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Short Squeezes and Their Consequences

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Abstract

A short squeeze occurs if borrowed shares are recalled and the short seller is unable to find another source of shares. This forces the short seller to terminate a position early. For most stocks, the probability of a short squeeze is very low. Short squeezes, however, are not unusual for the hardest to borrow stocks. For these stocks, trading costs from squeezes are high and have a significant impact on the returns to short selling. For hard-to-borrow stocks, short sellers also miss out on significant abnormal returns because squeezes force them to close positions.

I. Introduction

Short sellers face a number of risks. Like investors with long positions in stocks, they bear the risk that they are wrong or that new information will be revealed and the stock price will move against them. In addition, there are risks that are unique to short selling. Short sellers need to borrow shares to sell and shares are almost always borrowed for one day at a time. So, short sellers face the risk that borrowing fees will increase before a short position is closed (see Engelberg, Reed, and Ringgenberg (2018)). A second risk is that the price of the shorted asset will increase in the short run and the short seller will be forced to post more collateral. A third risk, and the focus of this article, is the risk of a short squeeze. A short squeeze occurs when borrowed shares are recalled and the short seller closes his short position. This can occur because the short seller refuses to borrow shares at significantly higher borrowing fees. In many cases though, the short seller cannot locate an alternative source of shares. D'Avolio ((2002), p. 280) notes that the short-run supply of shares is "essentially vertical" and short sellers may not be able to "reestablish recalled loans 'at any price.'"

Recent dramatic short squeezes in GameStop and AMC have caught the attention of academics and investors. These squeezes occurred after the end of this article's sample period, but are reminiscent of incidents that occurred during that

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time. In a Jan. 21, 2021 article on CNBC.com (https://www.cnbc.com/2021/01/27/tilray-ceo-brendan-kennedy-issues-a-warning-to-gamestop-amc-bosses.html), Brendan Kennedy, CEO of Canadian marijuana producer Tilray, said that "I've had a little PTSD over the last couple of days" while watching the trading in GameStop. Kennedy said, "I remember getting five different calls from Nasdaq in a single day about our stock being halted because the short sellers were being squeezed so badly." "I think the short sellers lost something like $600 million on that particular day, Sept. 19, 2018, which actually pales in comparison to what I have been reading about GameStop."

The first contribution of this article is to develop two proxies for short squeezes. These proxies are easily calculated by any researcher using lending market data from IHS Markit, the leading source of data on share lending. The first proxy, which corresponds to what I call an all lender squeeze, indicates that a squeeze has occurred when the shares available to lend are less than the shares on loan the previous day. The Sept. 19, 2018, Tilray squeeze provides an example. On Sept. 18, 2018, there were 427,790 shares available to borrow and 386,280 of them were on loan. The next day, the total number of shares available to borrow was only 344,917. Short sellers were forced to repurchase at least 41,363 shares. I identify two other all lender squeezes for Tilray during Sept. 2018. One occurred on Sept. 17 when the available shares fell to 472,033, slightly less than the 472,734 that were on loan the previous day. A third short squeeze occurred on Sept. 21 when the shares available dropped to just 276,684. The number of shares on loan the previous day was 297,300.[1]

The all lender squeeze measure is similar to the measure of short squeezes used in D'Avolio (2002) but with an important advantage. D'Avolio only has the shares on loan from a single lending agent who represented about 10% of the total lending market. If a short seller had a loan recalled from this lender, there is a good chance he would be able to locate another source of shares. The data from IHS Markit that is used here represents 90% of the North American share lending market. If shares are recalled so that there are fewer shares available to lend than had been out on loan, it is unlikely that short sellers will be able to find another source of shares.

The all lender squeeze proxy implies that there are not enough shares available for short sellers anywhere. This measure of short squeezes may be overly restrictive. The market for lending shares is a fragmented market and a short seller may have difficulty locating a new source of shares if a loan is recalled or may be unwilling to pay significantly higher fees to borrow from another lender. Kolasinski, Reed, and Ringgenberg (2012) point to large differences in lending fees across lenders as evidence that the search costs for shares are high. So, the second short squeeze proxy, which I call a current lender squeeze, indicates that a squeeze occurs if the total number of shares available to lend and the number of shares on loan fall by the same amount on the same day. For example, Tilray experienced a current lender squeeze on Dec. 27, 2018, when the shares available to borrow fell by 8,500 from 625,779 to 617,279 and the shares on loan also fell by 8,500 from 608,060 to 599,560.

[1]I am assuming that the regular way settlement is used and changes in shares on loan and shares available to lend show up 2 days later on the repurchase settlement date in the IHS Markit data.

I present evidence that the equal declines in shares on loan and shares available to lend are short squeezes and not just coincidences. If they did happen by chance, we would expect equal declines in shares on loan and shares available to loan on the same day to be about as common as declines in shares on loan equaling declines in available shares on one of the surrounding days. In fact, a decline in shares on loan is 15 times as likely to be matched by an equal decline in shares available to loan on the same day as on the day before or after. In addition, equal declines in shares on loan and available shares are much more common when it is harder to locate an alternative source of shares. Finally, a large portion of current lender squeezes are also all lender squeezes.

The second contribution of this article is to document the frequency of short squeezes and show how the frequency is affected by stock characteristics and lending market conditions. For most stocks at most times, squeezes are rare. Squeezes are more common for small firms than large firms and much more common for stocks that are hard to borrow than stocks that are easily borrowed. When utilization (the proportion of shares available to lend that is on loan to short sellers) is 25% or less, as it is for about 3 out of 4 stocks, an all lender squeeze occurs about once every 40 years. When a stock's utilization is 90% or more, an all lender short squeeze occurs about once every 11 days. When borrowing fees are less than 50 basis points per year, a current lender squeeze occurs about once every 10 years. When fees are greater than 10% a current lender squeeze occurs about once every 25 days.

A third contribution of this article is to show that short squeezes can significantly reduce expected returns to short selling by forcing short sellers to bear trading costs from closing and reestablishing positions, and by forcing them to close positions before stocks decline. For each stock each month, the expected cost of closing and reestablishing short positions after squeezes is estimated by multiplying the percentage decline in short positions from squeezes by ½ the bid–ask spread when the squeeze occurs and by ½ the spread if the position is reestablished. For most stocks, the expected trading costs from short squeezes are trivial because the likelihood of a squeeze is very small. For hard-to-borrow stocks with borrowing fees of 25% or more, the expected trading costs from short squeezes are 29 to 37 basis points per month. For stocks with utilization rates of 90% or more, the expected trading costs from short squeezes ranges from 56 to 73 basis points over the next month and from 1.04% to 1.34% over the next quarter. So, for hard-to-borrow stocks, the expected costs of closing and reopening positions as a result of short squeezes can be significant.

Inability to reestablish a short position after a squeeze is also costly. When investors short stocks with utilizations of 90% or more, they can expect to miss −30.9 basis points of excess returns over the next month because short squeezes occur and they cannot reestablish positions quickly. Over the next quarter, short sellers of these stocks are, on average, on the sidelines during excess returns of −0.937% following squeezes. Squeezes happen at bad times for short sellers.

Short squeezes significantly reduce the returns to short selling. For stocks with utilization above 90%, the mean excess return over the next month is −1.293%. The expected costs from squeezes range from 0.873% to 1.039%. Hence more than two-thirds of the excess returns to shorting these stocks are lost to the costs of short

squeezes alone. When fees range from 1% to 5% per year, the average monthly fee is 0.197%, which is actually less than the total cost of squeezes estimated using TAQ quoted spreads, 0.198%. Expected costs of squeezes can be economically significant.

Short sellers only short if they expect the returns from short selling to compensate them for the costs of squeezes as well as the fees to borrow shares. This article shows that the single best predictor of short squeezes is utilization, or the percentage of available shares that are on loan. Every month, I sort stocks into 25 portfolios based on the stocks' borrowing fees and utilization at the beginning of the month. I then calculate abnormal returns for each portfolio using the Fama–French (2015) 5-factor model. High-fee stocks earn significant negative abnormal returns, which compensate short sellers for borrowing costs. In addition, holding fees constant, I find that high-utilization stocks, which are most likely to experience short squeezes, earn significantly lower returns than low-utilization stocks. This is consistent with the risk of short squeezes being incorporated into share prices.

The rest of the article is organized as follows: Section II provides a review of the literature. The data used here is described in Section III. Section IV examines the determinants of short squeezes. Section V explores the consequences of squeezes for short sellers. Section VI summarizes the article and offers conclusions.

II. Evidence on the Returns, Costs, and Risks of Short Selling

Theory provides good reasons to believe that hard-to-borrow stocks will earn low returns. Miller (1977) notes that if short sale constraints prevent short sellers from trading, prices of stocks that are hard to borrow reflect the opinions of optimistic investors only. Hence they are overpriced and underperform in the future. A second reason for hard-to-borrow stocks to earn low returns is given by Duffie, Gârleanu, and Pedersen (2002). In their model, the price of a stock incorporates both its intrinsic value and the expected income from loaning the shares. Because the price includes the income from loaning out the shares, it can exceed even the most optimistic investor's assessment of the stock's intrinsic value. Another way to think about the relation between borrowing constraints and stock returns is that informed short sellers should short until the benefits of additional shorting are offset by the costs of shorting more shares. Therefore when stocks are expensive to borrow, short sellers will stop shorting when shares are still significantly overpriced.

A. Evidence that Hard-to-Borrow Stocks Earn Low Returns

There is overwhelming evidence that stocks with binding short-sale constraints, as measured by high borrowing fees or short interest, earn poor returns. Desai, Thiagarajan, and Balachandran (2002) show that heavily shorted stocks, defined as stocks with short interest exceeding 10% of shares outstanding, earn Fama–French–Carhart 4-factor abnormal returns of −1.13% per month. Jones and Lamont (2002) study stocks that were hard-to-borrow in the NYSE's centralized loan crowd over 1926–1933. They find that the stocks that were the most costly to short underperformed the least costly by 1.61% per month. Asquith, Pathak, and Ritter (2005) use high short-interest ratios as a proxy for high demand to short and

low institutional ownership as a proxy for a low supply of lendable shares. They find that equal-weighted portfolios of stocks in the highest percentile of short interest ratios and the lowest third of institutional ownership underperform by 215 basis points per month. Boehme, Danielsen, and Sorescu (2006) document that short-sale constrained firms subject to a large dispersion of beliefs have 1-month 4-factor abnormal returns that are more than 2% lower than stocks with a large dispersion of beliefs that are not short-sale constrained. Diether (2008) shows that micro-cap stocks and stocks with high loan fees are the most profitable to short. Kelley and Tetlock (2017) examine retail short selling over 2003–2007. They find that the quintile of stocks with the greatest retail short selling has 3-factor abnormal returns that are lower than the abnormal returns of lightly shorted stocks by 1.8% over the next 3 months. Nagel (2005) observes that institutions are more likely to make shares available to lend than are retail investors. Hence stocks with high levels of institutional ownership are less likely to be hard-to-borrow. Nagel shows that stocks with high analyst forecast dispersion, market-to-book, volatility, or turnover underperform less if they have significant institutional ownership.

