Persistent equity lenders and limits to arbitrage: Position-level evidence from mutual funds

Xi Dong* Qifei Zhu†

Abstract

Using new data on mutual funds' equity lending positions, we find that short sellers borrow shares of different stocks from a different but small set of repeated lenders. Through survey and empirical evidence, we argue that this fragmented, persistent lender structure is driven by myriads of lending-side institutional frictions and contributes to limits-to-arbitrage at the lender-stock level. When existing lenders sell their shares, short sellers struggle to find replacement lenders and get partially squeezed, even when conventional measures suggest lending supply is slack. Consequently, lending fees spike, and stocks become more likely to be overpriced. Ex ante, risks implied by lender structure are priced in equity prices. Overall, our findings suggest that lending-side frictions, a class of frictions unconsidered by prior literature, significantly hamper market efficiency.

JEL Classification: G11, G12, G14, G23

Keywords: Limits to Arbitrage, Equity Lending, Short Selling, Mutual Funds

*Zicklin School of Business, Baruch College. Email: xi.dong@baruch.cuny.edu

†Nanyang Business School, Nanyang Technological University, please send correspondence to Qifei.Zhu@ntu.edu.sg. For helpful comments, we thank Steve Dimmock, Jaewon Choi, Theodore Joyce, Jiacui Li, Tao Li, Weikai Li, TC Lin, Adam Reed, Yajun Wang, Wuyang Zhao, and seminar participants at Baruch College, City University of New York, Chinese University of Hong Kong, City University of Hong Kong, Hong Kong University, Lancaster University, and Nanyang Technological University.

I. Introduction

Short selling allows investors to profit from selling stocks that they believe to be overvalued but do not own, hence enhancing the market's ability to incorporate information and form efficient security prices (Miller, 1977; Hong and Stein, 2003). To short sell, an investor needs to borrow shares from shareholders who, for various reasons, may not make their shares available for securities lending. The level of securities lending supply hence largely determines the degree of short-sale constraints, which in turn has implication on limits-to-arbitrage and stock returns.[1] To measure short-sale constraints, researchers and practitioners commonly rely on the number of "lendable shares" (relative to total outstanding shares) at the stock level, which is provided by data vendors from surveying major custodian banks and prime brokers (Saffi and Sigurdsson, 2011). More lendable shares indicate higher lending supply, which relaxes short-sale constraints.

Due to data limitations, most past studies only observe securities lending at the stock level without identifying individual lenders.[2] Researchers hence have to take the aggregate lendable shares at the face value as an indicator for the level of short-sale constraints. However, not all lendable shares are equally available when they are reported as "lendable" by their owners. In a comment letter to the proposed SEC rule requiring the disclosure of "available to loan" data, data provider IHS Markit argues that "[t]he available to loan data would be difficult to interpret because of the intricacies of the lending program parameters between the lender and the beneficial owner. There are many restrictions around markets, counterparties, collateral types, concentration limits, etc. that would make the data misleading to market participants." In other words, two asset owners may both designate their shares as "lendable", but one of the owners might have very stringent conditions attached to equity lending that it never actually lends the shares out.

[1] For example, see Cohen, Diether, and Malloy (2007); Blocher, Reed, and Van Wesep (2013); Reed (2015); Porras Prado, Saffi, and Sturgess (2016); Chu, Hirshleifer, and Ma (2020).

[2] One notable exception is Kolasinski, Reed, and Ringgenberg (2013), who obtain data from 12 institutional lenders. They document substantial dispersion in loan fees across the lenders for the same stock. This suggests substantial difference in willingness-to-lend even among eventual lenders.

In this paper, we assemble a novel dataset of holding-level equity lending activities of mutual funds from Form N-PORT, which contains position-level information on whether a mutual fund lends out a particular stock at quarterly reporting dates from 2019Q3 to 2022Q2. The granular nature of the data allows us to compare the lending decision of a mutual fund relative to other funds holding the same stock at the same time. Such a within–stock–quarter approach enables us to isolate mutual funds' securities lending decisions from the shorting demand of a stock and gain insights on funds' true willingness to lend shares. We show that lendable shares alone do not provide a sufficient statistic for short-sale constraints, and that short-sale constraints may be binding even when lendable shares appear ample.

The most striking pattern we find in the position-level lending data is that short sellers borrow shares from a small set of repeated equity lenders. From one quarter to the next, the best predictor for a fund lending out a position is whether the same fund lent out the same stock in the previous period. As Figure 1 shows, the unconditional probability for a mutual fund to lend out a given position is 6.95%. If a mutual fund lent out a position in the previous quarter, the corresponding probability for lending out the same stock in this quarter jumps up to 62.79%.[3] Even when we account for each fund's average lending propensity and each stock's shorting demand by inserting fund–by–quarter fixed effects and stock–by–quarter fixed effects, the lending probability is still nearly 40 percentage points higher for fund–stock pairs that engage in lending in the previous quarter. Consequently, out of total dollar value of securities lent out by all mutual funds, more than two thirds are contributed by funds that lent out the same shares in previous quarters. This pattern holds even for stocks with relatively high lending fees or utilization ratios, suggesting lenders' inattention does not play a big role.

Several factors studied in extant literature help explain cross-fund differences in equity lending, but collectively explain little why lending propensities at the fund–stock level is

[3]Securities lending agreements are generally open-ended without a fixed maturity. Both borrower and lender can terminate the contract. The median length of securities lending in Markit database is 48 days. Choi, Park, Pearson, and Sandy (2020) reports a median length of 25 days for hedge funds' short trades. Hence, same lending deals spanning across quarters likely only explain a small part of the persistence.

heterogenous. First, mutual funds with longer expected holding horizons seem to lend more, consistent with Porras Prado, Saffi, and Sturgess (2016). Relatedly, ETFs are more willing to engage in securities lending, while passive and active traditional mutual funds have similar tendency to lend. Second, poorly performing funds appear more likely to lend stocks, perhaps as a means to supplement their returns. Third, funds holding a larger stake in a given stock (relative to shares outstanding) seem no less likely to engage in lending relative to funds with smaller stakes, suggesting that mutual funds are undeterred by the potential price impact of securities lending.

The large, unexplained lending persistence at the fund–stock pair level indicates that the willingness to lend certain securities are disparate across funds. It could be driven by managers' unobserved beliefs about individual stocks or heterogeneity in different funds' lending policies. For instance, some funds may screen on the creditworthiness of borrowers.[4]

To shed light on the actual explanations for the persistent and fragmented lending market structure that we observe, we survey seven major prime brokers and one largest custodian bank to collect their view of the lending market. Collectively, these banks oversee the majority of the lending business in the U.S. and thus their views are representative. Overall, our survey reveals that there are myriads of institutional constraints that generate idiosyncratic fund-stock level limits to short sellers' ability of borrowing shares. These idiosyncratic limits can be caused by considerations of all players in the lending market including lenders (mutual funds), prime brokers, custodian banks, and borrowers (short sellers), which we detail later. The idiosyncratic nature of these limits explains why few characteristics, if any, can systematically explain the lending persistence and fragmentation at the fund-stock level. However, the idiosyncratic and persistent nature of these limits imply that when the likely preferred lenders for a stock, discontinue lending, the effectiveness of the lending market for

[4]As an example, in the prospectus of AB Small Cap Value Portfolio, it states "In determining whether to lend securities to a particular borrower, the Adviser (subject to oversight by the Boards) will consider all relevant facts and circumstances, including the creditworthiness of the borrower. The loans will be made only to borrowers deemed by the Adviser to be creditworthy, and when, in the judgment of the Adviser, the consideration that can be earned at that time from securities loans justifies the attendant risk."

the stock may significantly deteriorate, as short sellers either cannot or do not wish to find other lenders. These institutional frictions could generate significant limits of arbitrage and market inefficiency.

Given such evidence, we therefore choose to be somewhat agnostic about the ultimate reasons of the micro-level individual lender-stock lending. Instead, we focus on a macro-level important question: do such fragmented and persistent lending relationships generate important asset pricing implications. In particular, what happens when some current lenders no longer make their shares available for lending? If the persistence that we observe is resulted from non-lending funds' unwillingness to provide shares to short sellers, removing current lenders would squeeze lending supply and raise lending fees for the affected stocks.

Consistent with our hypothesis, we find substantial disruptions in the securities lending market when existing mutual fund lenders sell off their positions, hence removing significant chunk of shares from the equity lending market. For example, when more than 5 percent of shorted shares are recalled and sold by their mutual fund lenders, the lending fee of these affected stocks raised by 30.0 basis points. The associated short volume drops by 0.2 percentage point of the total shares outstanding (the sample average short ratio is 3.3%). In contrast, position exits of non-lender mutual funds do not affect lending fees nor short ratios, even though they reduce the lendable shares measure. The increase in lending fees and the drop in shorting volume associated with lender exits suggest that the elimination of existing security lenders shifts inward the effective lending supply, which other institutional shareholders are unable to fully replenish in the short-term. Crucially, the changes in security lending quantities and prices are significant even after controlling for changes in conventional lending supply measures and in the subsample of stocks where the lagged utilization ratio is relatively low. This suggests that short-sale constraints indicated by aggregate statistics may understate the actual constrainedness of security lending.

Our working assumption is that mutual funds' decisions to sell lent-out holdings are independent of the (expected) conditions in the securities lending market. This is a plausible

assumption, as asset managers' equity lending desks are often run separately from portfolio allocation teams (D'Avolio, 2002). However, it is possible that mutual funds' portfolio decision is driven by the private information about future stock fundamentals. Nevertheless, bad news about a stock is generally associated with an increase in shorting demand, which should drive up, not down, short ratios. Therefore, our results are more consistent with an inward shift in lending supply.

To further isolate the supply-side effect on lending fees when some existing security lenders withdraw from the lending market, we consider a setting where the selling of security lenders are more likely to be liquidity-driven. Extant studies suggest that mutual funds on average scale up and down their holdings based on fund flows. Such flow-driven trades tend to be uninformative and generate price impact on traded stocks that subsequently reverse (Coval and Stafford, 2007; Frazzini and Lamont, 2008; Lou, 2012). We borrow insights from this literature and argue that, if security lenders exit their positions following a period of severe outflows, such removal of lending supply is less likely to correlate with the conditions in the securities lending market. Empirically, we measure fund flows to existing lenders of a given stock, and use this "lender fund flows" as an instrument for lenders' selling decisions. Consistent with our baseline analyses, we find a substantial increase in lending fees and reduction in short ratios when a stock's existing security lenders have to fire-sell their holdings to meet redemptions.

In the final part of the paper, we examine how a sudden contraction of securities lending supply affects equity returns and price efficiencies. For stocks that experience a period of significant lender exits, we observe a significantly positive stock return during the quarter when the lenders exit and the three months immediately afterwards. This suggests that the disruption in securities lending market squeezes short sellers and exacerbates limits to arbitrage. This finding that lender-exit stocks display positive short-term abnormal return also suggests that lenders who liquidated their positions are unlikely to be informed, as they would have earned more from both positive stock returns and higher lending fees had they

not sold their holdings. At a longer horizon of 12 to 18 months, we observe that the returns of these stocks reverse. In addition, using the mispricing measures based on the 100 anomalies from Dong, Li, Rapach, and Zhou (2022) and the 11 anomalies from Stambaugh, Yu, and Yuan (2012), respectively, we find that stocks are more likely to be subject to overpricing following large exits of existing equity lenders.

An increase in short-sale constraints is often associated with reduced stock price efficiency (Saffi and Sigurdsson, 2011). We document that a stock's return volatility and idiosyncratic volatility, which represents a form of arbitrage risk (Porras Prado, Saffi, and Sturgess, 2016), increase significantly following exits of the stock's existing equity lenders. Affected stocks are also more likely to realize extreme positive returns, which are associated with overpricing (Bali, Cakici, and Whitelaw, 2011). Using the price delay measure of Hou and Moskowitz (2005), we find that the price of these stocks suffering from severe limits-to-arbitrage are significantly slower in incorporating information.

To further support our claim that short-sale constraints induced by lender exits are associated with equity over-valuation, we examine whether informed parties unrestricted by limits-to-arbitrage would trade against it. While short sellers are by definition constrained from shorting these shares, firms and corporate insiders are able to capitalize on the mispricing of their own equities by issuing new shares or selling vested shares irrespective of short-sale constraints. Consistent with our premise that the exits of equity lenders induce over-valuation through short-sale constraints, we find that firms' composite and net share issuance activities significantly increase in the months following lender exits. Similarly, corporate insiders sell a larger share of their holdings following an episode of securities lending contraction.

Finally, we examine whether short sellers take into account the risks of potential lender exits and price such risks into stock price *ex ante*. Using a lender concentration measure from Markit and a longer time series of return data, we find that stocks with a higher lender concentration tend to underperform stocks with a more dispersed lender structure,

conditional on the level of stocks' short interest. This evidence is consistent with our argument that lender concentration contributes to limits-to-arbitrage and that short sellers are compensated by taking such risky short positions.

Literature and contribution

Our paper contributes to several strands of literature. First, our paper proposes a novel approach of identifying and measuring (changes in) short sale constraints. As discussed in Reed (2015), researchers face challenges in empirically measuring truly supply-side effect in the securities lending market. The amount of lendable shares is jointly determined by the demand of borrowing, price for borrowing, and the quantity borrowed. Outside of experimental settings (e.g., Kaplan, Moskowitz, and Sensoy, 2013; Chang, Cheng, and Yu, 2007), past studies use variations in news sentiment, short-term momentum, and discretionary accruals as plausible instruments for shorting demand and tease out the supply effect through estimating simultaneous equations (e.g., Kolasinski, Reed, and Ringgenberg, 2013; Aggarwal, Saffi, and Sturgess, 2015). Cohen, Diether, and Malloy (2007) uses the combination of ex post changes in shorting fees and quantities to identify supply shifts. Our paper constructs a novel measure of lending supply changes by combining position-level securities lending data and mutual fund trading decisions. Under plausible assumptions, our $LenderExits$ measure captures shift in securities lending supply that is uncontaminated by shorting demand.

