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Short Squeezes

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Abstract

Building upon the premise that short squeezes are most likely to occur following a large one day price increase for stocks with a short sale constraint and can be captured by the level of subsequent price reversal, we study how prevalent short squeezes are and the corresponding economic consequences. Using daily short interest data, we confirm that the occurrence of short squeezes is driven by both the capital constraint of the short sellers and the short sale constraint of the underlying stocks. Further analyses reveal that following a large price increase, the "squeezed" firms experience an increase in the demand for and cost of borrowing their shares, as well as an increase in their trading volume, idiosyncratic volatility, and abnormal return. These findings suggest that in addition to their impact on stock prices, short squeezes can also have a lingering effect on capital markets.

Keywords: Short selling, short squeezes, short sale constraint, price reversals
JEL Classification: G12, G14

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Short Squeezes

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Keywords: Short Selling; Short Squeeze; Short Sale Constraint; Price Reversals
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1. Introduction

Short sellers borrow shares of an asset they believe will drop in price with the expectation of buying shares back at a cheaper price and earning profits through the price difference. However, if the price unexpectedly jumps, short sellers may rush to buy back shares at a higher price in order to meet the margin requirements or to avoid greater losses. This short covering could further increase the price of the shorted asset, triggering more short sellers to buy back shares in order to cover their positions. This cascading purchase of shares could result in an even larger price increase and therefore further losses for those short sellers who have not already covered their position.

The above-mentioned risk faced by short sellers is often referred to as a short squeeze—a rapid increase in share price primarily due to excessive covering of short positions rather than a change in the fundamentals of the underlying asset. A recent example of this is the American video game retailer GameStop. In early January 2021, Citron Research, a well-known online newsletter, proposed that GameStop was overvalued. The message drew wide attention from large investors such as hedge funds who placed substantial short positions on the stock, resulting in a short interest of approximately 140% for the stock at its peak in January of 2021.[2] In response to the short selling of GameStop's shares by large investors, retail investors on the Internet forum Reddit organized a counterattack and bought both GameStop's shares and call options. Their trading drove the stock price to increase nearly 2,500% from $19.94 to its all-time high of $483.00 in the 12 trading days over the period of January 11th through January 28th, causing a squeeze among short sellers. According to the statistics of the global equity analytics platform Ortex, the trading losses of short sellers who suffered from the "GameStop squeeze" totaled approximately $11 billion.[3]

[2] Short interest exceeding 100 percent means that some shorted shares had been re-lent and shorted again.
[3] Among the list of short sellers include e.g., Melvin Capital, an investment fund that lost over $4 billion on their January trades on GameStop; and Andrew Left, the head of Citron Research who claimed to have closed his short position on GameStop at a total loss.

Due to their potential impact on stock prices and short sellers' trading profits, short squeezes have received wide attention from the financial media.[4] Academic research, however, has focused mainly on the theoretical explanations or small sample case studies.[5] In this study, we empirically explore the dynamics of short squeezes in a more systematic way. Specifically, we employ the daily short interest data for a large sample of stocks and build an identification methodology that enables a better examination of how prevalent short squeezes are and their corresponding economic consequences. Not only are the answers to these questions relevant to traders but they could also enrich existing studies on short selling, particularly those focusing on short sale constraints and the cost and risk of short selling.

The identification of short squeezes requires knowledge of the mechanism through which short squeezes occur. According to the U.S. Securities and Exchange Commission (SEC), short squeezes are driven by *"the pressure on short sellers to cover their positions as a result of sharp price increases or difficulty in borrowing the security the sellers short. The rush by short sellers to cover produces additional upward pressure on the price of the stock, which then can cause an even greater squeeze"*.[6] The definition indicates two conditions required for the occurrence of a short squeeze: 1) an unexpected and sharp stock price increase, which forces short sellers to cover their short positions (i.e., a capital constraint for the short sellers); and 2) the price increase is paired with a short sale constraint, which impedes new short sellers from entering the market and arbitraging away the mispricing.

Nevertheless, the upward drift in stock price would not continue forever. Once the demand from the "squeezed" short sellers concludes, the stock price should revert back to its fundamental level. Therefore, we conjecture that one strategy to identify the occurrence of a

[4] Short squeeze has been frequently cited in the news media. Searching under the key word "short squeeze(s)" over the period of January 1995 through August 2021 on the *Wall Street Journal* yields over 121 hits.
[5] See e.g., Jarrow (1992), Jarrow (1994), Cooper and Donaldson (1998), and Nyborg and Strebularv (2003), and Lamont (2012).
[6] https://www.sec.gov/investor/pubs/regsho.htm (last accessed on January 28, 2022).

short squeeze is to identify an event where there is a price reversal following a sharp price increase of a short sale constrained stock; and if so, the magnitude of the short squeeze can be captured by the level of the price reversal.

To test these conjectures, we focus on trading days where the increase in the daily return of a stock is greater than 15% (i.e., trading days where short sellers of the stock are likely to face a capital constraint). We then double sort these firm-trading-day observations (the events, thereafter) into 100 groups based on the extent to which the short sellers are facing a capital constraint and the extent to which the stock is facing a short sale constraint. Following Boehmer, Jones, and Zhang (2008) and Diether, Lee, and Werner (2009), we define short sellers' capital constraint as the percentage increase in the daily stock price (*Day 0 Raw Return*). To capture the stocks' short sale constraint, we rely on a widely-used proxy of daily short interest—the percentage of outstanding shares available for lending (*Loanable Shares*). A greater value of *Loanable Shares* indicates a lower level of short sale constraint.

Consistent with our conjecture, we find significant price reversals among stocks with bounded capital and short sale constraints. In particular, for stocks in both the highest capital constraint decile and the highest short sale constraint decile, the average next-day price reversal is -4.79% (the second greatest among all portfolio groups); in contrast, for stocks in both the lowest capital constraint decile and the lowest short sale constraint decile, the average next-day daily return is 0.48% (i.e., no price reversal at all).

We then perform multivariate analyses to further validate our conjecture. Specifically, we first run an OLS regression of the event day risk-adjusted stock return (*Day 0 Risk-Adjusted Return*) against the lagged short sale constraint (*Loanable Shares*) and a series of controls. Consistent with our conjecture that the short sale constraint combined with a sharp price increase would cause the stock price to drift upward further, we find that the lagged short sale constraint is significantly and positively correlated with *Day 0 Risk-Adjusted Return*. In particular, a one standard deviation increase in *Loanable Shares* is associated with a 1.68% decrease in *Day 0 Risk-Adjusted Return*. This result is economically meaningful as it accounts for 6.79% of the sample average *Day 0 Risk-Adjusted Return* (24.77%). The finding provides evidence that the first condition of a short squeeze has been met – a binding short sale constraint causes the stock price to drift upward after a sharp price increase.