Borrowing fees are a particularly powerful return predictor. D'Avolio (2002) notes that there is an excess supply of shares available to lend for most stocks and hence median lending fees are small, typically 25 basis points per year for his sample. For stocks that are on special, that is stocks that do not have a large excess supply of shares to lend, lending fees can be large. Engelberg et al. (2018) report a median loan fee of 11.6 basis points but a 99th percentile of 14.79%.[2] Blocher, Reed, and Van Wesep (2013) use data from 12 equity lenders for 2004–2007. They define a specialness indicator as lending fees above the 95th percentile. They show that stocks on special underperform by about 1.5% per month. Engelberg, Evans, Leonard, Reed, and Ringgenberg (2020) compare the power of stock borrowing fees to predict stock returns to that of 102 different anomalies. Over the period of 2006 to 2019, portfolios formed on the basis of borrowing fees provide larger long-short returns than portfolios formed on the basis of *any* of the 102 anomalies. Borrowing fees also provided the highest Sharpe ratio.

There is some evidence that short sellers earn abnormal returns even after subtracting out the costs of going short. Geczy, Musto, and Reed (2002) obtain data from a major U.S. equity lender for Nov. 1998 to Oct. 1999. They find that after paying borrowing fees, short sellers could still profit from underperformance of IPOs, from underperformance following the end of IPO lockups, and from the poor performance of recent losers. Using data from a major securities lender, Cohen, Diether, and Malloy (2007) define the combination of an increase in loan fee and an increase in the proportion of shares on loan as an increase in the demand to short. They demonstrate that increases in the demand to short are associated with negative risk-adjusted stock returns the following month. They find that a strategy of selling the portfolio of stocks with increased demand to short and buying the portfolio of stocks with decreasing demand to short each month produces excess returns of 4.5% per year after borrowing fees and transaction costs.

[2]Engelberg et al. (2018) have loan fee data, or the fee paid to lenders after subtracting out lending agents' fees. The data used here are borrowing fees, or the amount paid by short sellers to borrow shares.

B. Evidence on the Risks of Short Selling

Short sellers' ability to earn abnormal returns after paying borrowing fees suggests that there are significant risks to short selling. One risk is that fees will increase and the short seller will have to pay more to borrow the stock than expected. Engelberg et al. (2018) (ERR) use the predicted variance of stock borrowing fees as a measure of that short-selling risk. They forecast the variance of loan fees by regressing the daily variance of fees on the previous month's variance of new fees, variance of utilization, the tail of new fees, the tail of utilization, and variance of loan fees. The predicted value is what investors could be expected to know about the variance of fees. ERR do double sorts of stocks first on short interest, and then on their measure of short risk. Using data for July 2006 to Dec. 2011, they find that stocks with high short risk underperform stocks with low short risk in the same short interest quintile. Fama–MacBeth regressions are run with excess returns as the dependent variable and a number of explanatory variables, including short interest, short risk, and the loan fee. Coefficients on both loan fee and short risk are negative and significant.

Short-selling risk is also examined by Muravyev, Pearson, and Pollet (2022). They calculate implied borrowing fees using the differences between actual stock prices and prices implied by options through put-call parity. They find that the difference between implied borrowing fees and the fees realized over the lives of the options is small on average. This indicates that any risk premium from changes in the cost of borrowing shares is small. Muravyev et al. note that if the risk premium for short fee risk is large, it should be reflected in the returns to short selling after adjusting for borrowing fees. They find that borrowing fee risk, as estimated by ERR, does not predict returns after adjusting for fees.

Andrews, Lundblad, and Reed (2020) show that the median loan fee across stocks is correlated with several measures of risk, including momentum, the Ted Spread, and the VIX. When stocks are double sorted into portfolios on the basis of total and systematic loan fee volatility, they find that high systematic fee volatility stocks earn lower returns than low systematic fee volatility stocks. This is consistent with commonality of fees being a priced, systematic risk.

Risk to short sellers increases with the length of time that the short seller expects to maintain the position. Differences between actual stock prices and stock prices implied by options provide one case where the short knows how long the short position must be maintained. At the option's expiration, implied and actual stock prices will converge. Engelberg et al. (2018) define put-call disparity as the difference between the actual and implied stock prices. Put call disparity increases with the loan fee and short risk. Not surprisingly, the greater put-call disparity is associated with larger short volume. Of more interest is that the product of short risk and months to expiration is negatively correlated with short volume. Short sellers are more reluctant to sell short with a longer expected time to convergence.

Short sellers can reduce their risk if they can get the market to incorporate their information into prices more quickly. Ljungqvist and Qian (2016) show that some short sellers speed the process of price correction by releasing the information that motivated them to go short. Following the release of a report by a short seller, the price of the subject company shares fall, on average, by an immediate 7.5% and by

42%–47% over 12 months as investors with long positions dump shares. Ljungqvist and Qian show that the market reaction is greater for short sellers with a track record of finding overvalued stocks.

This article explores the risk to short sellers from short squeezes. I define squeezes as recalls of share loans that result in terminations of short positions. This is similar to Lamont's ((2012), p. 21) definition of a short squeeze as occurring when "a short seller is involuntarily forced to cover his short position because he is no longer able to borrow the security.[3]" The term short squeeze carries a lot of baggage, but the definition of short squeeze used here does not necessarily mean that loans are recalled with the intention of forcing short sellers to close positions, nor that the loan recall is part of any coordinated action to manipulate prices.[4] For the purposes of this article, a short squeeze is any recall of a share loan that results in short sellers closing positions. In the case of an all lender squeeze, there are not enough remaining shares with all lenders to meet the previous day's demand for shares to borrow. For a current lender squeeze, the reduction in shares on loan equals the reduction in available shares on the same day. This could mean that the short seller cannot find another source of shares. A current lender squeeze could also mean that the short seller closes his position because new shares can only be borrowed at a prohibitively high borrowing fee.

To date, the empirical work on short squeezes is limited. D'Avolio (2002) reports recalls of share loans affect about 2% of the stocks in his sample each month. He notes that recall risk is highest on days when trading volume is very high for the stocks that are subject to recall. D'Avolio's measure of short squeezes is, however, noisy. His data is from a single large loan provider who provided about 10% of share loans. A short seller who suffers a recall in his data may be able to find another source of shares.

Chuprinin and Ruf (2017) examine the risk of loan recalls. For a given stock on a given day, they define recall pressure as the trailing 90-day correlation between reductions in the number of shares lent and the number of lendable shares. They find that recall pressure is associated with lower stock returns over each of the next 4 months.

In this article, I show that high utilization is associated with a high likelihood of short squeezes. Boehmer, Huszár, Wang, and Zhang (BHWZ) (2018) examine the power of eight short-selling variables to predict returns in 38 countries from July 2006 to Dec. 2014. Interestingly, the lending fee is not one of their eight variables. They do not look explicitly at short squeezes but they find that utilization is particularly successful at predicting returns to short selling around the world. Boehmer et al. do not explain why utilization is associated with greater returns to short selling except to note (p. 10) that it "is generally associated with high shorting demand." As we will see, a high level of utilization is the single strongest predictor of short squeezes.

[3]In the popular press, incidents in which increasing prices impose losses on short sellers are often referred to as squeezes. That is not what is meant by squeezes either here or in Lamont (2012). A short squeeze occurs when share loans are withdrawn, not when short sellers experience losses.

[4]Lamont (2012) identifies 29 cases where firms attempted to coordinate share loan recalls. This can be done, for example, by having shareholders request delivery of their shares rather than allowing them to be held in "street name" with a broker.

III. Data

Data used here come from 3 sources. CRSP provides daily stock returns, shares outstanding, stock prices, and closing quoted bid–ask spreads. TAQ provides daily time-weighted quoted spreads, mean effective spreads, and volume-weighted effective spreads. IHS Markit is the source of data on short selling and the stock lending market. IHS Markit collects data daily on individual stocks from over 650 lending market participants, including 40 prime brokers, 120 custodian banks, and 500 hedge funds. Their data currently captures over 90% of all share lending for North American stocks and includes borrowing fees, the number of shares available to lend, the number of shares on loan, inventory, lending, and borrowing concentration, the utilization rate of shares available to lend, and several other variables.[5] Stocks with no share lending market are not included in the IHS Markit data.

Table 1 provides the distribution of variables across all stock-day observations. The first row shows the distribution of borrowing fees for individual stocks. These fees are for 1 day loans, but they are expressed in terms of annual interest rates. Shares in most stocks can be borrowed cheaply and there is little variation in the fees for easily borrowed stocks. The 25th percentile of fees is 37.5 basis points per year and the median fee is also 37.5 basis points per year. The distribution of borrowing fees is right-skewed with a mean of 2.673% and a 95th percentile of 11.0%. While most stocks can be borrowed cheaply, some are very expensive to borrow. The next 2 rows of Table 1 report the distribution of fees for 2006–2012 and for 2013–2019. The 25th percentile and median fees are 37.5 basis points per year in both subperiods. The fees in the right tail of the distribution, however, are greater in the second subperiod. For 2006–2012, the 95th percentile of fees is 8%, For 2013–2019, it is 14%. IHS Markit's coverage of the stock lending market expanded to include more market participants over this period and captured more of the hardest to borrow stocks at the end of the sample period.[6]

TABLE 1

The Distributions of Key Short-Selling Variables

The distribution of variables in Table 1 is calculated across all stock-day observations from July 2006 to Dec. 2019. Fee is the annualized borrowing fee for shares paid by short sellers. Utilization is the percentage of shares available for lending to short sellers that are on loan. Percent available is the percentage of shares outstanding that are available for lending.

Variable	Mean (%)	5% (%)	25% (%)	Median (%)	75% (%)	95% (%)
FEE	2.673	0.254	0.375	0.375	0.625	11.000
FEE 2006–2012	1.901	0.250	0.375	0.375	0.500	8.000
FEE 2013–2019	3.448	0.275	0.375	0.375	0.975	14.000
UTILIZATION	17.565	0.000	1.856	8.079	24.328	70.443

[5]IHS Markit's Oct. 9, 2012, white paper "Shining the Light on Short Interest" claims that their data "captures around 90% of the securities lending market in developed markets." In a second white paper from 2015, "Thresholds in Securities Lending Metrics," they claim coverage is "more than 90%" across U.S. large cap, U.S. small cap, developed Europe, and developed Asia universes. Both papers are available on their website at ihsmarkit.com/products/securities-finance.html#Securities. Markit employees tell me that they believe the coverage is closer to 95% for North American stocks in recent years.

