What Makes Short Selling Risky: Other Short Sellers

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Abstract

Short selling is risky. Borrowed shares may be recalled and the short seller may be forced to terminate a position early. The stock price may rise forcing the short seller to post additional collateral. Borrowing fees may be increased before the short position is closed. Utilization is the proportion of shares that are available to lend that are on loan. Each of these three short selling risks increase with high levels of utilization. Both high borrowing fees and high utilization are associated with lower stock returns and lower four-factor alphas over the following year.

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Preliminary. Comments welcome.

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1. Introduction

Short sellers are informed investors. A number of studies show that large short interest and high demand to borrow shares to short are followed by poor stock returns. But, while short sellers are able to identify overpriced stocks, it may be difficult for them to profit from their information. In addition to trading costs, short sellers pay to borrow shares. The borrowing fees for most stocks are quite small, typically less than 40 basis points per year. For some stocks, however, fees are very high – 10% or more per year. These are the stocks that are usually overpriced the most. If it takes a long time for share prices to incorporate the short seller's information, the potential return may be lost to fees.

In addition to the costs of shorting, short sellers face a number of risks. One risk is that borrowed shares may be recalled and the short will be unable to find another source of shares. In this case, the short seller may be forced to terminate his position early. Even if the short seller does find another source of shares later, he still bears the extra transactions costs from closing out the short position and reestablishing another one. A second risk for short sellers, which I term collateral risk, is that the stock price will increase in the short-term even if it ultimately falls. In this case the short seller will need to post additional collateral or reduce the size of the short position. The risk of having to post additional collateral may lead the short seller to take a smaller position initially. Related to this is the risk that prices will take a long time to reflect the short seller's information. A profitable short sale becomes unprofitable if the short seller has to pay borrowing fees for too long. A final risk is that the borrowing fees may increase and the short seller may be forced to pay more than originally expected. A short position that is profitable when borrowing fees are, say, 2%, may become unprofitable when they are 10%

A few recent papers, including Engelberg, Reed, and Ringgenberg (2018) and Andrews, Lundblad, and Reed (2020) have examined short selling risk. But, while these papers examine the impact of short selling risk on stock returns and market efficiency, this paper studies what makes stocks risky to short. Short selling risks are tied to utilization, or the proportion of shares available to lend that are actually on loan. To proxy for the risk that a loan recall may force a short seller to close a position, I use an equal reduction in shares available to lend and shares on loan on the same day. For most stocks, this is a rare event. For easily borrowed stocks, I estimate that a forced recall occurs about once in eight years. For stocks with utilization above 75%, forced recalls occur about once every 26 days. So, utilization is strongly associated with recall risk. As a proxy for the risk that additional collateral may be required, I use a stock price increase of 20% or more during a month. Stock return variance, as expected, is associated with these large returns. Utilization, however, is a more powerful predictor of large returns. This may be surprising, but consider what normally happens when stock prices increase – there is additional short selling. When utilization is high, short sellers are unable to borrow additional shares to short. Hence with already high utilization, short sellers cannot counteract purchases by overly exuberant investors and may be forced to post more collateral as prices move further out of line. High levels of utilization are also associated with the third risk of short selling, increased future borrowing fees. The variance of borrowing fees is a somewhat stronger predictor of large borrowing fee increases, but utilization provides significant additional predictive power. So, each of these short selling risks is greater when utilization is high, or, in other words, when there is a lot of short selling.

Short sellers are sophisticated investors and should expect to earn enough on their short sales to compensate for their costs of shorting. Hence higher borrowing fees should be associated with higher returns to short selling. The risks of share recalls, posting additional collateral, and paying higher fees are unsystematic risks, but they imply that the returns inferred from stock price changes are larger than the returns actually earned by short sellers. Therefore these risks, which arise with high levels of utilization, should also be associated with lower stock returns and higher returns to short selling. In double sorts on fees and utilization, I find that higher stock borrowing fees and higher utilization are both associated with lower stock returns and lower four factor alphas. Higher utilization means lower returns and lower alphas for both high and low borrowing fee stocks. In Fama-MacBeth regressions, I find that high utilization is associated with lower stock returns after adjusting for borrowing fees, for other measures that predict short selling risk, and for stock characteristics like size that are correlated with utilization.

Short selling is always risky. Short sellers can always lose money if the stock price increases rather than decreases. The risks peculiar to short selling however, arise when utilization is high, or, in other words, when there is a lot of short selling relative to the amount of available shares. When there is a lot of short selling it is more difficult to locate new shares if a share loan is recalled. It is more likely that fees will increase. New additional short selling will not keep prices from moving further out of line. It is when there is a lot of short selling and the potential returns to short selling are especially large that shorting is riskiest.

The rest of the paper is organized as follows. The market for share lending and the mechanics of short selling are discussed in Section 2. Section 3 provides a review of the literature. The data used here is described in Section 4. Section 5 examines risks of short selling. Section 6 explores the relations between stock borrowing fees, short selling risks, and stock returns. Section 7 summarizes the paper and offers conclusions.

2. The share lending market and the mechanics of short selling

Naked short selling consists of selling shares without obtaining them. This practice has been banned by regulators in the U.S. and most other countries. Covered short selling is the legal and legitimate way to profit from overpriced securities. It requires the short seller to borrow shares and return them to the lender when the position is closed.

Institutional investors are the main source of share loans. As of early 2018, 46% of shares available for lending came from mutual funds, 20% from pension funds, and 8% from insurance companies.[1] Institutions that follow passive or indexing investment strategies are particularly large suppliers of shares, and use share lending as a means to augment returns.

There is no centralized market for borrowing shares.[2] Typically, an institution lends shares through a lending agent, often the custodian that handles the institution's securities. The lending agent generally serves as custodian for a number of institutions that have agreed to lend shares and uses an algorithm to allocate shares from the different potential lenders to loans. The borrower of shares, a hedge fund for example, will typically borrow the shares through a prime broker rather than directly from the lending agent. Lending agents prefer to lend to prime brokers. Lending agents indemnify lenders against losses from a borrower default, and prime brokers, who are usually bank subsidiaries, present less counterparty risk than hedge funds. So, in a typical short sale, the ultimate lender will leave shares with a lending agent, who lends the shares to a prime broker, who in turn sells the shares on behalf of the ultimate borrower, the hedge fund. Institutional investors can lend shares without a lending agent, but there are a couple of reasons why they seldom do so. First, it is easier to locate shares with a lending agent who represents numerous potential lenders than with a single institution. Hence prime brokers usually approach a lending agent when they need to borrow shares. In addition, direct lending requires the lending institution to bear the costs of the personnel and infrastructure needed to carry out a securities lending program.

In return for the securities, the lender (through its lending agent) will receive collateral typically worth 102% of the value of the securities. Or, in other words, the collateral is the proceeds from the short sale plus 2%. The loan is marked to market daily and more collateral is required if the stock price increases. Most collateral is cash, but non-cash forms of collateral, like U.S. government securities are becoming more common. In addition, the Federal Reserve's Regulation T has traditionally required short sellers to post 50% of the value of a short sale with the prime broker as collateral. Hence for every $2 worth of stock sold short, the short seller needs to put up $1 in margin. Hedge funds have been able to circumvent this requirement by locating overseas and trading through a foreign prime broker. The leverage permitted short sellers under these arrangements depends on local laws and the prime broker's assessment of the risk presented by the hedge fund.

The lender receives a fee for lending shares. If the collateral is in cash, the lending agent will invest it in short term securities and pay a rebate rate to the borrower that is less than the interest earned. The difference between the short term interest rate and the amount rebated to the borrower on his

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[1] See Bassler and Oliver (2018).
[2] Reed (2013) provides details of the operation of the securities lending market.

collateral is the fee. A portion of this fee is retained by the lending agent, but most goes to the lender. In cases where the stock is hard-to-borrow or on special, the rebate rate may be negative. In this case the borrower receives no interest on his collateral and instead pays the lender. When the rebate rate is negative the fee is the interest earned by the lender on the collateral and the extra payments made by the borrower. If securities are used as collateral, a daily fee is paid directly. For most stocks, fees are minimal at less than 40 basis points per year. For stocks that are on special, fees can easily exceed 10% per year.

The great majority of loans are open, meaning that the lender can recall the loaned shares at any time. Some lenders, like mutual funds or pension funds are required by regulatory agencies to be able to recall loaned shares at any time. Term loans are loans with a fixed duration. They provide less flexibility for the lender but generate higher fees.

3. Evidence on the returns, costs and risks of short selling

There is overwhelming evidence that stocks with binding short sale constraints, as measured by high borrowing fees or short interest, earn poor returns. Desai, Ramesh, Thiagarajan, and Balachandran (2002) examine short interest of Nasdaq stocks over 1988-1994. Heavily shorted stocks, defined as stocks with short interest exceeding 10% of shares outstanding, earn Fama-French four-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 1926-33. They find that the stocks that were most costly to short underperform the least costly by 1.61% per month. Asquith, Pathak, and Ritter (2005) use high short interest ratios as a proxy for 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 one-month four-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 three factor abnormal returns that are lower than the abnormal returns of lightly shorted stocks by 1.8% in the three months after portfolio formation.

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 lending fees are small, typically 30-40 basis points per year. 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, Reed and Ringgenberg (2018) report a median loan fee of 11.6 basis points but a 99th percentile of 14.79%. 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 2006-2019 period, borrowing fees provide larger long-short returns than *any* of the 102 anomalies. Borrowing fees also had the highest Sharpe ratio.

Boehmer, Huszár, Wang, and Zhang (2018) (BHWZ) examine the power of eight short selling variables to predict returns in 38 countries from July 2006 through December, 2014. The variables include short interest, days-to-cover, lending supply, utilization, and four variables for shifts in supply and demand for share loans. Interestingly, lending fees are not one of their eight variables, although they do examine interactions between the variables and lending fee. BHWZ find that two measures are particularly successful at predicting returns to short selling around the world: days-to-cover, and untilization.

Miller (1977) provides one way to think about the low returns earned by stocks with short sale constraints. He 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. Another way to think about the high returns earned by short sellers in hard to borrow stocks is that informed short sellers should short until the benefits of additional shorting are offset by the costs of shorting more shares. The large negative abnormal returns earned by heavily shorted stocks suggest that the benefits, and hence the costs of shorting additional shares are large.

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 November 1998 through October, 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 provide evidence that the abnormal returns earned by short sellers survive lending and transactions costs. 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.

Short sellers' ability to earn abnormal returns after paying borrowing fees suggests that there are significant risks to short selling. These risks have not received much attention among researchers. One risk is that the share loan will be recalled, the short seller will be unable to replace the borrowed shares, and the short position will be involuntarily terminated. D'Avolio (2002) reports recalls of share loans affect only 2% of the stocks in his sample. D'Avolio also claims that recall risk is highest on days when trading volume is very high for the stocks that are subject to recall.

A second risk of short selling is that an overpriced stock may increase in price in the short run, and short sellers will be forced to either post more collateral or reduce the size of their positions. Stambaugh, Yu and Yuan (2015) show that the likelihood that a short seller will be required to post more collateral increases in the variance of the stock return. They also note that a margin call is more likely for a short position than a long position. Margin is the ratio of equity in a position to the position's total value. For a long investor, when a stock price falls both the equity and the position value decline. For a short investor, when the stock price increases the equity value in the position falls while the position value increases. This means that a given return has a bigger impact on the margin of a short position than the margin of a long position and makes margin calls more likely for short investors than long investors. Evidence of collateral risk is found in Blocher and Ringgenberg (2019). They find that short sellers are more likely to close their positions after price increases that may lead to calls for additional collateral. Short sellers are also more likely to close their short positions after increases in borrowing fees. Returns are negative after short positions in hard-to-borrow stocks are closed, suggesting that changing lending market conditions are forcing shorts to close positions early.

A third risk is that fees will increase and the short seller will have to pay more to borrow the stock than expected. Engelberg, Reed, and Ringgenberg (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 through December 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 with a number of explanatory variables, including short interest, short risk and the loan fee. Both loan fee and short risk are negative and significant.

ERR also find that short selling risk is associated with less price efficiency. Price efficiency is estimated as in Hou and Moskowitz (2005) by first regressing weekly stock returns on the weekly market return and on the four previous weeks' market returns. Greater delay in incorporating information in prices is symptomatic of less efficiency. The delay measure is based on the differences in R^2's when the four previous weeks' market are included in the regression and when they are not. Price delay is positively related to short risk and the bid ask spread and negatively related to capitalization.

Short selling risk is also examined by Muravyev, Pearson, and Pollet (2019). 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, Pearson, and Pollet conclude that "the borrowing fee risk for individual stocks is largely diversifiable."

Andrews, Lundblad, and Reed (2020) reach a different conclusion. They 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 systemic loan fee volatility, they find that high systematic fee volatility stocks earn lower returns that low systematic fee volatility stocks. This is consistent with commonality of fees being a priced, systematic risk. They also find that efficiency, as measured by Hou and Moskowitz (2005) is lower for stocks with high systematic loan fee volatility.