The second condition of a short squeeze is that a large short-run increase in the stock price tightens the capital constraint of short sellers and, thereby, induces a more severe short squeeze and correspondingly a larger next-day reversal. To test this, we perform an OLS regression where the dependent variable is the daily risk-adjusted stock return over the next trading day (*Day 1 Risk-Adjusted Return*) and the key independent variables are the *Day 0 Risk-Adjusted Return* and the *Loanable Shares*. If the event day price increase is indeed largely driven by a short squeeze, we should observe significant price reversal for stocks with high *Day 0 Risk-Adjusted Return* and low *Loanable Shares* (i.e., those that are most vulnerable to a short squeeze). Consistent with our conjecture, we find a significantly negative (positive) relation between *Day 0 Risk-Adjusted Return* (*Loanable Shares*) and *Day 1 Risk-Adjusted Return*. These findings, together with those of the two-way independent sorts, validate our conjecture that a capital constraint caused by a sharp stock price increase along with a short sale constraint of the underlying stock can cause a short squeeze, the magnitude of which can be captured by the later price reversal.

Further, we explore the economic consequences of short squeezes. Specifically, for each of the 100 portfolios double sorted based on the capital constraint (*Day 0 Raw Return*) and the lagged short sale constraint (*Loanable Shares*) decile ranks, we compare the difference in the average supply of loanable shares, demand for borrowing shares, cost to borrow shares, daily trading volume, idiosyncratic volatility, and abnormal return of the stock sixty trading days prior to and sixty trading days following the event.[7] We find that stocks identified as the most vulnerable to a short squeeze (i.e., those with the greatest capital constraint and greatest short sale constraint) generally experience an increase in the demand for and the cost of borrowing their shares, as well as an increase in their trading volume, idiosyncratic volatility, and abnormal return. These findings are in line with Miller (1977) and D'Avolio (2002) who suggest that fees for short selling are ultimately sustained and increased by the divergence of opinion, which leads to an increase in the short interest.

Our study contributes to the literature on short squeezes. While many existing studies have explored squeezes from a theoretical perspective (Jarrow (1992), Jarrow (1994), Cooper and Donaldson (1998), and Nyborg and Strebularv (2003)), or its presence outside the equity market (Kumar and Seppi (1992), Jegadeesh (1993), Pirrong (1993), Nyborg and Sundaresan (1996), Pirrong (2001), and Merrick, Naik, and Yadav (2005)), relatively little is known about how prevalent it is in equity markets and their corresponding economic consequences. An exception is Lamont (2012) who studies 29 short squeezes based on information collected from news coverage. Our study, which builds upon the premise that short squeezes are most likely to occur following large one-day price increases for stocks with short sale constraints and can be captured by the level of subsequent price reversal, provides a systematic approach to identify the prevalence of short squeeze. Moreover, our identification strategy enables an isolation of short squeezes from recall squeezes where the forced short sale exits are unlikely to create a surging demand for stocks and thus their stock prices (D'Avolio (2002) and Schultz (2020)).

Our paper is also relevant to studies examining the risk of short selling. For example, Nagel (2005), Engelberg, Reed, and Ringgenberg (2018) and Andrews, Lundblad, and Reed (2021) suggest that short sellers face unique risks including regulatory restrictions, recalled

[7] Specifically, we focus on the [-70, -10] and [10, 70] event windows. Since the occurrence of a short squeeze could last serval days, we skip trading days immediately prior to or following the event to have cleaner results.

shares, institutional constraints, and a common systematic risk. Qian (2016) shows that short sellers can reduce risk by releasing information that motivates them to go short. Our study further suggests that the potential risk of experiencing a short squeeze is an alternative factor to be considered by short sellers in their estimation about the cost of short selling. Note that our documentation of the price reversal following the day of binding short sellers' capital constraint and short sale constraint is likely to be a lower bound for the occurrence and magnitude of a short squeeze. When determining how many shares to short, short sellers take both the probability and the cost of short squeezes into consideration. If a stock is expected to have a higher chance or cost of squeeze, short sellers may reduce their short positions ex ante, which in turn reduces both the probability and cost of an actual squeeze ex post. To this extent, our results may also explain a series of empirical irregularities such as the zero short interest for illiquid stocks that are likely to have binding short sale constraints (D'Avolio (2002)),[8] as well as the low aggregate short interest in the presence of apparent market-wide over-pricing (Lamont and Stein (2004)).[9]

The remainder of this paper proceeds as follows. Section 2 discusses the conditions for the occurrence of a short squeeze. Section 3 describes the sample, data, and variable construction. Section 4 presents our identification strategy for short squeezes and empirical evidence on the validity of the strategy. Section 5 explores the economic consequences of short squeezes. Section 6 concludes.

2. Conditions for the occurrence of a short squeeze

In this section, we discuss the conditions under which a short squeeze could occur. As suggested by the SEC's definition of a short squeeze, a short squeeze is often triggered by a

[8] D'Avolio (2002) documents that about 10% of stocks (typically small firms with low liquidity) are never shorted despite readily available shares to borrow.
[9] That is, short sellers, in fear of short squeeze, could rationally refrain from shorting despite the apparent mispricing.

sharp price increase which places pressure on short sellers to cover their short positions in order to meet margin calls or to avoid greater potential losses, causing a larger price increase and thus greater squeeze. However, not all sharp price increases would result in a short squeeze. If there is enough supply of loanable shares in the market, the price would still reflect the fundamentals as other potential short sellers could freely enter the market and arbitrage away the overpricing due to forced short covering. Therefore, we propose that short sellers' capital constraint caused by a sharp price increase in conjunction with the short sale constraint of the underlying asset are two bounded conditions for the occurrence of a short squeeze.

Although the stock price is supposed to increase further during a short squeeze triggered by a sharp price increase, the upward drift in price would not last forever. Once the demand from the "squeezed" short sellers concludes, the stock price should revert back to the fundamental level. In that regard, the stock price around a short squeeze is likely to follow the pattern of an initial sharp increase, followed by a continued upward drift and a later reversal.

Note that squeezes caused by share recalls as studied in D'Avolio (2002) are unlikely to have such a price impact. Unless the borrowers' decisions to recall are highly correlated with each other, the forced exits caused by recalls would not all occur simultaneously, resulting in a surging demand for the stock and a sharp price increase. In contrast, squeezes due to an unexpected price increase as studied in our paper are likely to have a simultaneous and broad impact on short sellers, leading to a surge in share demand and the resulting large price impact.

3. Sample, data, and variable constructions

3.1. Sample and data

Our initial sample consists of all trading day observations for stocks traded on the NYSE, AMEX, or NASDAQ over the period from June 2006 through December 2020.[10] We

[10] Our sample period begins in June 2006, when the short interest data is first available on the IHS Markit database.

then apply the following filtering criteria: 1) the daily stock return is no less than 15%; 2) information for constructing our main variables of interest such as the daily abnormal stock return as well as short interests are not missing. Our final sample consists of 57,052 firm-trading-day observations (i.e., event days) over the period from June 2006 through December 2020.

We obtain the daily stock return information from the CRSP database. The equity lending and short selling data are obtained from the Securities Finance Data Feeds for Buyside produced by the IHS Markit database. The IHS Markit database covers stock loan trading information at a daily basis for participants (e.g., lending agents, prime brokers, and hedge funds) who make up approximately 85% of the OTC securities lending market since June 2006.