[6]Goyenko and Schultz (2021) find that IHS Markit's data includes 76.4% of CRSP stocks in 2006, increasing steadily to 97.3% in 2018.

The fourth row of Table 1 reports the distribution of the utilization, or the proportion of shares that are available for lending that are on loan. A high utilization rate means that some potential short sellers may be unable to locate shares to borrow. It also indicates that it may be difficult to find another source of shares if a loan is recalled. The median utilization rate is 8.08% and the interquartile range is from 1.86% to 24.33%. The 95th percentile is 70.44%. The distribution of utilizations indicates that there is an ample supply of shares for short sellers in most stocks. For some stocks, however, it can be difficult to locate shares to borrow. It might seem that shares could still be borrowed easily when utilization is just 70%, but the share lending market is a fragmented market. A potential borrower's normal sources of shares may have no shares to loan.

IV. Determinants of Short Squeezes

A. The Frequency of Short Squeezes

In this section, I examine how often shares are recalled and short sellers are forced to close their positions. Or, in other words, the frequency of short squeezes. I use two separate proxies for short squeezes. The first, which I call an all lender squeeze, is a dummy variable that equals 1 if the total shares available to loan falls below the number of shares on loan the previous day. So, for example, the all lender squeeze variable equals 1 for Benefytt Technologies for June 1, 2015. On the previous day, May 29, 2015, IHS Markit data shows there were 763,518 shares available to lend and 649,119 were on loan. On the next trading day, June 1, 2015, the number of shares available to lend declined by 185,721 to 577,797. At a minimum, over 70,000 of the 649,119 shares borrowed and shorted the previous day had to be returned. The number of shares on loan actually fell from 649,119 to 474,719.

The all lender squeeze may be an overly restrictive measure of short squeezes. It assumes that a short seller would be able to locate new shares to borrow from *any* source that has shares and that a squeeze only occurs when shares available from *all* sources decline to less than short interest. In practice, the share lending market is a fragmented market and it may be difficult to find shares. The second proxy for short squeezes, which I term a current lender squeeze, is a dummy variable that equals 1 if the shares available to loan and the shares on loan decrease by the same amount on the same day. This variable would indicate a short squeeze if a lender withdrew shares and the short seller could not locate a new source of shares in the fragmented lending market. It would also indicate a short squeeze if the short seller was able to locate another source of shares, but chose not to borrow because the borrowing fee was too high.

Table 2 shows the proportion of sample stock days with no squeeze of either type, the proportion that are all lender or current lender squeezes, and the proportion of stock days that are both. In total there are 12,495,061 stock days with data on shares on loan and shares available to loan both that day and the previous day. Squeezes are unusual. On 22,840 stock days, or 0.183% of the total, there is an all lender squeeze. On 58,551 stock days, or 0.469% of all stocks days there is a current lender squeeze. The current lender squeeze is intended to be a less restrictive proxy that accounts for the difficulty in locating shares from a new lender, so it is not

TABLE 2

The Number and Proportion of Days with All Lender Squeezes and Current Lender Squeezes

In Table 2, an all lender squeeze occurs if the total shares available to be borrowed by short sellers on day t is less than the number of shares borrowed on day $t-1$. A current lender squeeze occurs if the number of available shares and the number of shares on loan decrease by an equal amount on the same day.

	Current Lender Squeeze	No Current Lender Squeeze	Total
All lender squeeze	12,786 (0.102%)	10,054 (0.081%)	22,840 (0.183%)
No all lender squeeze	45,765 (0.366%)	12,426,456 (99.451%)	12,472,221 (99.817%)
Total	58,551 (0.469%)	12,436,510 (99.531%)	12,495,061 (100.0%)

surprising that they are more common than all lender squeezes. There are 12,786 stock days, or 0.102% of the total that are classified as having both an all lender squeeze and a current lender squeeze. This is more than 100 times as many as would be expected if they were independent events.

The all lender squeeze measure is clear and unambiguous. If the shares available to borrow on day t are less than the shares on loan on day $t-1$, some short sellers are forced to close positions. The current lender squeeze measure is noisier. An equal decrease in shares available for lending and shares on loan on the same day could be a mere coincidence. There are, however, three reasons to believe that few of the current lender squeezes are coincidences. First, as I have seen, many of the current lender squeezes are also all lender squeezes. Second, in many cases the number of shares withdrawn makes it seem highly unlikely that the equal decrease in shares available for lending and shares on loan is a coincidence. For example, on Dec. 6, 2007, there were 501,245 shares of Banctrust Financial Group available for lending and 305,627 were on loan. The next day, the quantity available for lending dropped by 14,200 shares to 487,045 and the quantity on loan decreased by 14,200 shares to 291,427. On Apr. 27, 2018, there were 52,659 shares of Opiant Pharmaceuticals available to lend and 50,100 were on loan. On the next trading day the number of shares available to loan fell by 11,800 shares to 40,859, while the number of shares also on loan fell by 11,800 shares to 38,300. Short squeezes from loan recalls can explain why the number of shares available to lend and the number of shares on loan fall by the same amount on the same day.

Third, although current lender squeezes are unusual, they occur much more often than would be expected if equal decreases in available shares and shares on loan were coincidences. If equal declines in shares available to lend and shares on loan on the same day were coincidences that had nothing to do with a loan recall, I might expect them to happen about as frequently as a reduction in shares available to lend and an equal reduction in shares on loan that occurs a few days before or after. To see if this is true, I calculate the proportion of stock days in which the number of shares available to lend and the number of shares on loan decline by the same amount. Then, for comparison, I calculate the proportion of stocks days for which the decrease in shares on loan is matched with an equal decrease in the shares available to lend from 1 to 5 days before and from 1 to 5 days afterward. Results are shown in Table 3.

The percentage of stock days in which there is a reduction in the number of shares on loan that is matched with an equal reduction in shares available to lend is shown in bold. These are the observations that I define as a current lender short

TABLE 3

The Proportion of Stock Days in Which a Reduction in Shares on Loan Has an Equal Reduction in Available Shares on the Same Day, and on 1 of the 5 Days Before or After

In Table 3, changes in shares on loan are compared with changes in shares available to lend for the same stock. The sample period is 2006–2019.

	All		Utilization < 50%		Utilization > 50%	
$\Delta LOAN_t =$	No. of Obs.	% Equal	No. of Obs.	% Equal	No. of Obs.	% Equal
$\Delta AVAILABLE_{t-5}$	13,100,963	0.029	11,731,161	0.029	1,369,750	0.038
$\Delta AVAILABLE_{t-4}$	12,465,992	0.030	11,105,589	0.029	1,360,403	0.036
$\Delta AVAILABLE_{t-3}$	12,472,994	0.030	11,111,121	0.029	1,361,873	0.037
$\Delta AVAILABLE_{t-2}$	12,480,288	0.031	11,116,707	0.030	1,363,501	0.039
$\Delta AVAILABLE_{t-1}$	12,487,802	0.031	11,122,532	0.030	1,365,270	0.042
$\Delta AVAILABLE_t$	12,495,061	**0.469**	11,128,324	**0.288**	1,375,870	**1.940**
$\Delta AVAILABLE_{t+1}$	12,491,105	0.031	11,125,779	0.030	1,365,326	0.041
$\Delta AVAILABLE_{t+2}$	12,484,908	0.032	11,120,597	0.031	1,364,311	0.043
$\Delta AVAILABLE_{t+3}$	12,479,448	0.030	11,116,210	0.029	1,363,238	0.033
$\Delta AVAILABLE_{t+4}$	12,473,763	0.029	11,111,550	0.029	1,362,213	0.037
$\Delta AVAILABLE_{t+5}$	12,468,443	0.030	11,107,673	0.030	1,360,770	0.033

squeeze. When all observations are included this occurs in about 0.469% of stock days. When utilization is less than 50%, equal declines in available shares and shares on loan occur in 0.288% of stock days. For utilizations greater than 50%, the proportion increases sharply to 1.940%. If the equal decrease in shares on loan and available shares is mere coincidence, I would expect to see changes in shares on loan match changes in available shares on surrounding dates just as frequently. That is clearly not true. When all stock days are considered, the probability that shares on loan and available shares decrease by the same amount on the same day is about 15 times as large as the probability that shares on loan decreases by the same amount that available shares decreases on any one of the 10 surrounding days. When I consider just stock days with utilization above 50%, the probability that shares on loan decreases by the same amount as available shares does on the same day is more than *45* times as large as the probability that shares on loan decreases by the same amount that available shares decreases in any of the 10 surrounding days.

So, it appears that equal same-day decreases in shares on loan and shares available to lend are far more common than would be expected by chance. This is not to say that the current lender squeeze proxy is never spurious. The results in Table 3 suggest that about 1 in 16 of the current lender squeezes are just coincidental declines in shares on loan and shares available to lend.

B. Hard-to-Borrow Stocks and Short Squeezes

For most stocks at most times, short squeezes are unusual. In some circumstances though they are common. As we will see, short squeezes are most likely to occur when the returns to short selling are greatest.

Table 4 shows how the probability of short squeezes varies with borrowing fees, utilization, and firm size. Panel A reports the probability of a squeeze for various levels of borrowing fees. The total number of stock-day observations is 12,449,100. About 0.36% of the observations in Table 2 are lost because of missing fee, utilization, or firm size data. Across all stocks and days, short squeezes are unusual. The probability of an all lender squeeze for a given stock day is 0.18%. The probability of a current lender squeeze is 0.47%. For about three-quarters of stocks

TABLE 4

The Probability of a Short Squeeze on a Stock Day

In Table 4, a short squeeze is defined as occurring if the number of shares available to lend and the number of shares lent out decline by the same number on the same day. Fees are the annualized fees paid to borrow a stock the previous day. Utilization is the proportion of shares available for lending that are lent out the previous day.