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 options expiration, implied and actual stock prices will converge. Engelberg, Reed and Ringgenberg (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, 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 associated with lower short volume. More months to expiration means a longer time that the short seller may have to maintain the short position and hence more risk. Short sellers are more reluctant to sell short with a longer expected time to convergence.

Short sellers can reduce the risk of their positions 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 corrections 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.

4. Data

Data used here come from two sources. CRSP provides daily stock returns. The returns are used to estimate the variance of daily stock returns over a month and the total return for each stock each month. 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 100 lending market participants, including prime brokers and lending agents. About 85% of all share lending is done through these institutions. Their data includes 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. Stocks that are not included in the IHS Markit data may be omitted because there is no share lending market for that stock. These stocks are not included in our empirical work.

Daily values of short selling variables are averaged over days in each calendar month over July 2006 through December 2019. Table 1 provides summary statistics across all stock-month observations. The first row shows the distribution of indicative fees for individual stocks. These fees are for one 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 39.3 basis points per year. The distribution of indicative fees is right-skewed with a mean of 2.756% and a 95th percentile of 10.381%. While most stocks can be borrowed cheaply, some are very expensive to borrow.

The second row of Panel A reports the distribution of the utilization of shares available to lend. Utilization is the proportion of shares that are available for lending that are on loan. A high utilization rate means that a stock is hard to borrow and that some potential short sellers may be unable to borrow shares. It also indicates that it may be difficult to find another source of shares if a loan is recalled. The median utilization rate is 8.76% and the interquartile range is from 2.40% to 25.02%. The 95th percentile is 69.377%. There is an ample supply of shares for short sellers in most stocks, but it can be difficult to locate shares to borrow in some stocks.

Lender concentration is a Herfindahl index for the lenders of shares out on loan. A value of 1.0 indicates that 100% of the loaned shares are from one lender, while an index value of 0.5 (0.33) means that shares on loan came entirely from two (three) lenders who lent equal numbers of shares. The median lender concentration is 0.322, suggesting that for most stocks, the shares that are lent out come from several lenders. The 95th percentile is, however, 0.959, indicating that essentially all of the shares out on loan come from the same dealer for 5% of the stocks. Inventory concentration is a similar Herfindahl index for the shares that are currently in inventory and available to be lent out. The distribution of the inventory concentration is reported in the fourth row of Table 1. In general, inventory concentration is lower than lender concentration. Still, for some of the stocks the inventory of shares available for lending is in the hands of just a couple of potential lenders.

The distribution of the variance of daily lending fees over the previous six months is shown next. This distribution is right skewed. The median variance is only 0.003%, but the 95th percentile is 4.284%. Most stocks that are easy to borrow have annual borrowing fees of 30 to 40 basis points, and these fees do not change very much. Hard-to-borrow stocks with large fees may also have a large variance of fees. The variance of daily returns calculated over the previous six months is shown in the second to last row. This variable is also right-skewed.

The distribution of IHS Markit's Daily Cost of Borrowing Score (DCBS) is presented in the last row. This is IHS Markit's proprietary measure of the cost of borrowing. The measure takes integer values from one to ten. A score of one indicates that the stock is easily and cheaply borrowed, while higher scores indicate increasing costs of borrowing. I calculate the average of daily values for each stock each month. The mean score is 1.68 and for most observations the value is 1. IHS Markit's measure indicates that most stocks are easy to borrow.

For the most part, these variables show modest variation over time. Mean borrowing fees however, increase significantly over our sample period. Figure 1 shows the mean and median of the borrowing fees across stock-months for each year from 2006-2019. The median fee is under 50 basis points every year and declines slightly over the sample period. The mean fee, on the other hand increases from about 1.5% in 2006 to almost 5% in 2019. The increase in the mean fee while the median fee declines indicates that the highest fees are increasing over time. It appears that the number of small, illiquid, and hard-to-borrow stocks covered by the IHS Markit data increases over time. It is not clear whether IHS Markit has expanded their coverage of lending agents and picked up more stocks, or whether it has become possible to borrow stocks at high cost that could not be borrowed at all in the early years of the sample period.

An issue is whether stocks with high fees and stocks with high utilization levels are all small stocks. To address this, I sort all NYSE stocks into ten size deciles each month. All stocks, regardless of where they trade, are placed into one of these size deciles each month. The median, 90th percentile, and 99th percentile of fees are calculated for each size category using all months. The distributions are described in Panel A of Table 2. The median borrowing fee is 0.644% for the smallest stocks, 0.388% for the second smallest decile, and 0.375% for all other size categories. Within every size category, most stocks are cheap to borrow. The 90th and 99th percentiles of fees decline steadily with firm size. The stocks that are very expensive to borrow are mostly small stocks. Nevertheless, the 99th percentile of borrowing fees is 5.85% for the seventh decile and 2.018% for the eighth size decile. Fees can be high even for large stocks.

The last three columns of Panel A report the median, 90th percentile, and 99th percentile of utilization for each size category. Median utilization ranges from 1.72% for the largest stocks to 15.55% for the fourth size decile. Hence, in every size category, utilization is low for the majority of stocks and there are far more shares available for lending than are actually lent out. The 90th and 99th percentiles of utilization decline steadily with firm size. Even in the 7th size decile, however, the 99th percentile of utilization is 75.37%. In the 8th decile it is 67.36%. Even in larger size categories, utilization is high and it is difficult to locate shares for some stocks.

Panel B of Table 2 describes the distribution of utilization for different levels of fees. Each stock is categorized by its fee each month relative to the distribution of fees across all months. The categories are the lowest 10% of fees, 10.1% - 25%, 25.1% - 50%, 50.1% - 75%, 75.1% - 90%, 90.1% - 95% and greater than 95% of fees. The fees do not vary much among the low fee categories. So, the 10.1% - 25% category is fees of 0.310% per year to 0.375% per year, while fees in the 25.1% to 50% category range from 0.376% to 0.392% per year. Within each fee category the median, 90th percentile, and 99th percentile of utilization is calculated. The median, 90th and 99th percentile of utilization all increase with fees. Nevertheless, the distribution of utilization overlaps across fee categories. So, the 99th percentile of utilization is 71.06% when fees range from 0.393% to 0.656% which exceeds the median utilization of 67.15% for stocks with fee in excess of 10.25%.

5. The risks of short selling

In this section, I examine three commonly discussed risks of short selling and show that all are associated with utilization. The first is the risk that shares will be recalled and short sellers will be forced to close their positions. The second is the risk that share prices will increase and short sellers will be forced to post additional collateral. The third is that short selling fees will increase. All of these risks are predominately idiosyncratic risks of the particular short position and not systematic risks that cannot be diversified away.[3] Since these risks are unsystematic, our concern is how they reduce the expected returns to short selling, not how they affect the variability of short selling returns. These three risks are not entirely separate risks. As Engelberg, Reed, and Ringgenberg (2018) note, "… recalls and fee changes are not independent risks: a share recall can be seen as an extremely high loan fee."

5.1 The risk of a share loan recall

The risk that a share loan will be recalled, forcing a short seller to cover his position, is similar to Lamont's (2012) definition of the risk of a short squeeze. He defines a short squeeze (p. 21) as occurring

[3] Andrews, Lundblad, and Reed (2020) provide evidence that the systematic common component of fee changes is a risk that is priced.

when “a short seller is involuntarily forced to cover his short position because he is no longer able to borrow the security.” Most of the forced position closures from loan recalls that are examined here are likely to be a result of independent recalls of share loans. Lamont, on the other hand, 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.

D’Avolio (2002), obtains lending data from a large institutional lending intermediary for 2000-2001. He finds that loan recalls are rare. In an average month, the lender recalls loans in just 2% of the stocks they have loaned out.[4] My proxy for a forced position closure from a share loan recall is a dummy variable that equals one if the lendable shares and the shares on loan for a stock both decrease by the same amount on the same day.[5] This could occur if a lender demanded return of his shares and the short seller was unable to find an alternative source of shares.

5.1.1 How good is the measure of forced closures?

There is some noise in this measure of forced closures. It is possible that a forced closure will not be picked up by the measure if another short seller voluntarily opens or closes a short position on the same day. It is also possible that this variable could falsely indicate a forced sale when a short seller voluntarily closes a position and a lender independently withdraws the same number of shares from the lending market. In other words, an equal decrease in shares available for lending and shares on loan on the same day could be a mere coincidence. In many cases though, 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 December 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 April 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 feel by 11,800 shares to 40,859, while the number of shares also on loan fell by 11,800 shares to 38,300. While it is possible that these equal declines in shares available to lend and shares on loan are coincidences, loan recalls seem much more plausible.

[4] Cohen, Diether, and Malloy (2007) note that recall risk is highest on high volume days.
[5] In D’Avolio’s data, which comes from a single lender, the shares available for lending are reduced on the day when a loan is recalled. The shares out on loan are not reduced until the shares are delivered on day t+3. IHS Markit officials tell me that in their data when a loan is recalled both the shares available to lend and the shares on loan are reduced on the delivery date. This is confirmed by the data in Table 3.

Suppose that an equal decline in shares available to lend and shares on loan on the same day is just a coincidence and has nothing to do with a loan recall. We might expect this 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 one to five days before and from one to five days afterwards. 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 use as a proxy for a loan recall and forced closure. When all observations are included this occurs in about 0.45% of stock days. When utilization is less than 50%, equal declines in available shares and shares on loan occur in 0.286% of stock days. For utilizations greater than 50%, the proportion increases sharply to 1.852%. If the equal decrease in shares on loan and available shares is mere coincidence, we 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. The probability that shares on loan and available shares decrease by the same amount on the same day is 15 times as large as the probability that shares on loan decreases by the same amount that available shares decreases in any of the ten surrounding days. When we 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 about *50* times as large as the probability that shares on loan decreases by the same amount that available shares decreases in any of the ten surrounding days.

An equal reduction in shares on loan and shares available to lend is seldom a coincidence. It is not obvious how a reduction in shares on loan would lead to a reduction in available shares. It is also difficult to think of other factors that would lead to equal reductions in shares available to lend and shares on loan. It is, however, easy to see how a reduction in available shares would lead to an equal reduction in shares on loan. The measure of recalls and forced closures used here is a proxy, but it appears to be a good one.

5.1.2 Determinants and consequences of forced closures

Panel A of Table 4 shows the proportion of stock days with forced closures for different categories of borrowing fees and utilization rates. In the first row of Panel A, when all stock-days are considered, there is a 0.45% chance of a forced closure on a given stock day. Or, put another way, there will be a forced closure every 222 days on average. This result is consistent with D'Avolio's (2002) claims that for most stocks, forced closure of a short position is unusual. Note that a value of one for the forced closure dummy variable does not mean that all short positions in the stock are closed that day. Any reduction in lendable shares that is matched by an equal reduction in shares on loan indicates a forced closure even if the great majority of shares on loan remain in the hands of short sellers.

The following rows of Panel A reveal that the probability of a forced closure increases with indicative fees. When the indicative fee is less than 0.5% per year, as it is with the great majority of stocks that are easy to borrow, the probability of a forced closure is 0.05%, or about once every eight years. It is possible that this is just noise in the recall measure. That is, a forced closure could be a simultaneous reduction in shares on loan and a reduction in lendable shares that are unrelated. For hard-to-borrow stocks with indicative fees of 1% to 5%, the probability of a forced closure on a given day is much higher at 1.06%, and for stocks with indicative fees above 5%, the probability is 2.90%, or a forced closure every 34 days. The probability of a forced closure also increases with utilization. When utilization is less than 25%, the likelihood of a forced closure on a given day is 0.27%. When utilization is greater than 75%, the probability of a forced closure is 3.81% or about once every 26 days. Cohen, Diether, and Malloy (2007) note (p 2062) that "…costs of shorting such as recall risk may also be increasing in quantity" [of shares borrowed]. That assertion is confirmed by the relation between forced closures and utilization that we document.

It is clear that forced closures are more common when utilization is high. It might seem that as long as utilization is less than one borrowed shares could always be replaced. But, Kolasinski, Reed, and Riggenberg (2012) point to a significant dispersion of loan fees across dealers as evidence that search costs are high. When shares are recalled a borrower may have to search beyond their usual lenders and may have difficulty locating shares. Even if shares are located, the borrower may have to pay significantly higher fees.

Panel B reports the expected proportion of shares on loan that are eliminated by a forced position closure per day. It is obtained by multiplying the forced closure dummy variable by the percentage decline in shares on loan. Across all stock days, the mean proportion is 0.092%. That is, the expected proportion of shorted shares recalled is 0.092% per day. For the majority of stocks with fees of less than 0.5%, the proportion is very small - just 0.011%. The proportion of shares on loan that are lost to forced recalls increases with both fees and utilization. It reaches over 0.5% for fees in excess of 5% or utilization greater than 75%.

Panel C of Table 4 reports lender concentration, inventory concentration, and changes in the concentration measures around forced recalls. On days without forced sales, there is, on average, a small decrease in lender concentration. On days with forced recalls, lender concentration increases on average from 0.7123 to 0.7274. Increasing concentration means that a larger proportion of the shares on loan are coming from a smaller proportion of the lenders. Or, in other words, the shares are being recalled by lenders with a small market share. This is not surprising. A lending agent with a small market position is unlikely to be able to replace a share loan if a lending institution demands their shares back. Similarly, on days without forced sales, inventory concentration falls by a small and insignificant amount. When there is a forced recall, inventory concentration increases from, on average, 0.5980 to 0.6081. Shares are being recalled by lenders with a small market share of inventory.

