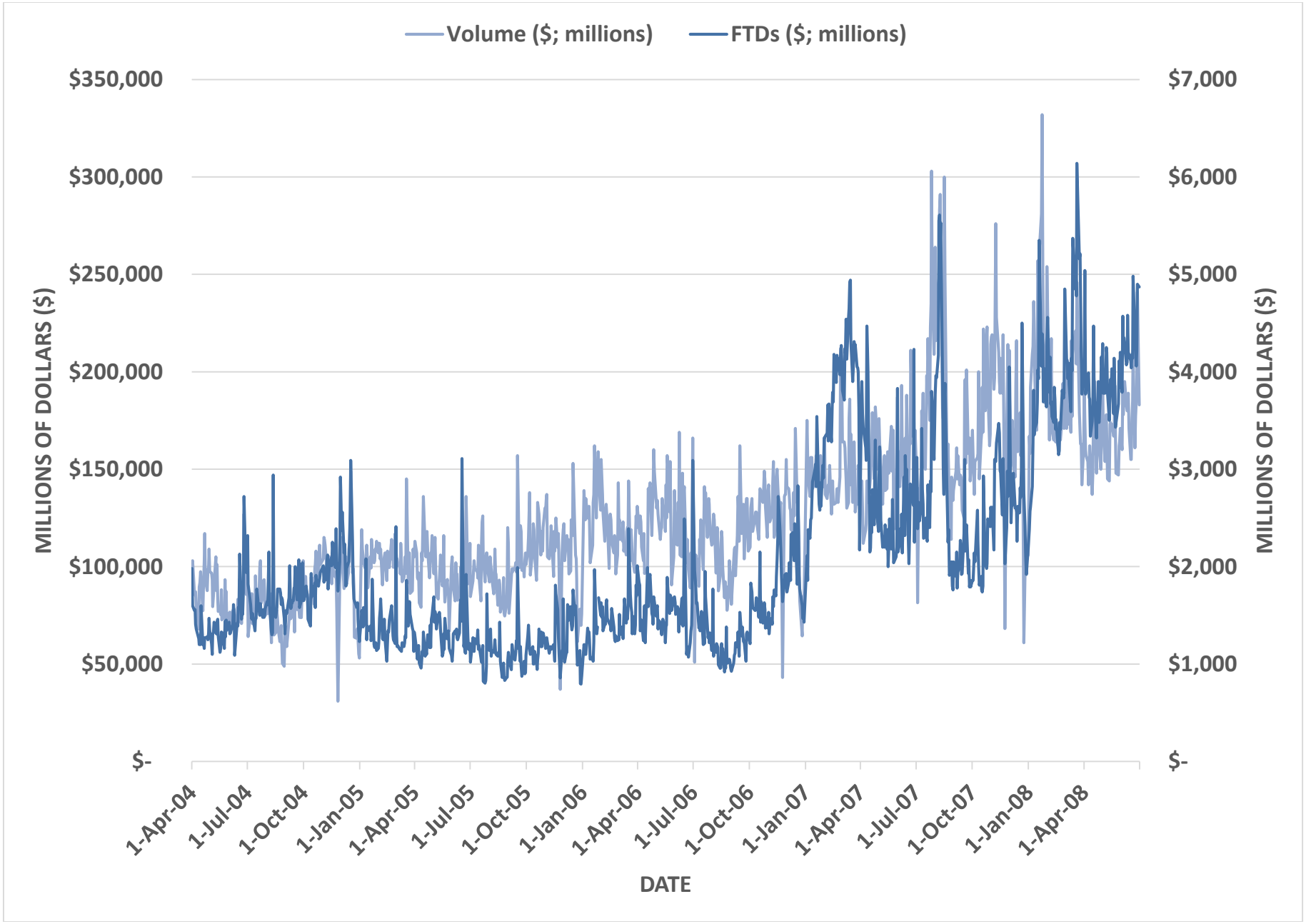


Fig. 1: Daily Russell 3000 Index trading volume and net FTDs. Data are for the period from April 2004 through June 2008. FTD data are from the SEC Freedom of Information Act (FOIA) Office, https://www.sec.gov/foia/docs/failsdata-archive.htm. We isolate daily FTDs for all Russell 3000 stocks, multiply by stock price, and the sum the daily FTDs through time. All values are in January 2010 dollars.