3.2. Main variables

3.2.1. Capital and short sale constraints

We define the short sellers' capital constraint as the percentage increase in daily stock price (*Day 0 Raw Return*). We use raw return rather than risk-adjusted return to capture the short sellers' capital constraint, because whether short sellers have to cover their short positions in order to meet margin calls is directly related to the change in the unadjusted stock price.

To capture the short sale constraint, we rely on a widely used proxy of short interest—*Loanable Shares*, defined as the percentage of outstanding shares available for lending on the trading day immediately prior to the event day. A greater value of *Loanable Shares* indicates a lower level of short sale constraint. When studying the consequences of short squeezes, we also employ *Loanable Shares* as our measure for the supply of shares able to be borrowed.

3.3.2. Risk-adjusted stock return

To study whether there is a significant price reversal following the trading day with a sharp stock price increase, we construct the variable *Day 1 Risk-Adjusted Return*, defined as the abnormal stock return on the trading day immediately following the event day. To estimate the daily abnormal stock return, we employ the market model, where the benchmark is the CRSP value-weighted market return. The estimation is based on return information from 252 to 20 trading days prior to the event day.[11]

3.3.3. Control variables

In the multivariate analyses, we introduce three stock-level controls that could simultaneously affect stock returns—*Size, Illiquidity*, and *Bid/Ask Spread*. We define *Size* as the average daily stock market value in the month immediately prior to the event. Following Amihud (2002), we define *Illiquidity* as the average of the ratio of daily absolute stock return to daily dollar trading volume in the month immediately prior to the event. We measure *Bid/Ask Spread* as the average daily closing ask price minus the average daily closing bid price, divided by the average of the two prices in the month immediately prior to the event.

Table 1 presents the summary statistics of our main variables. All continuous variables except *Loanable Shares* have been winsorized at the 1% and 99% levels. For *Loanable Shares*, as it is highly skewed, we winsorize it at the 5% and 95% levels.

4. Identifying short squeezes

Our previous discussions suggest that short squeezes are more likely to occur when short sellers' capital constraint caused by a sharp price increase is coupled with a short sale constraint of the underlying stock. We then propose that one strategy to identify the occurrence of a short squeeze is to investigate whether there is a price reversal following the event day. In this section, we test the validity of such identification strategy by performing univariate sorts, two-way independent sorts, and multivariate regression analyses.

4.1.Univariate analyses

We start our analyses by sorting our sample events into decile groups based on the

[11] We require at least 100 trading days of nonmissing return data for the estimation.

extent to which short sellers are facing a capital constraint as captured by *Day 0 Raw Return* and the extent to which the stock is short sale constrained as captured by *Loanable Shares*. Figure 1 plots the average *Day 1 Risk-Adjusted Return* across the capital constraint decile groups (the solid line) and the short sale constraint decile groups (the dashed line). For the capital constraint decile groups, we find that the average *Day 1 Risk-Adjusted Return* is negative across all decile groups and decreases with *Day 0 Raw Return*. The results suggest that stocks with a sharp event day price increase experience a price reversal over the following trading day and that the reversal magnitude increases with the event day price change. For the short sale constraint decile groups, we find that the *Day 1 Risk-Adjusted Return* decreases with *Loanable Shares* and that except for events in the two lowest short sale constraint decile groups, the average *Day 1 Risk-Adjusted Return* is negative. These results confirm our conjecture that the short sale constraint is a key driver of short squeezes and the subsequent price reversal.

4.2.Two-way independent sorts

Given that the occurrence of a short squeeze requires binding conditions of short sellers' capital constraint and the short sale constraint, we next study the combined effect of these two conditions on price reversal by performing analyses of two-way independent sorts.

Table 2 reports the average *Day 1 Risk-Adjusted Return* for 100 portfolios double-sorted based on short sellers' capital constraint as proxied by *Day 0 Raw Return* and short sale constraint as proxied by *Loanable Shares* decile ranks. We find that the significantly negative *Day 1 Risk-Adjusted Return* (i.e., a price reversal) are mostly concentrated in portfolios with low *Loanable Shares* (i.e., those with a high short sale constraint) and high *Day 0 Raw Return* (i.e., those in which short sellers face a high capital constraint). That is, 14 out of the 25 portfolios within the quadrant with the lowest *Loanable Shares* deciles and the highest *Day 0 Raw Return* deciles have a significantly negative *Day 1 Risk-Adjusted Return*; in sharp contrast, only one of the portfolios within the quadrant with highest *Loanable Shares* deciles and the lowest *Day 0 Raw Return* deciles have a significantly negative *Day 1 Risk-Adjusted Return*. Furthermore, portfolios within the three lowest *Loanable Shares* deciles and the highest *Day 0 Raw Return* decile generate the three most negative *Day 1 Risk-Adjusted Return* among all portfolios (-5.11%, -4.79%, and -4.70%, respectively). Overall, the results in Table 2 validate our conjecture that the short sellers' capital constraint combined with the short sale constraint cause short squeezes, which can be identified by the significant price reversals following the events.

4.3. Multivariate analyses

Although we have adjusted the event-day return for market risk in the univariate and the two-way independent sorting analyses, we cannot rule out the possibility that characteristics of each individual stock could also affect stock returns. For example, small and less liquid stocks with high bid-ask spread could be less attractive to arbitragers, which causes the mispricing to last longer (i.e., an immediate price reversal might not be observed). Also, high return volatility is often associated with greater price reversal irrespective of the occurrence of a short squeeze (Cox and Peterson (1994)). To further alleviate such concern, we conduct multivariate analyses with a series of controls including the book value of equity, bid-ask spread, stock illiquidity, and industry- and year-fixed effects.

We start by investigating whether there exists a positive relationship between the short sale constraint and the *Day 0 Risk-Adjusted Return* for events with a large initial price increase.[12] Specifically, we run an OLS regression of *Day 0 Risk-Adjusted Return* against *Loanable Shares*. Column 1 of Table 3 shows that the estimated coefficient of *Loanable Shares* is significantly negative (*p*-value <0.01). In particular, a one-standard-deviation increase in *Loanable Shares* is associated with a 1.68% decrease in *Day 0 Risk-Adjusted Return*.

[12] Note that our sample focuses on stock-trading-days with return no less than 15%; i.e., those that are more vulnerable to a short squeeze.

The positive relationship between the lagged short sale constraint and the event day return documented above is in line with our conjecture that a binding short sale constraint causes the stock price to drift upward further after a sharp price increase. Nevertheless, to further rule out the possibility that the event day return is driven by the change in stock fundamentals and therefore cannot be explained by short squeeze, we also need to examine how the stock price moves after the event day. If there exists a significant price reversal following the sharp price increase, the occurrence of a short squeeze could be ascertained as the stock price is expected to go back to its fundamental level once the demand from the "squeezed" short sellers concludes.