Second, we reveal the existence of many idiosyncratic lender-stock level limits to arbitrage due to institutional frictions in the lending market. Our results suggest that the frictions on the lending side are a new class of frictions to be considered by future studies as they are crucially important for understanding limits of arbitrage and market inefficiency. Prior literature exclusively focuses on the constraints to short sellers but not those on the lending side. Our results shows that disruptions in lending supply significantly affect the prices in securities lending market and equity market, as well as reducing stock price efficiency. Engelberg, Reed, and Ringgenberg (2018) suggests that short sellers face significant risks that stock loans might become expensive or get recalled. Our account of lending market

disruption caused by lender exits provides an illustrative micro-foundation for such short-selling risk. Conditional on the level of short interest, a more concentrated lender structure predicts lower future stock returns, reflecting a large risk premium demanded by short sellers.

II. Data and descriptive statistics

A. Position-level mutual fund securities lending data

The primary data source of this paper is mutual funds' N-PORT filings as newly mandated by the SEC. As part of the *Investment Company Reporting Modernization Rules*, on February 27, 2019, the SEC adopted the final rule on N-PORT filing, which replaces previous N-Q reports. The N-PORT filings reports position-level holdings of registered investment companies at the quarterly frequency. Most important for our study, for each position, the N-PORT filings include the question "Is any portion of this investment on loan by the Fund?". If the answer is yes, the N-PORT filings further provide information on the value of position that is on loan.

We download all N-PORT filings of U.S. domestic equity funds. We define domestic equity funds as funds from the CRSP mutual fund database with a CRSP objective code that starts with "ED". We link CRSP mutual fund database to the downloaded N-PORT filings through the series CIK of each fund. Our sample period starts in 2019Q3, which is the first quarter that mutual funds start to file N-PORT. The sample period ends in 2022Q2. Table I reports, quarter by quarter, the number of funds in our sample. Except for 2019Q3, when some smaller investment companies are still exempt from adopting the new reporting rule, we have on average around 4,000 mutual funds filing N-PORT each quarter.

Table I further reports the number of mutual funds that engage in securities lending each quarter. A fund is considered as engaging in securities lending if any of its positions is on loan in a given quarter. Throughout the sample period, around 42% of all domestic equity funds have securities on loan, similarly to the fraction reported by Evans, Ferreira,

and Porras Prado (2017) towards the end of their sample period (2008). The total dollar value on loan is relatively stable around $100 billion. As a point of comparison, the total value on loan for U.S. common equities at various points in time during our sample period is between $500 to $650 billion. This is consistent with Office of Financial Research (OFR)'s estimate that mutual funds account for 18% of securities lending.[5]

Conditional on a position being lent out, the average (median) fraction of value on loan is 62.0% (78.8%) of the position value. Figure 2a shows that the modal mutual fund lends out 100% of its holding value conditional on lending. In terms of a mutual fund's total value on loan as a fraction of its total net assets (TNA), Figure 2b displays the distribution. Conditional on some securities lending activities, the fraction of TNA on loan for the average (median) mutual fund is 3.87% (1.54%).[6]

B. Other data sources

Lending market outcomes, including short interest, lendable shares, lending fee, and utilization ratio, are obtained from Markit. We aggregate daily data from Markit to the stock-month or stock-quarter level and match Markit data to mutual fund equity lending data by stock CUSIPs. We define short ratio as number of shares on loan divided by total shares outstanding. Lending supply is defined as number of lendable shares divided by total shares outstanding. Utilization ratio is defined as number of shares on loan divided by lendable shares.

We obtain stock returns, return volatilities, turnovers, and bid-ask spreads from the CRSP. Other firm characteristics information is sourced from the Compustat and IBES. Mutual fund characteristics, such as TNA, expense ratio, portfolio turnover, index fund and ETF designations, fund flows, and past fund returns are obtained from the CRSP Mutual Fund Database.

[5]See Figure 9 of OFR's report at `https://financialresearch.gov/reports/files/ofr_asset_management_and_financial_stability.pdf`.

[6]SEC regulations require that funds may not have on loan at any time securities representing more than one-third of the fund's total value.

III. Empirical findings

A. Persistent security lenders

We first set out to examine factors that affect mutual funds' propensity to supply shares in the securities lending market. A large body of literature links a number of ownership characteristics with institution's propensity of making holdings available for lending. For example, long-term, passive investors are often associated with higher lending supply (Porras Prado et al., 2016; Palia and Sokolinski, 2021). Being able to observe securities lending at the position level allows us to disentangle a stock-selection effect from mutual funds' true willingness to lend. Under the stock-selection story, certain mutual funds lend more shares than other funds because these funds happen to hold stocks that command a high shorting demand. With our granular position-level data, we can use a within–stock–quarter empirical design to tease out the differential lending propensity across funds for the same stock, effectively holding the shorting demand invariant.

Aside from mutual fund characteristics such as asset under management, portfolio turnover ratio, and recent fund returns, one important determinant of securities lending that we examine is a fund's past history of lending the same stock. This is motivated by the empirical observation that securities lending is fairly "persistent" at the fund–stock pair level. For example, Figure 1 shows that the unconditional probability for a mutual fund to lend out a particular position is 6.95%. If a mutual fund lent out the same position in previous quarter, the corresponding probability for lending out this quarter jumps up to 62.79%. In stark contrast, if a mutual fund held a given position but did not lend out the shares in the previous quarter, the probability of lending out this position in the current quarter is only 2.72%. In our regression analysis, we control for various fund characteristics and high-dimensional fixed effects to further examine whether such starkly persistent securities lending activities reflect variations in mutual funds' propensity of lending a particular stock.

We estimate the following equation at the fund–stock–quarter level:

$$\mathbb{1}^{\text{OnLoan}}_{s,f,t} = \alpha_{s,t} + \beta \mathbb{1}^{\text{OnLoan}}_{s,f,t-1} + \gamma X_{s,f,t} + \epsilon_{s,f,t}, \tag{1}$$

where $\mathbb{1}^{\text{OnLoan}}_{s,f,t}$ is indicator variable that is set to one if fund f lends out (a positive amount of) its holdings in stock s at quarter t. The high-dimensional stock–quarter fixed effects $\alpha_{s,t}$ absorb the differences in shorting demand across stocks and compare the lending outcomes of different funds on the same stock at the same time. Additional fund(–stock) characteristics $X_{s,f,t}$ include portfolio weight of stock s in fund f, fund past returns, fund TNA, fund family TNA, fund expense ratio, fund portfolio turnover ratio, and indicators for whether fund f is an index fund or an ETF. The standard errors are double-clustered at the fund and the stock level.

Table III displays the results. As column (1) shows, accounting for stock–by–quarter fixed effects, relative to a fund that newly establishes a position in a stock, a fund's propensity to lend this particular stock is 46.4 percentage points higher if the fund lent out the same position in the previous quarter-end. In contrast, a fund is 1.89 percentage point less likely to lend the stock if the same fund held the stock in the previous quarter but did not lend. These represent economically large effects as the unconditional probability for lending a particular stock position is 6.92% (see summary statistics in Table II). A small part of the incremental lending propensity by previous mutual fund lenders is attributable to lending arrangements that span across multiple quarters. In the Markit database, the median length of securities lending in is 48 days for U.S. equities. Less than 20 percent of stock–months has securities lending with an *average* length of one quarter or more.[7]

In column (2) of Table III, we further include an explanatory variable indicating that a fund lent out the same stock two quarters before. Conditional on a fund's lending decision

[7] If we assume that 20 percent of securities lending agreements that mutual funds have at previous quarter-ends have a remaining length of a quarter or more, this conservative assumption suggests that being a security lender in the previous quarter is associated with 37.5% ($46.9\% * (1 - 20\%)$) higher probability for a fund to lend the same stock to a different short seller this quarter.

at quarter $t-1$, lending out a particular stock at quarter $t-2$ further increases a fund's propensity to lend the same stock at quarter t by 17.1 percentage points. This implies a combined increase in lending propensity of 56.1 percentage points ($17.1 + 39.0$) conditional on lending over the past two consecutive quarters relative to new shareholders. This result is unlikely attributable to long-term lending arrangements, as they seldom last for more than two quarters. It corroborates our argument that the willingness to participate in the securities lending market differ across mutual funds.

Is this difference in lending propensity driven by fund-level policies, or does it depend on considerations specific to a stock even for the same fund? Presumably, if some funds always lend all of their holdings, while others never lend, we would estimate a positive β on lagged lending indicator but the positive β would go away when fund–time fixed effects are included. However, this is not the case in the data. In column (3) of Table III, we further use fund–by–quarter fixed effects to absorb differences in the average lending propensity across funds. Effectively, we are comparing two different stocks held by the same fund — one being lent out in the previous quarter, while the other was not lent out. The estimated coefficient on $\mathbb{1}^{\text{OnLoan}}_{s,f,t-1}$ is 39.4 percentage points, and is virtually unchanged from column (2), where fund–by–quarter fixed effects are unaccounted for. This finding suggests that there is persistent difference in lending propensity at the fund–stock pair level. In other words, even for funds with similarly high average lending propensity, whether they lent out a particular stock in the previous quarter still possesses strong predictive power for their current securities lending outcomes.

Can the observed pattern of persistent securities lending possibly be explained by the inattention of some mutual funds (who do not lend) to the securities lending market? In the last two columns of Table III, we focus on the subsample of stocks that either have a lending fee greater than 100 basis points (column 4) or utilization ratio greater than 50% (column 5). For these stocks, it is reasonably to expect fund managers to be aware of securities lending opportunities. However, the coefficient estimates in columns (4) and

(5) show that, even among this set of high-fee, high-utilization stocks, securities lending activities in the previous quarter still predict a higher probability to lend in this quarter by about 25 percentage points. Moreover, relative to the omitted group of mutual funds that newly acquire the stock during the quarter, mutual funds that held the stock but did not lend in the previous quarter has a 10 to 20 percentage point *lower* probability to lend their holdings this quarter. In other words, the fact the some funds held shares without lending is more consistent with a deliberate choice than a result of inattention.[8]

The coefficients on other fund characteristics are also highly informative. Some of the estimates challenge the literature's received wisdom about securities lending supply, while others confirm past findings. First, quite a few past studies (e.g., Porras Prado et al., 2016) make the assumption that long-term investors are more likely to lend securities than short-term investors (or that long-term investors are more preferred by short sellers as lenders). Our analysis finds inconclusive evidence for this claim. Controlling for stock–quarter fixed effects, funds' turnover ratio, an inverse proxy for investment horizon, is uncorrelated with equity lending (columns 1 and 2). Another proxy we use for measuring the expected holding horizon at the fund–stock level is the distance between a fund's average investment style and a stock's style.[9] We argue that funds tend to have a longer holding horizon for stocks that are close to the fund's core investment style (Evans et al., 2017). We hypothesize that, the closer a stock is to the fund's core investment style, the more likely that the fund lends the stock's shares. As reported in columns (1) to (3) of Table III, we indeed find a negative coefficient the style distance of a stock. However, the economic magnitude of the coefficient is modest. For example, in column (1), a one standard deviation decrease in a stock's style distance (1.36) is only associated with an increase in lending probability of 0.24 percentage point ($-0.00175 * 1.36$).

[8] In Appendix Table A1, we use the fraction share of a position that is lent out as the outcome variable and repeat the analyses. We find consistent result that prior lenders tend to have a larger fraction share of the same position on loan in the current quarter.

[9] A stock's style is defined by its size and book-to-market deciles in the cross-section. A fund's average style is the average size and book-to-market deciles across its holdings. We then calculate the Euclidean distance for each stock–fund pair.

Another claim associated with investment horizon is that passive funds are more willing to supply shares for securities lending (e.g., Palia and Sokolinski, 2021) Our results show that this claim is true only for ETFs, but not for traditional index funds. As compared to active funds, ETFs are 1.65 percentage point more likely to lend the same stock (column 1), while non-ETF index funds do not show a disparage lending propensity. This finding suggests that the relation between passive management and securities lending supply documented by past studies is likely attributable to a stock-selection effect: i.e., passive investors tend to hold the type of stocks that other investors are inclined to make available for lending.

Second, mutual funds' lending propensity is negatively correlated with their recent performance. This is consistent with the idea that poor-performing funds use securities lending income to supplement their investment returns. This finding is compatible with Evans, Ferreira, and Porras Prado (2017), which finds negative relation between securities lending and fund performance at the fund level. Our within-stock result suggests that the negative relation between fund performance and securities lending is not entirely driven by poor stock selection. Poorly performing funds may be simply more willing to lend their holdings to generate additional revenues.

Third, we find that the relation between the ownership ratio (a fund's holdings of a stock relative to the stock's shares outstanding) is either positive (columns 1 and 2) or insignificant (column 3). This finding indicates that mutual fund lenders are not concerned about the price impact externalities from making their shares lendable. This is consistent with the discussion in Rizova (2011) and Kaplan, Moskowitz, and Sensoy (2013), but inconsistent with the argument in several other studies.