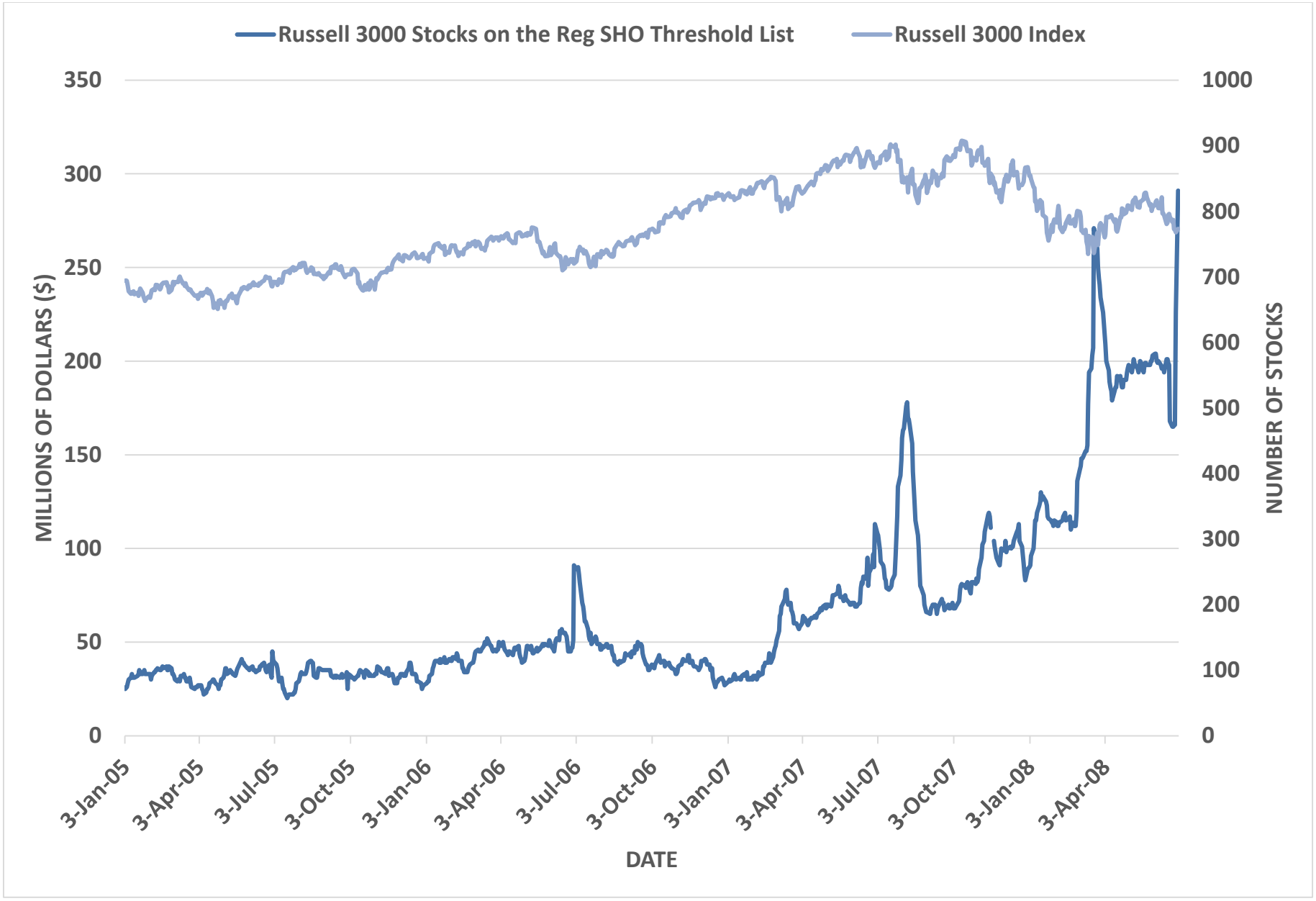
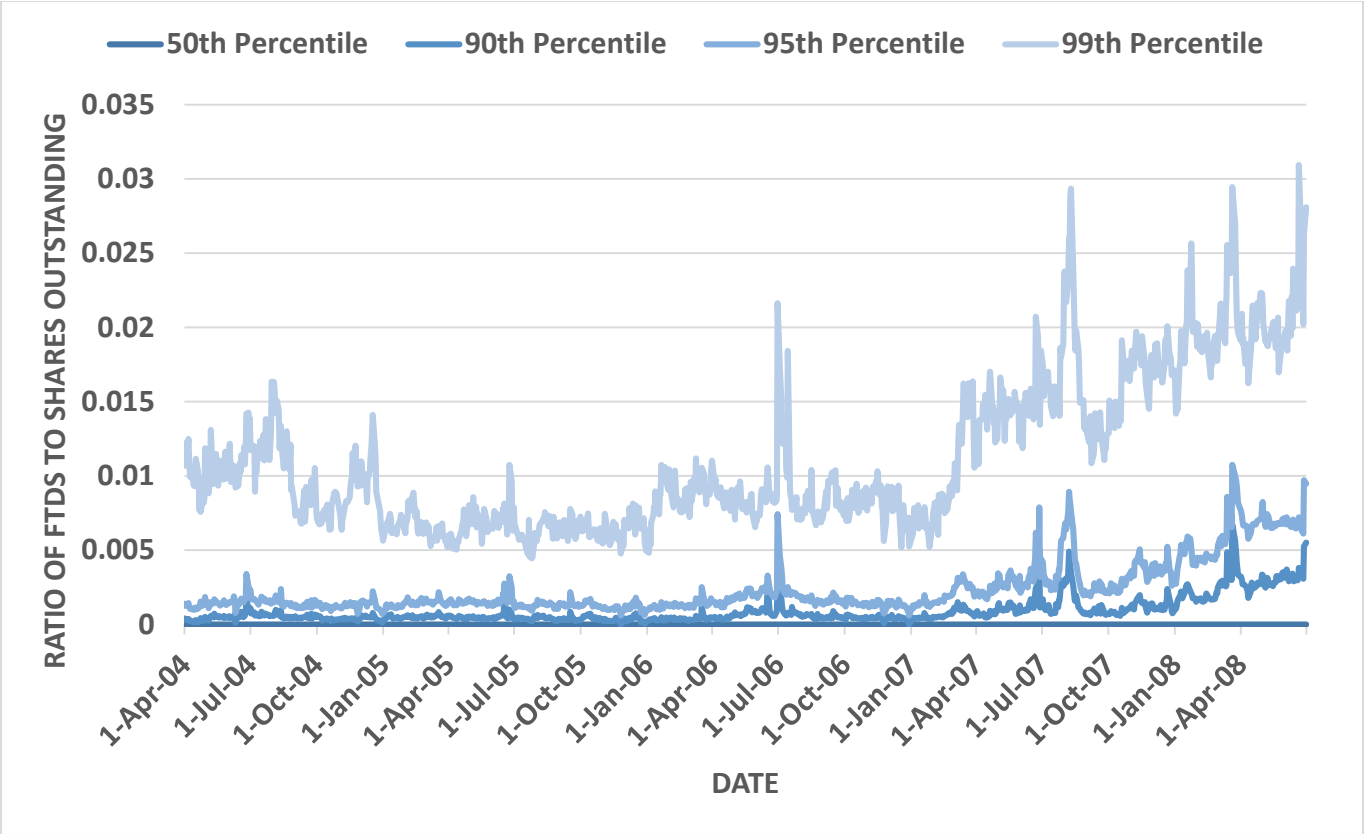
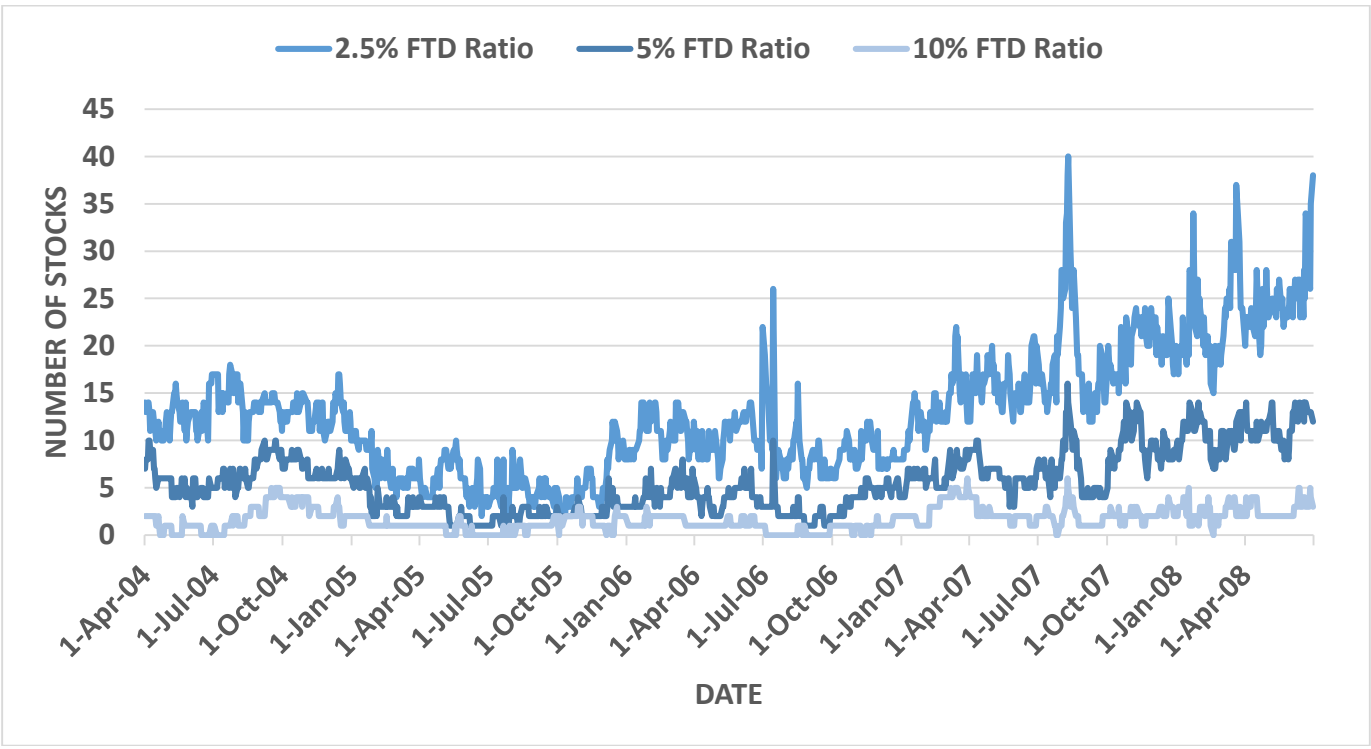