To test our conjecture, we regress *Day 1 Risk-Adjusted Return* against *Day 0 Risk-Adjusted Return*, *Loanable Shares*, and other control variables. Column 2 of Table 3 shows that the estimated coefficient of *Day 0 Risk-Adjusted Return* is significantly negative (p-value<0.01), suggesting a positive relationship between the short sellers' capital constraint and the subsequent price reversal. We also find a significantly positive relationship between *Loanable Shares* and *Day 1 Risk-Adjusted Return* (p-value<0.01), which indicates a positive relationship between the short sale constraint and price reversal. In Columns 3-4, we repeat the analyses in Columns 1-2 with a sample excluding stock-trading-day observations where the percentage of shares actively on loan exceeds 100%.[13] We find that our previous results remain quantitatively and qualitatively similar.

To summarize, the results of multivariate analyses, together with the results of individual- and double-sorting analyses, support our hypotheses that short squeezes do occur and can be identified by two conditions: 1) a sharp increase in share price that drifts further upward due to a binding short sale constraint, and 2) a reversal in share price after the binding short sale constraint has been alleviated.

[13] Such observations account for approximately one-quarter of our original sample.

5. The economic consequences of short squeezes

In this section, we employ a double-sorting framework to explore the economic consequences of short squeezes. Specifically, we examine how short squeezes affect the supply of loanable shares, the demand for borrowing shares, the costs to borrow shares, the divergence of opinion in stock trading, and the stock performance.

5.1. The impact of short squeezes on the supply of loanable shares and the demand for borrowing shares

We start by examining how short squeezes affect the supply of loanable shares (as captured by *Loanable Shares*) and the demand for borrowing shares (as captured by *Active Utilisation*, defined as the value of assets on loan from lenders divided by the active lendable value). Specifically, we double sort sample events into 100 portfolios based on the capital constraint (*Day 0 Raw Return*) and the short sale constraint (*Loanable Shares*) decile ranks. We then compare the difference in the daily average *Loanable Shares* and the daily average *Active Utilisation* for these portfolios sixty trading days prior to and sixty trading days following the sharp price increase event (the [-70, -10] versus [10, 70] event windows).[14]

Panel A of Table 4 reports the supply side results. We find an across-board reduction in *Loanable Shares* in the portfolios with a low short sale constraint. That is, 41 out of the 50 portfolios in the five highest *Loanable Shares* deciles show a significantly negative change in *Loanable Shares* following the event. These results are in line with the notion that price appreciation could drive suppliers in the loan market to withdraw their loanable shares and therefore decrease the supply of shares available to be loaned.

Furthermore, we find that the majority of the portfolios with low *Loanable Shares*

[14] As the occurrence of a short squeeze could last serval days, we focus on the [-70, -10] and [10, 70] trading windows to have a cleaner window of results.

experience an insignificant change in the total amount of shares available for lending following the event. One possible explanation we propose is that stocks with a higher short sale constraint are less attractive to investors who are sensitive to price movement (e.g., hedge funds or actively managed mutual funds); and the lack of participation from such investors results in an insignificant change in the supply of loanable shares.

The demand side results are reported in Panel B of Table 4. The demand for borrowing shares shows a tale of two patterns. For portfolios with a high short sale constraint, the demand generally increases following the event. In particular, 12 out of the 20 portfolios within the two lowest *Loanable Shares* deciles experience a significant increase in *Active Utilisation*. For the other 80 portfolios, however, the demand is either insignificant or decreases. These findings indicate that a sharp price increase deters short sellers in general; however, for stocks with the greatest short sale constraint where the upside pricing error could be the most difficult to correct, the demand from short sellers to borrow shares increases in the longer-term.

5.2.The impact of short squeezes on the cost to borrow shares

Despite the lack of empirical evidence, short squeezes are often referred to as an important factor contributing to the overall cost of short sales (e.g., Danielsen and Sorescu (2001); Alia, Hwang, and Trombley (2003); Chen and Singal (2003); Christophe, Ferri, and Angel (2004)). We test this theory by investigating whether there is a significant change in the cost of borrowing shares around the event of a sharp price increase.

Specifically, we introduce two variables obtained from the IHS Markit database—the expected cost of borrowing (*Indicative Fee*) and the Daily Cost to Borrow Score (*DCBS*). In particular, the *Indicative Fee* is the daily expected borrowing costs (in fee terms) for short sellers to borrow a stock, calculated using a proprietary algorithm that interpolates both the wholesale stock loan rate (i.e., fees paid by prime broker to agent lender for borrowing shares) and the buy-side rate (i.e., fees paid by hedge funds to prime broker for borrowing shares).

DCBS, which is a relative measure of borrowing costs constructed by IHS Markit, takes an integer from 1 (cheapest to borrow) to 10 (most expensive to borrow).

Panel A of Table 5 reports the difference between the average *Indicative Fee* sixty days prior to and sixty days following the event, for the 100 portfolios constructed based on short sellers' capital constraint and short sale constraint. We find that although almost all portfolios experience an increase in the cost of borrowing following the event, those that are more likely to have experienced a short squeeze (i.e., stocks with greater capital constraint and greater short sale constraint) saw the greatest jumps. In particular, all of the 25 portfolios in the quadrant that includes the five highest *Day 0 Raw Return* deciles and the five lowest *Loanable Shares* deciles are statistically positive, with the greatest magnitude (11.64%) observed in the portfolio with both the highest *Day 0 Raw Return* and the lowest *Loanable Shares*.

In Panel B of Table 5, we examine the difference in the average *DCBS* sixty days prior to and sixty days following the squeeze for the same portfolios. Consistent with our findings in Panel A, we find that 24 of the 25 portfolios in the quadrant that includes the five greatest capital constraint deciles and the five greatest short sale constraint deciles are statistically positive, with the greatest magnitude (0.63) observed in the portfolio with both the greatest capital constraint and the greatest short sale constraint.

5.3.The impact of short squeezes on the divergence of opinion in stock trading

Our results in Table 5 indicate an increased cost to borrow shares following short squeezes. As short-sale costs are ultimately sustained and increased by the divergence of opinion in investor valuations (D'Avolio (2002)), we further check whether the divergence of opinion increases following short squeezes.

To capture the divergence of opinion, we employ two variables—*Daily Trading Volume* and *Idiosyncratic Volatility*. Specifically, *Daily Trading Volume* is defined as the daily share volume divided by the number of shares outstanding; *Idiosyncratic Volatility* is defined as the standard deviation of the daily regression residual from the Fama-French-Carhart model over the [-70, -10] or the [10, 70] event window, where the regression residual is estimated using 252 trading day stock returns (minimum estimation window of 100 days) ending 127 trading days prior to the event day.

Panel A of Table 6 reports the change between the average *Daily Trading Volume* for the 100 portfolios sixty days prior to and sixty days following the event. We find that the trading volume generally increases with *Day 0 Raw Return* and is particularly high among the highest *Day 0 Raw Return* decile. Moreover, for portfolios within the highest *Day 0 Raw Return* decile, those with the lower *Loanable Shares* have a greater increase in trading volume following the event. That is, the five largest changes in *Daily Trading Volume* (4.27%, 4.99%, 5.12%, 7.40%, and 8.70%) all occur in the portfolios within the highest *Day 0 Raw Return* decile and the five lowest *Loanable Shares* deciles.