Utilization is a good predictor of position closures, but, as we have seen, it is correlated with both firm size and borrowing fees. To see whether utilization is associated with recalls and forced position closures after adjusting for size and fees, I first estimate the following ordinary least squares panel regression

$$D_{i,t}^{Recall} = \alpha_1 Utilization_{i,t-1} + \alpha_2 Fee_{i,t-1} + \alpha_3 Log(Size)_{i,t-1} + FE_i + FE_t + \varepsilon_{i,t} \quad (1)$$

Where $D_{i,t}^{Recall}$ is a dummy variable that equals one if there is a loan recall and forced closure for stock i on day t, $Utilization_{i,t-1}$ is the utilization for stock i on day t-1, $Fee_{i,t-1}$ is the borrowing fee for stock i on day t-1, $Log(Size)_{i,t-1}$ is the natural logarithm of the market capitalization of stock i on day t, FE_i is a fixed effect for stock i and FE_t is a fixed effect for day t.

The regression results are reported in Panel A of Table 5. The first column reports the regression results when all stock-day observations are included. The coefficient on utilization the previous day is 0.00022 with a t-statistic of 178.68. The standard deviation of utilization across all stock-days is 22.40, so a one standard deviation increase in utilization increases the probability of a recall and forced closure by 0.492%. The previous day's fee has a coefficient of 0.00210 with a t-statistic of 39.60. The standard deviation of fees is 0.09853, so a one standard deviation increase in fees increases the probability of a recall and forced closure by 0.02%. Size has a negative coefficient, -0.00126, with a t-statistic of -96.86. The next four columns report regressions for stocks by size quartile. These regressions still include the log of size as an explanatory variable, but splitting the sample by size quartile helps to control for nonlinear effects of size on forced closures. Fixed effects for each stock also help to control for size. Regardless, in each regression, the coefficient on utilization is positive and highly significant, although it does steadily decrease as the size of firms in the regressions increases. Fee, on the other hand, has a positive coefficient for small stocks and a negative coefficient for large stocks.

All in all, the evidence in Panel A of Table 5 indicates that there is a significant positive relation between the likelihood of a forced position closure from a recall and high utilization. This holds after adjustment for both fees and firm size, and after controlling for the month and stock.

Panel B reports logistic regressions with the same dependent variable and utilization, fee, and firm size variables as the OLS regressions in Panel A. The logistic regressions do not include date or firm fixed effects and use six rather than four size categories. Z-statistics are reported in parentheses under coefficients and odds ratios are reported in brackets. The main results of Panel A are also obtained with the logistic regressions. Utilization has a positive impact on the probability of a forced closure after adjusting for firm size and utilization. The z-statistics for utilization are larger than the z-statistics for size and borrowing fees. That is true for all firm sizes.

If the measure of forced closures captures a contraction in the supply of lendable shares relative to the demand for share loans, we would expect to see fees rise after forced closures. To see if fees increase after a recall and forced closure, I estimate the following panel regression

$$Fee_{i,t} - Fee_{i,t-1} = \alpha_0 + \alpha_1 \sum D_{i,t-j}^{Recall} + \alpha_2 Utilization_{i,t-1} + \alpha_3 Fee_{i,t-1} + FE_t + \varepsilon_{i,t} \quad (2)$$

where $Fee_{i,t}$ is the borrowing fee for stock i on day t, $D_{i,t-j}^{Recall}$ is a dummy variable that takes a value of one if there is a recall and forced closure of short positions in stock i on day t-j, $Utilization_{i,t-1}$ is the utilization of stock i on day t and FE_t is a fixed effect for day t.

Table 6 reports estimates of (2). The first regression includes observations for the entire July 2006 through December 2019 sample period and includes just the forced closure from the previous day as an explanatory variable. The coefficient on the dummy variable is 0.00065 with a t-statistic of 2.66. It suggests that a forced closure of a short position one day is followed by an increase in lending fees of 6.5 basis points the next day. The second regression includes utilization and fees the previous day in addition to the dummy variable for forced closure from a recall. The coefficient on utilization is positive and significant while the coefficient on fee is negative and significant. There appears to be mean reversion in fees. The coefficient on the forced closure dummy is now 0.00272, suggesting that a forced short position closure is associated with a 27.2 basis point increase in fees the next day. The t-statistic for the forced closure dummy is also much larger at 9.05. The next two regressions repeat the regression for two sample subperiods of roughly equal length: July 2006 through December 2012, and January 2013 through December 2019. In each case, the coefficients on forced sales and utilization are positive while the coefficient on fees is consistently negative. In each subperiod, a recall and forced closure is followed by an increase in fees. The last regression in Table 6 includes dummy variables for a forced closure one, two, three, and four days earlier. The coefficients on all of these dummy variables are positive and significant. A recall and forced closure affects fees for several days at a minimum.

If a short position is closed because the short seller cannot replace withdrawn shares, we might expect the supply of lendable shares to increase after the forced closure as lending agents look for additional sources of shares. To examine this, I run the following panel regression

$$\frac{Shares_{i,t} - Shares_{i,t-1}}{(Shares_{i,t} + Shares_{i,t-1})/2} = \alpha_0 + \sum_{n=1}^{5} \beta_i D_{i,t-n}^{Recall} + \alpha_1\, Utilization_{i,t-5} + \alpha_2 Fee_{i,t-5} + FE_t + \varepsilon_{i,t} \quad (3)$$

where $Shares_{i,t}$ is the number of shares available for lending for stock i on day t, $D_{i,t-n}^{Recall}$ is a dummy variable that equals one if there was a recall of shares and forced position close in stock i on day t-n, $Utilization_{i,t-5}$ is the utilization of stock i on day t-5, $Fee_{i,t-5}$ is the borrowing fee for stock i on day t-5, and FE_t is a day fixed effect. Estimates of (3) are reported in Table 7.

In the first regression of Table 7 I regress the percentage change in the quantity of lendable shares on just the dummy variable for a forced closure the day before and fixed effects for dates. The coefficient of 0.0042 suggests that the quantity of lendable shares increases by about 0.42%. The t-statistic is a highly significant 9.15. In the second regression I include dummy variables for a forced position closure in each of the previous five days. The coefficient on a forced close the day before remains positive and highly significant and the coefficient on a forced closure four days before is 0.0018 with a t-statistic of 3.82. Other coefficients are insignificant. The last regression also includes utilization and the borrowing fee on day t-5. Coefficients are positive for both. Over time, if a stock is hard to borrow, more shares are made available to lend. High fees, in particular, should induce more potential lenders to make shares available. The coefficient on a forced close is now 0.0035 with a t-statistic of 7.50. Even after adjusting go the level of fees and utilization, more shares are made available to lend after a forced closure. This finding, along with the finding that fees increase following a forced closure suggest that a simultaneous decline in shares available to lend and shares on loan is a good proxy for forced closures.

To summarize, forced closures happen much, much more frequently when utilization is high. This is not surprising. When utilization is high, it is hard to locate an alternative source of shares when a loan is recalled. Hence this risk of short selling is especially important when utilization is high.

5.2 Collateral Risk

Even if a short seller is right and a stock is overpriced, the price may move further out of line before it is corrected. If this happens, the short seller may be forced to post additional collateral or liquidate part of the short position.[6] The variance of stock returns is one variable that we would expect to be associated with collateral risk. Stambaugh, Yu and Yuan (2015) demonstrate that the likelihood of a margin call increases with volatility, and is greater for short positions than long positions. High utilization may also be associated with collateral risk. Short sellers typically sell additional shares when prices rise

[6] See Mitchell, Pulvino, and Stafford (2002) for a discussion of collateral risk.

and they believe that prices have moved further out of line. If utilization is high, short sellers may have a difficult time borrowing shares. Without short selling to check investor exuberance, overpriced stocks may become more overpriced in the short run.

I use a dummy variable for a return of 20% or more in a month as a rough proxy for the need to post additional collateral. When shares are sold short, 102% of the entire proceeds of the short sale are held by the lender. In addition, under regulation T, short sellers are required to post 50% of the value of a short sale with the broker as collateral.[7] A common maintenance margin for a short sale is 30%. Suppose a short seller sold 1,000 shares of stock at \$100 per share for a total of \$100,000. He would be required to post 0.5 x \$100,000 = \$50,000 as collateral. If the stock rose 20% to \$120, the value of the stock would be \$120 x 1,000 = \$120,000. The \$20,000 increase in the stock price would reduce the short seller's equity by \$20,000 to \$30,000. The maintenance margin would be 0.30 x \$120,000 = \$36,000. This exceeds the \$30,000 in equity in the position and hence the short seller would be required to post additional collateral. So, under Regulation T, a 20% return would result in a call for additional collateral from short sellers. At this time however, Regulation T provides only rough guidance as to when short sellers will need to post additional collateral. In 2005, the SEC approved portfolio margining in which collateral is determined on the basis of an investor's entire portfolio rather than on a position-by-position basis. In addition, Regulation T does not apply to hedge funds that are located offshore and trade through prime brokers that are located overseas.

I estimate the following panel regression to see which variables are associated with large returns and the need to post more collateral:

$$D_{i,t}^{Ret>20\%} = \alpha_0 + \alpha_1 D_t^{Rmkt>0} + \alpha_2 D_t^{Rmkt>5\%} + \alpha_3 D_t^{Rmkt>10\%} + \alpha_4 \sigma_{i,t-6,t-1} + \alpha_5 Utilization_{i,t-1} + \alpha_6 Fee_{i,t-1} + \varepsilon_{i,t} \quad (4)$$

where $D_{i,t}^{Ret>20\%}$ is a dummy variable that equals one if stock i has a returns of 20% or more in month t, $D_t^{Rmkt>0}$ is a dummy variable that equals one if the value-weighted market return is positive in month t, $D_t^{Rmkt>5\%}$ and $D_t^{Rmkt>10\%}$ are dummy variables that equal one if the market return is greater than 5% or greater than 10% in month t, $\sigma_{,t-6,t-1}$ is the standard deviation of daily stock returns for stock i over months t-6 to t-1, $Utilization_{i,t-1}$ is the utilization of stock i in month t-1, and $Fee_{i,t-1}$is the borrowing fee for stock i for month t-1. I estimate (4) for hard-to-borrow stocks, which I define in two ways: as those with borrowing fees greater than 1% or as those with borrowing fees greater than 5%.

[7] See Ang, Gorovyy, and van Inwegen (2011), and Fung and Hsieh (2011).

In regression (1) in Panel A of Table 8, I estimate (4) for stock months with fees greater than 1% but do not include utilization or fee among the explanatory variables. The coefficients on each of the market return dummies are positive and highly significant, as is the coefficient on the standard of stock returns over the previous six months. In regression (2), utilization during the previous month is included in the explanatory variables. The coefficient of utilization is positive and highly significant, with a t-statistic of 15.26. It is interesting and somewhat surprising that utilization has greater power to predict large positive returns in hard-to-borrow stocks than does the standard deviation of stock returns. For stocks with fees of 1% or more, the 25th percentile of utilization is 3.8 and the 75th percentile is 64.8. All else equal, a shift from the 25th to the 75th percentile of utilization increases the likelihood of a return of 20% or more by 0.00042 x (64.8 – 3.8) =2.56%. The third regression also includes the stock's average borrowing fee in the previous month as an explanatory variable. The fee is insignificant, while utilization remains positive and highly significant.

Regressions (4) through (6) of Panel A are similar to the first three regressions, but here the sample is limited to stocks with borrowing fees in excess of 5%. This leads to a loss of more than half of the observations. Results though, are unchanged. Coefficients on utilization are positive and significant. Higher utilization is associated with a greater likelihood of a large positive return for hard-to-borrow stocks. Utilization remains more significant than either the market return or the standard deviation of past stock returns.

As we will see later, high levels of utilization are associated with negative stock returns. Hence it is interesting that high levels of utilization are also associated with a higher probability of very large positive returns. One explanation for this is that when utilization is high, short sellers cannot prevent overpriced stocks from moving further away from intrinsic values. When stock returns are positive, short sellers usually short additional shares.[8] When utilization is high short sellers may not be able to locate shares to short and exuberant investors may move overpriced stocks further from their true values.