Fig. 2: Daily Russell 3000 Index level and Regulation SHO Threshold totals. Russell 3000 Data are for the period from April 2004 through June 2008. Threshold lists were not published until January 2005. The 5 major market centers that publish daily text files of Threshold List securities are NASDAQ, NYSE, Chicago Stock Exchange (CHX), BATS, and FINRA (OTC). We isolate the Reg SHO Russell 3000 tickers and sum the daily count. For more info, see Securities Exchange Commission, Key Points About Regulation SHO, "10. Where can I find threshold lists?", http://www.sec.gov/investor/pubs/regsho.htm.

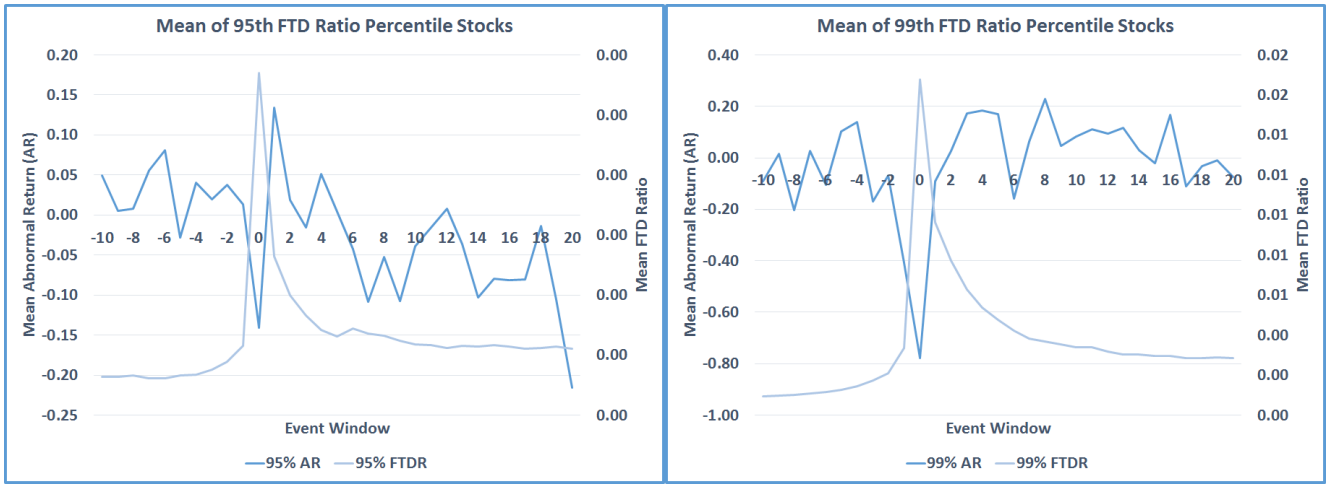


3a



3b

Fig. 3: Daily FTD ratio percentiles and portfolio counts for Russell 3000 Index stocks. Data are for the period from April 2004 through June 2008. FTD data are from the SEC Freedom of Information Act (FOIA) Office, https://www.sec.gov/foia/docs/failsdata-archive.htm. Shares Outstanding data are from Wharton Research Data Services (WRDS). For each Russell 3000 stock, we divide daily FTDs by daily shares outstanding and then calculate dailiy percentiles, as in Table 3a, or portfolio counts according to FTD ratio, as in Table 3b.



4a

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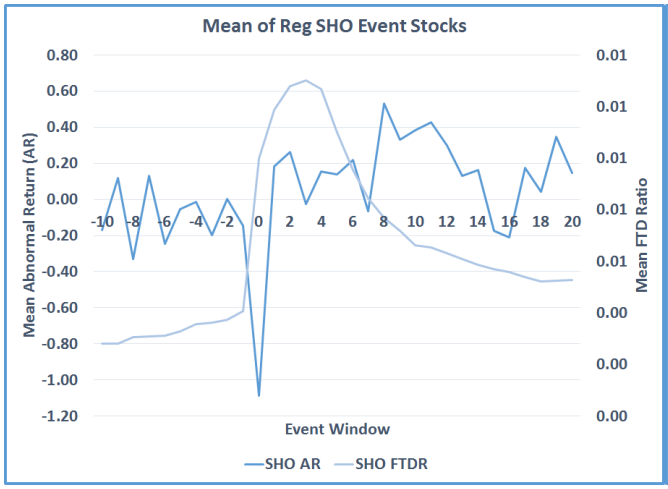

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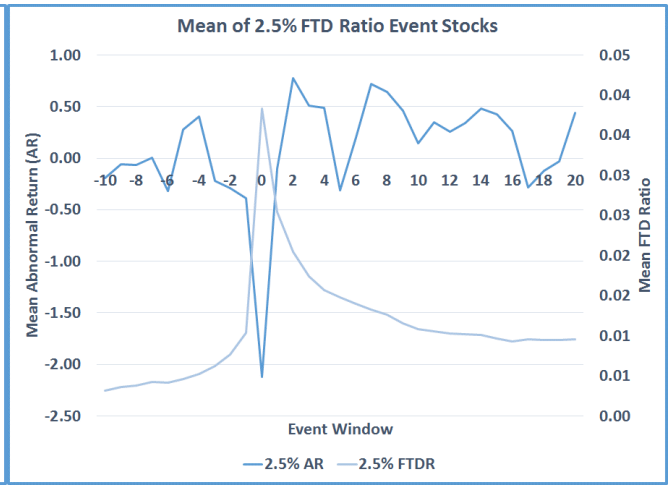