Panel B further reports the result of the change in *Idiosyncratic Volatility*. We find that all portfolios exhibit a significant increase in *Idiosyncratic Volatility* following the event. Similar to our findings in Panel A, we also show that *Idiosyncratic Volatility* in general is increased with *Day 0 Raw Return*. Particularly, the largest increase (2.95%) is observed in the portfolio presumably having the greatest probability of experiencing a short squeeze (i.e., the portfolio in the highest *Day 0 Raw Return* decile and the lowest *Loanable Shares* decile).

Overall, the results in Table 6 lend support to our conjecture that the divergence of opinion increases following short squeezes.

5.4.The impact of short squeezes on stock performance

In Sections 5.1 and 5.2, we show that the demand for and the cost of borrowing shares increased following the event, particularly so for stocks with the greatest likelihood of experiencing a short squeeze. These results suggest that the upside pricing error could be difficult to correct following short squeezes.

To test this conjecture, we investigate the change in *Fama-French-Carhart Alpha*, a widely used measure of abnormal return, in the sixty days prior to and sixty days following the event for the 100 portfolios. Specifically, we define *Fama-French-Carhart Alpha* as the raw return minus the Fama-French-Carhart model predicted return estimated based on information over the [-70, -10] or the [10, 70] event window. If as suggested that the upside pricing error is difficult to correct following short squeezes, we should observe an increase in *Fama-French-Carhart Alpha*, particularly for stocks where both the short sellers' capital constraint and the short sale constraint tend to be great.

The results reported in Table 7 confirm our conjecture. We find that all portfolios exhibit a significant increase in the *Fama-French-Carhart Alpha* following the event and that such effect is more pronounced for portfolios with high *Day 0 Raw Return* and low *Loanable Shares*. In particular, the greatest increase (0.30%) is observed for the portfolio with the highest *Day 0 Raw Return* and the lowest *Loanable Shares*.

6. Conclusion

Using daily short interest data for individual stocks, we provide systematic evidence of the occurrence of short squeezes. Focusing on stock-trading-days with at least a 15% price increase, we show that when bounded with a short sale constraint, short sellers' capital constraint caused by a sharp stock price increase can trigger a short squeeze, followed by a price reversal. In particular, stocks in both the highest capital constraint decile and the highest short sale constraint decile experience a price reversal of 4.79% following the day of a sharp price increase. The binding effect of short sellers' capital constraint and short sale constraint on the occurrence of a short squeeze is further validated in multivariate analyses where both short sellers' capital constraints and the short sale constraints are found to be significantly and positively correlated with the next day price reversal.

We also study the economic consequences of short squeezes. We show that in the months following a large price increase, the "squeezed" firms experience an increase in the demand for and the cost of borrowing their shares, as well as an increase in their trading volume, idiosyncratic volatility, and abnormal return. These findings are in line with Miller (1977) and D'Avolio (2002) who suggest that fees for short selling are ultimately sustained and increased by the divergence of opinion, which leads to an increase in short interest.

Our study, which shows that short squeezes are likely to occur in the case of large price increases and low loanable shares, cautions short sellers to include the potential risk of short squeezes as an alternative factor in their estimation of the short sale costs; it further suggests that short sellers' fear about short squeezes could be a potential explanation for the low short interest and arbitrage limit among stocks with apparent overpricing. Moreover, our findings regarding the consequences of short squeezes indicate that in addition to their impact on stock prices, short squeezes can also have a lingering effect on capital markets.

Appendix A. Variable descriptions

Variable	Definition
Active Utilisation (%)	The value of assets on loan from lenders divided by the active lendable value on the trading day immediately prior to the event day.
Bid-Ask Spread (%)	The average daily closing ask price minus the average daily closing bid price, divided by the average of the two prices in the month immediately prior to the event day.
Day 0 Raw Return (%)	The percentage increase in daily stock price.
Day 0 Risk-Adjusted Return (%)	The abnormal stock return on the event day, where the abnormal stock return is estimated based on the market model using return information from 252 to 20 trading days prior to the event day.
Day 1 Risk-Adjusted Return (%)	The abnormal stock return on the trading day immediately following the event day, where the abnormal stock return is estimated based on the market model using return information from 252 to 20 trading days prior to the event day.
Daily Trading Volume (%)	The daily share volume divided by the number of shares outstanding.
DCBS	A relative measure of borrowing costs constructed by IHS Markit that takes an integer from 1 (cheapest to borrow) to 10 (most expensive to borrow).
Fama-French-Carhart Alpha (%)	The raw return minus the Fama-French-Carhart model predicted return, where the latter is estimated using 252 trading day stock returns (minimum estimation window of 100 days) ending 127 trading days prior to the event day.
Idiosyncratic Volatility %	The standard deviation of the regression residual from the Fama-French-Carhart model estimation.
Illiquidity (%)	The average of the ratio of daily absolute stock return to daily dollar trading volume in the month immediately prior to the event multiplied by 100.
Indicative Fee (%)	The daily expected borrowing costs (in fee terms) for short sellers to borrow a stock, calculated using a proprietary algorithm that interpolates both the wholesale stock loan rate (i.e., fees paid by prime broker to agent lender for borrowing shares) and the buy-side rate (i.e., fees paid by hedge funds to prime broker for borrowing shares).
Loanable Shares	The percentage of outstanding shares available for lending on the trading day immediately prior to the event day. A greater value of *Loanable Shares* indicates a lower level of short sale constraint.
Size (in million dollars)	The average daily stock market value (in million dollars) in the month immediately prior to the event.

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Figure 1. Next Day Price Reversal for Decile Portfolios sorted by Capital Constraint or Short Sale Constraint

The figure plots the average *Day 1 Risk-Adjusted Return* for decile portfolios single-sorted by short sellers' capital constraint and by the short sale constraint. The sample consists of 57,052 firm-trading-day observations (i.e., events) for stocks traded on the NYSE, AMEX, or NASDAQ with daily return no less than 15% over the period from June 2006 through December 2020. We define *Day 1 Risk-Adjusted Return* as the abnormal stock return on the trading day immediately following the event day, where the abnormal stock return is estimated based on the market model using return information from 252 to 20 trading days prior to the event day. Our proxy for short sellers' capital constraint is *Day 0 Raw Return*, defined as the percentage increase in daily stock price. Our proxy for short sale constraint is *Loanable Shares*, defined as the percentage of outstanding shares available for lending on the trading day immediately prior to the event day.