		Probability of Squeeze		Expected Decline in Shorts	
Indicative Fee	Observations	All Lender (%)	Current Lender (%)	All Lender (%)	Current Lender (%)
Panel A. The Probability of a Short Squeeze by Fee					
All stock days	12,449,100	0.18	0.47	0.05	0.09
≤0.5%	9,207,564	0.01	0.04	0.01	0.01
0.5%–1.0%	743,158	0.03	0.16	0.02	0.04
1.0%–5.0%	1,188,482	0.23	1.11	0.10	0.31
5.0%–10%	596,641	0.66	1.93	0.21	0.46
>10.0%	713,255	2.06	3.96	0.41	0.58
Panel B. The Probability of a Short Squeeze by Utilization					
All stock days	12,449,100	0.18	0.46	0.05	0.09
<25%	9,278,669	0.00	0.26	0.00	0.07
25%–50%	1,806,369	0.03	0.39	0.02	0.05
50%–75%	843,429	0.16	0.67	0.09	0.08
75%–90%	324,686	0.67	1.26	0.26	0.14
≥90%	195,947	9.23	8.41	1.80	1.28
Panel C. The Probability of a Short Squeeze by Firm Size					
All stock days	12,449,100	0.18	0.46	0.05	0.09
>Median	6,534,544	0.02	0.03	0.01	0.00
25th–50th Per.	3,187,077	0.14	0.25	0.03	0.05
10th–25 Per.	1,731,050	0.48	1.53	0.12	0.30
<10th Percentile	996,429	0.83	2.16	0.25	0.47

Panel D. The Proportion of Days with Squeezes, Decreases in Shares Available, and Decreases in Shares on Loan by Utilization

		Percent Days			
$Utilization_{t-1}$	No. of Obs.	All Lender Squeeze	Current Lender Squeeze	Decrease in Shares Available	Decrease in Shares on Loan
<25%	9,278,669	0.00	0.26	42.95	44.27
25%–50%	1,806,369	0.03	0.39	45.66	48.24
50%–75%	843,429	0.16	0.67	45.85	46.89
75%–90%	324,686	0.67	1.26	45.68	45.81
≥90%	195,947	9.23	8.41	34.60	35.53

days, fees are 50 basis points or less. Squeezes almost never occur for these stocks. The likelihood of an all lender squeeze is 0.01% per day, or about once every 40 years. The likelihood of a current lender squeeze is 0.04% or about once every 9 years. So, for the great majority of stocks, the risk of a short squeeze is very small.

The probabilities of both types of squeezes increase monotonically with borrowing fees. At high fees of more than 10% per year, the probability of an all lender squeeze is 2.06%, or about once every 49 days. The probability of a current lender squeeze is 3.96%, or about once every 25 days. Squeezes are far, far more common for stocks that are costly to borrow than stocks that can be borrowed cheaply. Engelberg et al. (2020) find that loan fees are a very powerful predictor of stock returns. Hence the probability of a squeeze is highest for stocks that provide the highest returns to short sellers.

The last 2 columns in Panel A of Table 4 report the expected percentage decline in shares sold short from squeezes. It is calculated by multiplying the dummy variable for an all lender or current lender squeeze by the percentage reduction in shares on loan when the squeeze occurs. The expected percentage decline from all

lender squeezes is 0.01% when fees are 50 basis points or less. It increases steadily with fees and reaches 0.41% when fees are above 10%. So, when fees are above 10%, on average about four-tenths of 1% of short positions are closed every day as a result of all lender squeezes. The expected percentage decline in shares sold short from current lender squeezes also increases with fees. It is 0.01% when fees are 50 basis points or less and rises monotonically to 0.58% when fees are above 10%.

Panel B of Table 4 shows how the probability of a short squeeze changes with utilization. The relation between the likelihood of a squeeze and utilization is especially strong. When utilization is less than 25%, as it is in about three-quarters of stock days, the probability of an all lender squeeze is less than 0.01%, or less than one squeeze every 40 years. When utilization is above 90%, as it is in about 1 ½% of stock days, the probability of an all lender squeeze is 9.23%. In other words, for stocks with utilization above 90%, a squeeze occurs about once every 11 trading days, or about twice a month. The next column shows that the proportion of days with current lender squeezes increases from 0.26% when utilization is less than 25% to 8.41% when utilization exceeds 90%. The last 2 columns report the expected decline in shares sold short from squeezes for different levels of utilization. The expected decline is less than 0.01% from all lender squeezes for utilization less than 25%. When utilization is above 90%, the expected decline is 1.80%. At this rate, all shares on loan would be recalled in less than 3 months. Similarly, the expected decline in shares sold short in current lender squeezes rises from 0.07% for utilization less than 25% to 1.28% for utilization greater than 90%. With 21 trading days in a month, this means that more than a quarter of shorted shares can expect to be recalled in squeezes in a month.

Panel C of Table 4 shows how the probability of a short squeeze changes with firm size. Firms are divided into those with market capitalizations above the median, between the 25th and 50th percentiles, between the 10th and 25th percentiles, and below the 10th percentile. The relation between firm size and the probability of a squeeze is not as strong as the relation between the probability of a squeeze and utilization or fees. Nevertheless, it is clear that short squeezes are rare for firms that are above the median size of $423.4 million, and are much more common for smaller firms. For firms in the smallest decile of market capitalizations, the probability of an all lender squeeze on a given day is 0.83% and the probability of a current lender squeeze is 2.16%.

Panels A–C of Table 4 show that for most stocks on most days, the probability of a short squeeze is very small and does not appear to be a significant risk for short sellers. For the small number of hard-to-borrow stocks with high utilization and high fees, the likelihood of a short squeeze is much greater. For these stocks, short squeezes are a significant risk for short sellers. These are also the stocks with the highest returns to short selling.

There is a particularly strong relation between utilization and all lender squeezes. High rates of utilization mean that if shares are recalled there are no shares available to replace the borrowed shares. The relation between utilization and current lender squeezes also seems clear. The share lending market is fragmented and when shares are recalled a borrower may have to search beyond their usual lenders. With high utilization and high search costs, it may be difficult to find

shares to replace a recalled loan. There is, however, another possible explanation for the relation between utilization and current lender squeezes. Perhaps decreases in shares available and decreases in shares on loan both become more common as utilization increases. In this case, coincidental equal decreases in available shares and shares on loan could become more likely as utilization increases.

On a given day, the number of shares available to lend, like the number of shares on loan, can increase, decrease, or remain unchanged. In Panel D of Table 4, I calculate the proportion of stock days in which available shares decrease and shares on loan decrease for different levels of utilization. As utilization goes from 25%–50% to 75%–90%, the probability of a current lender squeeze more than triples, and the probability of an all lender squeeze increases more than 20-fold. Decreases in shares available occur on 45.66% of days when utilization is 25%–50% and is almost unchanged at 45.68% when utilization is 75%–90%. The proportion of days with a decrease in shares on loan actually falls from 48.24% when utilization is 25%–50% to 45.81% when utilization is 75%–90%. Hence, the increase in the number of squeezes when utilization increases from 25%–50% to 50%–75% is not explained by more days with decreases in shares available and shares on loan. When utilization exceeds 90% the likelihood of a current lender squeeze is much greater than at lower utilization levels. The proportion of days when the shares available decreases is 34.60%, much lower than the proportion for any other utilization level. Likewise, the proportion of days with decreases in shares on loan is just 35.53%, lower than the proportion in any other utilization category. Decreases in shares available and shares on loan are not more common at high levels of utilization. In fact, they are much *less* common at high utilization levels. Hence the increase in the proportion of current lender squeezes when utilization is high is not because decreases in shares available and decreases in shares on loan are more common. Instead, it seems that when utilization is high and a loan is recalled, it is harder to replace it.

C. The Determinants of Squeezes: Multivariate Results

The likelihood of both all lender squeezes and current lender squeezes increases with utilization, fees, and turnover and decreases with firm size.[7] These variables are correlated. To assess the relative importance of these factors in determining squeezes, I regress the dummy variable for a squeeze on a stock day on the utilization, fee, and firm size the previous day and fixed effects for the date. Standard errors are clustered by stock. Results with an all lender squeeze as the dependent variable are shown in Panel A of Table 5. When all stock days with fees, utilization, size, and turnover are included, the coefficients on the previous day's utilization, fees, and mean turnover for the 5 previous days are positive and significant and the coefficient on the natural log of firm size is negative and significant. Results in Table 4 indicate that the likelihood of a short squeeze is a nonlinear function of utilization and fees. So, the regression reported in the next column is piecewise linear in utilization and fees. Additional variables include interactions between utilization

[7]Cohen et al. (2007) find that recall risk is greatest when volume and hence turnover is high.

TABLE 5

Panel Regressions of Dummy Variables for Short Squeezes on Utilization, Fees, Firm Size, and Turnover

In Table 5, an all lender squeeze occurs when the number of shares available to lend is less than the number on loan the previous day. A current lender squeeze occurs the shares available to lend and the shares on loan fall by the same amount on the same day. Utilization is the proportion of shares available to lend that are on loan. Borrowing fees are the annualized cost of borrowing shares. Firm size is shares outstanding times the stock price. Turnover is the daily volume divided by shares outstanding. Observations are daily. The sample period is July 2006 to Dec. 2019.

	All Obs.	All Obs.	Small 25%	25%–50%	50%–75%	Large 25%
Panel A. Regressions with an All Lender Short Squeeze as the Dependent Variable						
INTERCEPT	0.00575	0.00566	0.01582	0.0065	0.00127	0.00001
	(11.72)	(12.78)	(6.82)	(4.15)	(1.39)	(0.19)
$UTILIZATION_{t-1}$	0.00022	0.00002	0.00004	0.00002	0.00001	0.00000
	(19.56)	(14.13)	(7.55)	(6.81)	(4.02)	(2.49)
$UTIL_{t-1} \times D_{UTIL > 50\%}$		0.00003	0.00007	0.00001	0.00001	0.00001
		(15.26)	(11.71)	(5.91)	(3.93)	(2.19)
$UTIL_{t-1} \times D_{UTIL > 90\%}$		0.00093	0.00114	0.00060	0.00034	0.00015
		(24.70)	(24.38)	(15.70)	(6.60)	(3.49)
FEE_{t-1}	0.00672	−0.03223	−0.04127	0.00101	−0.01319	−0.00533
	(9.32)	(−6.25)	(−5.35)	(0.16)	(−1.81)	(−0.63)
$FEE_{t-1} \times D_{FEE > 10\%}$		0.01818	0.02117	−0.00700	0.01164	0.00058
		(3.63)	(3.02)	(−0.99)	(1.95)	(0.07)
$FEE_{t-1} \times D_{FEE > 25\%}$		0.01695	0.02177	0.00857	0.00582	0.00854
		(4.11)	(3.70)	(2.21)	(0.90)	(1.21)
$\ln(SIZE)_{t-1}$	−0.00064	−0.00043	−0.00143	−0.00054	−0.00010	−0.00000
	(−14.27)	(−13.26)	(−6.72)	(−4.33)	(−1.45)	(−0.07)
$TURNOVER_{t-5,\ t-1}$	0.00039	0.00034	0.00103	0.00142	0.00012	0.00000
	(2.08)	(2.00)	(3.03)	(2.06)	(1.40)	(0.94)
No. of obs.	11,777,481	11,777,481	2,660,985	2,987,782	3,054,904	3,073,810
Date FEs	3,394	3,394	3,394	3,394	3,394	3,394
Firm clusters	7,142	7,142	3,712	4,310	3,624	2,197
Adj. R^2	0.0233	0.0746	0.1049	0.0500	0.0275	0.0119
Panel B. Regressions with a Current Lender Short Squeeze as the Dependent Variable						
INTERCEPT	0.03656	0.02909	0.10603	0.02225	0.00165	−0.00265
	(27.03)	(23.51)	(18.43)	(9.25)	(1.68)	(−7.92)
$UTILIZATION_{t-1}$	0.00020	0.00004	0.00030	−0.00001	−0.00000	0.00001
	(16.10)	(6.00)	(10.55)	(−2.25)	(−1.00)	(5.08)
$UTIL_{t-1} \times D_{UTIL > 50\%}$		−0.00004	−0.00013	−0.00001	−0.00000	−0.00000
		(−4.80)	(−4.97)	(−2.47)	(−2.27)	(−1.78)
$UTIL_{t-1} \times D_{UTIL > 90\%}$		0.00072	0.00078	0.00034	0.00016	0.00003
		(18.87)	(18.62)	(10.61)	(3.36)	(1.53)
FEE_{t-1}	0.00977	0.12488	0.04746	0.07759	0.02480	−0.00312
	(11.40)	(10.34)	(2.91)	(7.97)	(2.39)	(−0.56)
$FEE_{t-1} \times D_{FEE > 10\%}$		−0.03811	0.00588	−0.03473	−0.01545	−0.00127
		(−3.06)	(0.35)	(−3.25)	(−1.86)	(−0.36)
$FEE_{t-1} \times D_{FEE > 25\%}$		−0.07969	−0.04996	−0.03860	−0.00602	0.00571
		(−8.37)	(−4.32)	(−4.21)	(−0.87)	(1.30)
$\ln(SIZE)_{t-1}$	−0.00273	−0.00210	−0.00921	−0.00176	−0.00012	0.00018
	(−25.97)	(−22.92)	(−17.32)	(−9.14)	(−1.62)	(8.22)
$TURNOVER_{t-5,\ t-1}$	0.00017	0.00015	0.00016	−0.00068	−0.00011	0.00000
	(1.90)	(1.88)	(3.77)	(−1.24)	(−2.28)	(0.61)
No. of obs.	11,777,481	11,777,481	2,660,985	2,987,782	3,054,904	3,073,810
Date FEs	3,394	3,394	3,394	3,394	3,394	3,394
Firm clusters	7,142	7,142	3,712	4,310	3,624	2,197
Adj. R^2	0.0229	0.0359	0.0611	0.0151	0.0068	0.0016