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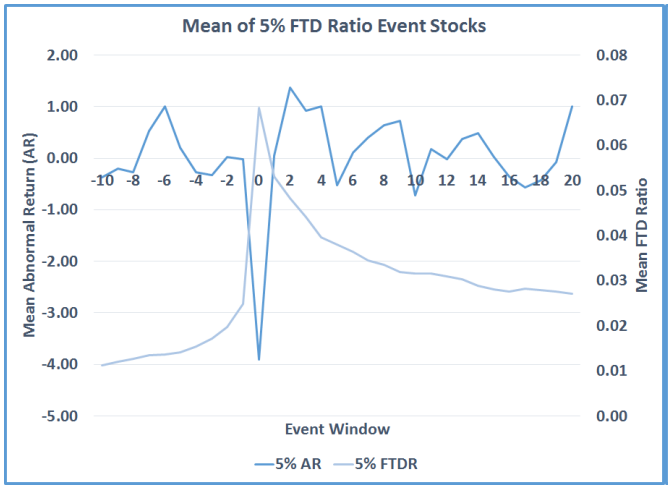

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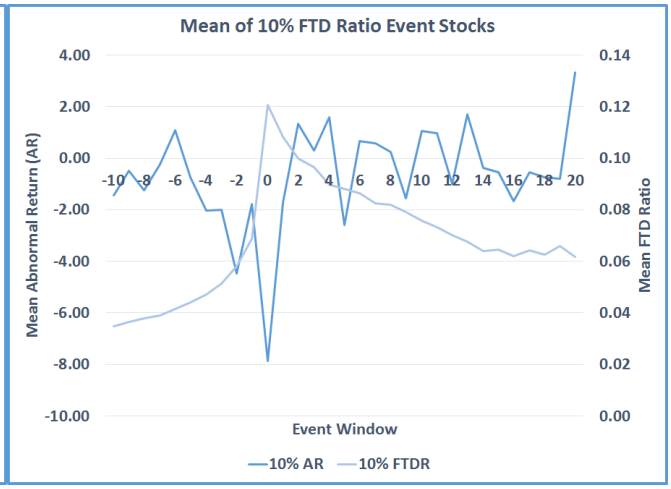

4f

Fig. 4. Graphs of mean abnormal return vs mean FTD ratio by FTD ratio group. Data are daily averages for stocks that achieve a significant FTD ratio at least once during the period from April 2004 through June 2008. For each ticker *i* that achieves an FTD ratio threshold, we identify a common 30 day event window [-10,20] and calculate daily abnormal returns based upon a 30 day estimation window [-90,-61]. Next, we calculate daily averages by FTD ratio group. The resulting figures show a composite comparison of abnormal returns by FTD ratio group during the event period.

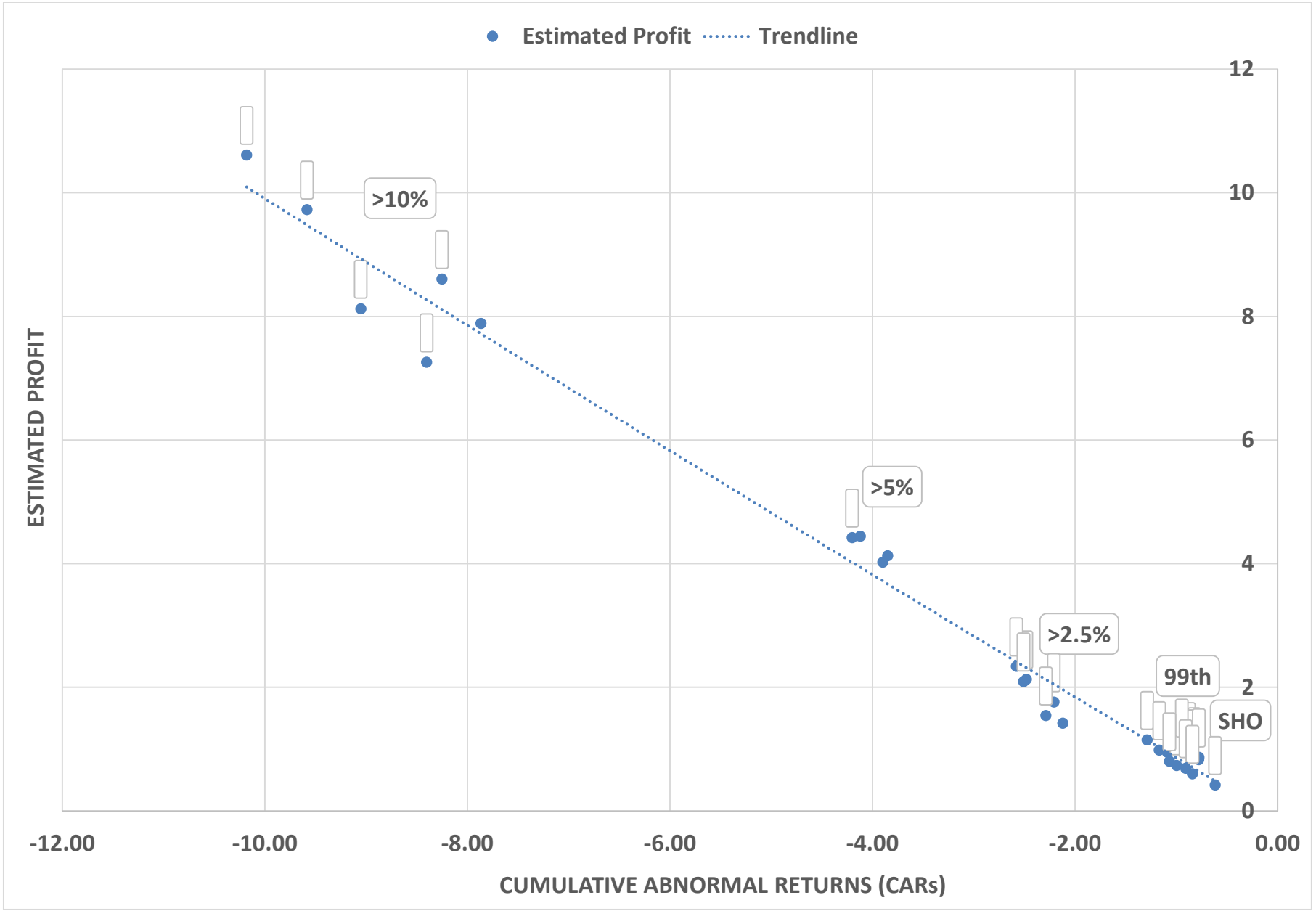

Fig. 5: Comparison of estimated profits from short selling and cumulative abnormal returns for high FTD stocks. This figure compares the estimated profit event study data in Table 4 to the cumulative abnormal return (CAR) event study data in Table 3. For each Russell 3000 ticker, short sale profits are calculated by subtracting annualized SunGard Astec stock borrow costs from cumulative abnormal returns (CARs) during an FTD ratio event. Estimated profits are in annual percentages. Data clusters are labeled by FTD ratio group.