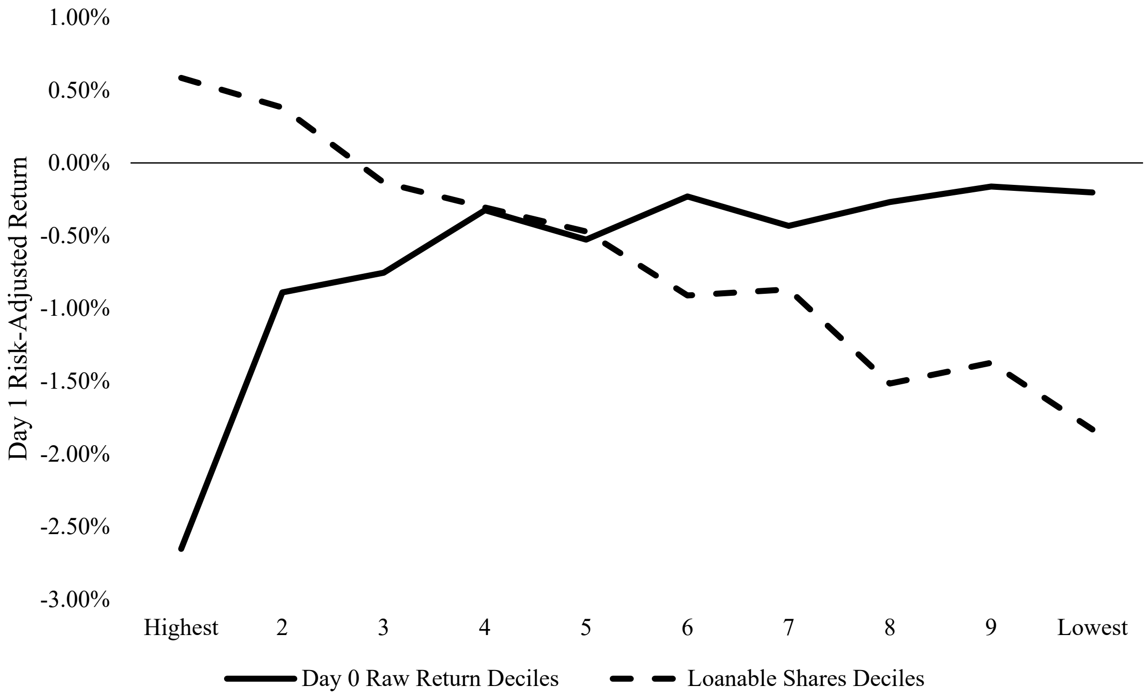

Table 1. Descriptive Statistics

This table reports the descriptive statistics for our main variables. The sample consists of 57,052 firm-trading-day observations (i.e., events) for stocks traded on the NYSE, AMEX, or NASDAQ with daily return no less than 15% over the period from June 2006 through December 2020. Detailed variable descriptions are presented in Appendix A.

Variables	N	Mean	Median	25th	75th	St. Dev.
Day 0 Raw Return (%)	57,052	26.18	20.00	16.95	26.74	26.23
Day 0 Risk-Adjusted Return (%)	57,052	24.77	19.14	15.83	26.02	27.46
Day 1 Risk-Adjusted Return (%)	57,052	-0.67	-1.43	-6.73	3.35	15.92
Loanable Shares	57,052	0.1185	0.0665	0.0169	0.1882	0.1461
Size (in million dollars)	57,052	1,050.70	103.65	28.98	416.59	6,205.03
Bid-Ask Spread (%)	57,052	3.18	1.13	0.38	3.48	5.47
Illiquidity (%)	57,052	18.98	0.14	0.01	1.68	139.36

Table 2. Identifying Short Squeezes: Two-Way Independent Sorts

This table presents the average *Day 1 Risk-Adjusted Return* for 100 portfolios double-sorted based on short sellers' capital constraint as proxied by *Day 0 Raw Return* and short sale constraint as proxied by *Loanable Shares* decile ranks. The sample consists of 57,052 firm-trading-day observations (i.e., events) for stocks traded on the NYSE, AMEX, or NASDAQ with daily return no less than 15% over the period from June 2006 through December 2020. We define *Day 1 Risk-Adjusted Return* as the abnormal stock return on the trading day immediately following the event day, where the abnormal stock return is estimated based on the market model using return information from 252 to 20 trading days prior to the event day. *Day 0 Raw Return* is defined as the percentage increase in daily stock price. *Loanable Shares* is defined as the percentage of outstanding shares available for lending on the trading day immediately prior to the event day. Statistics reported in cells highlighted in tan (grey) are significantly positive (negative) at the 5% level.

Change in Day 1 Risk-Adjusted Return

Day 0 Raw Return Deciles	Loanable Shares Deciles									
	Highest	2	3	4	5	6	7	8	9	Lowest
Highest	-1.10	0.30	-0.19	-1.00	-0.77	-3.96	-0.32	-4.70	-5.11	-4.79
2	1.57	0.10	-0.42	0.23	-1.66	0.00	-2.21	-1.84	-0.96	-2.14
3	1.16	1.10	-0.45	-1.02	0.00	-1.34	-1.74	-2.06	-1.07	-1.86
4	1.19	0.02	0.23	0.38	0.29	-0.52	-1.28	-0.98	-1.08	-1.32
5	0.44	0.36	-0.47	-0.68	0.09	-0.75	-0.95	-1.51	-0.09	-2.02
6	0.30	1.45	0.20	0.14	-0.47	-0.49	-1.01	-0.55	-1.62	-0.75
7	0.24	0.30	-0.37	-0.33	-0.86	-0.65	-0.20	-1.13	0.60	-2.07
8	0.82	0.03	-0.38	0.25	-0.48	-0.05	-0.28	-1.07	-1.68	-0.29
9	0.27	0.19	0.11	-0.23	-0.37	-1.02	0.29	0.72	-0.57	-1.12
Lowest	0.48	0.03	0.33	-0.82	-0.21	-0.07	-0.72	-0.54	-0.59	-0.27

Table 3. Identifying Short Squeezes: Multivariate Analyses

This table performs multivariate OLS regressions to identify the occurrences of short squeezes. The sample consists of 57,052 firm-trading-day observations (i.e., events) for stocks traded on the NYSE, AMEX, or NASDAQ with daily return no less than 15% over the period from June 2006 through December 2020. In Column 1 (Column 2), the dependent variable is *Day 0 Risk-Adjusted Return* (*Day 1 Risk-Adjusted Return*). We define *Day 0 Risk-Adjusted Return* (*Day 1 Risk-Adjusted Return*) as the abnormal stock return on the event day (on the trading day immediately following the event day), where the abnormal stock return is estimated based on the market model using return information from 252 to 20 trading days prior to the event day. *Loanable Shares* is defined as the percentage of outstanding shares available for lending on the trading day immediately prior to the event day. Columns 3-4 repeat the analyses in Columns 1-2 but excluding observations where the shares active on loan is greater than or equal to 100%. In all regressions, we control for year-fixed effects and industry-fixed effects, and we cluster standard errors at the industry level. Detailed variable descriptions are presented in Appendix A. The coefficient estimates of the constant are omitted for brevity. t-statistics are reported in brackets. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