B. Persistent and fragmented lending relationships: Insights from the lending market players

Our analysis in the last section suggest that few characteristics systematically explain why fund-stock level lending is persistent and also fragmented—i.e., different funds lend out

different stocks in their portfolios. A conversation with Markit representives indicates that the lending terms of individual stocks of individual funds are determined by fund specific arrangements with brokers and custodian banks. We therefore conduct a survey on major prime brokers and custodian banks to draw insights from their perspective on this issue. We contacted seven major prime brokers-Goldman Sachs, JPMorgan Chase, Morgan Stanley, Credit Suisse, Bank of America Merrill Lynch, Citigroup and Barclays, and the largest custodian bank State Street. We ask the employees of those banks to provide their views on what determines some stocks of a fund are persistently lent out while other stocks are usually not. Together, these banks involve in the bulk of the lending business in the lending market and their observations and views are therefore representative. We collect many reasons, for which we summarize in categories below.

Mutual funds

Usually, mutual funds that lend shares are called beneficiary owners (BO) in the lending market. BO only put a portion of their holdings as lendable inventory. They choose which stocks to lend by setting terms in their contracts with custodian banks. They are likely to lend out the stocks that they expect to benefit from lending. Therefore some fund-stock level characteristics might explain persistent lending of a stock such as expected holding horizon and core asset or not. This explains why we find some modest evidence that investment horizon or style measures are related to lending decisions of a stock in a fund.

However, many other reasons are idiosyncratic at the fund-stock level. They include: (1) Fund mandates, objectives and strategies: Different funds have distinct investment mandates, objectives, strategies, which imply different constraints for different stocks in the fund portfolio. For example, the lending of some stocks might not align with the investment strategy considerations of the beneficial owners. (2) Risk profiles and tolerance: Lending some stocks might be suitable for Fund 1's risk profile but considered too risky for Fund 2. (3) Concentration risks and limits: Some funds have stock specific leverage or concentration limits that prevent the lending of a stock. They may avoid lending stock A if it leads to

undue concentration risks in the lending portfolio but persistently lend stock B if such risk is not a major concern. (4) Insider or restricted stock: A stock in a fund might be classified as insider or restricted stock, making it subject to limitations that prevent or discourage lending. (4) Liquidity needs, liquidity management strategies, and redemption policies: If Fund 2 expects higher redemptions or has a more stringent or superior/inferior liquidity management strategy, it might choose not to lend a stock to ensure it has enough liquidity to meet potential redemptions. Fund 1 might not have the same liquidity considerations for the same stock. (5) Tax considerations: The tax implications of lending a particular stock might differ, depending on the fund's structure, investor base, or jurisdiction. This could influence the decision to lend the stock from one fund but not the other. (6) Sub-fund or share class considerations: If Fund 1 and Fund 2 are structured with different sub-funds or share classes, this might introduce complexities that affect the feasibility or attractiveness of lending a stock from one fund but not the other. (7) Preferences and beliefs: For example, if Fund 2 has a specific focus on ESG (Environmental, Social, and Governance) principles, it might have different criteria for lending stocks compared to Fund 1. More generally, BO might specifically allow or disallow the lending of particular stocks due to various pecuniary and nonpecuniary preferences or beliefs that restrict the lending of certain securities. (8) Regulatory and compliance requirements: Different funds might be subject to different regulatory regimes or compliance requirements, depending on factors like fund type, domicile, investor base, or strategy. This might affect the ability to lend different subset of stocks in different funds.

Broker and custodian banks

Besides mutual funds, prime brokers and custodian banks also face some constraints that significantly affect fund-stock level lending outcomes. These constraints center around relationship, reputation, regulatory, legal (such as insider trading), compliance, risk management, and conflict of interest (between the custodian, brokers and the clients) concerns. These concerns are highlighted by bankers as fairly important to the extent that different

prime brokers have different private internal lists restricting their lending desk to lend some stocks. In situations where a broker has a business relationship or investment banking services, underwriting securities, or maintaining a close advisory relationship with a particular company, they may choose not to lend the shares of that company to short sellers or other borrowers. This can be due to the broker's desire to maintain a positive relationship with the company, avoid conflicts of interest and regulatory or legal investigations pertaining to insider trading, maintain a trustworthy reputation, or prevent any negative implications for their broader business dealings. Essentially, brokers consider a tradeoff between the direct and indirect benefits from lending a firm's shares to their hedge fund clients and the long-term business revenues from their firm client. The decision is highly firm-specific and thus unpredictable from an outsider point of view as it involves a complex set of internal considerations.

Given there are many brokers and custodian banks serving different mutual fund clients, the three-way combinations can result in many fund-stock level lending differences.

Lender-induced short seller choices

Finally, short sellers as share borrowers may end up choosing a fixed set of lenders for different stocks based on the attractiveness of the terms attached with each stock by each fund. As a result, different stocks may always lent out through a different set of lenders even though other lenders also make the same stocks available for lending. These terms include (1) Fund-specific fees: Different mutual funds may charge different level of fees for different stocks for many reasons, some of which are outlined above. Markit informs us that this fund-stock level fee difference can be very large. (2) Collateral Management Practices: Different funds might have different preferences or requirements for managing collateral in securities lending transactions; (2Borrower eligibility: Lenders may have criteria for determining the eligibility of borrowers. They may require borrowers to meet certain creditworthiness standards, have established relationships with reputable institutions, or have adequate financial resources to provide collateral. For example, fund 1 and 2 can both hold stock A only, then if fund 2 has

lower requirements then stock A will always be lent out through fund 2. (3) Loan terms and durations: Securities lending programs specify the terms and durations of the loans. Lenders may set limits on the duration of the loans to control risk and ensure liquidity. Additionally, lenders may have the ability to recall the loaned securities under certain circumstances, such as when they need to vote on important shareholder matters or respond to exceptional market conditions.

As a result of the above lender restrictions, borrowers may naturally prefer the lender-stock choices with the lowest fees and favorable terms. These lenders emerge as the persistent lenders of a particular set of stocks. If these lenders decide to discontinue lending of some stocks, short sellers may refrain from borrowing from new lenders if the terms of the new lenders are too unfavorable.

Overall, our survey reveals that there are many institutional constraints coming from the lender side that generate idiosyncratic fund-stock level limits to short sellers' ability of borrowing shares. Given econometricians lack the inside information of different players on the lending market, there is no way to identify the micro-level reasons for lender-stock level lending outcomes. However, at the macro level, When the persistent, and likely preferred lenders for a stock, exit, the effectiveness of the lending market for the stock may significantly deteriorate. In other words, these institutional frictions could be associated with significant limits of arbitrage and market inefficiency. We provide such evidence in subsequent sections.

C. Position exits by securities lenders as a shock to lending supply

Mutual funds that lent out shares in the equity lending market tend to continue to make the same stock's shares available for lending in the future. These past lenders are economically important in supplying short sellers with shares. As Figure 3 shows, when we aggregate the total dollar value of on-loan shares lent by all mutual funds, 68.1% of the lending value is borrowed from mutual funds that lent out the same stock in the previous quarter. As a comparison, only 21.8% of the lending value is borrowed from mutual funds that held

the stock but did not lend it out last quarter. The balance, 10.1% of the lending value, is borrowed from mutual funds that newly purchased the stock during the concurrent quarter.

One interpretation of why some mutual funds persistently lend their shares to short sellers while other funds do not lend is that there are heterogeneous reasons to supply shares in the securities lending market. However, one caveat is that our data do not allow us to observe shareholders who make their shares available to lend but do not end up lending. Therefore, an alternative possibility is that short sellers have persistent preference for borrowing from a specific set of mutual funds. To distinguish these two alternative explanations, in this section we examine the responses to some existing securities lenders exiting their positions. The rationale is as follows: if the persistent lending is driven by investors' limited lending supply, then when existing security lenders exit their position and hence make these shares unavailable for lending, the supply in securities lending market should drop significantly, causing an increase of lending fees and a reduction in the short ratio. In contrast, if it is borrowers' preference that drives persistent securities lending, it means that non-lending mutual funds are equally willing to make their shares available and can step in once current securities lenders exit their positions. Therefore, the effect of lender exits on the securities lending market should be relatively limited.

To empirically evaluate these two competing hypotheses, we construct a measure that tracks position exits of existing securities lenders. Specifically, for each stock–quarter, we are interested in mutual funds that lend their shares in quarter $t-1$, and completely sell off their holdings of the stock between quarters $t-1$ and t. Absence of position exits, these prior mutual fund lenders have a high propensity to make their shares available for lending in quarter t. As they sell off their holdings, these mutual funds lender are no longer able to supply securities lending and have to recall their shares if their loans are still outstanding. To capture its economic impact on the securities lending market, our measure of lender position exits ($LenderExits$) scales the number of shares (measured at quarter $t-1$) lent by mutual funds who exit their position by the total number of shares on loan (measured at quarter

$t-1$):

$$LenderExits_{i,t} = \frac{\sum_{j \in Owners_{i,t-1}} (\mathbb{1}_{i,j,t}^{\text{Position Exit}} \cdot Shares\ on\ Loan_{i,j,t-1})}{Total\ \#\ Shares\ on\ Loan_{i,t-1}}, \tag{2}$$

where i indexes stocks, j indexes mutual funds that are shareholders of i, and t indexes quarters. The binary variable $\mathbb{1}_{i,j,t}^{\text{Position Exit}}$ indicates that fund j completely sells off its holdings of i during quarter t. We focus on complete portfolio exits because a fund is unable to lend the shares after such exits, and we can abstract away from funds' lending decisions after partial exits.

The variable $LenderExits$ has a very skewed distribution. About 71% of the stock–quarters have $LenderExits = 0$, indicating either no mutual fund lenders observed from previous quarter or no lender existing. For the rest of stock–quarters with positive $LenderExits$, the histogram is shown in Figure 4. To ease economic interpretation, in most of our analyses, we use an indicator variable for $LenderExits \geq 5\%$, which accounts for about seven percent of the observations. Most of our results are robust to using alternative thresholds such as $LenderExits \geq 10\%$ or $LenderExits > 0\%$.

We first use an event-study framework to examine the impact on securities lending fees when a significant fraction of existing lenders exist their positions. To this end, we select the set of stock–quarters where $LenderExits \geq 5\%$ and trace their changes in lending fees surrounding the quarter when existing lenders exit their positions. To account for time trends in equity lending fees, we adjust lending fees by the sample-average equity lending fee in each month. We control for stock fixed effects in the regression:

$$LendingFee_{i,t} = \alpha_i + \sum_{k=-3}^{9} \beta_k \cdot \mathbb{1}^{k\ month\ from\ lender\ exit\ events} + \epsilon_{i,t}. \tag{3}$$

Figure 5 shows the evolution of lending fees before and after the lender exit events. Before the quarter when more than 5% of existing lenders exit their positions, the level of lending fees is relatively stable. During the 3 months when lenders sell their positions and cease to provide lending supply, the level of lending fees begin to rise significantly. Lending fees are

about 60 basis points higher in the first month after the sell-off, and remain significantly elevated at 25-27 basis points for Months 2 and 3. This relatively prolonged disruption of about one quarter is consistent with the recall risk as discussed in D'Avolio (2002). This piece of evidence suggests that there are considerable frictions in the securities lending market such that non-lending institutional investors do not step in to provide securities lending immediately after a set of existing securities lenders are unable to provide shares for lending.

To further examine in a multivariate setting the effect of the exit of existing lenders on the securities lending market, we estimate panel regressions on the quarter-to-quarter changes of securities lending outcomes, such as lending fees, utilization ratios, and short ratios:

$$\Delta Y_{i,t} = \alpha_t + \beta_1 LenderExits_{i,t} + \beta_2 NonLenderExits_{i,t} + \gamma \Delta LendingSupply_{i,t} + \eta Y_{i,t-1} + \lambda X_{i,t-1} + \epsilon_{i,t}, \tag{4}$$

where $LenderExits$ is measured between quarters $t-1$ and t. The variable $NonLenderExits$ is defined as the number of shares sold by non-lending mutual funds that terminate their positions between quarters $t-1$ and t, scaled by total number of shares held by non-lending mutual funds at quarter $t-1$. This variable accounts for the general selling of shares by mutual funds unrelated to securities lending considerations. Later we contrast the coefficient estimates on $LenderExits$ and $NonLenderExits$. We control for $\Delta LendingSupply$ in regressions to highlight that, when existing lenders cease to make their shares available for lending, the conventional measure for lendable shares does not fully capture the true lending supply. The vector X represents stock-level characteristics such as mutual fund ownership, book-to-market ratio, gross profitability, past stock return, stock turnover ratio, and bid-ask spread. We include quarter fixed effects and cluster standard errors at the stock level.

Table IV shows the results. In column (1), we first confirm that both the exit of security-lending mutual funds and the exit of non-lenders are associated with a decrease in lendable shares as indicated by the $Markit$ database. When the security lenders who exit their positions represent more than five percent of shares on loan, the associated drop in lendable

shares is 1.77 percent of shares outstanding. The exits of non-lending mutual funds are similarly associated with a reduction in lendable shares, suggesting that some of these non-lenders have indicated the availability for lending of their shares to the data vendor Markit. In column (2), we show that the utilization ratio of lendable shares increases significantly when a sizable fraction of lenders exit their positions. When $LenderExits$ is greater than 5%, the associated change in utilization ratio is about 1.68%. In column (3), we find that the short ratio of stocks affected by lender exits drops by about 0.19 percentage point. Given that the sample average short ratio is 3.3%, the observed reduction in short ratio is economically meaningful. Importantly, the exits of non-lenders are not associated with changes in utilization ratio nor short ratio.