and dummies for utilization in excess of 50% and utilization in excess of 90% and interactions between fees and dummy variables for fees greater than 10% and fees greater than 25%. This increases the adjusted R^2 of the regression from 0.0233 to

0.0746. When these new variables are included, the coefficient on utilization becomes smaller and the *t*-statistic falls from 19.56 to 14.13. The coefficient on the interaction between utilization and the dummy for utilization greater than 50% is now 0.00003 with a *t*-statistic of 15.26. The coefficient on the interaction between utilization and the dummy for utilization greater than 90% is now 0.00093 with a *t*-statistic of 24.70. Holding all else equal, this suggests that the probability of a squeeze on a given day will increase by $(0.00002 + 0.00003 + 0.00093) \times 95 – 0.00002 \times 10 = 9.29\%$ when utilization increases from 10% to 95%. For very high levels of utilization, all lender squeezes are not uncommon. The coefficient on Fee is −0.03223 with a highly significant *t*-statistic of −6.25. The likelihood of an all lender squeeze initially falls with fees, but the positive coefficients on the interactions between fee and fees above 10% and fees above 25% are positive and significant. After adjusting for utilization, the likelihood of a squeeze declines with fees when fees are low, but not when they are high.

In this regression, the coefficient on turnover is 0.00034 with a *t*-statistic of 2.00. Higher turnover means a greater chance of a short squeeze. With higher turnover, it is more likely that a lender will sell shares and recall their share loan. Turnover seems to be a relatively weak predictor of squeezes though. The coefficient on the log of firm size is −0.00043 with a *t*-statistic of −13.26. The likelihood of an all lender squeeze falls with firm size.

The next 4 columns report separate regressions for stock days in different quartiles of firm size.[8] Results are especially strong for the smallest 25% of firms. The coefficients are similar to the coefficients in the regression with all observations, but tend to be larger in absolute value. For larger size firms, the coefficients on all of the fee size and turnover variables are statistically insignificant.

The number one determinant of all lender squeezes appears to be utilization. Each of the utilization variable coefficients is positive and highly significant in every regression. The likelihood of an all lender squeeze increases at an increasing rate with utilization. This is not surprising. The higher the level of utilization, the more likely that a recall of share loans will reduce the number of available shares to less than the shares on loan.

Panel B of Table 5 is similar to Panel A but the dependent variable is now a dummy variable for a current lender squeeze rather than an all lender squeeze. Adjusted R^2s are smaller than in regressions with all lender squeezes as the dependent variable. Current lender squeezes are more difficult to predict. When all observations are included, the coefficient on the interaction between utilization and the dummy variable for utilization in excess of 90% is large, positive, and highly significant. The coefficient on the interaction between utilization and the dummy variable for utilization in excess of 50% is negative and significant but much smaller in magnitude. The coefficients on the borrowing fees indicate that the likelihood of a current lender squeeze increases with fees, but at a decreasing rate. The coefficient on turnover is only positive and significant for the smallest firms.

[8]There are more observations in the regressions for larger firm sizes because there are fewer days with missing fees or utilizations.

V. Consequences of Short Squeezes

A. Short Squeezes, the Costs of Closing and Reestablishing Positions, and the Costs of Missed Returns

I next estimate the expected direct costs of short squeezes over the next month and next quarter for short sellers who intend to maintain positions for the entire period. The first direct cost of a squeeze is the trading cost from being forced to close a position and, possibly, from reestablishing it at a later date. I use bid–ask spreads to measure trading costs. The second direct cost of short squeezes is the lost returns when a position is closed. I measure both the excess returns to short selling and the lost excess returns using the difference between a stock's return and the CRSP value-weighted index return.

For a specific stock over a specific month (or quarter), direct costs of short squeezes are only incurred if there are short squeezes during the month. On the day a squeeze occurs, the expected trading costs for short sellers are the percentage reduction in shares on loan on the day of the squeeze times ½ the bid–ask spread. So, if there are 1,000,000 shares on loan the day before the squeeze and the number on loan falls to 600,000 with the squeeze, the expected trading costs are $(1 - 600{,}000/1{,}000{,}000) = 0.4$ times ½ the bid–ask spread. Missing excess returns are measured starting the next day as the percentage reduction of shares on loan times the difference between the stock return and the CRSP value-weighted index. So, if the stock return was 0.0% and the index return was 1%, the missing excess return that day in our example would be $0.4 \times (0.0–1.0) = -0.4\%$. When the shares on loan returns to 1,000,000 the short position would be reestablished at a cost of 0.4 times ½ of that day's bid–ask spread.

It is usually easy to calculate the direct costs of short squeezes, but there can be complications. If there is a second squeeze during the period and shares on loan fall from 600,000 to 400,000 the expected trading costs would be the percentage of the original short sellers' position that was still active times the percentage reduction in shares on loan times half the spread. Or, $(0.6)(1 - 400{,}000/600{,}000) = 0.2$ times half the spread. The missing excess return on succeeding days would be 0.6 times the difference between the stock return and the index return. Additional squeezes are treated in the same way.

It is easy to identify when short squeezes occur, but more difficult to determine when positions are reestablished. I assume that closed short positions are reestablished on the day that the shares on loan equal or exceed the number of shares on loan when the first short squeeze occurred. So, in the previous example, on the day that the shares on loan are again equal to 1,000,000, the trading costs would be the percentage of the original position that was lost to squeezes, 0.6, times ½ the bid–ask spread.[9] Missing excess returns are no longer calculated as of the day the short

[9]I assume that a short position is reestablished when shares on loan return to the level they had before the squeeze. Alternatively, I could assume that smaller increases in shares on loan within the period reflect a partial recovery on the original short sellers' positions. So, in our example, if shares on loan fell from 1,000,000 to 600,000 with the squeeze and then recovered to 800,000 a few days later, I could assume that the original short sellers reestablished short positions in 200,000 shares. Missing excess returns would then be 0.2 times the excess returns rather than 0.4 times the excess returns. But, if a second

position is reestablished. If the end of the period is reached, shares on loan had never reached the level before the first squeeze, and the shares on loan are at or below the level as of the last squeeze, I assume that none of the short positions has been reestablished. On the other hand, if the shares on loan have increased since the last squeeze but are below the original amount, I assume part of the position is reestablished. In the example above, the 1,000,000 shares on loan had been reduced to 400,000 after two squeezes. If the shares on loan were 500,000 at the end of the period, I assume that the 100,000 shares are shorted at that time. The expected cost of reestablishing that position would be (100,000/1,000,000) = 0.1 times ½ the bid–ask spread.

This exercise is intended to approximate the expected costs of short squeezes for short sellers at the beginning of a period who intend to maintain a short position throughout the period. This is unlikely to be an optimal short-selling strategy. The short seller may, for example, want to terminate a position before the end of the period if the stock price has declined sufficiently or if short-selling fees have increased. Note also that this exercise estimates the expected costs of short squeezes. The actual costs will vary by stock and by short seller. For the stocks that actually experience a short squeeze, costs are much higher than the expected amounts. Likewise, if 400,000 shares out of 1,000,000 on loan are recalled, some short sellers will be forced to close their entire positions while others may be unaffected. There is uncertainty about the costs of short squeezes that may present significant risk to short sellers.

I estimate spreads in 4 ways. The first is the closing quoted bid–ask spread from CRSP. It is calculated by dividing the difference between the closing ask and bid prices by the closing bid–ask midpoint. TAQ, the second source of data, provides daily time-weighted percentage bid–ask spreads, and simple and share-volume weighted average effective spreads. The effective spread for each trade is estimated as 2 times the absolute value of the difference between the transaction price and the bid–ask midpoint, divided by the midpoint. It incorporates any price improvement that a trader receives. I would usually expect sophisticated investors like short sellers to receive price improvement on their trades. On the other hand, a short squeeze requires short sellers to repurchase shares quickly and may limit their ability to seek price improvement.

Panel A of Table 6 reports the means of the estimated spreads across all stock days by fee. When all observations are included the mean effective spread is the lowest cost estimate at 0.59%, the mean closing quoted spread from CRSP is 0.62%, the volume-weighted effective spread is 0.64%, and the time-weighted quoted spread from TAQ is 0.86%. Each of these spread measures increases with fees and hence with the likelihood of a short squeeze. When fees exceed 10%, spreads range from 1.67% for effective spreads to 2.16% for TAQ quoted spreads. Panel B reports mean spreads by utilization. They are much larger for the highest utilization stock days than for others. This again demonstrates that when short squeezes are most likely to occur, trading costs are especially large.

squeeze occurred and, say, 50% of shares on loan were repurchased, the original short sellers would be forced to repurchase 400,000 shares rather than 300,000 and trading costs would be 0.4 times ½ the spread rather than 0.3 times ½ the spread.