	Full Sample		**Shares Active on Loan <100%**	
	(1)	(2)	(3)	(4)
	Day 0 Risk-Adjusted Return	Day 1 Risk-Adjusted Return	Day 0 Risk-Adjusted Return	Day 1 Risk-Adjusted Return
Day 0 Risk-Adjusted Return		-0.017***		-0.029***
		[-6.74]		[-10.54]
Loanable Shares	-0.115***	0.016***	-0.080***	0.009***
	[-13.86]	[3.30]	[-10.35]	[2.18]
Size	-0.012***	0.002	-0.011***	0.002*
	[-5.86]	[1.38]	[-5.92]	[1.71]
Bid-Ask Spread	0.677***	-0.220***	0.621***	-0.257***
	[27.12]	[-14.62]	[26.32]	[-19.45]
Illiquidity	-0.003***	0.000	-0.002***	0.001
	[-2.97]	[-0.26]	[-2.82]	[1.35]
Industry Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	56,687	56,681	41,361	41,356
Adj. R^2	0.034	0.010	0.041	0.023

Table 4. Change in the Loanable Shares and Shares Active on Loan following the Event Day

Panel A (Panel B) of this table presents the change in average *Loanable Shares* and *Active Utilisation* sixty trading days prior to versus sixty trading days following the event (the [-70, -10] versus [10, 70] event windows), for 100 portfolios double-sorted based on the short sellers' capital constraint (as proxied by *Day 0 Raw Return*) and the short sale constraint (as proxied by *Loanable Shares*) decile ranks. The sample consists of 57,052 firm-trading-day observations (i.e., events) for stocks traded on the NYSE, AMEX, or NASDAQ with daily return no less than 15% over the period from June 2006 through December 2020. We define *Loanable Shares* as the percentage of daily outstanding shares available for lending. *Active Utilisation* is defined as the value of assets on loan from lenders divided by the active lendable value. Detailed variable descriptions are presented in Appendix A. Statistics reported in cells highlighted in tan (grey) are significantly positive (negative) at the 5% level.

Panel A. Change in Loanable Shares

Day 0 Raw Return Deciles	Loanable Shares % Deciles									
	Highest	2	3	4	5	6	7	8	9	Lowest
Highest	-2.71	-3.06	-1.43	-0.81	-0.74	-0.47	-0.17	-0.13	0.07	-0.04
2	-1.81	-2.18	-0.91	-0.94	-0.75	-0.38	-0.13	-0.16	-0.11	-0.02
3	-1.24	-1.24	-1.12	-0.66	-0.08	-0.52	-0.20	-0.12	-0.07	-0.01
4	-0.89	-1.19	-0.68	-0.44	-0.19	-0.25	-0.08	-0.04	-0.08	-0.07
5	-0.54	-0.92	-0.68	-0.63	-0.14	-0.17	-0.09	-0.09	-0.11	-0.06
6	-0.94	-0.70	-0.81	-0.28	-0.14	-0.16	-0.03	-0.15	-0.06	-0.10
7	-0.41	-0.69	-0.58	-0.28	-0.20	-0.08	-0.03	-0.16	0.00	-0.07
8	-0.10	-0.66	-0.66	-0.39	-0.21	-0.14	-0.07	-0.22	-0.04	-0.09
9	-0.38	-0.47	-0.50	-0.23	0.04	0.21	0.00	0.05	-0.07	-0.02
Lowest	-0.50	-0.68	-0.79	-0.22	-0.05	-0.15	0.02	-0.03	-0.03	-0.02

Panel B. Change in Active Utilisation %

Day 0 Raw Return Deciles	Loanable Shares % Deciles									
	Highest	2	3	4	5	6	7	8	9	Lowest
Highest	-1.33	0.52	-0.87	1.43	0.15	-1.28	0.65	0.82	3.16	3.67
2	0.05	-1.06	0.07	0.09	-0.23	-0.01	-0.43	0.30	2.36	2.90
3	-1.05	-0.78	-0.74	-0.46	-3.33	-2.03	0.38	-2.08	2.93	2.49
4	0.07	-0.29	-0.20	-0.99	-2.29	0.21	-0.34	-1.02	0.19	0.16
5	-1.15	0.14	-0.84	-0.78	-1.12	-0.19	-2.11	1.65	0.29	1.65
6	-0.73	-0.67	-0.72	-1.40	-0.29	0.15	-0.22	0.32	2.14	1.71
7	-0.15	-0.49	-0.37	-0.35	-1.90	0.96	0.86	-3.18	2.67	2.68
8	-0.43	-1.12	-0.55	-0.65	-1.32	0.73	0.53	-0.46	3.59	3.14
9	-0.56	-0.21	-0.17	-1.50	-1.50	-0.35	0.62	-0.63	2.52	1.94
Lowest	-0.98	-1.07	-0.22	-1.25	-0.55	-1.22	-0.56	-0.46	1.35	1.41

Table 5. Change in the Cost of Short Sale following the Event Day

This table presents the change in the average cost of short sale sixty trading days prior to versus sixty trading days following the event (the [-70, -10] versus [10, 70] event windows), for 100 portfolios double-sorted based on the short sellers' capital constraint (as proxied by *Day 0 Raw Return*) and short sale constraint (as proxied by *Loanable Shares*) decile ranks. The sample consists of 57,052 firm-trading-day observations (i.e., events) for stocks traded on the NYSE, AMEX, or NASDAQ with daily return no less than 15% over the period from June 2006 through December 2020. Panel A (Panel B) reports the results when *Indicative Fee* (*DCBS*) is employed as the proxy for the cost of short sale. *Indicative Fee* is the daily expected borrowing costs (in fee terms) for short sellers to borrow a stock, calculated using a proprietary algorithm that interpolates both the wholesale stock loan rate and the buy-side rate. *DCBS* is a relative measure of borrowing costs constructed by IHS Markit that takes an integer from 1 (cheapest to borrow) to 10 (most expensive to borrow). Detailed variable descriptions are presented in Appendix A. Statistics reported in cells highlighted in tan (grey) are significantly positive (negative) at the 5% level.

Panel A. Change in Indicative Fee

Day 0 Raw Return Deciles	Loanable Shares % Deciles									
	Highest	2	3	4	5	6	7	8	9	Lowest
Highest	2.57	2.42	0.37	2.27	3.49	4.96	5.36	7.32	6.67	11.64
2	1.30	0.59	0.61	1.04	1.87	1.76	2.04	2.72	3.84	2.56
3	0.61	0.75	0.66	0.50	0.85	0.96	1.64	2.49	3.02	3.25
4	0.50	0.15	0.48	0.78	1.66	1.44	1.08	1.60	2.26	1.97
5	-0.10	0.77	0.49	0.99	1.08	1.27	0.90	1.83	1.81	2.73
6	0.25	0.25	0.66	1.07	0.79	0.80	1.91	1.49	1.40	3.44
7	0.24	0.29	0.33	0.92	0.58	0.94	1.41	1.55	1.44	1.95
8	0.28	0.11	0.20	0.51	0.69	0.59	0.65	0.43	2.50	2.97
9	0.15	0.30	0.37	0.30	0.71	0.05	0.93	0.90	0.49	1.51
Lowest	0.20	0.22	0.52	0.35	0.65	1.02	1.24	1.58	1.39	1.55