To estimate the impact of returns on the amount of short selling and how that is affected by utilization, I run the following regression:

$$\begin{aligned}\Delta Util_{i,t} = {} & \alpha_0 + \alpha_1 Util_{t-1} + \alpha_2 D_{t-1}^{Ret<-40\%} + \alpha_3 D_{t-1}^{-40\%<Ret<-20\%} + \alpha_4 D_{t-1}^{-20\%<Ret<-10\%} \\ & + \alpha_5 D_{t-1}^{10\%<Ret<20\%} + \alpha_6 D_{t-1}^{20\%<Ret<40\%} + \alpha_7 D_{t-1}^{40\%<Ret} \\ & + Util_{t-1}\big(\alpha_8 D_{t-1}^{Ret<-40\%} + \alpha_9 D_{t-1}^{-40\%<Ret<-20\%} + \alpha_{10} D_{t-1}^{-20\%<Ret<-10\%} \\ & + \alpha_{11} D_{t-1}^{10\%<Ret<20\%} + \alpha_{12} D_{t-1}^{20\%<Ret<40\%} + \alpha_{13} D_{t-1}^{40\%<Ret}\big) + FE_t + \varepsilon_{i,t}. \quad (5)\end{aligned}$$

[8] Diether, Lee and Werner (2009) show that short selling increases with returns over the previous five days. Using data from 1976-1993, Dechow, Hutton, Meulbroek, and Sloan (2001) find that (p101) "short-sellers take positions in stocks experiencing price runups and then cover their positions as prices decline."

The dependent variable, $\Delta Util_{i,t}$ is the change in stock i's utilization from month t-1 to month t. The explanatory variables include the level of utilization the previous month, $Util_{t-1}$, dummy variables for different levels of returns in the previous month, and interactions between the prior month return dummies and the prior month utilization. Note that there is no dummy variable for month t-1 returns between -10% and 10%. Fixed effects are included for each month.

Table 9 reports estimates of (5). The regression in the first column uses all stock-months, the regression in the second column uses just stocks with mean borrowing fees in the previous month of less than 1%. These are the easy to short stocks. The regressions described in the next two columns use just stocks with mean borrowing fees greater than 1% or borrowing fees greater than 5%. These are hard-to-borrow stocks and very hard-to-borrow stocks. Consider first the regression using stocks with fees greater than 5%. The coefficients on the dummy variables for returns of 10%-20%, 20%-40%, and more than 40% are 0.6613, 2.9020, and 5.7231 respectively. All are statistically different from zero at the 1% level. If utilization is low, utilization and hence short selling increase after a month with positive returns. The interactions between utilization and the dummies for returns of 20% to 40% or returns greater than 40% are negative and significant. So, high levels of utilization prevent short sellers from responding to large positive returns with more short selling.

For stocks with fees greater than 5%, the 25th percentile of utilization is 13.9. For these stocks the estimates in Table 9 suggest that utilization will increase by 1.8589 + (-0.0744-0.0460) x13.9 +5.7231 = 5.91% of shares available for lending if the return in the prior month was 40% or more. The 75th percentile of utilization is 77.5 for stocks with fees greater than 5%. For these stocks utilization *decreases* by 1.8589 + (-0.0744-0.0460) x77.5 +5.7231 = -1.75% of available shares when the prior month return is greater than 40%. Similarly, stocks at the 25th percentile of utilization experience an increase in utilization of 1.8589 + (-0.0744 -0.0204) x13.9 +2.9020 = 3.44% of available shares when the stock return is between 20% and 40%. For stocks with utilization at the 75th percentile, the change in utilization is 1.8589 + (-0.0744 -0.0204) x77.5 +2.9020 = -3.40%. When all stocks with fees greater than 1% are considered, the 25th percentile for utilization is 3.8% and the 75th percentile is 64.8%. For stocks at the 25th percentile of utilization, a 40% return means that utilization will increase by 1.3666 + (-0.0698 – 0.0280)3.8 + 4.1111 = 5.11%. For stocks at the 75th percentile, utilization *decreases* by 1.3666 + (-0.0698 – 0.0280)64.8 + 4.1111 = -0.86%.

So, short selling increases after positive returns, but only if utilization isn't too high. If utilization is high, short sellers close positions putting additional upward pressure on prices.

The relations between utilization and changes in utilization estimated in the regressions are depicted in Figure 2 for fees of at least 5% and returns of at least 40%, fees of 5% or more and returns of

20% to 40%, and fees of more than 1% and returns of more than 40%. In each case, following large returns there are large increases in utilization when utilization is low. When utilization is high, changes in utilization are small or negative even after large returns. For hard-to-borrow stocks, high utilization means that short sellers will not respond to large positive returns with additional short selling. Without short selling, overpriced stocks can move further out of line before their prices revert to their true values.

To demonstrate that high utilization stocks remain good shorts after a large stock price increase, I separate stocks into four categories each month based on whether the return the prior month was greater or less than 20%, and whether the utilization the prior month was greater or less than 50%. I then calculate the return and excess return (return minus value-weighted market return) for stocks in each category. I then calculate simple averages of returns for each category across all months. Results are in Table 10.

The first two rows present returns and excess returns for one month after the stock had (or did not have) a 20% return. In each cell, the average return or excess return is shown with t-statistics underneath in parentheses and the number of observations in brackets. Stocks with utilization in excess of 50% underperform stocks with lower utilization regardless of whether the return the previous month was greater or less than 20%. Of particular interest is the performance of stocks with both high utilization and a return of 20% or more in the previous month. These stocks earn an average raw return of -24 basis points and an excess return of -87 basis points. The excess return is significantly different from zero with a t-statistic of -2.23.

The next two rows report returns and excess returns for the three months after a stock had or did not have a 20% return. The stocks with a utilization of more than 50% and a return of 20% or more earn raw returns on -2.33% over the following three months. Excess returns over the next three months are -4.31% on average. So, stocks with high utilization remain good shorts after a large positive return. But, as a result of the return, short sellers may have to post additional collateral or close part of their position.

5.3 The Risk of Fee Increases

Short sellers face the risk that the fee that they pay to borrow shares will be increased over the life of their short positions. I next test how well utilization predicts fee changes after adjusting for two other variables that could be associated with fee changes: the variance of borrowing fees and the variance of stock returns.[9] Each month I calculate the change in borrowing fees as the average daily fee during the month minus the average daily fee during the previous month. Utilization is the average of the daily utilizations during the previous month. The variance of the daily fees is measured each month, and I use

[9] The variance of utilization is one of the variables that Engelberg, Reed, and Ringgenberg (2018) use to predict he variance of borrowing fees.

the average over the previous six months as the variance of borrowing fees. Similarly, the variance of daily returns is calculated each month. The average of the daily return variances over the previous six months is used as the variance of returns. Each regression also includes the mean fee in the previous month to capture reversion in fees and fixed effects for the month. In regressions, I use four different measures of borrowing fee changes to measure risk. The first is the change in the average daily fee from month t-1 to month t. The other three are dummy variables. The first takes a value of one if the change in fees is positive. The change is positive 41.1% of the time and zero or negative for the other 58.9% of stock months. The second equals one if the change in fees exceeds 1%. This variable equals one 4.88% of the time. The third dummy variable is one if the change in fees is greater than 2%. This happens in 2.91% of stock months.

Regression results are reported in Table 11. In the first regression, when the dependent variable is the change in fees, the coefficient on the variance of fees is 0.0005. It is insignificant with a t-statistic of just 0.37. The coefficient on utilization is 0.0129 with a t-statistic of 69.71. The standard deviation is 21.51, so a one standard deviation in utilization increases fees the following month by about 28 basis points. The coefficient on the variance of returns over the previous six months is 5.6561 with a t-statistic of 16.76, so a higher variance of returns leads to an increase in fees. The coefficient on fees in the previous month is -0.0444 with a t-statistic of -81.62. Fees exhibit regression to the mean.

The dependent variable in the second regression is a dummy variable that equals one if the fee increases. The coefficient on the variance of fees is positive and significant. A stock with a higher variance of fees over a six month period is likely to experience an increase in fees the next month. The coefficient on utilization is 0.0010, with a t-statistic of 28.46. A one standard deviation increase in utilization increases the probability of an increase in fees by about 2.1%. The coefficient on the variance of returns over the previous six months is 0.3606 with a t-statistic of 5.87. The standard deviation of the return variance is 0.0107, so a one standard deviation increase in the return variance increases the probability of a fee increase by about 0.4%.

The last two regressions feature dummy dependent variables that equal one for large fee increases of 1% or 2%. In each of these regressions the coefficients on each of the risk measures are positive and highly significant. When the dependent variable is a dummy that equals one when the increase in fees is greater than 1%, the coefficient on the variance of fees is 0.0089. The standard deviation of the variance of fees is 3.65, so a one standard deviation in the fee variance increases the likelihood that fees will increase by 1% or more by about 3.2%. The coefficient on utilization is 0.0013. A one standard deviation increase in utilization increases the probability of a fee increase of 1% or more by 2.8%. Finally, the coefficient on the variance of returns is 0.5861, so a one standard deviation increase in the return variance increases the probability of a 1% increase in fees by about 0.6%.

Short sellers face the risk that stock borrowing fees will increase while their short positions are open, leading them to pay more to borrow stock than they expected. Both the variance of fees over the previous six months and utilization are positively related to the likelihood of a large increase in fees, with the variance of fees having more predictive power. Utilization is positively related to changes in fees, while the fee variance over the previous six months is not significantly related to changes in fees.

To summarize, short selling is riskiest when there is a lot of short selling and utilization is high. When utilization is high it is hard to locate shares to borrow. That makes it hard to maintain a short position when a loan is recalled. It puts upward pressure on borrowing fees. And, if additional shares can't be shorted, short sellers cannot prevent exuberant investors from pushing shares further out of line with fundamentals. This can force short sellers to put up additional collateral.

6. Short Selling Fees, Risk Measures, and Returns

6.1 Utilization, fees, and stock returns

Fees are a direct measure of the costs of maintaining a short position. We would expect them to be tied directly to stock returns as short sellers will only find it worthwhile to short if returns fully compensate them for the fees they expect to pay. Utilization appears to be behind the risks that borrowed shares will be recalled, that additional collateral will be required, and that short selling fees will increase. These risks are mostly unsystematic, but each leads to stock returns overstating the likely returns to short selling. Therefore we would expect that high utilization, along with high fees, will be associated with low stock returns.

Each month, stocks are first sorted into five groups by mean daily borrowing fees. Most stocks are easy to borrow and have very similar fees, so the 50% with the lowest fees are placed in the low fee group. The next 20% of stocks are placed in the second fee group. Stocks in the 70th to 80th fee percentile are place in the third group, stocks in the 80th to 90th percentile are placed in the fourth group, and stocks with the highest 10% of fees are placed in the high fee group. Stocks in each of the five fee categories are then sorted into five portfolios based on the mean utilization over the previous month. The extreme values of utilization may be very different from the medians, so utilization sortings place the lowest 10% in one portfolio, the next 20% in the second portfolio, the middle 40% in the third portfolio, the 70th to 90th percentile of stocks in the 4th portfolio, and the stocks with the highest 10% of the variable in the high utilization portfolio.

Table 12 reports the mean borrowing fees for the stocks in each fee/utilization portfolio at the time the portfolio is established. For the 70% of stocks with the lowest fees, the mean fees are less than 50 basis points per year. There is little variation in fees for these stocks across utilization categories. For stocks with the lowest 50% of fees, the mean fee is 37 basis points for each utilization category. For stocks in the 50^{th} to 70^{th} percentile of fees, the difference in fees between high and low utilization categories is just three basis points. Hence, differences in returns across utilization categories cannot be attributed to differences in borrowing fees for the low fee categories. For the 10% of stocks with the highest fees, fees exceed 10% per year. Fees increase monotonically from 10.34% for the low utilization portfolio to 36.10% for the high utilization portfolio. For high fee stocks, differences in returns across utilization categories could be the result of differences in fees.

The equal-weighted return for each of the 25 portfolios is then calculated for the next month. Averages of the monthly portfolio returns over 2006-2019 and t-statistics that test whether they are different from zero are shown in Panel A of Table 13. Within each utilization category, high fee stocks underperform low fee stocks. Or, put another way, high fee stock provide larger returns to short sellers. For the three highest utilization categories the high fee stocks earn negative raw returns on average. For the highest 10% fee and highest 10% utilization category, the average monthly return is -1.83%. The t-statistic of -2.64 indicates that the return is significantly less than zero at the 1% level. The difference in returns between the low fee and high fee portfolio is statistically significant for the three highest utilization categories. The difference is especially large, 2.60%, for stocks in the high utilization category. Likewise, within each fee category, higher utilization stocks earn lower returns than low utilization stocks. In the high fee category, the high utilization stocks earn returns of -1.83% and the low utilization stocks earn returns of 0.59%. The difference, 2.42% is economically significant and also statistically significant with a t-statistic of 4.17. Within the high fee category though, high utilization stocks have higher average fees than low utilization stocks. Much of that 2.42% difference could reflect differences in fees. On the other hand, within the low fee category there is no difference in fees across the utilization portfolios. The low utilization low fee portfolio outperforms the low fee high utilization portfolio by 52 basis points per month. The t-statistic for the difference is 2.15. Differences in returns between low and high utilization stocks are positive if insignificant across other fee categories as well. Utilization appears to have predictive power for returns that is independent of fees.