TABLE 6

Daily Trading Cost Estimates 2015–2019

In Table 6, the CRSP Quoted Spread is the closing bid–ask spread. The TAQ Quoted spread is the time-weighted average spread over the day. The effective spread for a trade is 2 times the absolute value of the difference between the trade price and the bid–ask midpoint. It is averaged across all trades during the day to get the effective spread. The volume-weighted effective spread is a weighted average of the effective spread across all trades during the day where the weights are the share volumes of the trades. Each spread estimate is expressed as a percentage of the bid–ask midpoint. Mean spreads are calculated across stock days and reported in the table.

Fee	Observations	CRSP Quoted Spread (%)	TAQ Quoted Spread (%)	Effective Spread (%)	Vol. Weighted Effective Spread (%)
Panel A. Mean Spreads by Borrowing Fee					
All stock days	3,949,532	0.62	0.86	0.59	0.64
<0.5%	2,615,778	0.61	0.42	0.25	0.28
0.5%–1.0%	270,175	0.51	0.82	0.55	0.60
1.0%–5.0%	496,411	0.65	1.71	1.22	1.31
5.0%–10.0%	204,465	0.77	2.09	1.54	1.66
≥10%	362,703	1.70	2.16	1.67	1.80
Panel B. Mean Spreads by Utilization					
<25%	3,082,482	0.61	0.84	0.57	0.62
25%–50%	475,692	0.51	0.74	0.49	0.55
50%–75%	227,115	0.65	0.90	0.62	0.71
75%–90%	93,587	0.77	1.01	0.71	0.81
≥90%	70,656	1.70	2.06	1.61	1.74
Panel C. Mean Spreads Around Days with Squeezes					
Day of a squeeze					
All lender	11,006	2.03	2.48	1.90	2.04
Current lender	38,069	2.44	2.91	2.27	2.44
Three days before a squeeze					
All lender	10,916	2.04	2.44	1.88	2.05
Current lender	38,010	2.45	2.93	2.25	2.41
Five days after a squeeze					
All lender	10,947	2.04	2.57	1.90	2.09
Current lender	37,927	2.45	2.98	2.25	2.41

Panel C of Table 6 reports spreads on days with squeezes. They are particularly large. For all lender squeezes, mean spreads range from 1.90% for effective spreads to 2.48% for time-weighted quoted spreads from TAQ. For current lender squeezes, mean spread estimates range from 2.27% to 2.91%. Spread estimates are almost exactly the same 3 days before and 5 days after a squeeze.[10]

For short sellers of each stock with spread information and IHS Markit coverage, I calculate the excess return, as well as expected missing returns and expected trading costs resulting from short squeezes for each month over 2015–2019. The first row of Panel A of Table 7 reports excess returns and direct costs of short squeezes averaged across all stocks and all months. In Table 7, both all lender and current lender squeezes are used to calculate the costs of squeezes. The mean excess return, measured as the difference between the stock returns and CRSP value-weighted index is −0.023% or about −2 basis points. The expected return

[10]If a lender recalls shares and a short seller closes a short position by buying shares and returning them, IHS Markit records the change in shares on loan and the change in available shares on the settlement date. In some cases, with cash settlement, the settlement date and trade date will be the same. It seems likely that in most cases, the trade will be settled regular way and the actual trade will occur 3 days before the settlement date (2 days starting Sept. 5, 2017). For simplicity, I use the spreads on the settlement day to calculate trading costs, but as Panel C of Table 6 shows, spreads are almost identical 3 days before.

TABLE 7

Expected Missing Excess Returns and Trading Costs from All Lender and Current Lender Short Squeezes, 2015–2019

In Table 7, excess returns are the difference between the stock return and the CRSP value-weighted return. Missing excess returns are the excess returns that occurred while a short squeeze forced short sellers to reduce positions, multiplied by the proportion of positions reduced. Fees are the borrowing fees paid while short positions are in effect. Trading costs from squeezes are the percentage reduction in shares on loan on the day of a short squeeze times half the spread, plus an additional half of the spread when shares on loan increase to the level before the squeeze.

		Excess Return		Spread Trading Costs from Squeezes			
Utilization$_{t-1}$	No. of Obs.	Total (%)	Missing (%)	CRSP Quoted (%)	TAQ Quoted (%)	Effective (%)	Vol. Weight Eff. (%)
Panel A. Monthly Excess Returns and Expected Short Squeeze Costs by Utilization							
All months	190,700	−0.023	−0.012	0.074	0.083	0.065	0.068
<25%	148,945	0.149	−0.002	0.063	0.071	0.057	0.059
25%–50%	22,799	−0.080	−0.000	0.054	0.059	0.044	0.046
50%–75%	10,910	−1.125	−0.056	0.065	0.069	0.054	0.056
75%–90%	4,442	−1.759	−0.059	0.112	0.116	0.092	0.103
≥90%	3,604	−1.293	−0.309	0.651	0.730	0.564	0.602
Panel B. Monthly Excess Returns and Expected Short Squeeze Costs by Borrowing Fees							
<0.5%	121,976	0.168	0.000	0.005	0.006	0.004	0.005
0.5%–1%	16,250	−0.115	−0.012	0.021	0.024	0.018	0.019
1%–5%	24,034	0.070	−0.006	0.171	0.192	0.153	0.156
5%–10%	10,018	0.084	0.032	0.286	0.325	0.257	0.262
10%–25%	8,175	−0.847	−0.017	0.336	0.380	0.303	0.321
≥25%	10,247	−1.810	−0.218	0.335	0.366	0.286	0.301
Panel C. Quarterly Excess Returns and Expected Short Squeeze Costs by Utilization							
<25%	53,691	0.396	0.006	0.155	0.175	0.138	0.143
25%–50%	8,125	0.115	0.086	0.101	0.106	0.081	0.086
50%–75%	3,952	−3.415	−0.123	0.137	0.147	0.114	0.120
75%–90%	1,582	−3.206	0.045	0.230	0.227	0.175	0.205
≥90%	1,442	−5.650	−0.937	1.264	1.339	1.040	1.084
Panel D. Quarterly Excess Returns and Expected Short Squeeze Costs by Borrowing Fees							
<0.5%	42,247	0.328	0.006	0.015	0.017	0.012	0.012
0.5%–1%	7,232	0.064	−0.026	0.054	0.065	0.050	0.051
1%–5%	8,652	0.615	0.025	0.389	0.437	0.344	0.365
5%–10%	3,697	−0.310	0.114	0.608	0.680	0.548	0.563
10%–25%	3,030	−1.603	−0.006	0.727	0.804	0.625	0.660
≥25%	3,934	−4.618	−0.358	0.765	0.817	0.641	0.666

that is missed due to short squeezes is −0.012% or about 1 basis point. The expected trading costs from being forced to close and possibly reestablish positions as a result of short squeezes are estimated using four different percentage spread estimates. The expected trading cost from short squeezes is 8.3 basis points per month when TAQ quoted spreads are used and 7.4 basis points when quoted spreads from CRSP are used. Trading costs are somewhat lower when measured with effective spreads. They are 6.5 basis points for the effective spreads based on equal weighting of trades, and 6.8 basis points when effective spreads are volume weighted by trade size.

For most stocks most months, the expected direct costs of short squeezes are small.

Stocks are next sorted into five categories by utilization at the end of the previous month. Utilizations can and do change within a month. Small stocks in particular can exhibit large swings in utilization if a small number of lenders enter or leave the lending market. More than three-quarters of stocks have utilization below 25%. For these stocks, short squeezes are very unusual and the direct costs of squeezes are small. Depending on the bid–ask spread measure that is used, the

expected trading costs that result from squeezes range from 5.7 to 7.1 basis points. Missing excess returns that result from short squeezes are very small, just two-tenths of 1 basis point.

The likelihood of squeezes, and hence the expected costs of squeezes increases with utilization. When utilization is 90% or greater, the mean excess return of these stocks is −1.293% per month. A short seller who attempts to exploit the underperformance will find that on average 30.9 basis points or almost a quarter of the underperformance cannot be captured because short squeezes have forced the short seller out of the market. The expected trading costs from short squeezes are more severe, ranging from 56.4 to 73.0 basis points. So, for these stocks, the expected costs of short squeezes by themselves eliminate most of the expected profits from a short sale.

Panel B of Table 7 reports the expected costs of short squeezes by the borrowing fee at the beginning of the month. Trading costs from squeezes are high for stocks with fees of 5%–10%, 10%–25%, and above 25%. Stocks with borrowing fees of 10%–25% earn average excess returns of −0.847%. About 40% of the abnormal return is eliminated by trading costs from squeezes. For stocks with fees at the beginning of the month that are greater than or equal to 25%, the mean excess return is −1.810%. On average, short sellers are unable to earn 21.8 basis points of that return because squeezes force them to close their positions. The expected trading costs from squeezes range from 28.6 basis points to 36.6 basis points depending on the measure of bid–ask spreads.

In one way, the results for 1 month holding periods may be most relevant. A short seller is more likely to want to maintain a position for 1 month than a longer period if his strategy involves shorting until the stock price reaches a certain level. Nevertheless, Panel C of Table 7 replicates Panel A but reports results for nonoverlapping quarters over 2015–2019. Again, squeezes become important when stocks have high levels of utilization at the start of the quarter. When utilization is 75%–90%, expected costs from being forced to trade by short squeezes is 17.5–23 basis points. When utilization is 90% or more, stocks underperform the CRSP value-weighted index by 5.650% over the next quarter. On average, 93.7 basis points of that underperformance is lost for the short seller because he is forced to be out of the market as a result of short squeezes. Estimates of the trading costs from forced trades from short squeezes ranges from 1.040% to 1.339%.

Panel D of Table 7 provides short squeeze costs over a quarter for stocks categorized by borrowing fees at the beginning of the quarter. When annual borrowing fees are greater than or equal to 25%, the mean excess return over the next quarter is −4.618%. Expected trading costs from squeezes range from 64.1 basis points to 81.7 basis points. The average missing return is −35.8 basis points.

B. The Total Costs of Short Squeezes and the Total Costs of Short Selling

The total direct costs of a squeeze are obtained by summing the extra trading costs to close and reestablish short positions and the excess return the short seller misses because his position is closed as a result of a squeeze. Short sellers also pay

the borrowing fee. I calculate the daily borrowing cost based on 252 trading days during a year as

$$\text{DAILY\_FEE} = \sqrt[252]{(1 + \text{ANNUAL\_FEE})} - 1.$$

Fees can change day-to-day and the total fees paid over a month are obtained by cumulating the daily fees. Returns are not earned on a short position if there is a squeeze and fees are not paid on shares that are recalled. If there is a short squeeze during a month, the fees are reduced by the percentage reduction in shares on loan. So, if shares on loan are reduced by 10% for the remainder of a month as a result of a squeeze, fees are also reduced by 10% for the remainder of the month. I obtain high and low total costs of shorting by adding the borrowing fees and expected missed excess returns to the highest and lowest estimates of trading costs. Results are shown in Table 8.