Columns (4) and (5) of Table IV display results on lending fees. During the quarter when more than 5% of existing lenders sell their shares, the $DCBS$ lending fee score, which ranges from one to ten, increases by 0.131 unit, while the indicative lending fee increases by 30.0 basis points. Both increases are statistically significant. The magnitude of lending fee increase is comparable to the increase found in the event study around month $t+3$, as shown in Figure 5. Again, $NonLenderExits$ is uncorrelated with lending fee changes, suggesting these non-lending shareholders do not bind conditions in the securities lending market.

Finally, in column (6), we restrict the sample to stocks whose utilization ratio was below 10% at the end of the previous quarter. Such a low utilization ratio indicates that there should be ample "available" shares that are presumably lendable from alternative lenders. However, even within this set of stocks, exits of existing lenders still raise the lending fee significantly by 13.3 basis points. This result is consistent with Aggarwal, Saffi, and Sturgess (2015), who find that, in the context of voting-induced recalls, supply shifts have a significant impact on lending fees even at relatively low levels of utilization.

The joint observation of an increase in lending fess and a reduction in short selling volume (as measured by short ratios) suggests an inward shift in securities lending supplies (Cohen, Diether, and Malloy, 2007). In other words, when prior security-lending mutual funds exit

their positions and remove their shares from the supply of lendable shares, other institutional investors fail to step in and provide lending supply at a similar level of fee. This set of findings suggest that the persistent lending relationship observed in our data is likely attributable to some mutual funds being more willing to lend certain stocks at borrower-friendly terms than other mutual funds.

In Appendix Table A2, we repeat the analyses using the continuous variable $LenderExits$. Consitent with our main results, $LenderExits$ is negatively associated with changes in lendable shares and short ratios, and positively associated with changes in utilization ratio, lending fee score ($DCBS$), and lending fee. In Panel B of Appendix Table A2, we scale $LenderExits$ by a stock' number of shares outstanding. When regressing this rescaled $LenderExits$ on changes in short ratio, we find a coefficient of -0.164 (column 3). This indicates that, when existing lenders cease to lend shares, about 16% of borrowers are unable to find replacement lenders and presumably have to cover their shorts. The rest of the borrowers are able to find lendable shares, but presumably at higher lending fees.

D. Fund flows as an instrument for lender exits

The working assumption of our analyses so far is that a mutual fund's decision to sell a stock holding is uncorrelated with the stock's condition in the securities lending market. This is a plausible assumption: as D'Avolio (2002) notes that "short-run [equity loan] supply is essentially vertical" because equity lending desks are often run separately from portfolio allocation desks. However, it is also possible that security-lending mutual funds are informed about future changes of lent stocks' fundamentals and adjust their portfolios based on such information. While we examine the contemporaneous and future stock returns in the next section, in this section we use an instrumental variable approach to mitigate the concern about endogenous portfolio sales. In particular, we use fund flows as plausible exogenous shocks that force existing securities lenders to exit their positions.

A vast literature has shown that mutual funds' portfolio purchases and sales are largely

driven by fund flows (e.g., Pollet and Wilson, 2008; Lou, 2012). When faced with redemption requests, fund managers tend to proportionally scale down their holdings, and the associated selling decisions are likely uninformative and often associated with price reversals (Coval and Stafford, 2007; Frazzini and Lamont, 2008; Edmans, Goldstein, and Jiang, 2012; Lou, 2012). Motivated by this literature, we use the fund flows (during quarter t) to a stock's current security lenders (measured at $t-1$) as an instrument for these security lenders' position exits between quarters $t-1$ and t. In particular, for stock i at quarter t:

$$LenderFlow_{i,t} = \frac{\sum_{j \in Owners_{i,t-1}} (FundFlow_{j,t} \cdot Shares\ on\ Loan_{i,j,t-1})}{Total\ \#\ Shares\ on\ Loan_{i,t-1}}, \tag{5}$$

where $FundFlow_{j,t}$ is the fractional flow for fund j during quarter t. When existing lenders suffer from large outflows (signified by a negative $LenderFlow$), we posit that these lenders are more likely to sell their shares, hence restricting the supply in the securities lending market.

We first estimate the reduced-form effects of lender fund flows to outcomes in the securities lending market. The outcome variable Y includes lending fees, utilization ratios, and short ratios:

$$\Delta Y_{i,t} = \alpha_t + \beta_1 LenderFlow_{i,t} + \beta_2 NonLenderFlow_{i,t} + \eta Y_{i,t-1} + \gamma X_{i,t-1} + \epsilon_{i,t}, \tag{6}$$

the variable $NonLenderFlow$ is defined as the holding-weighted flows to funds that held stock i but did not lend the shares in quarter $t-1$. We control for the average flow to non-lender funds to account for confounding factors that affect flows to certain fund investment styles. The vector X represents a set of stock characteristics.

Table V shows the effects of $LenderFlow$ on securities lending outcomes. In column (1), we find that flows to securities lenders are positively associated with changes in lendable shares, indicating that an outflow (negative flow) to existing lenders is correlated with a reduction in lending supply. In column (2), we find that flows to securities lenders are

negatively associated with changes in utilization ratio. A negative $LenderFlow$ therefore correlates with a significant increase in the utilization ratio of lendable shares. In column (3), the coefficient estimate suggests that an outflow from existing lenders is associated with a reduction in short ratio.

In columns (4) and (5), we find that $LenderFlow$ is significantly negatively associated with lending fee score ($DCBS$) and indicative lending fee. These coefficient estimates suggest that, when mutual funds that previously lent out the shares suffer from a severe outflow, stocks' lending fee tend to increase, reflecting a contraction in securities lending supply.

To further examine whether lender fund flows affect the securities lending market through the channel of lender exits, we adopt an instrumental variable (IV) framework by estimating the following equations:

$$\mathbb{1}_{i,t}^{LenderExits\geq 5\%} = \beta LenderFlow_{i,t} + \eta Y_{i,t-1} + \gamma X_{i,t-1} + \epsilon_{i,t} \tag{7}$$

$$\Delta Y_{i,t} = \alpha_t + \beta_1 \widehat{\mathbb{1}}^{LenderExits\geq 5\%} + \beta_2 NonLenderFlow_{i,t} + \eta Y_{i,t-1} + \gamma X_{i,t-1} + \epsilon_{i,t}, \tag{8}$$

where $\widehat{\mathbb{1}}^{LenderExits\geq 5\%}$ is the instrumented indicator for $LenderExits \geq 5\%$.

Table VI shows the results from IV regressions. Column (1) shows that fund flows to existing lenders have a strong explanatory power for lender position exits. For example, a 10 percentage point drop in lender flows increases the probability of significant lender exit ($LenderExits \geq 5\%$) by 30.7 percentage points. The Wald F statistics for the first stage IV regression exceeds 100, indicating a strong instrument.

Columns (2) to (6) of Table VI report the second-stage regression results. The instrumented lender exit dummy is significantly associated with a reduction in lendable shares and short ratio, and an increase in utilization ratio and securities lending fee. These findings are consistent with the baseline results using uninstrumented lender exits. They suggest that, when existing security lenders remove lendable shares due to flow considerations, the prices and quantities in the securities lending market are significantly impacted. Moreover,

the magnitude of estimated effects is considerably larger under the IV setting than under the baseline results. Such differences suggest that, when mutual fund lenders are not selling shares to meet redemptions, they may internalize the potential ramification in the securities lending market. For example, some of lenders may refrain from selling a stock that earns an abnormally high lending income.

IV. Asset pricing implications

In this section, we gauge the economic importance of position exits by security lenders through the lens of their impact on stock prices. We argue that a sudden contraction in equity lending supply exacerbates the limits to arbitrage for the equity market, hence squeezing the stock price and adversely affecting stock price efficiency.

A. Stock returns

We first study the return predictability of lender position exits. To this end, we investigate what happens to stock returns during and after lenders exit their positions by estimating a monthly cross-sectional regression of the following form:

$$Ret_{i,t,t+n} = \alpha + \beta_1 LenderExits_{i,t} + \beta_2 \Delta MFHoldings_{i,t} + \gamma X_{i,t-1} + \epsilon_{i,t}, \tag{9}$$

where we transform the quarterly $LenderExits$ dummy into monthly frequency by assigning the same dummy value to all months of the same quarter. We examine stock returns Ret at the contemporaneous month $Ret_{i,t-2,t}$ and subsequent periods including $Ret_{i,t+1,t+3}$, $Ret_{i,t+4,t+6}$,$Ret_{i,t+7,t+12}$, and $Ret_{i,t+13,t+18}$. To ensure a fair comparison across horizons, we keep a stock-month observation if return outcome variables across all horizons are non-missing. We control for the general effect of mutual holding changes on returns using $\Delta MFHoldings_{i,t}$, as prior literature has shown the price impact of aggregate mutual fund trading (e.g., Lou, 2012). The vector X represents a set of stock characteristics that are

shown to be important cross sectional return determinants in the Fama-French four factor model including the log of market cap, book to market ratio, and momentum. We use time (month) fixed effects in the regression to ensure we focus on the cross-sectional return predictability. Standard errors are double-clustered at the firm and month levels.

Table VII shows that *LenderExits* in the current quarter is slightly positively related to the contemporaneous stock return (column (1)). The cumulative abnormal return during the quarter is about 1.7%. This result suggests that, at the time of lender exiting from a stock, there is no obvious sign that there is bad news in the underlying stock and that the exit of securities lenders possibly force some short sellers to cover their positions and generate positive stock returns. In the next three months following lenders' exit (column (2)), stock returns continue to be abnormally positive (4.2% and t=2.457), suggesting that a sudden contraction in equity lending market may generate economically meaningful mispricing in the stock market. The return of stocks affected by lender exits seems to plateau during months t+4 to t+6 and months t+7 to t+12. Finally, we observe significant reversal of stock returns averaging about 4.4% during months t+13 to t+18 (column (5)). This is consistent with the lending supply of these stocks eventually becoming normalized and overvaluation being corrected.

Throughout our tests, we control for the overall changes in mutual fund holdings, which are negatively correlated to the stock return over multiple horizons. The negative relation is consistent with the pattern documented in Dasgupta, Prat, and Verardo (2011) and Lou (2012), which argue that mutual fund trading exerts temporary price pressure that will revert in the long term. We also control for the change in lendable shares from Quarter t-1 to Quarter t. We do not find that changes in this convention measure for lending supply have much impact on future stock returns. This result is consistent with the finding of Kaplan, Moskowitz, and Sensoy (2013).

These results offer strong evidence that stocks may experience significant overpricing following lender exits. They also strengthen our argument that exited lenders are unlikely

to have been driven by private information about loaned-out stocks: Had they not exited their positions, they would have earned more from both increased lending fees and higher stock prices.

B. Price efficiency

In this section, we examine how securities lender exits affect equity market price efficiency. Theories suggest that increased limits-to-arbitrage is associated with less efficient stock prices. To investigate this relation, we estimate the following equation:

$$Efficiency_{i,t,t+n} = \alpha + \beta_1 LenderExits_{i,t} + \beta_2 \Delta MFHoldings_{i,t} + \gamma X_{i,t-1} + \epsilon_{i,t}, \quad (10)$$

where the dependent variable is price efficiency measures that are measured either in the contemporaneous quarter with *LenderExits* or as the monthly average of these measures over month t+1 to t+6.

In Table VIII, we use mispricing scores as the price (in)efficiency measure. To construct the level of mispricing of a stock, we follow the existing literature by aggregating each stock's ranking of a number of anomalies that are widely used in the literature. Stambaugh, Yu, and Yuan (2015) show that returns to individual anomalies have low correlations with each other but relatively high correlations with the returns to a long-short strategy that combines all these anomalies, suggesting that each captures a different element of aggregate cross-sectional mispricing. They argue that this aggregation "diversifies away [the] noise in each individual anomaly and ... increases precision" for measuring aggregate mispricing. Accordingly, we proceed in three steps. First, every month, we rank stocks into deciles according to next month's return as predicted by each anomaly, from 1 (most undervalued) to 10 (most overvalued). Second, for each stock and month, we compute the average of these anomaly-specific ranks, and then sort stocks into deciles according to this averaged rank. We refer to this decile ranking as the composite mispricing score with a higher score again

indicating higher likelihood of overpricing. For robustness, we utilize two sets of anomalies when generating this score. The first score MISP DLRZ is based on the 100 anomalies studies in Dong et al. (2022). The second score MISP SYY is based on the 11 anomalies used in Stambaugh et al. (2012). Both studies show that their anomaly sets are related to mispricing, dominated by the overpricing in the short legs of the anomalies considered. Table II, Panel C, shows that the mispricing score for individual stocks has an average around 5.4 and a standard deviation of around 2.8.

Table VIII shows that $LenderExits$ is statistically significantly associated with more overpricing at the 1% level across all specifications. The relation is also economically important. Using MISP DLRZ as an example, since the score is a decile ranking measure, the coefficient estimate on the $LenderExits$ dummy in column (2) suggests that a stock's overpricing ranking moves up by about 18.5 percentiles on average during the six months following lender exists. This move equals to 70% of the standard deviation of the mispricing score, which is substantial. Similarly, based on the SYY mispricing measure, stocks that experienced lender exits becomes more overvalued by about 11.2 percentiles (column 4). This is consistent with our conjecture that stocks experiencing a reduction in lending supply and an increase in short-sale constraint are more likely to be overpriced.