Panel B provides Fama-French-Carhart four-factor abnormal returns for portfolios formed on double sorts of borrowing fees and utilization. Low fee – low utilization portfolios have positive and significant abnormal returns. So, for example, stocks in the lowest 50% of fees and the lowest 10% of utilization earn abnormal returns of 50 basis points per month. The alphas of high fee – high utilization portfolios are negative. The mean alpha for the highest fee – highest utilization portfolio is -2.85% per month with a t-statistic of -6.07. As with raw returns, differences between alphas of low and high fee portfolios are positive for each utilization category, and positive and significant for the three highest utilization categories. Here, the impact of utilization on risk adjusted stock returns is easily seen. The difference in alphas between low and high utilization stocks is positive for each fee category. It is significantly different from zero in four of the five fee categories. In the fifth, consisting of stocks with fees in the 80^{th} – 90^{th} percentile, the t-statistic for the difference is 1.77. Utilization has a strong association with four factor alphas. For the lower fee categories there is very little difference in fees across utilization categories, but low utilization portfolios significantly outperform high utilization portfolios. Utilization appears to affect risk-adjusted returns independently of borrowing fees.

Portfolios used up to this point have been equal-weighted, so the question arises as to whether the returns of these portfolios are distorted by the smallest stocks that they contain. Panel C of Table 13 presents four-factor abnormal returns for value-weighted portfolios formed on double sorts of fees and utilization. For the most part, results for value-weighted portfolios are very similar to results for equal-weighted portfolios. With equal-weighted portfolios, abnormal returns for low utilization portfolios exceed the abnormal returns for high utilization portfolios for every fee category. The differences are statistically significant for the lowest, second lowest, third lowest, and highest fee categories. With value-weighted portfolios, abnormal returns for low utilization portfolios again exceed the abnormal returns for high utilization portfolios for every fee category. The differences are statistically significant for the second highest and highest fee categories. For the lowest fee category, the abnormal returns of value-weighted low utilization portfolio exceed the abnormal returns of the high utilization portfolio by 39 basis points per month. The t-statistic for the difference is 1.82.

Transactions costs could eliminate the abnormal returns if portfolios were rebalanced frequently. Panel D of Table 13 reports the abnormal returns earned over the succeeding 12 months for equal-weighted portfolios formed by double sorts on fees and utilization. Abnormal returns are the intercepts of a regression of the next 12 months return in excess of the risk-free rate on the total returns to each of the Fama-French-Carhart factors over the next 12 months. The portfolio returns are calculated using overlapping periods, so t-statistics are based on Newey-West standard errors with 12 lags.

Within each utilization category, high fee stocks underperform low fee stocks. For the middle and high utilization categories the differences in alphas of low and high fee portfolios are quite large. For the middle utilization category the difference is 15.98% per year, for the second highest utilization category the difference is 20.69% per year, and for the high utilization stocks the difference in alphas is 20.72% per year. But, capturing these differences in abnormal returns involves shorting the portfolio of high fee stocks. The borrowing fees for these high fee stocks, as shown in Table 12, are as large or larger than the 12 month abnormal returns earned by this strategy.

Panel D also shows that within any fee category low utilization stocks earn higher four-factor abnormal returns than high utilization stocks. Capturing these abnormal returns involves shorting high utilization stocks. Within the high fee category, the abnormal returns from the long-short strategy will be eliminated by borrowing fees. But, in the other fee categories the borrowing fees are lower than the abnormal returns to be earned from the long-short strategy. For example, among the lowest fee stocks, the strategy of going long the low utilization stocks and short the high utilization stocks produces abnormal returns of 5.18% per year. The cost of borrowing the stocks in the short position is only 37 basis points per year. Similarly, for the second lowest fee category, a long position in the low utilization stocks and a short position in the high utilization stocks brings average abnormal returns of 7.15% per year. Table 12 shows that the cost of going short the high utilization stocks is just 49 basis per year. Why don't short sellers exploit these opportunities by buying the low utilization stocks and selling the high utilization stocks? Because, as we have seen, shorting high utilization stocks is risky.

Finally, Panel E shows the four-factor abnormal returns earned over the 12 months following portfolio formation for value-weighted portfolios. For each utilization category, the low fee portfolio outperforms the high fee portfolio by statistically significant amount. For each fee category, the low utilization portfolio outperforms the high utilization portfolio by a statistically significant amount. For all but the highest fee category, the difference in returns between high and low utilization portfolios far exceeds the costs of borrowing to short the high utilization stocks.

6.2 Regressions of returns on fees, utilization, and other variables

Both the borrowing fee and utilization are correlated with other variables that can explain returns. To examine the marginal contribution of each, I estimate the following cross-sectional regression each month over 2007 through 2019:

$$Ret_{i,t} = \alpha_0 + \alpha_1 Fee_{i,t-1} + \alpha_2 \sigma^{2,fee}_{i,t-6,t-1} + \alpha_3 \sigma^{2,Ret}_{i,t-6,t-1} + \alpha_4 Util._{i,t-1} + \alpha_5 Fee_{i,t-1} \times \sigma^{2,fee}_{i,t-6,t-1} + \alpha_6 Fee_{i,t-1} \times \sigma^{2,Ret}_{i,t-6,t-1} + \alpha_7 Fee_{i,t-1} \times Util._{i,t-1} + \sum \beta Controls + \varepsilon_i \quad (6)$$

where $Fee_{i,t-1}$ is the mean of the daily borrowing fees over month t-1, $\sigma^{2,fee}_{i,t-6,t-1}$ is the variance of the daily fees over the prior six months, $\sigma^{2,Ret}_{i,t-6,t-1}$ is the variance of daily stock returns over the previous six months and $Util._{i,t-1}$ is the mean of daily utilization over the previous month. The variance of loan fees is one of the variables used by Engelberg, Reed, and Ringgenberg (2018) to predict the risk of future fee changes. The variance of returns is shown by Stambaugh, Yu and Yuan (2015) to be associated with the likelihood that a short seller will be forced to post more collateral. The controls include the turnover (volume divided by shares outstanding) and the return over the previous month and the market capitalization of the stock at the end of the previous month. Mean coefficients and t-statistics for the mean coefficients are calculated across the individual monthly regressions as in Fama and MacBeth (1973).

Regressions results are presented in Table 14. Regression (1) includes only the borrowing fee and controls as an explanatory variables. The coefficient on the borrowing fee is -0.00083 with a t-statistic of -8.54. Across all stock months the median fee is 39 basis points, while the 90th percentile fee is 5.00% and the 95th percentile fee is 10.38%. Hence the coefficient estimate implies that a stock with a fee at the 90th percentile will underperform a stock with the median fee by about 38 basis points per month. A stock with a fee at the 95th percentile will underperform a stocks with a fee at the median level by 83 basis points per month.

Regression (2) includes the variance of fees over the previous six months, the variance of returns over the previous six months, and the mean utilization over the previous month. When these measures are included, the coefficient on the borrowing fee shrinks from -0.00083 to -0.00054 but remains highly significant. The coefficient on the fee variance is -0.00007 with a t-statistic of just -0.48. The correlation of the fee with the fee variance is over 0.6, so it is not surprising that the fee becomes less significant and the fee variance is insignificant when both are included in the regression. The coefficient on the return variance is -0.5479 and is significant in this regression with a t-statistic of -2.46. The median variance of daily returns across all stock months is 0.0006534 and the 90th percentile is 0.003032. A stock with a variance at the 90th percentile will underperform a stock with a return variance at the median by about 13 basis points per month. Utilization, on the other hand, is a much stronger predictor of stock returns. The coefficient on utilization is -0.00015 with a t-statistic of -5.01. The median utilization is 8.758 and the 90th percentile is 51.492, so a stock at the 90th percentile of utilization should underperform a stock at the median of utilization by about 64 basis points per month. Two of the controls have the expected sign and are statistically significant. The coefficient on the return in the previous month is -0.01487 with a t-statistic of -2.23. The reversal in returns could reflect price pressure or other microstructure noise. The coefficient on the log of the firm size is -0.00156 with a t-statistic of -2.13.

Regression (3) includes interactions between the borrowing fee and the measures of short risk. When the interactions are included, the coefficient on the borrowing fee falls to -0.00021 with a t-statistic of -0.71. The coefficient on the return variance is now -0.3469 with a t-statistic of -1.13. The variance of the borrowing fee remains insignificant. Utilization, however remains highly significant with a coefficient of -0.00015 and a t-statistic of -4.44. None of the interaction terms is significant.

The Fama-MacBeth regressions in Table 14 show that higher borrowing fees and higher utilization are both associated with lower future stock returns after adjustment for a number of other variables. Utilization is highly significant even when control variables that are correlated with it, like size, are included in the regressions. Fees and utilization are economically as well as statistically significant determinants of returns.

7. Conclusions

Short sellers face several risks. There is the risk that the shares they borrowed will be recalled and they will not be able to find another source of shares. A second risk is that the stock price will increase in the short run, requiring them to post additional collateral. A similar risk is that it takes a long time for the stock price to incorporate the short sellers' information, forcing them to pay borrowing fees longer than expected. Finally, short sellers face the risk that borrowing fees will increase and it will be more expensive to maintain a short position than they expected.

All of these risks increase with utilization – the proportion of shares available to lend that are currently on loan. If utilization is high and a share loan is recalled, it is difficult to find a new source of shares. If an overpriced stock moves further away from its intrinsic value and utilization is high, short sellers will not be able short additional shares. Hence high utilization is also associated with collateral risk. Finally, higher utilization is associated with a greater likelihood of large fee increases in the future. Short selling is riskiest when there is a lot of short selling and the potential rewards are greatest.

Short sellers will only find it worthwhile to take risky short positions if the returns offer compensation for the risks as well as the costs of short selling. Double sorts of stocks into portfolios on borrowing fees and utilization reveals that for a given level of borrowing fees, high utilization stocks earn lower returns and alphas than low utilization stocks. Utilization appears to be a good predictor of the unique risks faced by short sellers.

References

Andrews, Spencer, Christian Lundblad, and Adam Reed, 2020, Dancing to the same tune: Commonality in securities lending fees, working paper, available at papers.ssrn.com/sol3/papers.cfm?abstract_id=3690337.

Ang, Andrew, Sergiy Gorovyy, and Gregory van Inwegen, 2011, Hedge fund leverage, Journal of Financial Economics 102, 102-126,

Appel, Ian, and Vyacheslav Fos, 2020, Active short selling by hedge funds, ECGI Finance Working Paper 609/2019.

Asquith, Paul, Parag Pathak, and Jay Ritter, 2005, Short interest, institutional ownership, and stock returns, Journal of Financial Economics 78, 243-276.

Bassler, Peter, and Ed Oliver, 2018, Securities Lending Best Practices: A Guidance Paper for Institutional Investors, eSecLending, Securities Finance Trust Company.

Beneish, M.D., C.M.C. Lee and D.C. Nichols, 2015, In short supply: Short-sellers and stock returns, Journal of Accounting and Economics 60, 33-57.

Blocher, Jesse, Adam Reed, and Edward Van Wesep, 2013, Connecting two markets: An equilibrium framework for shorts, longs, and stock loans, Journal of Financial Economics 108, 302-322.

Blocher, Jesse and Matthew Ringgenberg, 2018, Stock options, stock loans, and the law of one price, working paper, Vanderbilt University.

Blocher, Jesse and Matthew Ringgenberg, 2019, Short covering, working paper, Vanderbilt University.

Boehme, Rodney, Bartley Danielsen, and Sorin Sorescu, 2006, Short-sale constraints, differences of opinion and overvaluation, Journal of Financial and Quantitative Analysis 41 (2), 455-487.

Boehmer, Ekkehart, Zsuzsu Huszar, and Bradford Jordan, 2010, The good news in short interest, Journal of Financial Economics 96, 80-97.

Boehmer, Ekkehart, Zsuzsu Huszar, Yanchu Wang, and Xiaoyan Zhang, 2018, Are shorts equally informed? A global perspective, working paper, Singapore Management University.

Cohen, Lauren, Karl Diether, and Christopher Malloy, 2007, Supply and demand shifts in the shorting market, Journal of Finance 62 (5), 2061-2096.

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

Dechow, Patricia, Amy Hutton, Lisa Meulbroek, and Richard Sloan, 2001, Short-sellers, fundamental analysis, and stock returns, Journal of Financial Economics 61, 77-106.

Desai, Hemang, K. Ramesh Thiagarajan, and Bala Balachandran,2002, An investigation into the role of short interest in the Nasdaq market, Journal of Finance 57, 2263-2287.

Diether, Karl, Kuan-Hui Lee, and Ingrid Werner, 2009, Short-sale strategies and return predictability, Review of Financial Studies 22 (2), 575-607.

Diether, Karl, 2008, Short Selling, Timing, and Profitability, working paper, Ohio State University.

Engelberg, Joseph, Richard Evans, Greg Leonard, Adam Reed, and Matthew Ringgenberg, 2020, The loan fee anomaly: A short seller's best ideas, working paper, available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3707166

Engelberg, Joseph, Adam Reed, and Matthew Ringgenberg, 2012, How are shorts informed? Short-sellers news and information processing, Journal of Financial Economics 105, 260-278.

Engelberg, Joseph, Adam Reed, and Matthew Ringgenberg, 2018, Short-selling risk, Journal of Finance 73 (2), 755-786.

Fama, Eugene, and James MacBeth, 1973, Risk, return, and equilibrium: Empirical tests, Journal of Political Economy 81, 607-636.