Appendix A

We provide additional tests of Hypothesis 1 using alternate specifications and time periods. First, we retest Hypothesis 1 for daily, monthly, and weekly portfolios of low and high FTD stocks using Fama-French factors but omit the momentum factor suggested by Carhart (1997):

$$Port_{it} - RF_t = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_{it} \quad \text{(A1)}$$

Equation (A1) is identical to equation (4) except that we omit the momentum factor. We can now test weekly data, which was previously omitted in the four-factor model as Kenneth French does not provide weekly momentum factor data. Tables A1, A2, and A3 report concurrent portfolio returns for daily, monthly, and weekly data using a three-factor model. The results are similar in direction and magnitude to those obtained using a four-factor model. The negative and statistically significant coefficients on the "⩾10%" and " ⩾95th & <99th" daily and monthly EW and VW portfolios provide strong support for Hypothesis 1.

Tables A4 and A5 present results for the persistence of monthly and weekly portfolio abnormal returns, respectively. Monthly portfolios of stocks that have experienced FTD ratios of at least 10 percent in the previous twelve months experience negative abnormal returns of between -3.576 percent and -4.093 percent. Similarly, weekly 10 percent FTD ratio stocks experience persistent abnormal negative returns of between -0.878 percent and -1.387 percent.

In Table A6, we report abnormal future returns results for high FTD portfolios sorted monthly. The ">10%" FTD ratio VW portfolio experiences monthly abnormal returns of -3% in the following month. Other EW and VW monthly portfolios experience negative abnormal returns that are not statistically significant. This can be explained by the fact that abnormal returns associated with FTDs are realized quickly in the concurrent period.

Appendix B

We supplement our empirical results for the determinants of FTDs in section 4.5 using weekly and monthly panel data. The results in Tables B1 and B2, where we use monthly and weekly data, indicate a stronger relationship between short interest and FTDs than the daily data in Table 10. This is due to a more accurate timing match between monthly short interest reporting and mean daily FTDs per month. In Table B1, for example, a 100 percent increase in monthly short interest leads to between 40.9 percent and 74 percent higher FTDs. In Table B2, a 100 percent increase in weekly mean short interest leads to between 39.5 percent and 55.2 percent higher FTDs.

Tables B1 and B2 also show positive and statistically significant relationships between FTDs and put option OI, stock loan spreads, and market capitalization. This holds for both FTD size and persistence. The negative and statistically significant relationship between FTDs and market cap persists as well using weekly and monthly averages. As with Table 10, the monthly and daily data indicate a large, positive, and statistically significant relationship between stock loan spread and FTDs. This relationship holds when we control for other factors including market capitalization.

Table A1

Three-factor model parameters for daily portfolios of low and high FTD Russell 3000 stocks

The dependent variable is Portit - RFt, the daily excess return of portfolio i over the risk-free rate, on either an equal-weighted (EW) or value-weighted (VW) basis, on day t. The market risk premium in period t is Russellt - RFt. The daily factor return realizations are provided by Kenneth French. SMB is the daily return on a portfolio of small stocks minus the daily return on a portfolio of big stocks. HML is the daily return on a portfolio of high book-to-market (value) minus low book-to-market (growth) stocks. For April 1, 2004 through June 30, 2008, 1047 daily returns are used in all regressions except the SHO portfolio. The SHO portfolio, which begins in 2005, is composed of all Regulation SHO Threshold Stocks on a given date. The ≥2.5% & <5% portfolio is composed of all Russell 3000 Index stocks with a ratio of FTDs to shares outstanding greater than 2.5% but less than 5%. The ≥5% & <10%, ≥10%, ≥95th & <99th percentile, and ≥99th percentile portfolios are similarly defined, and portfolios are updated daily. Robust standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1.

$$Port_{it} - RF_t = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_{it}$$

Sample	Intercept	Russell-RF	SMB	HML	*N*	*R*-squared
Panel A: Daily EW Russell 3000 Portfolios, April 1, 2004– June 30, 2008						
SHO	-0.0681**	1.255***	0.967***	0.266*	867	0.66
	(0.031)	(0.044)	(0.083)	(0.147)		
≥2.5% & <5%	-0.130**	1.391***	0.985***	0.322	1047	0.34
	(0.06)	(0.07)	(0.15)	(0.21)		
≥5% & <10%	-0.212***	1.268***	1.228***	0.254	1046	0.28
	(0.07)	(0.10)	(0.16)	(0.23)		
≥10%	-0.261***	1.522***	0.992***	0.277	1047	0.27
	(0.08)	(0.10)	(0.20)	(0.25)		
≥95th & <99th	0.0311*	1.253***	1.084***	0.0616	1047	0.83
	-0.0179	-0.0333	-0.0545	-0.0833		
≥99th	-0.0932**	1.342***	0.902***	0.352*	1047	0.49
	(0.04)	(0.06)	(0.11)	(0.19)		
Panel B: Daily VW Russell 3000 Portfolios, April 1, 2004– June 30, 2008						
SHO	-0.0494	1.218***	0.883***	0.179	867	0.62
	(0.033)	(0.045)	(0.087)	(0.153)		
≥2.5% & <5%	-0.0854	1.376***	1.019***	0.488*	1048	0.29
	(0.07)	(0.10)	(0.18)	(0.27)		
≥5% & <10%	-0.175**	1.180***	1.072***	0.0876	1046	0.24
	(0.07)	(0.10)	(0.17)	(0.25)		
≥10%	-0.359***	1.530***	1.179***	0.32	1047	0.23
	(0.09)	(0.11)	(0.18)	(0.32)		
≥95th & <99th	0.0218	1.227***	0.826***	0.162	1047	0.73
	-0.0225	-0.0365	-0.0628	-0.103		
≥99th	-0.0864**	1.291***	0.861***	0.267	1047	0.45
	(0.04)	(0.06)	(0.10)	(0.19)		

Table A2

Three-factor model parameters for monthly portfolios of low and high FTD Russell 3000 stocks

The dependent variable is Portit - RFt, the monthly excess return of portfolio i over the risk-free rate, on either an equal-weighted (EW) or value-weighted (VW) basis, in month t. The market risk premium in period t is Russellt - RFt. The monthly factor return realizations are provided by Kenneth French. SMB is the return on a portfolio of small stocks minus the return on a portfolio of big stocks. HML is the return on a portfolio of high book-to-market (value) minus low book-to-market (growth) stocks. For April 1, 2004 through June 30, 2008, 49 monthly returns are used in all regressions except the SHO portfolio. The SHO portfolio, which begins in 2005, is composed of all stocks that have appeared on the Regulation SHO Threshold List at least once in month t. The ≥2.5% & <5% portfolio is composed of all Russell 3000 Index stocks with a maximum ratio of FTDs to shares outstanding greater than 2.5% but less than 5% in month t. The ≥5% & <10%, ≥10%, ≥95th & <99th percentile, and ≥99th percentile portfolios are similarly defined, and portfolios are updated monthly. Robust standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1.