Limits-to-arbitrage is detrimental to the incorporation of new information into stock prices. In Table IX, we consider other alternative price (in)efficiency measures as the dependent variable in Equation 10. We compute measures of the inverse of price efficiency ($Delay$) using the $Delay3$ measure in Hou and Moskowitz (2005). Higher values of $Delay$ indicate more price delay, which indicates worse price efficiency. Return volatility measures ($Volatility$ and $IdioVol$) are computed using daily returns following Ang, Hodrick, Xing, and Zhang (2006). The extreme positive return measure ($MaxRet$) is computed as the maximum daily return during a month following Bali, Cakici, and Whitelaw (2011). Higher return volatility, idiosyncratic volatility, or $MaxRet$ is associated with inefficient prices especially overpricing (see, e.g., Bali, Cakici, and Whitelaw, 2011; Stambaugh, Yu, and Yuan,

2015). To ease the interpretation of economic magnitude, all the price efficiency measures in the table are standardized.

Table IX shows that *LenderExits* is significantly positively associated with higher price inefficiency at the 1% level across all measures. During Month t+1 to t+6, *LenderExits* is associated with 13% higher price delay, 33% higher return volatility, 31% higher idiosyncratic volatility, and 24% higher MaxRet on average relative to these variables' standard deviation. These results suggest that limits to arbitrage, which are induced by reduced lending supply, prevent short sellers from impounding their information into security prices. As a result, stocks prices are less informational efficient and more susceptible to overpricing following the exits of equity lenders.

Overall, since each price efficiency measure is computed using very different input data, these measures provide a more holistic view of price efficiency. Therefore, our results in this section provide robust and economically important evidence that lender exits are associated with inefficient prices and particularly overpricing.

C. Trading by informed investors

If stocks are overpriced, informed traders might trade against the overvaluation by selling the shares. Therefore, to obtain more convincing evidence that the stocks experiencing lender exits are overpriced, we examine whether informed investors trade against it. However, short sellers are constrained from lending the shares in the event of lender exits. As our return-related evidence in Table VII suggests, the overpricing associated with lender exists are only partially corrected after more than one year, consistent with securities lenders being persistent in their lending and arbitrageurs being short-constrained. Nevertheless, two sets of informed investors are less subject to short-sale constraints: companies themselves, who can issue new shares, and company insiders, who have already owned company stocks. There is a long literature that indicates firms' issuance and repurchase behaviors are informative (e.g., Pontiff and Woodgate, 2008; Daniel and Titman, 2006). Similarly, trades made by

corporate insiders, such as executives and directors, are shown to be predictive of future stock returns (Lakonishok and Lee, 2001).

We capture firms' trading using two measures. The first measure is used in Da, Dong, Wu, and Zhou (2022), *Net Firm Trading* (NFT), computed as the change in the split-adjusted shares outstanding over a month relative to its past 12-month average, scaled by the 12-month average. The measure essentially captures the abnormal net share issuance over a month. The second measure for firms' issuance, based on Daniel and Titman (2006), is *Composite Equity Issuance* (CEI), which is defined as the amount of equity a firm issues (or retires) in exchange for cash or services (i.e., percentage change in market equity value minus the return over the same period). Under this measure, seasoned issues and share-based acquisitions increase the issuance measure, while repurchases, dividends, and other actions that take cash out of the firm reduce this issuance measure.

To capture the trading by firm insiders, we consider the *Net Insider Sales* (NIS) measure in Da et al. (2022), computed as the negative change in the insider holdings over a month relative to insiders' past 12-month average holdings, scaled by the 12-month average. The measure again captures the abnormal net insider sales over a month. We replace the dependent variable in Equation 9 with the firm sales and insider sales activities measured contemporaneously with $LenderExits$ or measured as the monthly average of these measures over Month t+1 to t+6. To ease the interpretation of economic magnitude, we again standardize the outcome variables.

Table X shows that $LenderExits$ is significantly associated with higher firm share issuance for both firm trading measures. Taking NFT as an example, the coefficient estimate of 0.26 on $LenderExits$ in column (1) implies that abnormal net firm issuance is about 26% higher relative to its standard deviation. Overall, during the contemporaneous quarter or during the subsequent 6 months surrounding the lender exists, columns (1)-(4) show that firms' selling activity is 21% to 26% higher relative to its standard deviation. The results suggest that companies exploit the overpricing in stock experiencing lender exists by issuing

more shares. This finding corroborates a recent study by Schultz (2021), who documents that some seasoned equity offerings (SEOs) are motivated by short-sale constraints. Similarly, insider sales are also 13% higher relative to NIS's standard deviation during the contemporaneous quarter or during the subsequent 6 months surrounding the lender exists. The response of insiders is smaller than that of firms, consistent with the literature finding that insider trades appear less informed than firm trades Da et al. (2022).

D. Are risks associated with lender structure priced ex ante?

The analyses so far focus on the *ex post* asset pricing effects of lenders' exits. Our results suggest that lending fees subsequently spike and short sellers get partially squeezed out of the shorting market. From short sellers' perspective, such lender exit events impose considerable risks on their shorting strategies. Such short-selling risks should be priced in the stock market *ex ante* (Engelberg et al., 2018). In this section, we examine the relationship between lender structure and future stock returns.

Specifically, we argue that the concentration of equity lenders is a source of short-selling risks that short sellers should consider. Compare two stocks with similar levels of short interest but different lender concentration: The lending condition of the stock with a concentrated lender structure is more subject to the idiosyncratic shocks that force a few of their lenders to exit their positions, as compared to the stock with a more dispersed lender base. Taking this dynamic consideration into account, we expect stocks with a more concentrated lender base to be more short-sale constrained and to have lower average future returns than stocks whose lendership is more dispersed.

To empirically examine this relationship between lender concentration and stock returns, we use a longer time series (April 2006 to December 2022) and utilize the *LenderConcentration* measure provided by Markit. The variable *LenderConcentration* is a Herfindahl-Index-like measure at the stock level that describes the concentration of lenders. It takes the value between $(0, 1]$ where a very small number indicates a large number of lenders with low value

on loan and 1 indicates a single lender with all the value on loan. Since there is a negative correlation between a stock's *LenderConcentration* and its short interest,[10] it is important that we control for stock short ratio when examining the return predictability of lender concentration.

To this end, we conduct dependent double sorts of stock on short ratios and lender concentration. Each month, we form portfolios by first sorting stocks into quintiles using the previous month's average daily short ratio and then sorting into terciles using the previous three months' average lender concentration (Markit's *LenderConcentration*). Panels A and B of Table XI report average returns and Fama-French four-factor alphas for these portfolios. Conditional on the level of short interest in each row, the last column presents the portfolio returns to a strategy that buys firms with the highest lender concentration and shorts firms with the lowest lender concentration.

Focusing on the Fama-French four-factor alphas (Panel B), we find that stocks with a more concentrated lender structure underperform stocks whose lender base is more dispersed, when the level of short interest is within intermediate range (short interest quintiles 2, 3, and 4). The monthly underperformance of high-lender-concentration stocks ranges from 24 to 31 basis points per month. This is consistent with our hypothesis that lender concentration heightens short-selling risk and makes it more likely that short sellers need to replace key lenders in the future. Ex ante, short sellers require a higher level of compensation to short such stocks.

It also makes sense that stocks with high lender concentration only underperform when short interest is modest: For highest-short-interest stocks (quintile 5), the sorting on lender concentration generates a large-enough spread in the level of short interest within the quintile. In untabulated test we find that, within Quintile 5 of high-short-interest stocks, stocks with high lender concentration have a short ratio that is almost four percentage points lower than stocks with low lender concentration. Given it is well known that a high short interest itself

[10]Consider a stock with only one share being shorted, naturally all the on-loan share is provided by a single lender.

predicts lower future stock return (e.g., Boehmer, Jones, and Zhang, 2008), the predictive power of short interest and the predictive power of lender concentration potentially offset each other in the high-short-interest quintile.

V. Conclusions

In this paper, we use novel position-level equity lending data from mutual funds to uncover several new, stylized facts about securities lending activities. Shares are lent out repeatedly by a small set of mutual fund shareholders, suggesting heterogeneity at the lender-stock level in supply the securities on the lending market. When a significant portion of current lenders exit their holdings, the lending market experiences a contraction in supply of shares and a spike in lending fees. These findings suggest that short sellers might be more constrained than conventional statistics suggest: even when the aggregate lendable shares seem sufficient, potential lenders do not appear to step in under similar terms to provide lending supply when existing lenders are no longer able to lend shares. Consequently, short sellers are exposed to the risk of recalled shares and spiking lending fees, contributing the short selling risk as in Engelberg, Reed, and Ringgenberg (2018).

Constrained lending supply caused by lender exits also has the potential to distort equity prices. We find that stocks experiencing lender exits generate abnormally high returns in the months following the lender exits before reversing later. Various price efficiency measures suggest that the price of affected stocks becomes less efficient. Finally, informed parties seem to trade against such mispricing induced by limits-to-arbitrage. In particular, after the contraction of equity lending market, affected companies take advantage of the favorable valuation to issue more shares.Overall, our findings suggest that lending-side frictions, a class of frictions unconsidered by prior literature, significantly hamper market efficiency.

References

Aggarwal, Reena, Pedro AC Saffi, and Jason Sturgess, 2015, The role of institutional investors in voting: Evidence from the securities lending market, *The Journal of Finance* 70, 2309–2346.

Ang, Andrew, Robert J Hodrick, Yuhang Xing, and Xiaoyan Zhang, 2006, The cross-section of volatility and expected returns, *The Journal of Finance* 61, 259–299.

Bali, Turan G, Nusret Cakici, and Robert F Whitelaw, 2011, Maxing out: Stocks as lotteries and the cross-section of expected returns, *Journal of Financial Economics* 99, 427–446.

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

Boehmer, Ekkehart, Charles M Jones, and Xiaoyan Zhang, 2008, Which shorts are informed?, *The Journal of Finance* 63, 491–527.

Chang, Eric C, Joseph W Cheng, and Yinghui Yu, 2007, Short-sales constraints and price discovery: Evidence from the hong kong market, *The Journal of Finance* 62, 2097–2121.

Choi, Jaewon, Ji Min Park, Neil D Pearson, and Shastri Sandy, 2020, Profitability of hedge fund short sales: Evidence from opening and closing transactions, *University of Illinois at Urbana-Champaign Working Paper* .

Chu, Yongqiang, David Hirshleifer, and Liang Ma, 2020, The causal effect of limits to arbitrage on asset pricing anomalies, *The Journal of Finance* 75, 2631–2672.

Cohen, Lauren, Karl B Diether, and Christopher J Malloy, 2007, Supply and demand shifts in the shorting market, *The Journal of Finance* 62, 2061–2096.

Coval, Joshua, and Erik Stafford, 2007, Asset fire sales (and purchases) in equity markets, *Journal of Financial Economics* 86, 479–512.

Da, Zhi, Xi Dong, Ke Wu, and Dexin Zhou, 2022, Inside and outside informed trading, *University of Notre Dame and Baruch College Working Paper* .

Daniel, Kent, and Sheridan Titman, 2006, Market reactions to tangible and intangible in-

formation, *The Journal of Finance* 61, 1605–1643.

Dasgupta, Amil, Andrea Prat, and Michela Verardo, 2011, Institutional trade persistence and long-term equity returns, *The Journal of Finance* 66, 635–653.

Dong, Xi, Yan Li, David E Rapach, and Guofu Zhou, 2022, Anomalies and the expected market return, *The Journal of Finance* 77, 639–681.

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

Edmans, Alex, Itay Goldstein, and Wei Jiang, 2012, The real effects of financial markets: The impact of prices on takeovers, *The Journal of Finance* 67, 933–971.

Engelberg, Joseph E, Adam V Reed, and Matthew C Ringgenberg, 2018, Short-selling risk, *The Journal of Finance* 73, 755–786.

Evans, Richard, Miguel A Ferreira, and Melissa Porras Prado, 2017, Fund performance and equity lending: Why lend what you can sell?, *Review of Finance* 21, 1093–1121.

Frazzini, Andrea, and Owen A Lamont, 2008, Dumb money: Mutual fund flows and the cross-section of stock returns, *Journal of Financial Economics* 88, 299–322.

Hong, Harrison, and Jeremy C Stein, 2003, Differences of opinion, short-sales constraints, and market crashes, *The Review of Financial Studies* 16, 487–525.

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

Kaplan, Steven N, Tobias J Moskowitz, and Berk A Sensoy, 2013, The effects of stock lending on security prices: An experiment, *The Journal of Finance* 68, 1891–1936.

Kolasinski, Adam C, Adam V Reed, and Matthew C Ringgenberg, 2013, A multiple lender approach to understanding supply and search in the equity lending market, *The Journal of Finance* 68, 559–595.

Lakonishok, Josef, and Inmoo Lee, 2001, Are insider trades informative?, *The Review of Financial Studies* 14, 79–111.

Lou, Dong, 2012, A flow-based explanation for return predictability, *The Review of Financial*

Studies 25, 3457–3489.

Miller, Edward M, 1977, Risk, uncertainty, and divergence of opinion, *The Journal of Finance* 32, 1151–1168.

Palia, Darius, and Stanislav Sokolinski, 2021, Strategic borrowing from passive investors: implications for security lending and price efficiency, *Available at SSRN* 3335283.

Pollet, Joshua M, and Mungo Wilson, 2008, How does size affect mutual fund behavior?, *The Journal of Finance* 63, 2941–2969.

Pontiff, Jeffrey, and Artemiza Woodgate, 2008, Share issuance and cross-sectional returns, *The Journal of Finance* 63, 921–945.

Porras Prado, Melissa, Pedro AC Saffi, and Jason Sturgess, 2016, Ownership structure, limits to arbitrage, and stock returns: Evidence from equity lending markets, *The Review of Financial Studies* 29, 3211–3244.