Panel B. Change in DCBS

Day 0 Raw Return Deciles	Loanable Shares % Decile									
	Highest	2	3	4	5	6	7	8	9	Lowest
Highest	0.36	0.24	0.10	0.25	0.41	0.46	0.48	0.49	0.55	0.63
2	0.20	0.10	0.06	0.13	0.23	0.18	0.24	0.30	0.25	0.18
3	0.07	0.10	0.11	0.09	0.11	0.12	0.22	0.17	0.17	0.21
4	0.08	0.04	0.07	0.11	0.15	0.18	0.12	0.17	0.16	0.18
5	-0.01	0.12	0.08	0.12	0.10	0.18	0.10	0.16	0.12	0.19
6	0.03	0.06	0.09	0.09	0.09	0.07	0.15	0.17	0.22	0.24
7	0.07	0.07	0.03	0.14	0.05	0.15	0.17	0.09	0.17	0.14
8	0.07	-0.01	0.02	0.03	0.05	0.10	0.10	0.07	0.23	0.30
9	0.02	0.06	0.08	0.03	0.03	0.01	0.23	0.09	0.11	0.20
Lowest	0.03	0.02	0.08	0.04	0.10	0.09	0.10	0.14	0.13	0.13

Table 6. Change in the Divergence of Opinions following the Event Day

This table presents the change in the divergence of opinions sixty trading days prior to versus sixty trading days following the event (the [-70, -10] versus [10, 70] event windows), for 100 portfolios double-sorted based on the short sellers' capital constraint (as proxied by *Day 0 Raw Return*) and short sale constraint (as proxied by *Loanable Shares*) decile ranks. The sample consists of 57,052 firm-trading-day observations (i.e., events) for stocks traded on the NYSE, AMEX, or NASDAQ with daily return no less than 15% over the period from June 2006 through December 2020. Panel A (Panel B) reports the results when *Daily Trading Volume* (*Idiosyncratic Volatility*) is employed as the proxy for the divergence of opinions. *Daily Trading Volume* is calculated as the daily share volume divided by the number of shares outstanding. *Idiosyncratic Volatility* is defined as the standard deviation of the regression residual from the Fama-French-Carhart model estimated using 252 trading day stock returns (minimum estimation window of 100 days) ending 127 trading days prior to the event day. Detailed variable descriptions are presented in Appendix A. Statistics reported in cells highlighted in tan (grey) are significantly positive (negative) at the 5% level.

Panel A. Change in Daily Trading Volume %

Day 0 Raw Return Deciles	Loanable Shares % Deciles									
	Highest	2	3	4	5	6	7	8	9	Lowest
Highest	1.89	2.29	1.55	2.11	3.21	5.12	7.40	8.70	4.99	4.27
2	1.17	0.76	0.96	0.76	1.25	1.89	1.97	1.74	1.90	1.57
3	0.91	0.62	0.46	0.51	0.59	0.98	1.54	1.42	1.14	1.53
4	0.68	0.67	0.55	0.58	0.78	0.44	0.67	1.59	1.00	0.47
5	0.42	0.75	0.39	0.48	0.87	1.06	-0.19	1.11	0.43	1.31
6	0.73	0.39	0.16	0.40	0.48	0.74	1.08	0.73	1.60	1.11
7	0.37	0.29	0.19	0.47	0.32	0.75	1.32	0.60	0.34	0.67
8	0.32	0.15	0.19	0.15	0.19	0.46	0.58	0.77	0.13	1.46
9	0.22	0.29	0.21	0.39	0.26	0.19	1.13	1.26	0.44	0.33
Lowest	0.30	0.21	0.24	0.14	0.20	0.47	1.07	0.51	-0.08	0.41

Panel B. Change in Idiosyncratic Volatility %

Day 0 Raw Return Deciles	Loanable Shares % Deciles									
	Highest	2	3	4	5	6	7	8	9	Lowest
Highest	2.17	2.62	2.13	2.06	2.19	2.20	2.38	2.86	2.48	2.95
2	1.34	1.16	1.23	1.20	1.15	1.25	1.18	1.32	1.24	1.68
3	1.03	0.91	0.92	0.96	1.01	1.10	1.14	1.12	1.19	1.17
4	0.93	0.86	0.81	0.87	0.83	0.82	0.94	1.17	0.97	0.86
5	0.78	0.88	0.76	0.82	0.80	0.84	0.92	0.99	1.06	0.86
6	0.78	0.66	0.68	0.68	0.64	0.76	0.75	0.82	0.74	0.87
7	0.72	0.58	0.60	0.71	0.63	0.71	0.78	0.69	0.84	0.62
8	0.66	0.60	0.60	0.66	0.62	0.68	0.73	1.05	0.83	0.80
9	0.69	0.54	0.53	0.56	0.56	0.48	0.67	0.71	0.66	0.73
Lowest	0.63	0.56	0.59	0.56	0.58	0.55	0.59	0.66	0.54	0.61

Table 7. Change in Fama-French-Carhart Alpha following the Event Day

This table presents the change in the average daily *Fama-French-Carhart Alpha* sixty trading days prior to and sixty trading days following the event (the [-70, -10] versus [10, 70] event windows), for 100 portfolios double-sorted based on the short sellers' capital constraint (as proxied by *Day 0 Raw Return*) and short sale constraint (as proxied by *Loanable Shares*) decile ranks. The sample consists of 57,052 firm-trading-day observations (i.e., events) for stocks traded on the NYSE, AMEX, or NASDAQ with daily return no less than 15% over the period from June 2006 through December 2020. The *Fama-French-Carhart Alpha* is calculated as raw return minus the Fama-French-Carhart model predicted return estimated using 252 trading day stock returns (minimum estimation window of 100 days) ending 127 trading days prior to the event day. Detailed variable descriptions are presented in Appendix A. Statistics reported in cells highlighted in tan (grey) are significantly positive (negative) at the 5% level.

Change in Fama-French-Carhart Alpha

Day 0 Raw Return Deciles	Loanable Shares % Deciles									
	Highest	2	3	4	5	6	7	8	9	Lowest
Highest	0.13	0.13	0.15	0.15	0.20	0.23	0.25	0.28	0.26	0.30
2	0.07	0.07	0.09	0.10	0.09	0.14	0.13	0.13	0.14	0.15
3	0.06	0.06	0.06	0.06	0.08	0.09	0.12	0.11	0.13	0.12
4	0.05	0.05	0.05	0.08	0.08	0.09	0.10	0.11	0.10	0.09
5	0.05	0.04	0.05	0.05	0.08	0.09	0.11	0.11	0.12	0.10
6	0.02	0.04	0.05	0.07	0.07	0.09	0.08	0.09	0.08	0.09
7	0.04	0.04	0.04	0.06	0.05	0.08	0.08	0.09	0.09	0.07
8	0.03	0.04	0.04	0.05	0.05	0.07	0.08	0.09	0.08	0.09
9	0.04	0.02	0.04	0.04	0.05	0.06	0.09	0.08	0.07	0.07
Lowest	0.03	0.02	0.04	0.05	0.05	0.07	0.06	0.07	0.08	0.08