Fung, William, and David Hsieh, 2011, The risk in hedge fund strategies: Theory and evidence from long/short equity hedge funds, Journal of Empirical Finance 18. 547-569.

Geczy, Christopher, David Musto, and Adam Reed, 2002, Stocks are special too: An analysis of the equity lending market, Journal of Financial Economics 66, 241-269.

Hanson, Samuel, and Adi Sunderam, 2014, The growth and limits of arbitrage: Evidence from short interest, Review of Financial Studies 27 (4), 1238-1286.

Hong, Harrison, Weikai Li, Sophie Nie, Jose Scheinkman, and Philip Yan, 2015, Days to cover and stock returns, NBER working paper 21166.

Hou, Kewei, and Tobias Moskowitz, 2005, Market frictions, price delay, and the cross-section of expected returns, Review of Financial Studies 18, 981-1020.

Jones, Charles, and Owen Lamont, 2002, Short-sale constraints and stock returns, Journal of Financial Economics 66, 207-239.

Kelley, Eric, and Paul Tetlock, 2017, Retail short selling and stock prices, Review of Financial Studies 30 (3), 801-832.

Kolasinski, Adam, Adam Reed, and Matthew Ringgenberg, 2012, A multiple lender approach to understanding supply and search in the equity lending market, Journal of Finance 68 (2), 559-595.

Lamont, Owen, 2012, Go down fighting: Short sellers vs. firms, Review of Asset Pricing Studies 2 (1), 1-30.

Ljungquist, Alexander, and Wenlan Qian, 2016, How constraining are limits to arbitrage? Review of Financial Studies 29 (8), 1975-2028.

Mitchell, Mark, Todd Pulvino, and Erik Stafford, 2002, Limited arbitrage in equity markets, Journal of Finance 62 (2), 551-584.

Muravyev, Dmitriy, Neil Pearson, and Joshua Pollet, 2019, Is there a risk premium in the stock lending market? Evidence from equity options, working paper, University of Illinois.

Rapach, David, Matthew Ringgenberg, and Guofu Zhou, 2016, Short interest and aggregate stock returns, Journal of Financial Economics 121, 46-65.

Reed, Adam, 2013, Short selling, Annual Review of Financial Economics (5), 245-258.

Stambaugh, Robert, Jianfeng Yu, and Yu Yuan, 2012, The short of it: Investor sentiment and anomalies, Journal of Financial Economics 104, 288-302.

Stambaugh, Robert, Jianfeng Yu, and Yu Yuan, 2015, Arbitrage asymmetry and the idiosyncratic volatility puzzle, Journal of Finance 70 (5), 1903-1948.

Table 1
The distributions of key short selling variables.
The distribution of variables is calculated across all stock-month observations from July 2006 through December 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. Lender concentration and inventory concentration are Herfindahl indices for shares lent by individual lending agents and shares in inventory of individual lending agents. The variance of fees is the daily variance of fees within the month. The daily return variance is the variance of daily returns within the month. DCBS is the average of the daily IHS Markit cost of borrowing score. The cheapest and easiest stock to borrow have a DCBS of 1 and the most costly stocks to borrow have a DCBS of 10.

	Mean	5%	25%	Median	75%	95%
Fee	2.576%	0.285%	0.375%	0.393%	0.696%	10.381%
Utilization	17.922%	0.252%	2.403%	8.758%	25.021%	69.377%
Lender Conc.	0.400	0.161	0.235	0.322	0.499	0.959
Inventory Conc.	0.266	0.128	0.157	0.196	0.286	0.709
Variance of Fees	0.858%	0.000%	0.001%	0.003%	0.081%	4.284%
Daily Return σ^2	0.158%	0.013%	0.031%	0.066%	0.144%	0.495%
DCBS	1.68	1.00	1.00	1.00	1.10	5.80

Table 2. The relationships between borrowing fees, utilization, and firm size.

Panel A. The distribution of borrowing fees and utilization across NYSE size deciles.

	Borrowing Fees				Utilization		
	Obs.	Median	90th Per.	99th Per.	Median	90th Per.	99th Per.
Small	207,179	0.644%	11.190%	85.976%	6.54%	61.80%	97.09%
2	77,128	0.388%	2.810%	27.826%	12.81%	57.88%	88.46%
3	55,388	0.375%	1.356%	20.950%	13.03%	54.80%	85.50%
4	45,335	0.375%	0.901%	15.228%	15.55%	53.79%	84.06%
5	38,370	0.375%	0.645%	11.296%	14.76%	49.16%	82.44%
6	32,098	0.375%	0.500%	8.000%	11.53%	42.64%	77.31%
7	30,465	0.375%	0.462%	5.850%	8.23%	37.42%	75.37%
8	28,252	0.375%	0.434%	2.018%	7.02%	32.79%	67.36%
9	27,321	0.375%	0.418%	1.168%	4.72%	11.55%	64.20%
Large	26,371	0.375%	0.411%	0.506%	1.72%	9.23%	40.51%

Panel B. The distribution of utilization by fee category.

Fee Category	Fees	Obs.	Median	90th Per.	99th Per.
Lowest 10%	< 0.310%	56,708	5.54%	23.20%	40.51%
10.1%-25%	0.310% -0.375%	180,662	6.23%	22.65%	42.91%
25.1% - 50%	0.376% - 0.392%	47,412	6.49%	27.44%	51.61%
50.1% - 75%	0.393% - 0.656%	141,237	12.29%	45.16%	71.06%
75.1% - 90%	0.657% - 4.825%	85,102	16.89%	65.20%	88.05%
90.1% - 95%	4.826% - 10.25%	28,391	36.74%	82.41%	99.76%
> 95%	10.26%+	28,395	67.15%	93.79%	99.99%

Table 3.
The proportion of stock days in which a reduction in shares on loan is matched with an equal reduction in available shares on the same day, one of the five days before, or one of the five days afterwards.

	All		Utilization < 50%		Utilization > 50%	
$\Delta Loan_t$ =	Observations	% Equal	Observations	% Equal	Observations	% Equal
$\Delta Available_{t-5}$	13,100,963	0.029%	11,731,161	0.029%	1,369,750	0.038%
$\Delta Available_{t-4}$	13,108,300	0.028%	11,737,411	0.028%	1,370,837	0.034%
$\Delta Available_{t-3}$	13,115,637	0.029%	11,743,665	0.028%	1,371,920	0.035%
$\Delta Available_{t-2}$	13,122,981	0.030%	11,749,964	0.029%	1,372,965	0.037%
$\Delta Available_{t-1}$	13,130,328	0.029%	11,756,274	0.028%	1,374,002	0.038%
$\Delta Available_{t}$	13,145,031	**0.450%**	11,769,108	**0.286%**	1,375,870	**1.852%**
$\Delta Available_{t+1}$	13,130,328	0.030%	11,755,943	0.029%	1,374,332	0.041%
$\Delta Available_{t+2}$	13,122,981	0.031%	11,749,262	0.029%	1,373,666	0.041%
$\Delta Available_{t+3}$	13,115,637	0.028%	11,742,584	0.028%	1,373,000	0.032%
$\Delta Available_{t+4}$	13,108,300	0.028%	11,735,921	0.027%	1,372,326	0.035%
$\Delta Available_{t+5}$	13,100,963	0.029%	11,729,259	0.028%	1,371,651	0.033%

Table 4.
The probability of a forced closure of a short position on a stock-day.
A short position is defined as forced to be closed 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. Utilization is the proportion of shares available for lending that are lent out. Lender concentration is a Herfindahl index of the shares lent by individual lending agents. Inventory concentration a Herfindahl index of the shares inventory of individual lending agents.

Panel A. The probability of a forced closure by fee and utilization.

Indicative Fee	Probability of a Forced Position Close	Utilization	Probability of a Forced Position Close
All Stock Days	0.45%	All Stock Days	0.45%
Fee ≤ 0.5%	0.05%	Utilization < 25%	0.27%
0.5% < Fee ≤ 1.0%	0.17%	Utilization 25% - 50%	0.36%
1.0% < Fee ≤ 5.0%	1.06%	Utilization 50% - 75%	0.63%
5.0% < Fee	2.90%	Utilization ≥ 75%	3.81%

Panel B. The proportion of shares sold short that are forced to be repurchased on a given stock-day.

Indicative Fee	Expected Proportion of Short Positions Closed	Utilization	Expected Proportion of Short Positions Closed
All Stock Days	0.092%	All Stock Days	0.092%
Fee ≤ 0.5%	0.011%	Utilization < 25%	0.083%
0.5% < Fee ≤ 1.0%	0.044%	Utilization 25% - 50%	0.035%
1.0% < Fee ≤ 5.0%	0.284%	Utilization 50% - 75%	0.057%
5.0% < Fee	0.532%	Utilization ≥ 75%	0.506%

Panel C. Change in lender and inventory concentration on forced sale days

	Forced Sale that Day	No Forced Sale that Day
Mean Lender Concentration t-1	0.7123	0.4033
Change Lender Concentration	0.0151	-0.0001
	(40.42)	(-5.12)
Mean Inventory Concentration t-1	0.5980	0.2839
Change Inventory Concentration	0.0101	-0.0000
	(42.37)	(-1.80)

Table 5.
The impact of firm size, borrowing fees, and utilization on the likelihood of a recall and forced position closure.

Panel A. OLS regressions with forced closure as the dependent variable and date and firm fixed effects.

	All Obs	Smallest 25%	25% - 50%	50% - 75%	Largest 25%
Intercept	0.0114	0.0090	0.0295	-0.0011	-0.0023
	(38.19)	(7.12)	(25.68)	(-2.51)	(-4.95)
$Utilize_{t-1}$	0.00022	0.00053	0.00011	0.00002	0.00001
	(178.68)	(120.59)	(55.44)	(27.68)	(8.57)
Fee_{t-1}	0.00210	0.00128	0.00153	-0.00080	-0.00033
	(39.60)	(10.95)	(13.11)	(-7.36)	(-2.46)
$Ln(Size)_{t-1}$	-0.00126	-0.00207	-0.00304	-0.00001	0.00014
	(-96.86)	(-26.84)	(-34.79)	(-0.04)	(4.97)
Obs.	12,223,643	2,465,112	3,206,040	3,271,390	3,281,101
Date FEs	161	161	161	161	161
Firm FEs	7,165	7,145	4,472	3,877	2,345
Adj. R^2	0.0677	0.0773	0.0591	0.0652	0.0186

Panel B. Logistic regressions with forced closure as the dependent variable. Z-statistics in parentheses, odds ratios in brackets

Firm Size	Intercept	$Utilize_{t-1}$	Fee_{t-1}	$Log(Size)_{t-1}$	Obs.	Pseudo R^2
≤ 10^{th} Per.	-8.3201	0.0269	0.1167	0.4457	778,587	0.1279
	(-128.52)	(120.09)	(20.65)	(53.71)		
	[0.0002]	[1.0273]	[1.1238]	[1.5617]		
10^{th} – 25^{th} Per.	1.7739	0.0222	0.1261	-0.6163	1,686,255	0.0817
	(16.55)	(143.48)	(23.37)	(-60.05)		
	[5.8936]	[1.0224]	[1.1344]	[0.5399]		
25^{th} – 50^{th} Per.	16.6414	0.0263	0.2973	-1.9568	3,206,040	0.1092
	(51.13)	(81.21)	(26.88)	(-71.04)		
	[16.9e^7]	[1.0267]	[1.3462]	[0.1413]		
50^{th} – 75^{th} Per.	3.9844	0.0431	0.5315	-1.0174	3,271,390	0.1033
	(3.47)	(35.99)	(13.50)	(-12.04)		
	[53.7555]	[1.0441]	[1.7016]	[0.3615]		
75^{th} – 90^{th} Per.	-15.0948	0.0500	0.3635	0.3024	1,967,706	0.0916
	(-5.44)	(20.75)	(5.47)	(1.65)		
	[0.0000]	[1.0513]	[1.4383]	1.3532]		
> 90^{th} Per.	-14.5969	0.0364	-9.4152	0.3862	1,313,395	0.0183
	(-19.65)	(14.01)	(-2.11)	(9.04)		
	[0.0000]	[1.0371]	[0.0001]	[1.4714]		

Table 6.
Changes in short selling fees for the days after a short position in the stock is forced closed.
A short position is defined as forced to be closed if the number of shares available to lend and the number of shares lent out decline by the same number on the same day. The dependent variable in the regression is the change in fees from day t-1 to day t. The explanatory variables are a dummy variable that equals one if a short position was forced to be closed he previous day, and the utilization the previous day. Utilization is the proportion of shares available for lending that are lent out.