TABLE 8

Total Costs of Short Squeezes and Total Costs of Short Selling

In Table 8, the excess return is the difference between the return on the stock and the CRSP value-weighted index during that month or quarter. Squeezes costs are obtained by summing the expected return short sellers miss from being out of the market as a result of a squeeze with the expected costs from being forced to trade when a squeeze occurs and to reestablish a position. The costs are estimated with four measures of trading costs on the day of the squeeze: the CRSP quoted spread at the close, the TAQ time-weighted quoted spread, the effective spread, and the volume-weighted effective spread. The low squeeze costs are obtained by summing the missing returns and the lowest of the four trading costs estimates, the high squeeze costs are obtained by summing the missing returns and the highest of the four trading cost estimates. Borrowing fees are obtained by converting the annual fee to a daily fee and then cumulating daily fees over the holding period. Fees are not paid for the portion of a position that is closed as a result of a squeeze.

Utilization_{t-1}	No. of Obs.	Excess Return (%)	Squeeze Costs: Low (%)	Squeeze Costs: High (%)	Fees (%)	Low Total (%)	High Total (%)
Panel A. Monthly Excess Returns and Shorting Costs for Stocks Sorted on Utilization							
All months	190,700	−0.023	0.078	0.095	0.244	0.322	0.339
<25%	148,945	0.149	0.059	0.073	0.109	0.168	0.182
25%–50%	22,799	−0.080	0.044	0.059	0.261	0.305	0.320
50%–75%	10,910	−1.125	0.110	0.125	0.764	0.874	0.889
75%–90%	4,442	−1.759	0.151	0.175	1.552	1.703	1.727
≥90%	3,604	−1.293	0.873	1.039	2.531	3.404	3.570
Panel B. Monthly Excess Returns and Shorting Costs for Stocks Sorted on Borrowing Fees							
All months	190,700	−0.023	0.077	0.095	0.244	0.321	0.339
<0.5%	121,976	0.168	0.004	0.006	0.033	0.037	0.039
0.5%–1%	16,250	−0.115	0.030	0.036	0.060	0.090	0.096
1%–5%	24,034	0.070	0.159	0.198	0.197	0.356	0.395
5%–10%	10,018	0.084	0.225	0.293	0.539	0.764	0.832
10%–25%	8,175	−0.847	0.320	0.397	1.042	1.362	1.439
≥25%	10,247	−1.810	0.504	0.584	2.236	2.740	2.820
Panel C. Quarterly Excess Returns and Shorting Costs for Stocks Sorted on Utilization							
All quarters	68,792	−0.066	0.160	0.201	0.689	0.849	0.890
<25%	53,691	0.396	0.132	0.168	0.305	0.437	0.473
25%–50%	8,125	0.115	−0.005	0.002	0.661	0.656	0.663
50%–75%	3,952	−3.415	0.237	0.270	1.956	2.193	2.226
75%–90%	1,582	−3.206	0.131	0.186	4.069	4.200	4.255
≥90%	1,442	−5.650	1.977	2.276	5.585	7.562	7.861
Panel D. Quarterly Excess Returns and Shorting Costs for Stocks Sorted on Borrowing Fees							
All quarters	68,792	−0.066	0.161	0.202	0.689	0.850	0.891
<0.5%	42,247	0.328	0.006	0.011	0.094	0.100	0.105
0.5%–1%	7,232	0.064	0.076	0.081	0.167	0.243	0.248
1%–5%	8,652	0.615	0.319	0.412	0.551	0.870	0.963
5%–10%	3,697	−0.310	0.434	0.566	1.705	2.139	2.271
10%–25%	3,030	−1.603	0.631	0.810	2.775	3.406	3.585
≥25%	3,934	−4.618	0.999	1.175	4.905	5.904	6.080

Panel A of Table 8 reports total squeeze costs and total shorting costs for 1-month periods for stocks sorted on utilization. Across all stock months, the costs of squeezes and of shorting are small. The direct costs of squeezes range from 7.8 basis points to 9.5 basis points. When fees are included, the total costs of shorting range from 32.2 basis points to 33.9 basis points depending on the measure of the spread that is used. As utilization increases, excess returns turn negative, indicating that short selling would be profitable with no market friction. But, both fees and squeeze costs rise with utilization. When utilization is 90% or greater, the mean excess return is −1.293% or the month. The direct costs of squeezes range from 0.873% to 1.039%. Most of the potential profit from shorting is wiped out by the costs of squeezes. Fees are even higher at 2.531%. Total costs of shorting range from 3.404% to 3.570%, much larger than the excess return to be earned from shorting.

Panel B of Table 8 shows squeeze costs and total shorting costs for 1-month periods for stocks sorted on borrowing fees. When fees reach the range of 10% to 25%, the mean excess return turns negative at −0.847%. Expected squeeze costs range from 0.32% to 0.397% and so eliminate about 40% of the potential profits from short selling. Fees average 1.042% and so eliminate excess returns to short selling by themselves. When fees exceed 25%, the mean excess return is −1.810%. Expected squeeze costs range from 0.504% to 0.584% and hence eliminate a significant proportion of the excess returns to short selling. Fees average 2.236% and the total costs of short selling range from 2.74% to 2.82%.

Panels C and D of Table 8 report excess returns and shorting costs over the next quarter rather than over the next month. When I go from 1 month to 3-month periods, the expected costs of squeezes and the amount paid in fees increase, but for high fee or high utilization stocks they do not triple. Fees and utilization are mean reverting. A stock with a utilization rate of 90% or a borrowing fee of 25% is likely to experience declining utilization rates and borrowing fees over the next 3 months.

Nevertheless, the sum of expected squeeze costs and short-selling fees is enough to offset expected excess returns to short-selling over 3-month periods. So, for example, in Panel C of Table 8, when utilization is over 90%, the mean excess return over the next quarter is −5.65%. The expected costs of squeezes range from 1.977% to 2.276%. When fees are included, the total costs of short selling range from 7.562% to 7.861%. Likewise, in Panel D, when fees are 25% or more the mean excess return over the next quarter is −4.618%, Squeeze costs range from 0.999% to 1.175% and total costs of short selling from 5.904% to 6.08%.

These are the expected costs of short squeezes. For a short seller, the actual costs of short squeezes are uncertain. Some hard-to-borrow stocks go months without a squeeze while others with similar utilization and borrowing fees will experience several. When a short squeeze does occur, some short sellers have their shares recalled while others are able to maintain their positions. This uncertainty could be a significant risk of a short position.

The expected costs of short squeezes documented in Table 8 may be surprisingly large. In another way though, the results in Table 8 are not surprising. Simple trading rules like short stocks with high utilization or stocks with high fees should not produce abnormal returns after incorporating all of the costs of short selling. It is just too easy. Of course, the simple strategies of shorting stocks for a month or a quarter examined here are by no means optimal strategies.

Additional information on the costs of short squeezes is found in the Supplementary Material. It contains tables showing the costs of all lender squeezes alone, expected fee increases after squeezes, and the relation between turnover and squeezes. The Supplementary Material also describes the operation of the share lending market.

C. Are Short Squeeze Risks Priced?

Rational investors only short if expected returns from shorting are large enough to compensate them for the borrowing fees that they pay. If expected returns to short selling are too low for them to earn adequate returns after fees, they will close positions and fees will fall. Hence, borrowing costs should be priced and higher borrowing fees should be associated with lower returns. This prediction is confirmed in several empirical studies referenced earlier. I might also expect the risk of short squeezes to be priced. As I have seen, for some stocks the costs of short squeezes can reduce the expected returns to short selling significantly. In addition, short-squeeze costs are highly variable. They add to the uncertainty about the ultimate profitability of a short position.

Table 5 demonstrates that the strongest predictor of short squeezes is utilization. The relation is a nonlinear one, with both all lender and current lender squeezes becoming much more common at high levels of utilization. So, I use utilization as a proxy for short squeeze risk. Utilization and borrowing fees are positively correlated, so an issue is whether the risk of short squeezes is priced after accounting for the costs of shorting as measured by borrowing fees.

Each month from July 2006 to Nov. 2019, I first sort stocks into 5 categories based on the average borrowing fee during the month. Most stocks are easily borrowed and there is very little variation in fees across them, so the entire 50% of stocks with the lowest fees are placed into one category. Stocks in the 50th–70th percentiles of fees are placed in the second category. Stocks in the 70th–80th percentile of fees are in the third category, while stocks in the 80th–90th percentiles are in the fourth category, and stocks with fees above the 90th percentile are in the fifth category. Within each fee, category stocks are sorted into 5 portfolios based on utilization. Portfolios are formed of stocks in the lowest 10% of utilizations, in the 10th to 30th percentile of utilization, in the 30th to 70th percentile, in the 70th to 90th percentile, and in the top 10% of utilization. Returns and abnormal returns are calculated for each of the 25 portfolios for the following month.

Borrowing fees are averaged across all months for each of the 25 portfolios. These time-series averages are reported in Panel A of Table 9. Within each utilization category, high-fee stocks have fees at least 30 times as large as low-fee stocks. Within the high utilization category, the mean fees for the high fee portfolio are 38.22% per year, more than 100 times the fee of 0.36% for the low fee portfolio. For the lowest 50%, 50%–70%, and 70%–80%, there is very little difference in fees across utilization portfolios. For the 5 portfolios in the lowest 50% of fee categories, there is no difference in fees at all. For these portfolios, differences in returns across the utilization categories cannot be attributed to differences in fees.

Panel B of Table 9 provides the time-series average utilization for each of the 25 portfolios. Within each fee category, utilization increases at least 60-fold

TABLE 9

Mean Monthly Returns and Fama–French 5-Factor Abnormal Returns for Portfolios Formed Using Borrowing Fees and Utilization

In Table 9, each month from July 2006 to Nov. 2019, stocks are sorted into five categories based on average borrowing fees. Stocks in each of the five borrowing fee categories are then sorted into five categories based on the average utilization over the month. Equal-weighted portfolio returns are calculated for the next month and then averaged across all months for each portfolio. Abnormal returns are calculated with a time-series regression of each portfolio return on the Fama and French (2015) five factors.