Reed, Adam V, 2015, Connecting supply, short-sellers and stock returns: Research challenges, *Journal of Accounting and Economics* 60, 97–103.

Rizova, Savina, 2011, Securities lending by mutual funds, *Available at SSRN 2056651* .

Saffi, Pedro AC, and Kari Sigurdsson, 2011, Price efficiency and short selling, *The Review of Financial Studies* 24, 821–852.

Schultz, Paul, 2021, The response to share mispricing by issuing firms and short sellers, *Journal of Financial and Quantitative Analysis* 1–59.

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

Stambaugh, Robert F, Jianfeng Yu, and Yu Yuan, 2015, Arbitrage asymmetry and the idiosyncratic volatility puzzle, *The Journal of Finance* 70, 1903–1948.

Figure 1: Probability of a stock position lent out by a mutual fund

This figure shows the probability that a mutual fund stock holding is lent out in a given quarter. In addition to the unconditional probability, we also tabulate the lending probability for a position that is (i) held and lent out by the same fund in the previous quarter, (ii) held and not lent out by the same fund in the previous quarter, and (iii) not held by the same fund in the previous quarter.

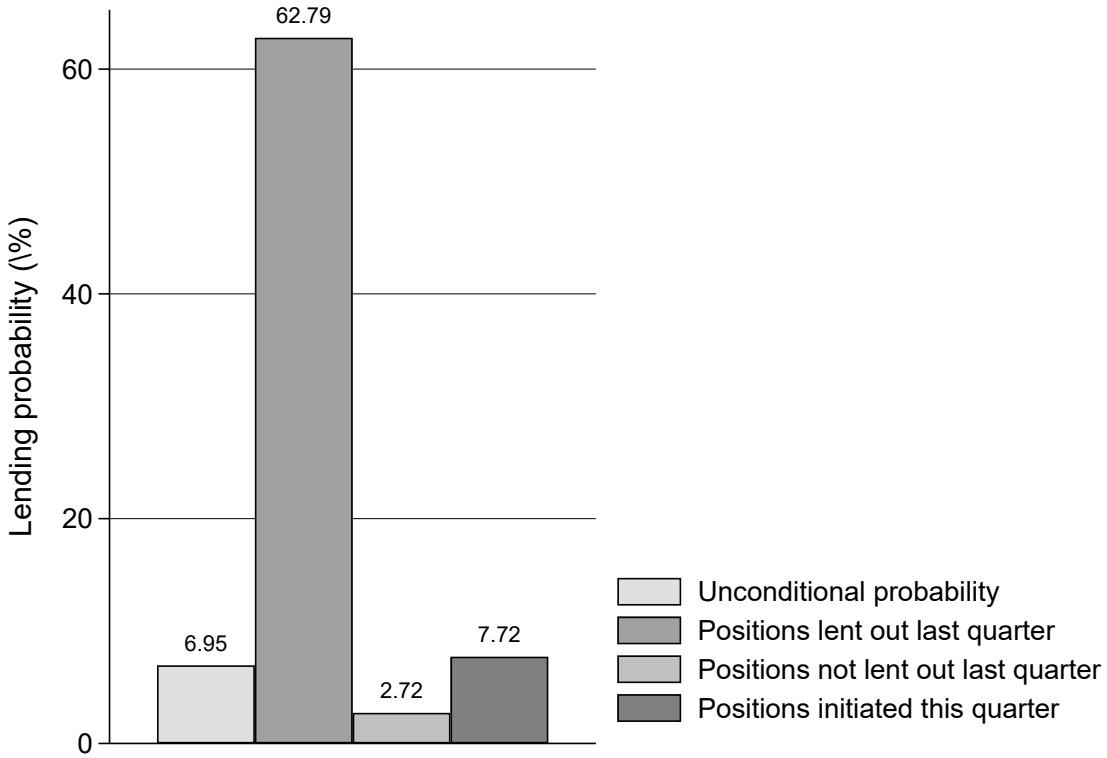
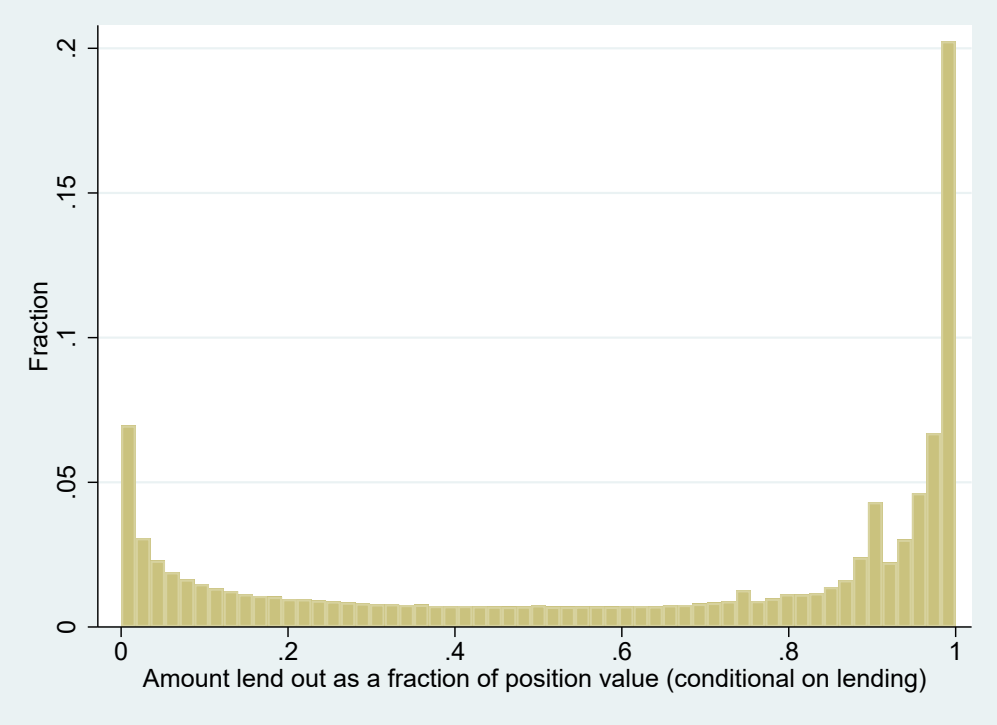
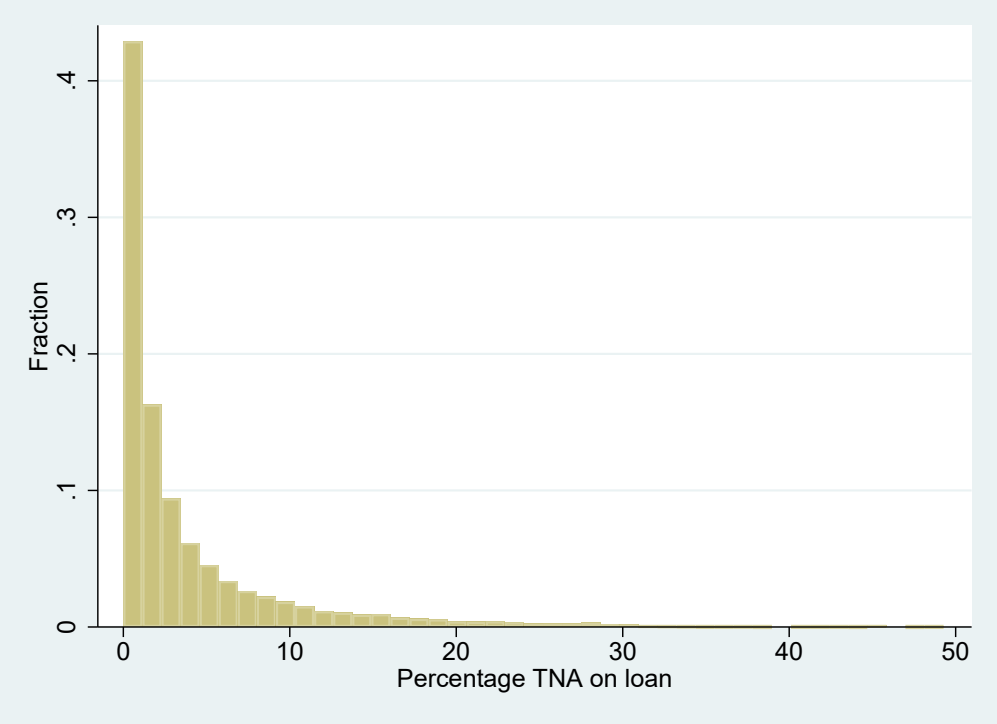


Figure 2: Distribution of mutual fund securities lending (conditional on lending)

These figures show the fractions of assets loaned out conditional on securities lending. Panel (a) shows the fraction of value on loan for a given security holding, conditional on the said security holding loaned out. Panel (b) shows that fraction of TNA on loan for a given fund–quarter, conditional on the fund engages in securities lending.



(a) Fraction of value loaned out for a given stock holding



(b) Fraction of TNA loaned out for a given fund

Figure 3: Shares of securities lending by different set of mutual funds

This figure shows the share of securities lending done by different set of mutual funds relative to the total dollar value of securities lent by all mutual funds. Past lenders refer to mutual funds that lent out the same stock in the previous quarter-end. Non-lenders refer to mutual funds that held the stock last quarter but did not lend out its shares. New investors refer to mutual funds that did not hold shares of the stock last quarter and only purchased the stock this quarter.

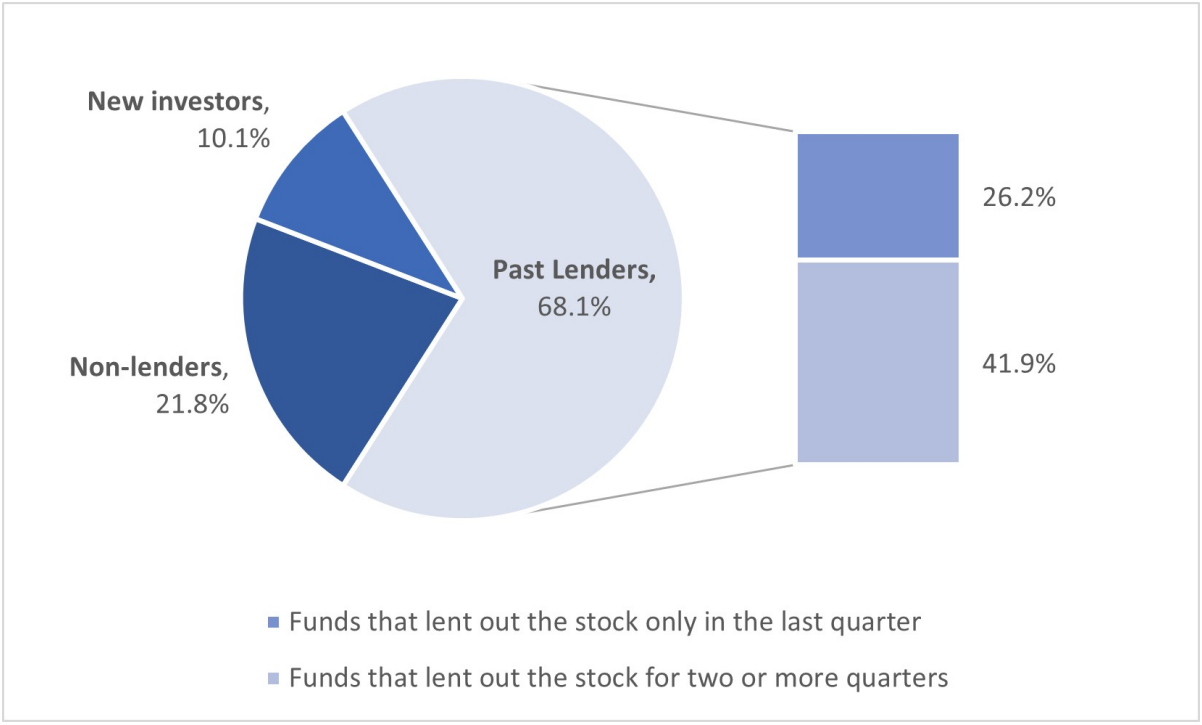


Figure 4: Distribution of *LenderExits* Conditional on Positive Value

This figure shows the distribution of *LenderExits* variable, conditional on $LenderExits > 0$. The variable *LenderExits* is defined as the the number of shares lent out (measured at quarter $t-1$) by mutual funds that exit its position between quarters $t-1$ and t, scaled by the stock's total number of shares on loan in quarter $t-1$.