	2006-2019	2006-2019	2006-2012	2013-2019	2006-2019
Intercept	0.00001	-0.00016	-0.00010	-0.00018	-0.00016
	(6.20)	(-15.35)	(-9.25)	(-11.89)	(-15.55)
$D_{Forced\ Close\ t-1}$	0.00065	0.00272	0.00177	0.00266	0.00213
	(2.66)	(9.05)	(3.98)	(8.04)	(7.20)
$D_{Forced\ Close\ t-2}$					0.00110
					(4.16)
$D_{Forced\ Close\ t-3}$					0.00180
					(6.48)
$D_{Forced\ Close\ t-4}$					0.00138
					(5.25)
$Utilization_{t-1}$		0.0028	0.0018	0.0039	0.0028
x 10^2		(26.37)	(17.31)	(21.00)	(26.29)
Fee_{t-1}		-0.0135	-0.0139	-0.0140	-0.0138
		(-24.99)	(-13.89)	(-21.97)	(-25.19)
Adj. R^2	0.0019	0.0086	0.0145	0.0071	0.0093
Fixed Effects	2,231	2,231	1,074	1,157	2,231
Clusters	7,219	7,219	5,534	5,195	7,211
Observation	12,482,335	12,482,335	6,235,958	6,246,377	12,459,598

Table 7.
The percentage change in quantity of shares available for lending is calculated as

$$Percent\ Change = 2 \times \frac{Available\ Shares_t - Available\ Shares_{t-1}}{Available\ Shares_t + Available\ Shares_{t-1}}$$

This percent change in available shares is regressed on dummy variables for a forced closure of a short position each of the five days before and on utilization and borrowing fees five days before. A short position is defined as forced to be closed if the number of shares available to lend and the number of shares lent out decline by the same number on the same day. Regressions include fixed effects for dates.

	(1)	(2)	(3)
Intercept	0.0004	0.0002	-0.0002
	(12.89)	(6.50)	(-4.82)
$ForcedClose_{t-1}$	0.0042	0.0043	0.0035
	(9.15)	(9.16)	(7.50)
$ForcedClose_{t-2}$		-0.0002	-0.0007
		(-0.49)	(-1.43)
$ForcedClose_{t-3}$		0.0005	0.0002
		(1.06)	(0.33)
$ForcedClose_{t-4}$		0.0018	0.0016
		(3.82)	(3.33)
$ForcedClose_{t-5}$		-0.0004	-0.0009
		(-0.86)	(-1.97)
$Utilization_{t-5}$			0.00002
			(14.01)
Fee_{t-5}			0.0008
			(4.93)
Fixed Effects	2,232	2,232	2,232
Observations	13,064,564	13,037,534	13,030,811
Adjusted R^2	0.0242	0.0248	0.0251

Table 8.

The likelihood that additional collateral will be required.

Ordinary least squares regressions are run with a dummy variable for a return in month t of 20% or more as the dependent variable. Explanatory variables include the variance of stock returns over the previous six months, the utilization in the previous month, the borrowing fee in the previous month, and dummies for the contemporaneous market return. Utilization is the proportion of shares available to be lent out that are on loan. The utilization for month t-1 is the mean of daily utilizations for that month. The return on the market is the return on the CRSP value-weighted index.

	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.0625	0.0472	0.0472	0.0687	0.0526	0.0534
	(41.35)	(25.98)	(25.98)	(29.14)	(17.02)	(17.14)
$R_{Mkt,t} > 0$	0.0448	0.0455	0.0455	0.0460	0.0467	0.0470
	(23.53)	(23.89)	(23.90)	(15.63)	(15.88)	(15.97)
$R_{Mkt,t} > 5\%$	0.0715	0.0713	0.0712	0.0833	0.0828	0.0827
	(23.81)	(23.75)	(23.74)	(18.07)	(17.96)	(17.94)
$R_{Mkt,t} > 10\%$	0.1011	0.1011	0.1010	0.1299	0.1292	0.1291
	(11.37)	(11.38)	(11.38)	(9.39)	(9.34)	(9.33)
$\sigma_{t-6,\, t-1}$	0.2761	0.2479	0.2502	0.2190	0.1993	0.2078
	(7.49)	(6.42)	(6.46)	(4.34)	(3.95)	(4.10)
$Utilization_{t-1}$		0.00042	0.00042		0.00033	0.00036
		(15.26)	(14.50)		(8.08)	(8.31)
Fee_{t-1}			-0.00004			-0.00012
			(-0.80)			(-2.04)
Obs.	119,497	119,497	119,497	54,361	54,361	54,361
Adj. R^2	0.0163	0.0182	0.0182	0.0187	0.0199	0.0199
Fee_{t-1}	≥ 1%	≥ 1%	≥ 1%	≥ 5%	≥ 5%	≥ 5%

Table 9.
Regressions of month-to-month changes in utilization on the previous month's stock return and the previous month's utilization. Utilization is the proportion of shares on loan divided by the total number of shares available for lending. Utilization for a month is the average of daily utilizations during the month.

	All	$Fee_{t-1} < 1\%$	$Fee_{t-1} > 1\%$	$Fee_{t-1} > 5\%$
Intercept	0.5728	0.3279	1.3666	1.8589
	(43.06)	(32.46)	(22.17)	(15.32)
$Utilization_{t-1}$	-0.0491	-0.0304	-0.0698	-0.0744
	(-92.44)	(-54.54)	(-50.52)	(-33.73)
$D_{t-1}^{Ret < -40\%}$	3.0106	1.7735	3.9802	5.3739
	(21.12)	(13.43)	(10.00)	(7.39)
$D_{t-1}^{Ret < -40\%}$ x $Utilization_{t-1}$	-0.0499	-0.0268	-0.0540	-0.0770
	(-16.09)	(-5.61)	(-7.74)	(-6.94)
$D_{t-1}^{-40\% < Ret < -20\%}$	1.3887	0.7844	2.0992	2.2908
	(23.36)	(15.69)	(10.64)	(6.37)
$D_{t-1}^{-40\% < Ret < -20\%}$ x $Util_{t-1}$	-0.0153	-0.0058	-0.0173	-0.0254
	(-10.23)	(-2.95)	(-4.79)	(-4.47)
$D_{t-1}^{-20\% < Ret < -10\%}$	0.4998	0.1958	0.9692	1.3017
	(12.85)	(6.38)	(6.26)	(4.54)
$D_{t-1}^{-20\% < Ret < -10\%}$ x $Util_{t-1}$	-0.0017	0.0062	-0.0040	-0.0118
	(-1.41)	(4.40)	(-1.33)	(-2.48)
$D_{t-1}^{10\% < Ret < 20\%}$	0.2023	0.1616	0.5582	0.6613
	(5.43)	(5.73)	(3.21)	(1.97)
$D_{t-1}^{10\% < Ret < 20\%}$ x $Util_{t-1}$	0.0082	0.0051	0.0063	0.0056
	(6.34)	(3.71)	(1.78)	(0.98)
$D_{t-1}^{20\% < Ret < 40\%}$	0.6927	0.4197	1.6411	2.9020
	(12.45)	(9.51)	(7.70)	(7.33)
$D_{t-1}^{20\% < Ret < 40\%}$ x $Util_{t-1}$	0.0018	-0.0049	-0.0035	-0.0204
	(1.09)	(-2.51)	(-0.83)	(-3.09)
$D_{t-1}^{40\% < Ret}$	2.2790	1.1997	4.1111	5.7231
	(23.83)	(14.29)	(14.42)	(11.07)
$D_{t-1}^{40\% < Ret}$ x $Utilization_{t-1}$	-0.0140	-0.0215	-0.0280	-0.0460
	(-5.69)	(-6.01)	(-5.03)	(-5.37)
Adj. R^2	0.0383	0.0325	0.0501	0.0573
Observations	572,422	449,278	122,891	56,577
P-value, Date F.E.s = 0	0.000	0.0000	0.000	0.000

Table 10. Monthly returns and excess returns after a 20% return for stocks with high and low utilization. Each month, stocks are sorted into four categories based on whether the stock's return in the prior month was greater or less than 20% and whether utilization in the prior month was greater or less than 50%. Returns and excess returns are calculated for the following month and the following three months and the average is calculated using all stock month observations for each category. T-statistics are shown in parentheses and the number of stock-month observations are in brackets under average returns and excess returns.

	$R_{t-1} < 20\%$		$R_{t-1} \geq 20\%$	
	Utilization < 50%	Utilization > 50%	Utilization < 50%	Utilization > 50%
R_t	0.0097	-0.0087	0.0204	-0.0024
	(44.78) [479,123]	(-8.79) [53,441]	(15.66) [29,867]	(-0.61) [6,417]
$R_t - R_{Mkt,t}$	0.0013	-0.0130	0.0094	-0.0087
	(6.29) [479,123]	(-13.59) [53,441]	(7.51) [29,867]	(-2.23) [6,417]
$R_{t,\ t+2}$	0.0295	-0.0242	0.0534	-0.0233
	(72.96) [467,520]	(-13.35) [52,011]	(22.52) [29,046]	(-3.66) [6,234]
$R_{t,t+2} - R_{Mkt,t,\ t+2}$	0.0038	-0.0357	0.0172	-0.0431
	(10.35) [467,520]	(-20.84) [52,011]	(7.81) [29,046]	(-7.14) [6,234]

Table 11.
The risk of fee changes.
The fee for a stock for month t is the average of daily borrowing fees for that month. Regressions are run with the change in fee from month t-1 to month t and dummy variables for positive fee changes, fee changes in excess of 1%, and fee changes of 2% or more. Explanatory variables are the variance of daily borrowing fees over the previous six month, the variance of stock returns over the previous six months, and utilization over the previous month. Utilization is the number of shares on loan divided by the total number of shares available to be lent. The utilization for month t-1 is the mean of the daily utilizations for that month.

	$\Delta Fee = Fee_t - Fee_{t-1}$	$D_{\Delta Fee > 0}$	$D_{\Delta Fee > 1\%}$	$D_{\Delta Fee > 2\%}$
Intercept	-0.1062	0.3974	0.0077	-0.0015
	(-22.94)	(472.10)	(22.09)	(-5.52)
$Fees_{t-1}$	-0.0444	-0.0019	0.0016	0.0015
	(-81.62)	(-18.89)	(39.71)	(48.64)
σ^2 $Fees_{t-6,\, t-1}$	0.0005	0.0012	0.0089	0.0069
	(0.37)	(5.21)	(93.71)	(94.89)
$Utilization_{t-1}$	0.0129	0.0010	0.0013	0.0009
	(69.70)	(28.46)	(96.05)	(87.61)
σ^2 $Rets_{t-6,\, t-1}$	5.6561	0.3606	0.5861	0.3103
	(16.76)	(5.87)	(23.18)	(16.05)
Fixed Effects	156	156	156	156
Observations	537,649	537,649	537,649	537,649
Adj. R^2	0.0220	0.0751	0.0912	0.0921

Table 12. Mean stock borrowing fees for portfolios formed on the basis of fees and utilization. Portfolios are formed monthly over July 2006 through November 2019. The mean fees are the time series average of individual month mean fees.

	Utilization				
	Low 10%	10%- 30%	30% - 70%	70% - 90%	High 10%
Lowest 50% Fee	0.0037	0.0037	0.0037	0.0037	0.0037
50^{th} – 70^{th} Percent	0.0046	0.0044	0.0044	0.0046	0.0049
70^{th} – 80^{th} Percent	0.0091	0.0091	0.0089	0.0089	0.0098
80^{th} – 90^{th} Percent	0.0265	0.0259	0.0269	0.0273	0.0301
Highest 10% Fee	0.1034	0.1116	0.1546	0.2407	0.3610

Table 13.
Next month raw returns and Fama-French-Carhart four-factor abnormal returns for portfolios formed by first sorting on borrowing fees then on utilization. Portfolios are formed monthly over July 2006 through November 2019.