$$Port_{it} - RF_t = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_{it}$$

Sample	Intercept	Russell-RF	SMB	HML	*N*	*R*-squared
Panel A: Monthly EW Russell 3000 Portfolios, April 1, 2004– June 30, 2008						
SHO	-0.759	1.288**	1.207***	-0.141	40	0.57
	(0.857)	(0.491)	(0.412)	(0.438)		
≥2.5% & <5%	-1.866	1.126**	0.623	0.893	49	0.22
	(1.14)	(0.42)	(0.61)	(0.78)		
≥5% & <10%	1.046	1.039	2.427***	-0.357	48	0.24
	(2.04)	(0.97)	(0.86)	(1.05)		
≥10%	-7.351***	2.210**	2.00	0.978	49	0.26
	(2.12)	(1.03)	(1.22)	(1.26)		
≥95th & <99th	-0.466	1.158***	1.364***	0.213	49	0.72
	(0.55)	(0.31)	(0.31)	(0.30)		
≥99th	-2.543***	1.515***	0.671	1.406**	49	0.43
	(0.94)	(0.53)	(0.55)	(0.59)		
Panel B: Monthly VW Russell 3000 Portfolios, April 1, 2004– June 30, 2008						
SHO	-0.429	1.238***	1.082**	-0.17	40	0.56
	(0.791)	(0.343)	(0.447)	(0.416)		
≥2.5% & <5%	-1.601	1.243***	1.104**	0.663	49	0.28
	(1.30)	(0.33)	(0.46)	(0.82)		
≥5% & <10%	0.926	0.469	2.729***	-0.845	48	0.24
	(1.94)	(0.80)	(0.66)	(1.05)		
≥10%	-8.284***	1.871	3.246**	0.355	49	0.25
	(2.92)	(1.17)	(1.45)	(1.26)		
≥95th & <99th	-1.154	1.242***	1.237***	0.51	49	0.61
	(0.71)	(0.30)	(0.32)	(0.39)		
≥99th	-2.402***	1.450***	1.128***	0.906*	49	0.52
	(0.84)	(0.35)	(0.39)	(0.46)		

Table A3

Three-factor model parameters for weekly portfolios of low and high FTD Russell 3000 stocks

The dependent variable is Portit - RFt, the weekly excess return of portfolio i over the risk-free rate, on either an equal-weighted (EW) or value-weighted (VW) basis, in week t. The market risk premium in period t is Russellt - RFt. The weekly factor return realizations are provided by Kenneth French. SMB is the return on a portfolio of small stocks minus the return on a portfolio of big stocks. HML is the return on a portfolio of high book-to-market (value) minus low book-to-market (growth) stocks. The UMD momentum factor is not available for weekly data. For April 1, 2004 through June 30, 2008, 219 monthly returns are used in all regressions except the SHO portfolio. The SHO portfolio, which begins in 2005, is composed of all stocks that have appeared on the Regulation SHO Threshold List at least once in a given month. The ≥2.5% & <5% portfolio is composed of all Russell 3000 Index stocks with a ratio of FTDs to shares outstanding greater than 2.5% but less than 5%. The ≥5% & <10%, ≥10%, ≥95th & <99th percentile, and ≥99th percentile portfolios are similarly defined, and portfolios are updated monthly. Robust standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1.

$$Port_{it} - RF_t = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_{it}$$

Sample	Intercept	Russell-RF	SMB	HML	*N*	*R*-squared
Panel A: Weekly EW Russell 3000 Portfolios, April 1, 2004– June 30, 2008						
SHO	-0.0901	1.202***	1.239***	0.0873	179	0.52
	(0.194)	(0.124)	(0.232)	(0.410)		
≥2.5% & <5%	-0.562	1.331***	0.37	-0.0454	219	0.19
	(0.35)	(0.21)	(0.35)	(0.51)		
≥5% & <10%	-0.471	1.581***	0.878	0.125	212	0.16
	(0.51)	(0.28)	(0.54)	(0.76)		
≥10%	-1.512	2.419***	0.895	0.515	201	0.12
	(0.96)	(0.76)	(1.62)	(1.51)		
≥95th & <99th	-0.0589	0.987***	0.860***	0.362	219	0.43
	(0.17)	(0.11)	(0.19)	(0.30)		
≥99th	-0.369	1.384***	0.709**	0.338	219	0.38
	(0.24)	(0.16)	(0.29)	(0.41)		
Panel B: Weekly VW Russell 3000, April 1, 2004– June 30, 2008						
SHO	-0.0626	1.065***	1.019***	-0.135	179	0.46
	(0.197)	(0.127)	(0.224)	(0.345)		
≥2.5% & <5%	-0.387	1.151***	0.445	-0.24	219	0.18
	(0.33)	(0.21)	(0.34)	(0.50)		
≥5% & <10%	-0.709	1.505***	0.916*	-0.116	212	0.16
	(0.49)	(0.25)	(0.47)	(0.74)		
≥10%	-2.018**	1.894***	1.638	1.265	201	0.11
	(0.91)	(0.45)	(1.13)	(1.14)		
≥95th & <99th	-0.134	0.930***	0.611***	0.274	219	0.38
	(0.17)	(0.12)	(0.20)	(0.28)		
≥99th	-0.411*	1.210***	0.551**	0.00566	219	0.33
	(0.24)	(0.13)	(0.24)	(0.33)		

Table A4

Persistence of four-factor model parameter estimates for monthly portfolios of low and high FTD Russell 3000 stocks

The dependent variable is Portit - RFt, the monthly excess return of portfolio i over the risk-free rate, on either an equal-weighted (EW) or value-weighted (VW) basis, for the period from April 1, 2004 through June 30, 2008. The market risk premium in month t is Russellt - RFt. The monthly factor return realizations for book-to-market value, firm size, and momentum are provided by Kenneth French. The SHO portfolio, which begins in 2005, is composed of all stocks that have appeared on the Regulation SHO Threshold List at least once in the previous 12 months. The ≥2.5% & <5% portfolio is composed of all Russell 3000 Index stocks that have experienced a maximum FTDs to shares outstanding ratio greater than 2.5% but less than 5% at any point in the previous 12 months. The ≥5% & <10%, ≥10%, ≥95th & <99th percentile, and ≥99th percentile portfolios are similarly defined, and portfolios are updated monthly. Robust standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1.