	Utilization (%)				
	Lowest 10%	10%–30%	30%–70%	70%–90%	Highest 10%
Panel A. Average Borrowing Fees					
Low 50% fee	0.36	0.36	0.36	0.36	0.36
50%–70%	0.45	0.44	0.43	0.45	0.48
70%–80%	0.91	0.91	0.90	0.89	0.98
80%–90%	2.72	2.67	2.79	2.84	3.13
High 10% fee	11.03	12.31	17.26	25.52	38.22
Panel B. Average Utilization					
Low 50% fee	0.53	2.47	8.00	18.31	32.90
50%–70%	0.25	1.34	8.86	27.75	47.71
70%–80%	0.15	1.19	15.35	42.58	63.41
80%–90%	0.12	1.28	18.13	55.17	78.17
High 10% fee	0.70	10.12	51.54	81.66	94.16
Panel C. Mean Monthly Raw Returns					
Low 50% fee	0.0126	0.0112	0.0107	0.0093	0.0074
50%–70%	0.0126	0.0134	0.0094	0.0088	0.0090
70%–80%	0.0120	0.0085	0.0105	0.0056	0.0060
80%–90%	0.0084	0.0119	0.0111	0.0074	0.0072
High 10% fee	0.0059	0.0046	−0.0054	−0.0133	−0.0183

Panel D. Fama–French 5-Factor Abnormal Returns

	Utilization					
	Low 10%	10%–30%	30%–70%	70%–90%	High 10%	Low–High
Low 50% fee	0.0056	0.0026	0.0021	0.0006	−0.0011	0.0067
	(3.13)	(2.67)	(3.42)	(0.69)	(−1.00)	(3.19)
50%–70%	0.0074	0.0069	0.0014	0.0000	0.0010	0.0064
	(3.09)	(4.01)	(1.18)	(0.03)	(0.48)	(2.23)
70%–80%	0.0093	0.0039	0.0036	−0.0027	−0.0026	0.0119
	(3.12)	(1.62)	(1.68)	(−1.08)	(−0.83)	(2.91)
80%–90%	0.0048	0.0080	0.0048	−0.0009	−0.0037	0.0084
	(1.81)	(2.84)	(1.64)	(−0.35)	(−1.01)	(2.07)
High 10% fee	0.0029	−0.0016	−0.0119	−0.0216	−0.0267	0.0297
	(0.82)	(−0.40)	(−3.13)	(−5.01)	(−5.35)	(5.34)
Low–high	0.0028	0.0044	0.0140	0.0228	0.0262	
	(0.77)	(1.18)	(3.67)	(5.21)	(5.21)	

between the low and high utilization portfolios. Here, however, the difficulty in disentangling the impact of fees and utilization can be seen. Within each utilization category, utilization is much higher for the high-fee portfolio than the low-fee portfolio. For the low-fee portfolio, stocks within the 30%–70% utilization range have mean utilization of 8.00%. Stocks in the high fee portfolio and utilization within the 30th to 70th percentile have an average utilization of 51.54%.

Panel C of Table 9 reports the time series average of the monthly equal-weighted portfolio returns for each portfolio. As expected, there appears to be a strong relation between borrowing fees and raw returns. Within each utilization category, portfolios with high fees earn returns that are at least 60 basis points per month less than stocks with low fees. There are 3 portfolios that earn negative

returns on average, and each is the highest fee portfolio for a given utilization category. The high-fee portfolios also tend to have high utilization, but this does not appear to explain the poor returns of high-fee portfolios. The high fee portfolio with utilization between the 30th and 70th percentile earns an average return of −54 basis points per month. It has an average utilization of 51.54%. The portfolio of stocks in the second highest fee category and utilization in the 70th to 90th percentile has a slightly higher average utilization at 55.17% but much lower fees. It earns a much higher average return of 74 basis points per month. Similarly, the portfolio of high-fee stocks with utilization in the 70th to 90th percentile has an average utilization of 81.66% and earns average returns of −1.33% per month. The portfolio of stocks in the second highest fee category and highest 10% of utilizations has a similar mean utilization of 78.17%. But, borrowing fees are much lower and that portfolio earns an average monthly return of 0.72%. Higher fees are associated with lower returns when utilization is held constant.

Panel C of Table 9 also shows that higher levels of utilization are associated with lower returns after holding fees constant. For the low fee category, Panel A shows that mean fees are the same across utilization categories. The low-utilization stocks earn mean raw returns of 1.26% per month while the high-utilization portfolio earns raw returns of just 74 basis points per month. Likewise, fees are little changed across utilization categories for stocks in the 50th to 70th and 70th to 80th percentiles of fees. Returns are, however, lower for the high-utilization stocks than the low-utilization stocks by 36 and 60 basis points per month. Both higher borrowing fees and higher utilization are associated with lower returns.

It is possible that differences in returns across portfolios with different fees or utilizations could reflect differences in risk. To account for this possibility, I estimate abnormal returns using the Fama–French (2015) 5-factor model. For each portfolio, I run the following time-series regression:

$$R_{pt} - R_{Ft} = a_p + b_p(R_{Mkt,t} - R_{Ft}) + s_i\mathrm{SMB}_t + h_i\mathrm{HML}_t + r_i\mathrm{RMW}_t + c_i\mathrm{CMA}_t + e_{pt.}$$

In this regression, $R_{Mkt,t}$ is the return on the market portfolio over month t, R_{Ft} is the riskfree return, SMB is the return on a portfolio of small stocks minus the return on a portfolio of large stocks, HML is the difference between the return of a portfolio of high book-to-market stocks and the return on a portfolio of low book-to-market stocks, RMW is the return on a portfolio of stocks with robust profitability minus the return on a portfolio of stocks with weak profitability and CMA is the difference in returns between a portfolio of stocks with conservative investment policies and a portfolio of stocks with aggressive investment policies. The intercept, a_p, is the monthly abnormal return earned by portfolio p after adjustment for risk captured by these 5 factors.

Monthly abnormal returns for these portfolios are presented in Panel D of Table 9. t-statistics that test whether abnormal returns are different from zero are presented under the abnormal returns. The last row of the table has abnormal returns of long-short portfolios formed by buying the portfolio of low-fee stocks and selling the portfolio of high-fee stocks in the same utilization category. The last column of the table has abnormal returns of long-short portfolios formed by buying the

portfolio of low-utilization stocks and selling the portfolio of utilization stocks in the same fee category.

Panel D of Table 9 shows that low fee–low utilization stocks earn statistically significant positive abnormal returns while high fee–high utilization stocks earn significant negative abnormal returns. The portfolio of stocks with the lowest 10% of utilizations among stocks in the lowest half of fees earns an average abnormal return of 56 basis points per month. The portfolio composed of stocks with the highest 10% of fees and highest 10% of utilizations earns abnormal returns of −2.67% per month.

Both fees and utilization, while correlated, seem to have independent power to explain returns. The portfolio of stocks with the highest 10% of fees and with utilization within the 30th to the 70th percentiles earns abnormal returns of −1.19% per month. As shown in Panels A and B of Table 9, this portfolio has slightly lower utilization and much higher fees than the portfolio with fees between the 80th and 90th percentile and utilization between the 70th and 90th percentile. That portfolio only underperforms by 9 basis points per month. Hence, higher fees are associated with lower abnormal returns holding utilization constant. The long-short portfolios that go long low-fee stocks and short high-fee stocks earn abnormal returns of 1.4% per month for the middle utilization category, 2.28% for utilizations between the 70th and 90th percentile, and 2.62% for the portfolio of stocks with high utilizations. These abnormal returns can only be earned, however, by shorting stocks with high annual borrowing fees.

Higher utilization is associated with lower abnormal returns after adjusting for fees. For stocks in the lowest 3 fee categories, fees are virtually unchanged across utilization categories. But, for each of the 5 fee categories, the long-short portfolio that buys low-utilization stocks and sells high-utilization stocks earns statistically significant positive abnormal returns. For the low-fee category, the long-short portfolio earns abnormal returns of 67 basis points per month. For the 70th percentile to 80th percentile fee category, the long-short portfolio earns abnormal returns of 1.19% per month. But, earning these abnormal returns involves shorting high-utilization stocks. There is a significant chance of short squeezes and the expected costs from short squeezes are high for strategies that include shorting high-utilization stocks.

The results in Table 9 show clearly that high utilization is associated with lower stock returns even after adjusting for borrowing fees. Utilization is the single strongest predictor of short squeezes and the expected costs of squeezes. Hence these results are consistent with short squeeze risk being incorporated in stock prices.

VI. Conclusions

Short sellers face unique risks. One is the risk of short squeezes – that is the risk that the shares they borrowed will be recalled and they will not be able to find another source of shares. In this article, I use two proxies for short squeezes. The first, which I refer to as an all lender squeeze, indicates that a squeeze has taken place when the shares available to borrow one day are less than the number on loan the previous day. This is intended to be a very stringent measure of squeezes. When

the total shares available to borrow falls below the number of shares on loan, some short sellers must close their positions. The second measure, which I refer to as a current lender squeeze, indicates that a squeeze has occurred when the number of shares available to lend and the number of shares on loan decrease by the same amount on the same day. This measure is intended to incorporate the fragmentation of the share lending market. A short seller who has shares recalled by a lending agent may have difficulty locating an alternative source of shares. Although the two measures may seem very different they are strongly related. About half of all lender squeezes are also current lender squeezes. Joint occurrences of current lender and all lender squeezes happen more than 100 times as frequently as they would if they were independent events.

I find that the likelihood of squeezes is very low for most stocks. The risk of a squeeze becomes important when stocks are hard-to-borrow. Utilization, that is the proportion of shares available to lend that are currently on loan, has a strong positive correlation with the probability of a short squeeze. If utilization is high and a share loan is recalled, it is difficult to find a new source of shares. I find that for the majority of stocks that have low utilization rates, an all lender short squeeze appears about once every 40 years. For stocks with very high utilization of 90% or more, an all lender squeeze occurs about once every 11 days. The stocks that offer the highest returns to short sellers are the ones that are likely to experience squeezes.

A squeeze imposes several costs on short sellers. First, they are forced to repurchase the shares they have shorted. If they can find another source of shares later, they need to sell the shares again. The stocks that experience short squeezes are often small and illiquid stocks and trading costs can be significant. I find that the expected cost of forced transactions from squeezes is 29–37 basis points per month for high-fee stocks, and 56–73 basis points per month for stocks with very high utilization rates. In addition, the short seller who is forced to close a position as a result of a squeeze may miss out on significant returns before he is able to reestablish a short position. I estimate that short sellers of the highest utilization stocks, on average, miss out on excess returns of −30.9 basis points over the next month. Over that time, the expected trading costs and missing returns from squeezes eliminate more than two-thirds of the returns to shorting these stocks.

I find evidence consistent with short squeeze risks being priced. Utilization is closely associated with the likelihood of a short squeeze. Holding borrowing fees constant, stocks with high levels of utilization earn significantly lower 5-factor risk-adjusted returns than stocks with low levels of utilization.

Supplementary Material

To view supplementary material for this article, please visit http://doi.org/10.1017/S0022109022001533.

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