Panel A. Mean raw returns

	Utilization					
	Low 10%	10%- 30%	30% - 70%	70% - 90%	High 10%	Low-High
Lowest 50% Fee	0.0126	0.0112	0.0107	0.0093	0.0074	0.0052
	(3.40)	(2.82)	(2.45)	(2.02)	(1.56)	(2.15)
50^{th} – 70^{th} Percent	0.0126	0.0134	0.0094	0.0088	0.0090	0.0036
	(3.29)	(3.40)	(2.01)	(1.69)	(1.80)	(1.15)
70^{th} – 80^{th} Percent	0.0120	0.0085	0.0105	0.0056	0.0060	0.0060
	(3.25)	(2.20)	(2.13)	(0.96)	(1.04)	(1.28)
80^{th} – 90^{th} Percent	0.0084	0.0119	0.0111	0.0074	0.0072	0.0012
	(2.47)	(2.99)	(2.16)	(1.27)	(1.16)	(0.25)
Highest 10% Fee	0.0059	0.0046	-0.0054	-0.0133	-0.0183	0.0242
	(1.40)	(0.88)	(-0.86)	(-1.88)	(-2.64)	(4.17)
Low - High	0.0068	0.0068	0.0161	0.0231	0.0260	
	(1.89)	(1.88)	(4.23)	(5.36)	(5.47)	

Panel B. Fama-French-Carhart four factor alphas

	Utilization					
	Low 10%	10%- 30%	30% - 70%	70% - 90%	High 10%	Low-High
Lowest 50% Fee	0.0050	0.0028	0.0022	0.0005	-0.0012	0.0063
	(3.25)	(3.25)	(3.92)	(0.62)	(-1.13)	(3.11)
50^{th} – 70^{th} Percent	0.0063	0.0062	0.0006	-0.0013	0.0004	0.0059
	(2.77)	(3.76)	(0.50)	(-0.94)	(0.21)	(2.16)
70^{th} – 80^{th} Percent	0.0066	0.0023	0.0017	-0.0047	-0.0045	0.0111
	(2.23)	(0.96)	(0.80)	(-2.00)	(-1.47)	(2.78)
80^{th} – 90^{th} Percent	0.0033	0.0053	0.0023	-0.0024	-0.0037	0.0070
	(1.33)	(1.95)	(0.85)	(-1.00)	(-1.08)	(1.77)
Highest 10% Fee	0.0006	-0.0036	-0.0153	-0.0230	-0.0285	0.0291
	(0.18)	(-0.99)	(-4.44)	(-5.87)	(-6.07)	(5.58)
Low - High	0.0045	0.0066	0.0175	0.0239	0.0277	
	(1.29)	(1.82)	(4.87)	(5.84)	(5.77)	

Panel C. Value-weighted portfolio four-factor abnormal returns

	Utilization					
	Low 10%	10%- 30%	30% - 70%	70% - 90%	High 10%	Low-High
Lowest 50% Fee	0.0027	-0.0003	0.0001	-0.0009	-0.0011	0.0039
	(1.81)	(-0.45)	(0.14)	(-1.03)	(-0.74)	(1.82)
50th – 70th Percent	0.0027	-0.0009	-0.0002	-0.0006	-0.0007	0.0034
	(1.15)	(-0.50)	(-0.12)	(-0.34)	(-0.31)	(1.12)
70th – 80th Percent	0.0102	0.0024	-0.0060	-0.0079	0.0021	0.0078
	(3.05)	(0.70)	(-1.81)	(-2.99)	(0.55)	(1.48)
80th – 90th Percent	0.0159	0.0101	-0.0007	-0.0064	-0.0036	0.0192
	(1.92)	(3.09)	(-0.25)	(-2.18)	(-0.84)	(2.10)
Highest 10% Fee	0.0128	-0.0060	-0.0181	-0.0226	-0.0306	0.0441
	(1.12)	(-1.44)	(-4.77)	(-5.73)	(-4.56)	(3.50)
Low - High	-0.0098	0.0056	0.0178	0.0217	0.0298	
	(-0.85)	(1.32)	(4.60)	(5.41)	(4.36)	

Panel D. Fama-French-Carhart four-factor alphas for the 12 months after portfolio formation. Utilization is the short-selling risk measure. T-statistics are based on Newey West standard errors with 12 lags. Equal-weighted portfolios.

	Utilization					
	Low 10%	10%- 30%	30% - 70%	70% - 90%	High 10%	Low-High
Lowest 50% Fee	0.0473	0.0408	0.0303	0.0164	-0.0045	0.0518
	(3.28)	(2.61)	(2.09)	(1.17)	(-0.25)	(8.86)
50th – 70th Percent	0.0539	0.0618	0.0237	0.0068	-0.0176	0.0715
	(2.96)	(3.22)	(1.58)	(0.43)	(-0.94)	(4.49)
70th – 80th Percent	0.0713	0.0643	0.0252	-0.0307	-0.0135	0.0849
	(2.85)	(3.35)	(0.87)	(-1.08)	(-0.41)	(2.90)
80th – 90th Percent	0.0186	0.0449	0.0143	-0.0098	-0.0578	0.0757
	(0.82)	(2.21)	(0.60)	(-0.40)	(-2.26)	(2.84)
Highest 10% Fee	0.0192	-0.0027	-0.1298	-0.1885	-0.2117	0.2309
	(1.12)	(-0.11)	(-4.53)	(-5.85)	(-6.45)	(6.62)
Low - High	0.0281	0.444	0.1598	0.2069	0.2072	
	(1.69)	(1.99)	(7.77)	(8.12)	(8.43)	

Panel E. Fama-French-Carhart four-factor alphas for the 12 months after portfolio formation. Utilization is the short-selling risk measure. T-statistics are based on Newey West standard errors with 12 lags. Value-weighted portfolios.

	Utilization					
	Low 10%	10%- 30%	30% - 70%	70% - 90%	High 10%	Low-High
Lowest 50% Fee	0.0252	-0.0010	-0.0053	-0.0116	-0.0123	0.0376
	(4.24)	(-0.29)	(-1.02)	(-2.00)	(-1.63)	(4.65)
50^{th} – 70^{th} Percent	0.0219	0.0163	-0.0061	-0.0092	-0.0334	0.0553
	(3.39)	(1.50)	(-1.13)	(-0.92)	(-2.92)	(3.52)
70^{th} – 80^{th} Percent	0.0188	0.0087	-0.0074	-0.0404	-0.0433	0.0621
	(1.18)	(0.74)	(-0.51)	(-2.30)	(-2.58)	(2.22)
80^{th} – 90^{th} Percent	0.0214	0.0144	-0.0333	-0.0672	-0.0785	0.1000
	(0.98)	(1.07)	(-2.36)	(-3.27)	(-3.98)	(2.77)
Highest 10% Fee	-0.0171	-0.0319	-0.1292	-0.1577	-0.2168	0.1997
	(-1.18)	(-2.33)	(-8.92)	(-2.73)	(-3.63)	(3.05)
Low - High	0.0424	0.0309	0.1239	0.1461	0.2045	
	(2.40)	(2.04)	(7.92)	(2.70)	(3.39)	

Table 14.
Fama-MacBeth regressions of monthly returns on borrowing fees and measures of short selling risk. The borrowing fee is the average of daily fees over the previous month. The variance of fees is calculated using daily fees over the previous six months. The return variance is calculated using daily stock returns over the previous six months. Utilization is the average of daily utilizations over the previous month. The sample period is January 2007 through December 2019. Regressions include month fixed effects. Standard errors clustered by firm.

	(1)	(2)	(3)
Intercept	0.01601	0.02003	0.01869
	(2.17)	(2.86)	(2.81)
Borrowing Fee_{t-1}	-0.00083	-0.00054	-0.00021
	(-8.54)	(-5.56)	(-0.71)
Fee $Variance_{t-6,t-1}$		-0.00007	-0.00032
		(-0.48)	(-1.37)
Return $Variance_{t-6,t-1}$		-0.5479	-0.3469
		(-2.46)	(-1.13)
$Utilization_{t-1}$		-0.00015	-0.00014
		(-5.01)	(-4.44)
Fee_{t-1} x Fee $Variance_{t-6,t-1}$			0.00001
			(0.69)
Fee_{t-1} x Return $Variance_{t-6,t-1}$			-0.01313
			(-0.64)
Fee_{t-1} x $Utilization_{t-6,t-1}$			-0.00000
			(-1.22)
Log($Turnover_{t-1}$)	0.00080	0.00203	0.00198
	(0.67)	(1.82)	(1.79)
$Return_{t-1}$	-0.01510	-0.01487	-0.01466
	(-2.25)	(-2.23)	(-2.18)
Log($Size_{t-1}$)	-0.00107	-0.00156	-0.00144
	(-1.39)	(-2.13)	(2.08)
Number of Regressions	156	156	156

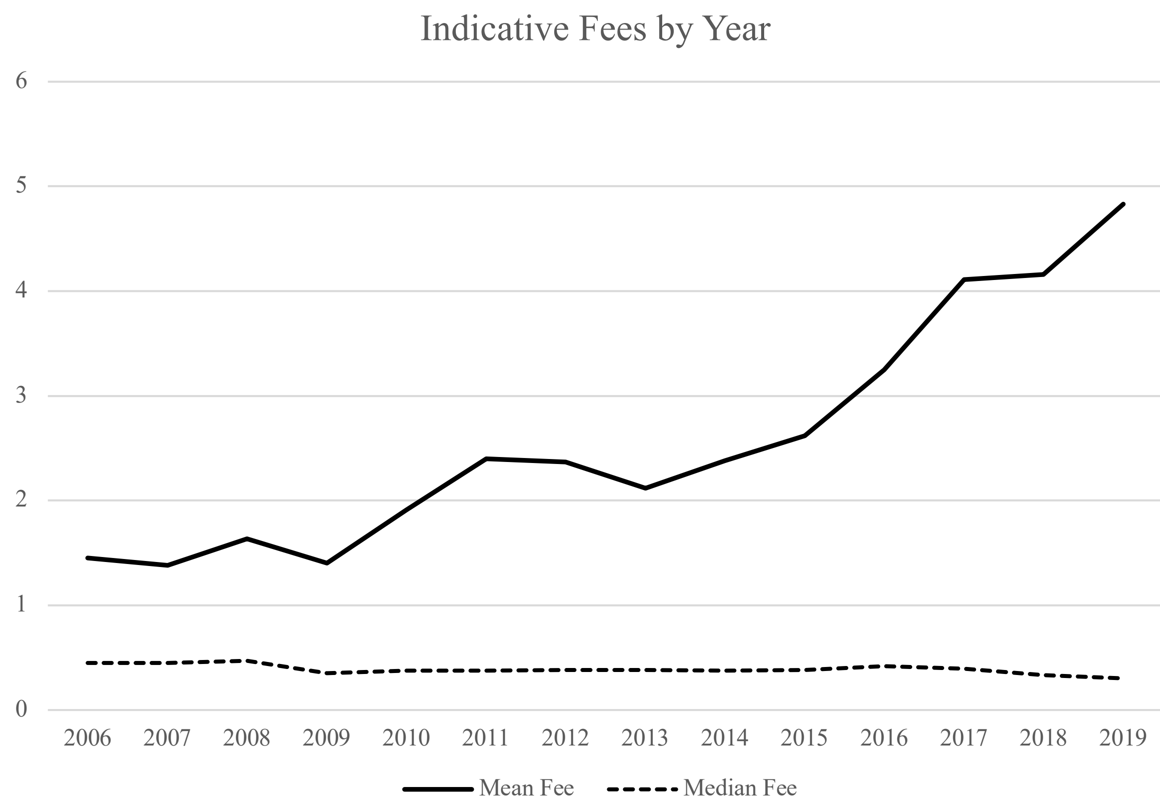

Figure 1. Mean and median borrowing fees by year.

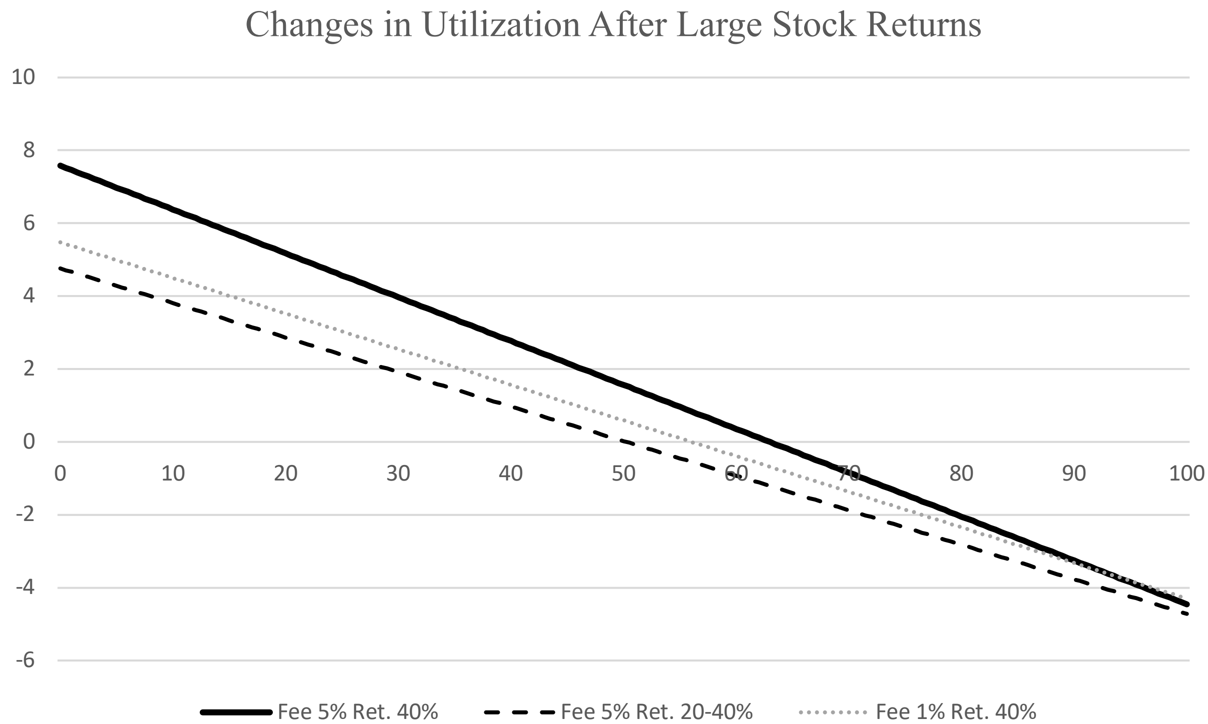

Figure 2. Changes in utilization after large stock returns. Estimates are from regressions of changes in utilization on dummy variables for stock returns and interactions between stock returns and utilization.