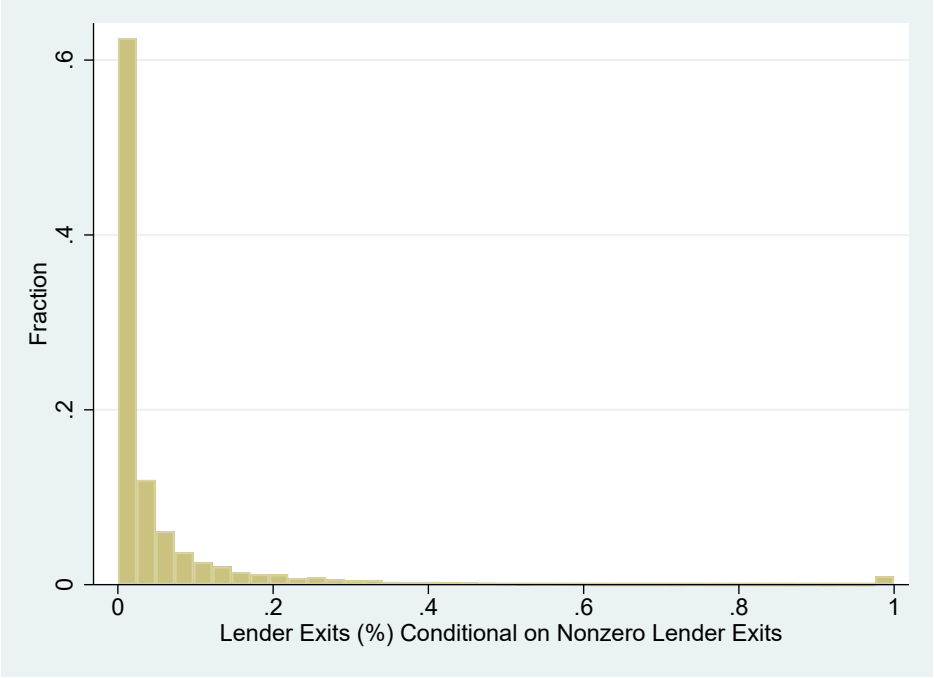


Figure 5: The effect of position exits by existing security lenders on lending fees

This figure shows the dynamic impact on securities lending fee surrounding a significant lender exit events, defined as stock–quarters where a stock's $LenderExits \geq 5\%$. The lending fee is adjusted by the cross-sectional median lending fee. Each point and range represents the β_k estimates and the associated 95% confidence intervals from the following equation:

$$LendingFee_{i,t} = \alpha_i + \sum_{k=-3}^{9} \beta_k \cdot \mathbb{1}^{k \text{ month from lender exit events}} + \epsilon_{i,t},$$

where the standard errors are clustered at the stock level.

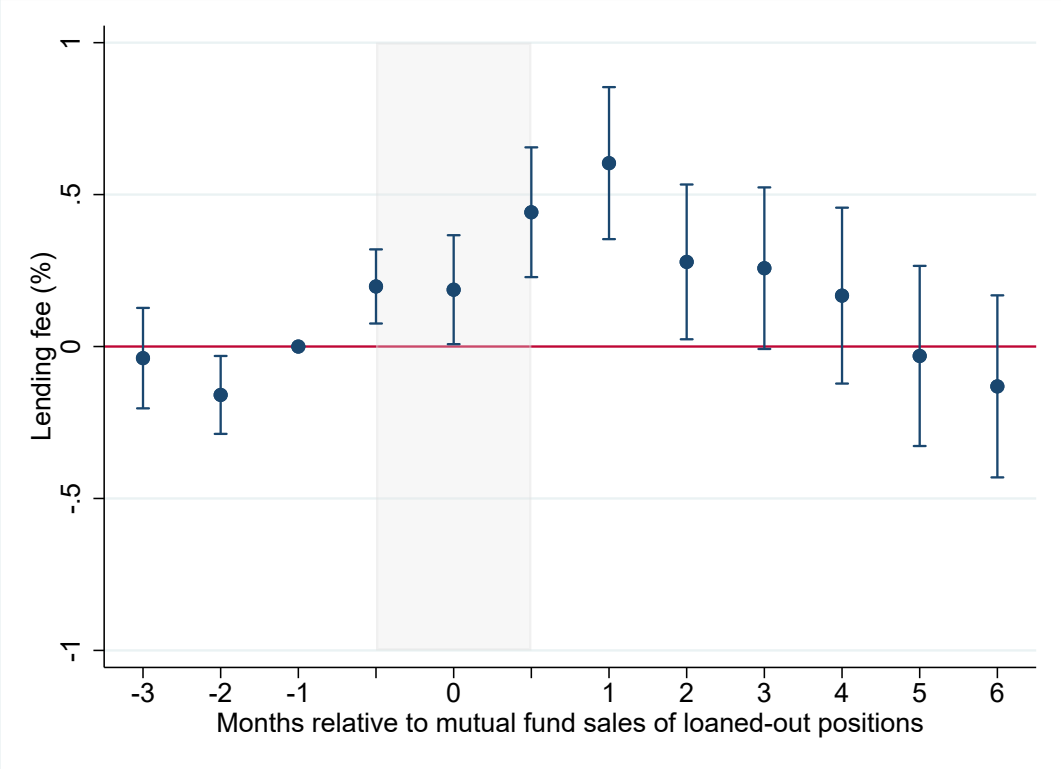


Table I: Sample of funds by year

This table shows the number of sample funds, the number of sample funds with positive securities lending, the percentage of security-lending funds, and the total value of securities on loan in each quarter of our sample.

Quarter	Number of funds	Number of funds with securities on loan	% of funds with securities on loan	Total value ($bil) of securities on loan
2019q3	2,089	883	42.26	68.90
2019q4	3,505	1,654	47.18	114.23
2020q1	3,850	1,737	45.11	101.17
2020q2	3,688	1,584	42.95	106.27
2020q3	3,932	1,693	43.05	93.93
2020q4	3,894	1,670	42.88	96.26
2021q1	4,040	1,647	40.76	98.12
2021q2	4,013	1,712	42.66	109.80
2021q3	4,006	1,724	43.03	110.02
2021q4	3,979	1,704	42.82	105.16
2022q1	4,169	1,752	42.02	114.74
2022q2	4,135	1,741	42.10	107.54

Table II: Summary statistics

This table shows the summary statistics of the dependent variables and independent variables used in the paper.

Panel A: Fund–stock–quarter level variables

	N	Average	Std Dev	P25	Median	P75
Position is on loan this quarter	6,863,417	0.069	0.254	0.000	0.000	0.000
Same fund lent out the stock last quarter	6,863,417	0.057	0.232	0.000	0.000	0.000
Same fund held the stock but not lent last quarter	6,863,417	0.774	0.418	1.000	1.000	1.000
Same fund lent out the stock two quarters ago	6,863,417	0.047	0.211	0.000	0.000	0.000
Stock's weight in fund portfolio (%)	6,863,417	0.429	0.887	0.026	0.107	0.424
Percentage ownership fund holds in the company	6,863,417	0.141	0.467	0.003	0.014	0.070
Stock's style distance to fund average style	6,863,417	2.896	1.360	1.927	2.896	3.698
Past 12-month fund return	6,863,417	0.186	0.197	0.041	0.173	0.331
Ln(Fund TNA)	6,863,417	6.525	2.239	5.221	6.591	8.009
Ln(Fund family TNA)	6,863,417	10.917	3.623	8.275	11.651	13.634
Fund expense ratio	6,863,417	0.006	0.004	0.002	0.006	0.009
Fund portfolio turnover	6,863,417	0.512	0.518	0.180	0.470	0.648
D(Fund is an index fund (non-ETF))	6,863,417	0.278	0.448	0.000	0.000	1.000
D(Fund is an ETF)	6,863,417	0.265	0.441	0.000	0.000	1.000

Panel B: Stock–quarter level variables

	N	Average	Std Dev	P25	Median	P75
Δ Lendable shares	36,045	0.219	3.652	-0.606	0.262	1.363
Δ Utilization ratio	36,045	-0.155	19.195	-1.906	0.000	1.469
Δ Short ratio	36,045	-0.022	1.982	-0.586	-0.011	0.523
Δ DCBS fee score	36,045	-0.010	0.886	0.000	0.000	0.000
Δ Lending fee	36,045	-0.147	3.403	-0.046	-0.001	0.036
$LenderExits$	36,045	0.015	0.068	0.000	0.000	0.002
$LenderExits \geq 5\%$	36,045	0.068	0.252	0.000	0.000	0.000
Fund flows to securities lenders	36,045	-0.001	0.006	-0.003	-0.000	0.000
$NonLenderExits$	36,045	0.057	0.149	0.002	0.014	0.041
Flows to non-lending mutual fund owners	36,045	-0.005	0.036	-0.017	-0.007	0.004
Mutual fund ownership	36,045	0.234	0.162	0.091	0.223	0.361
Ownership by index funds	36,045	0.022	0.016	0.008	0.020	0.035
Ownership by ETFs	36,045	0.103	0.072	0.042	0.093	0.153
Log(Market Cap)	36,045	7.033	2.102	5.495	7.038	8.453
Book-to-market ratio	36,045	0.667	0.706	0.212	0.464	0.880
Gross profitability	36,045	0.187	0.245	0.039	0.172	0.319
Past 6-month return	36,045	0.099	0.446	-0.142	0.073	0.294
Monthly stock turnover	36,045	0.266	0.390	0.093	0.157	0.274
Bid-ask spread	36,045	0.004	0.009	0.000	0.001	0.004

Panel C: Stock–month level variables

	N	Average	Std Dev	P25	Median	P75
MISP DLRZ	76150	5.41	2.80	3	5	8
MISP SYY	76150	5.51	2.87	3	6	8
Delay	106235	0.17	0.20	0.05	0.10	0.21
Volatility	112770	0.04	0.04	0.02	0.03	0.04
Idio Vol	112733	2.76	3.22	1.23	2.02	3.34
MaxRet	112771	0.08	0.14	0.03	0.05	0.09
NFT	134569	0.06	0.20	0.00	0.00	0.03
CEI	132287	0.19	0.77	-0.03	0.00	0.06

Table III: Determinants of position-level securities lending

This table shows the determinants of whether a stock holding is on loan. The observations are at the fund–stock–quarter level. The sample contains all domestic equity funds' stock holdings between 2019Q3 and 2022Q2. In column (4), only stocks with a lending fee greater than 100 basis points are included. In column (5), only stocks with a utilization ratio greater than 50 percent are included. The first three explanatory variables are binary indicators. Standard errors are double-clustered at the stock level and the fund level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Dependent variable: D(Position on loan)					
Sample		Full sample		Fee >100bps	Utilization >50%
	(1)	(2)	(3)	(4)	(5)
Same fund lent out the stock last quarter	0.464***	0.390***	0.394***	0.352***	0.320***
	(0.009)	(0.006)	(0.008)	(0.015)	(0.014)
Same fund held the stock but not lent last quarter	-0.0189***	-0.0223***	-0.0133***	-0.128***	-0.234***
	(0.002)	(0.002)	(0.001)	(0.013)	(0.015)
Same fund lent out the stock two quarters ago		0.171***			
		(0.005)			
Stock's weight in fund portfolio (%)	0.000255	0.000310	0.00128***	0.0113	0.00723
	(0.001)	(0.001)	(0.000)	(0.007)	(0.007)
Percentage ownership fund holds in the company	0.0131**	0.0112**	-0.000251	0.0181**	0.0204***
	(0.006)	(0.006)	(0.002)	(0.007)	(0.008)
Stock's style distance to fund average style	-0.00175***	-0.00157***	-0.000707*	-0.00392	0.000150
	(0.000)	(0.000)	(0.000)	(0.003)	(0.002)
Past 12-month fund return	-0.0818***	-0.0698***		-0.263***	-0.223***
	(0.017)	(0.015)		(0.078)	(0.072)
Ln(Fund TNA)	0.00506***	0.00444***		0.0233***	0.0212***
	(0.001)	(0.001)		(0.006)	(0.005)
Ln(Fund family TNA)	-0.00276***	-0.00254***		-0.00381	-0.00351
	(0.001)	(0.001)		(0.003)	(0.003)
Fund expense ratio	-1.809***	-1.645***		-4.071	-5.700*
	(0.701)	(0.630)		(3.531)	(3.431)
Fund portfolio turnover	-0.00124	-0.000587		0.0151	0.0116
	(0.002)	(0.002)		(0.016)	(0.012)
D(Fund is an index fund (non-ETF))	-0.00653	-0.00663		0.0119	0.0271
	(0.005)	(0.005)		(0.023)	(0.024)
D(Fund is an ETF)	0.0157**	0.0144**		0.0629**	0.0596**
	(0.007)	(0.006)		(0.029)	(0.025)
Observations	6982291	6982291	6982291	281147	167092
Adjusted R^2	0.413	0.426	0.464	0.434	0.411
Stock-by-quarter FE	Y	Y	Y	Y	Y
Fund style-by-quarter FE	Y	Y	NA	Y	Y
Fund-by-quarter FE	N	N	Y	N	N