$$Port_{it} - RF_t = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{it}$$

Sample	Intercept	Russell-RF	SMB	HML	UMD	*N*	*R*-squared
Panel A: Monthly EW Russell 3000 Portfolios, April 1, 2004– June 30, 2008							
SHO	-0.651	1.139***	1.161***	-0.0367	-0.637***	41	0.73
	(0.485)	(0.201)	(0.279)	(0.270)	(0.228)		
≥2.5% & <5%	-1.083**	1.208***	1.004***	0.538**	-0.447**	50	0.70
	(0.45)	(0.22)	(0.29)	(0.23)	(0.21)		
≥5% & <10%	-0.628	1.247***	1.697***	0.214	-0.995***	50	0.60
	(0.76)	(0.37)	(0.47)	(0.38)	(0.29)		
≥10%	-3.576***	2.011***	0.524	0.925	-0.32	50	0.35
	(1.30)	(0.68)	(0.88)	(0.74)	(0.54)		
≥95th & <99th	-0.467	1.124***	1.050***	0.24	-0.300*	50	0.76
	(0.38)	(0.17)	(0.24)	(0.23)	(0.16)		
≥99th	-1.130**	1.236***	1.088***	0.547**	-0.489**	50	0.76
	(0.42)	(0.21)	(0.29)	(0.23)	(0.20)		
Panel B: Monthly VW Russell 3000 Portfolios, April 1, 2004– June 30, 2008							
SHO	-0.429	1.172***	1.066***	0.0638	-0.440**	41	0.74
	(0.400)	(0.189)	(0.273)	(0.282)	(0.168)		
≥2.5% & <5%	-0.0562	1.054***	0.817**	-0.0532	-0.268	50	0.53
	(0.63)	(0.22)	(0.32)	(0.29)	(0.21)		
≥5% & <10%	-0.387	1.248***	0.826*	-0.13	0.164	50	0.48
	(0.83)	(0.34)	(0.46)	(0.47)	(0.27)		
≥10%	-4.093**	1.862**	1.377*	-0.0609	0.312	50	0.38
	(1.74)	(0.70)	(0.74)	(0.94)	(0.63)		
≥95th & <99th	-0.503	1.114***	0.689***	0.125	-0.284	50	0.73
	(0.39)	(0.17)	(0.21)	(0.20)	(0.17)		
≥99th	-0.661	1.194***	0.672**	0.125	0.0221	50	0.64
	(0.51)	(0.21)	(0.29)	(0.25)	(0.17)		

Table A5

Persistence of three-factor model parameter estimates for weekly portfolios of low and high FTD Russell 3000 stocks

The dependent variable is Portit - RFt, the weekly excess return of portfolio i over the risk-free rate, on either an equal-weighted (EW) or value-weighted (VW) basis, for the period from April 1, 2004 through June 30, 2008. The market risk premium in week t is Russellt - RFt. The weekly factor return realizations for book-to-market value and firm size are provided by Kenneth French. The SHO portfolio, which begins in 2005, is composed of all stocks that have appeared on the Regulation SHO Threshold List at least once in the previous 12 weeks. The ≥2.5% & <5% portfolio is composed of all Russell 3000 Index stocks that have experienced a maximum FTDs to shares outstanding ratio greater than 2.5% but less than 5% at any point in the previous 12 weeks. The ≥5% & <10%, ≥10%, ≥95th & <99th percentile, and ≥99th percentile portfolios are similarly defined, and portfolios are updated weekly. Robust standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1.

$$Port_{it} - RF_t = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_{it}$$

Sample	Intercept	Russell-RF	SMB	HML	*N*	*R*-squared
Panel A: Weekly EW Russell 3000 Portfolios, April 1, 2004– June 30, 2008						
SHO	-0.305*	1.103***	1.142***	0.258	180	0.55
	(0.167)	(0.108)	(0.188)	(0.344)		
≥2.5% & <5%	-0.426**	1.215***	0.686***	0.299	219	0.44
	(0.18)	(0.12)	(0.21)	(0.33)		
≥5% & <10%	-0.629**	1.350***	0.945***	0.0418	219	0.38
	(0.26)	(0.17)	(0.29)	(0.40)		
≥10%	-0.878*	1.778***	0.942	0.0432	219	0.20
	(0.51)	(0.36)	(0.74)	(0.76)		
≥95th & <99th	-0.153	0.893***	0.763***	0.233	219	0.47
	(0.14)	(0.09)	(0.16)	(0.25)		
≥99th	-0.277*	1.152***	0.698***	0.309	219	0.48
	(0.16)	(0.11)	(0.20)	(0.30)		
Panel B: Weekly VW Russell 3000 Portfolios, April 1, 2004– June 30, 2008						
SHO	-0.195	1.045***	0.905***	0.115	180	0.53
	(0.160)	(0.111)	(0.187)	(0.310)		
≥2.5% & <5%	-0.340*	1.094***	0.467***	0.205	219	0.40
	(0.18)	(0.11)	(0.18)	(0.29)		
≥5% & <10%	-0.762***	1.194***	0.991***	-0.13	219	0.37
	(0.24)	(0.13)	(0.28)	(0.37)		
≥10%	-1.387***	1.509***	1.577**	0.187	219	0.21
	(0.50)	(0.26)	(0.61)	(0.64)		
≥95th & <99th	-0.124	0.888***	0.444***	0.113	219	0.45
	(0.13)	(0.09)	(0.15)	(0.23)		
≥99th	-0.298*	1.027***	0.453***	0.222	219	0.43
	(0.16)	(0.11)	(0.16)	(0.26)		

Table A6

Four-factor model parameters for future monthly portfolios of low and high FTD Russell 3000 stocks

The dependent variable is Portit+1 - RFt+1, the monthly excess return of portfolio i over the risk-free rate, on either an equal-weighted (EW) or value-weighted (VW) basis, in month t+1. The market risk premium for month t+1 is Russellt+1 - RFt+1. The monthly factor return realizations are provided by Kenneth French. SMB is the return on a portfolio of small stocks minus the return on a portfolio of big stocks. HML is the return on a portfolio of high book-to-market (value) minus low book-to-market (growth) stocks. UMD is the return on a portfolio of prior winners minus the return on a portfolio of prior losers. For April 1, 2004 through June 30, 2008, 49 monthly returns are used in all regressions except the SHO portfolio. The SHO portfolio, which begins in 2005, is composed of all stocks that have appeared on the Regulation SHO Threshold List at least once in month t, whichis the previous month. The ≥2.5% & <5% portfolio is composed of all Russell 3000 Index stocks with a ratio of FTDs to shares outstanding greater than 2.5% but less than 5% in month t. The ≥5% & <10%, ≥10%, ≥95th & <99th percentile, and ≥99th percentile portfolios are similarly defined, and portfolios are updated monthly. Robust standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1.

$$Port_{it+1} - RF_{t+1} = \alpha_{it} + \beta_1 (Russell_t - RF_t) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{it}$$

Sample	Intercept	Russell-RF	SMB	HML	UMD	*N*	*R*-squared
Panel A: Future Monthly EW Russell 3000 Portfolios, April 1, 2004– June 30, 2008							
SHO	-2.174**	1.229***	1.265***	0.203	-0.871**	40	0.58
	(0.802)	(0.379)	(0.389)	(0.427)	(0.399)		
≥2.5% & <5%	-0.753	1.100***	1.777***	0.662	-0.650***	49	0.57
	(0.650)	(0.314)	(0.456)	(0.492)	(0.235)		
≥5% & <10%	-1.584	1.117**	1.031	-0.339	-1.023**	48	0.25
	(1.386)	(0.547)	(0.652)	(0.739)	(0.463)		
≥10%	-2.642	2.554**	2.248	1.008	-1.634*	49	0.34
	(2.026)	(1.048)	(1.500)	(1.109)	(0.915)		
≥95th & <99th	-0.583	1.123***	1.271***	0.191	-0.526**	49	0.73
	(0.573)	(0.253)	(0.299)	(0.252)	(0.246)		
≥99th	-1.225	1.613***	1.498**	0.707	-0.977**	49	0.62
	(0.824)	(0.452)	(0.579)	(0.456)	(0.381)		
Panel B: Future Monthly VW Russell 3000 Portfolios, April 1, 2004– June 30, 2008							
SHO	-1.968***	1.210***	1.091***	0.502	-0.281	40	0.55
	(0.685)	(0.271)	(0.372)	(0.390)	(0.282)		
≥2.5% & <5%	0.0495	0.872**	1.454***	-0.251	-0.668**	49	0.48
	(0.837)	(0.351)	(0.409)	(0.462)	(0.284)		
≥5% & <10%	-2.322	0.83	1.079	0.0725	-0.832	48	0.17
	(1.499)	(0.570)	(0.706)	(0.864)	(0.510)		
≥10%	-3.005*	2.080***	2.828***	0.0647	-0.906	49	0.44
	(1.578)	(0.572)	(0.906)	(0.777)	(0.552)		
≥95th & <99th	-0.337	0.873***	1.054***	0.248	-0.464*	49	0.61
	(0.511)	(0.254)	(0.297)	(0.262)	(0.241)		
≥99th	-1.198	1.276***	1.716***	0.525	-0.811***	49	0.59
	(0.782)	(0.325)	(0.442)	(0.379)	(0.296)		

Table B1

The Determinants of FTDs using Monthly Data

In specifications (1) through (3), the dependent variable is the average log dollar value of CNS fails-to-deliver (FTDs) for stock i in month t. In specifications (4) through (6), the dependent variable is the ratio of FTDs to shares outstanding. In specifications (7) through (9), the dependent variable is the likelihood that a ticker will appear on the Regulation SHO Threshold List. Data are for the period from April 1, 2004 through June 30, 2008. All regressions include stock fixed effects and in all regressions standard errors are clustered by ticker. Standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1. All dollar amounts are in real 2010 dollars.

$$FTD_{it} = \beta_1 \, Short\ Int_{it} + \beta_2 \, Put\ OI_{it} + \beta_2 \, Spread_{it} + \beta_3 \, Market\ Cap_{it} + \beta 4 \;\; Volume_{it} + \gamma_i + \varepsilon_{it}$$

	Log FTDs ($)					FTDs / Shares Outstanding					Regulation SHO Threshold List				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Log Short Interest	0.740***				0.409***						0.00473***				0.00287***
	(0.058)				(0.068)						(0.001)				(0.001)
Short Interest / Shares Outstanding						0.0385***				0.0225***					
						(0.006)				(0.004)					
Log Put Option IO		0.615***			0.256***		0.000488***			-0.000110***		0.0130***			0.00832***
		(0.023)			(0.025)		(0.000)			(0.000)		(0.001)			(0.001)
Spread			0.329***		0.220***			0.00150***		0.00124***			0.0341***		0.0356***
			(0.030)		(0.022)			(0.000)		(0.000)			(0.003)		(0.003)
Log Market Cap				0.013	-2.903***				-0.00126***	0.000370*				-0.0392***	-0.0471***
				(0.083)	(0.103)				(0.000)	(0.000)				(0.004)	(0.005)
Log Volume ($)					2.504***										0.0176***
					(0.056)										(0.002)
Volume / Shares Outstanding										0.0852***					
										(0.016)					
Constant	-5.139***	4.357***	7.565***	7.639***	19.60***	-0.00166**	-0.00314***	-0.00110***	0.0270***	-0.0104**	-0.0642***	-0.0820***	-0.0179***	0.841***	0.581***
	(1.027)	(0.187)	(0.036)	(1.747)	(1.766)	(0.000)	(0.001)	(0.000)	(0.009)	(0.005)	(0.013)	(0.009)	(0.003)	(0.086)	(0.095)
N	155,516	104,327	123,423	156,659	84,714	155,516	104,327	123,423	156,659	84,714	155,478	104,259	123,330	156,553	84,690
R- squared	0.43	0.37	0.42	0.41	0.42	0.44	0.37	0.52	0.36	0.57	0.38	0.44	0.54	0.39	0.61

Table B2

The Determinants of FTDs using Weekly Data

In specifications (1) through (3), the dependent variable is the average log dollar value of CNS fails-to-deliver (FTDs) for stock i in week t. In specifications (4) through (6), the dependent variable is the ratio of FTDs to shares outstanding. In specifications (7) through (9), the dependent variable is the likelihood that a ticker will appear on the Regulation SHO Threshold List. Data are for the period from April 1, 2004 through June 30, 2008. All regressions include stock fixed effects and in all regressions standard errors are clustered by ticker. Standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1. All dollar amounts are in real 2010 dollars.

$$FTD_{it} = \beta_1 \, Short\ Int_{it} + \beta_2 \, Put\ OI_{it} + \beta_2 Spread_{it} + \beta_3 \, Market\ Cap_{it} + \beta 4 \;\; Volume_{it} + \gamma_i + \varepsilon_{it}$$

	Log FTDs ($)					FTDs / Shares Outstanding					Regulation SHO Threshold List				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Log Short Interest	0.552***				0.395***						0.00417***				0.00310***
	(0.046)				(0.064)						(0.001)				(0.001)
Short Interest / Shares Outstanding						0.0385***				0.0234***					
						(0.006)				(0.004)					
Log Put Option IO		0.616***			0.287***		0.000489***			-6.89e-05**		0.0126***			0.00855***
		(0.024)			(0.023)		(0.000)			(0.000)		(0.001)			(0.001)
Spread			0.475***		0.337***			0.00148***		0.00123***			0.0338***		0.0352***
			(0.037)		(0.031)			(0.000)		(0.000)			(0.002)		(0.003)
Log Market Cap				-0.723***	-3.645***				-0.00126***	0.000298				-0.0389***	-0.0447***
				(0.090)	(0.106)				(0.000)	(0.000)				(0.004)	(0.005)
Log Volume ($)					2.422***										0.0141***
					(0.036)										(0.001)
Volume / Shares Outstanding										0.0655***					
										(0.011)					
Constant	-4.721***	1.011***	4.487***	20.16***	33.58***	-0.00168**	-0.00316***	-0.00106***	0.0272***	-0.00899*	-0.0549***	-0.0789***	-0.0175***	0.834***	0.582***
	(0.813)	(0.192)	(0.044)	(1.885)	(1.932)	(0.000)	(0.001)	(0.000)	(0.009)	(0.005)	(0.011)	(0.009)	(0.003)	(0.083)	(0.090)
N	668,494	447,953	525,474	673,036	362,264	668,494	447,953	525,474	673,036	362,264	667,684	447,452	524,712	672,149	361,858
R- squared	0.33	0.30	0.35	0.33	0.37	0.41	0.35	0.49	0.34	0.53	0.32	0.38	0.46	0.32	0.52