Table IV: The effect of loan termination on securities lending market

This table estimates the effect of the position exits of a stock's equity lenders on securities lending outcomes. The observations are at the stock–quarter level. The sample period spans 2019Q4 and 2022Q2. The variable $LenderExits \geq 5\%$ is a binary indicator. The variable $LenderExits$ is defined as the the number of shares lent out (measured at quarter $t-1$) by mutual funds that exit its position between quarters $t-1$ and t, scaled by the stock's total number of shares on loan in quarter $t-1$. All outcome variables are measured as changes between quarters $t-1$ and t. Control variables (except $LenderExits$ and $NonLenderExits$) are measured at quarter $t-1$. In column (6), only stock–quarters with lagged utilization ratio below 10% are included. Standard errors are clustered at the stock level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Sample	Full sample					Utilization <10%
Dependent variable Δy	ΔSupply	ΔUtilization	ΔShortRatio	ΔDCBS	ΔFee	ΔFee
	(1)	(2)	(3)	(4)	(5)	(6)
$LenderExits \geq 5\%$	-1.770***	1.684***	-0.190***	0.131***	0.300***	0.133**
	(0.115)	(0.471)	(0.056)	(0.025)	(0.082)	(0.056)
$NonLenderExits$	-6.807***	0.810	0.105	-0.00907	0.550***	0.0227
	(0.343)	(0.979)	(0.100)	(0.057)	(0.199)	(0.111)
Mutual fund ownership	5.392***	-9.847***	-0.462***	-0.133***	-0.120	-0.166***
	(0.474)	(0.966)	(0.113)	(0.034)	(0.105)	(0.045)
Ownership by index funds	-10.93***	-16.20	-0.0368	1.448***	1.803	-1.030
	(3.166)	(10.511)	(1.341)	(0.463)	(1.687)	(0.640)
Ownership by ETFs	7.797***	-9.083***	-0.261	-0.753***	-1.026**	-0.448***
	(0.914)	(2.710)	(0.330)	(0.119)	(0.424)	(0.172)
Log(Market Cap)	0.285***	-1.302***	-0.000390	-0.0375***	-0.0590***	-0.0280***
	(0.017)	(0.073)	(0.005)	(0.003)	(0.011)	(0.006)
Book-to-market ratio	-0.0269	-1.252***	-0.0249	-0.00428	0.0788*	0.0201
	(0.033)	(0.191)	(0.016)	(0.010)	(0.046)	(0.023)
Gross profitability	0.128*	-2.652***	0.0280	-0.0591***	-0.0472	0.0514
	(0.077)	(0.482)	(0.039)	(0.023)	(0.081)	(0.048)
Past 6-month return	0.178***	-3.772***	-0.0868***	-0.197***	-0.519***	-0.0625**
	(0.056)	(0.287)	(0.033)	(0.018)	(0.073)	(0.030)
Monthly stock turnover	0.194***	7.468***	-0.129***	0.185***	0.334***	0.254**
	(0.065)	(0.384)	(0.045)	(0.027)	(0.123)	(0.114)
Bid-ask spread	-22.22***	118.5***	-1.347	6.798***	24.59***	13.74***
	(1.991)	(25.438)	(0.871)	(1.177)	(4.112)	(2.372)
Change in lendable shares		0.0263	0.145***	0.00741***	0.00837	0.00474**
		(0.026)	(0.007)	(0.002)	(0.006)	(0.002)
Observations	36077	36045	36077	36077	36077	21968
Adjusted R^2	0.163	0.177	0.091	0.121	0.221	0.169
Control for lagged y	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y

Table V: Reduced-form effects of fund flows to existing lenders on securities lending market

This table estimates the effect of fund flows to a stock's existing equity lenders on securities lending outcomes. The observations are at the stock–quarter level. The sample period spans 2019Q4 and 2022Q2. The variable $LenderFlow$ is measured as weighted-average quarterly fractional flows to all mutual funds that lent their holdings of stock i, where the weight is each fund's on-loan shares. $NonLenderFlow$ is the weighted-average quarterly flow to all mutual funds that held stock i but did not lend, where the weight is each fund's holdings. All outcome variables are measured as changes between quarters $t-1$ and t. Control variables (except $LenderFlow$ and $NonLenderFlow$) are measured at quarter $t-1$. Standard errors are clustered at the stock level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Dependent variable Δy	ΔSupply	ΔUtilization	ΔShortRatio	ΔDCBS	ΔFee
	(1)	(2)	(3)	(4)	(5)
Fund flows to securities lenders	18.86***	-48.73***	4.219**	-2.749***	-8.311***
	(3.106)	(14.934)	(2.105)	(0.749)	(2.369)
Flows to non-lending mutual fund owners	1.690***	4.292	0.119	-0.0343	-0.296
	(0.537)	(3.081)	(0.353)	(0.148)	(0.596)
Mutual fund ownership	5.590***	-9.908***	-0.283**	-0.139***	-0.202*
	(0.475)	(0.969)	(0.119)	(0.035)	(0.108)
Ownership by index funds	-14.21***	-14.46	-2.979**	1.287***	2.064
	(3.296)	(10.403)	(1.369)	(0.457)	(1.679)
Ownership by ETFs	8.309***	-9.758***	-0.308	-0.744***	-1.184***
	(0.939)	(2.688)	(0.339)	(0.118)	(0.434)
Log(Market Cap)	0.299***	-1.311***	0.0163***	-0.0380***	-0.0606***
	(0.017)	(0.074)	(0.005)	(0.003)	(0.011)
Book-to-market ratio	-0.0662*	-1.260***	-0.0574***	-0.00796	0.0767*
	(0.036)	(0.192)	(0.017)	(0.010)	(0.047)
Gross profitability	0.179**	-2.739***	0.0122	-0.0658***	-0.0588
	(0.081)	(0.480)	(0.041)	(0.022)	(0.081)
Past 6-month return	0.501***	-3.850***	-0.00990	-0.204***	-0.559***
	(0.057)	(0.283)	(0.036)	(0.018)	(0.073)
Monthly stock turnover	-0.268***	7.559***	-0.174***	0.192***	0.397***
	(0.065)	(0.379)	(0.048)	(0.026)	(0.123)
Bid-ask spread	-9.695***	112.7***	-0.526	6.549***	23.40***
	(1.880)	(25.361)	(0.913)	(1.176)	(4.102)
Observations	36332	36299	36332	36332	36332
Adjusted R^2	0.064	0.176	0.020	0.120	0.220
Control for lagged y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y

Table VI: The effect of lender exits on securities lending: Instrumental variable using lender fund flows

This table estimates two-stage-least-squared (2SLS) regressions, where $LenderFlow$ is used as an instrumental variable (IV) for the indicator variable $LenderExits \geq 5\%$. The variable $LenderExits$ is defined as the the number of shares lent out (measured at quarter $t-1$) by mutual funds that exit its position between quarters $t-1$ and t, scaled by the stock's total number of shares on loan in quarter $t-1$. The variable $LenderFlow$ is measured as weighted-average quarterly fractional flows to all mutual funds that lent their holdings of stock i, where the weight is each fund's on-loan shares. All outcome variables are measured as changes between quarters $t-1$ and t. Control variables (except $LenderFlow$, $LenderExits$ and $NonLenderExits$) are measured at quarter $t-1$. Standard errors are clustered at the stock level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Dependent variable Δy	$LenderExits \geq 5\%$	ΔSupply	ΔUtilization	ΔShortRatio	ΔDCBS	ΔFee
	(1)	(2)	(3)	(4)	(5)	(6)
Fund flows to securities lenders	-3.072***					
	(0.303)					
$LenderExits \geq 5\%$		-5.528***	15.85***	-1.244*	1.305***	3.776***
		(1.068)	(5.356)	(0.685)	(0.284)	(0.896)
$NonLenderExits$	0.345***	-5.360***	-5.870***	-0.585**	-0.460***	-0.547
	(0.017)	(0.516)	(2.119)	(0.253)	(0.116)	(0.376)
Mutual fund ownership	0.0212	0.738***	-1.571***	-0.348***	0.0612*	0.131
	(0.016)	(0.215)	(0.588)	(0.117)	(0.034)	(0.120)
Ownership by index funds	0.464**	-18.15***	11.75	-2.545*	-0.336	-5.907***
	(0.217)	(2.773)	(9.457)	(1.408)	(0.522)	(1.910)
Ownership by ETFs	-0.125***	-1.728**	-3.815*	-0.548	0.110	2.737***
	(0.048)	(0.698)	(2.317)	(0.346)	(0.128)	(0.483)
Log(Market Cap)	-0.0131***	0.0216	0.270***	-0.000700	0.0230***	0.134***
	(0.001)	(0.018)	(0.091)	(0.010)	(0.005)	(0.017)
Book-to-market ratio	-0.00506*	-0.202***	0.396***	-0.0551***	0.0549***	0.282***
	(0.003)	(0.032)	(0.130)	(0.017)	(0.009)	(0.040)
Gross profitability	-0.0277***	-0.317***	0.708**	-0.0246	0.0795***	0.407***
	(0.007)	(0.085)	(0.342)	(0.044)	(0.022)	(0.098)
Past 6-month return	-0.0520***	0.00453	-1.258***	-0.0994**	-0.115***	-0.396***
	(0.005)	(0.078)	(0.397)	(0.050)	(0.024)	(0.094)
Monthly stock turnover	0.0463***	0.338***	-1.138***	-0.0688	-0.199***	-1.529***
	(0.005)	(0.088)	(0.390)	(0.057)	(0.027)	(0.122)
Bid-ask spread	-1.770***	-15.26***	10.23	-4.008***	4.847***	15.36***
	(0.178)	(2.615)	(25.431)	(1.491)	(1.154)	(4.155)
Observations	36077	36077	36045	36077	36077	36077
Adjusted R^2	0.094	0.048	-0.021	0.018	-0.059	0.004
Control for lagged y	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y
Kleibergen-Paap Wald F statistic	102.8					

Table VII: Lender exits and stock returns

This table estimates the effect of the position exits of a stock's equity lenders on stock returns. The observations are at the stock–month level. The sample period spans 2019Q4 and 2022Q2. The variable $LenderExits \geq 5\%$ is a binary indicator. The variable $LenderExits$ for each month t is defined as the the number of shares lent out (measured at the last quarter) by mutual funds that exit its position between the current quarter and the last quarter, scaled by the stock's total number of shares on loan at the end of last quarter. Control variables are measured at the same month as $LenderExits$. Standard errors are double-clustered at the stock and the month level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Cumulative return over months:	$Ret_{t-2,t}$	$Ret_{t+1,t+3}$	$Ret_{t+4,t+6}$	$Ret_{t+7,t+12}$	$Ret_{t+13,t+18}$
	(1)	(2)	(3)	(4)	(5)
LenderExits $\geq 5\%$	0.0170**	0.0421**	0.0206	-0.0154	-0.0441***
	(0.007)	(0.017)	(0.024)	(0.023)	(0.014)
ΔMutual Fund Holdings	0.00783	-0.0248*	-0.0658***	-0.127***	-0.119***
	(0.009)	(0.013)	(0.013)	(0.023)	(0.019)
ΔLendable shares	-0.0225	-0.0722*	-0.0400	-0.0951	-0.0194
	(0.028)	(0.037)	(0.038)	(0.062)	(0.016)
Log(Market Cap)	-0.00189	-0.0110**	-0.00530	0.00320	0.0261***
	(0.002)	(0.005)	(0.005)	(0.008)	(0.003)
Book-to-market ratio	0.00508*	0.000417	0.00837	0.0373**	0.0414***
	(0.003)	(0.005)	(0.005)	(0.013)	(0.009)
Past 6-month return	0.0274***	-0.00414*	-0.00485	-0.0207***	-0.0127**
	(0.007)	(0.002)	(0.004)	(0.004)	(0.006)
Observations	64,776	64,776	64,776	64,776	64,776
Adjusted R2	0.198	0.191	0.174	0.316	0.126
Time FE	Y	Y	Y	Y	Y

Table VIII: Lender exits and stock mispricing

This table estimates the effect of the position exits of a stock's equity lenders on stock mispricing scores. The mispricing score is a decile ranking that ranges between 1 and 10 with 10 being most likely overpriced and 1 being least likely overpriced. MISP DLRZ is a mispricing score based on the 100 anomalies in Dong et al. (2022). MISP SYY is a mispricing score based on the 11 anomalies in Stambaugh et al. (2012). The observations are at the stock–month level. The sample period spans 2019Q4 and 2022Q2. The variable $LenderExits \geq 5\%$ is a binary indicator. The variable $LenderExits$ for each month t is defined as the the number of shares lent out (measured at the last quarter) by mutual funds that exit its position between the current quarter and the last quarter, scaled by the stock's total number of shares on loan at the end of last quarter. Control variables are measured at the same month as $LenderExits$. Standard errors are double-clustered at the stock and the month level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

	MISP DLRZ$_t$	MISP DLRZ$_{t+1,t+6}$	MISP SYY$_t$	MISP SYY$_{t+1,t+6}$
	(1)	(2)	(3)	(4)
LenderExits $\geq$ 5%	1.82***	1.85***	1.01***	1.12***
	(0.115)	(0.106)	(0.113)	(0.128)
Δ Mutual Fund Holdings	2.28***	2.38***	1.83***	2.34***
	(0.151)	(0.181)	(0.150)	(0.175)
ΔLendable shares	1.24*	0.49*	1.58***	0.46
	(0.649)	(0.271)	(0.541)	(0.308)
Log (Market Cap)	-0.0060	0.0048	-0.44***	-0.41***
	(0.025)	(0.026)	(0.025)	(0.027)
Book-to-market ratio	-0.73***	-0.64***	-0.45***	-0.44***
	(0.104)	(0.098)	(0.079)	(0.081)
Past 6-month return	0.21**	0.30***	0.00089	0.16***
	(0.087)	(0.056)	(0.065)	(0.037)
Observations	61,628	43,499	61,465	43,499
Adjusted R2	0.09	0.09	0.12	0.13
Time FE	Y	Y	Y	Y

Table IX: Lender exits and other stock price efficiency measures

This table estimates the effect of the position exits of a stock's equity lenders on stock efficiency measures. *Delay* is the inverse of price efficiency measure *Delay*3 in Hou and Moskowitz (2005). Return volatility measures ($Volatility$ and $IdioVol$) are computed using daily returns following Ang et al. (2006). The extreme positive return measure ($MaxRet$) is computed as the maximum daily return during a month following Bali, Cakici, and Whitelaw (2011). All price efficiency measures are standardized. The observations are at the stock–month level. The sample period spans 2019Q4 and 2022Q2. The variable $LenderExits \geq 5\%$ is a binary indicator. The variable $LenderExits$ for each month t is defined as the the number of shares lent out (measured at the last quarter) by mutual funds that exit its position between the current quarter and the last quarter, scaled by the stock's total number of shares on loan at the end of last quarter. Control variables are measured at the same month as $LenderExits$. Standard errors are double-clustered at the stock and the month level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

	Delay_t	$\text{Delay}_{t+1,t+6}$	$RetVol_t$	$RetVol_{t+1,t+6}$	$IdioVol_t$	$IdioVol_{t+1,t+6}$	$MaxRet_t$	$MaxRet_{t+1,t+6}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LenderExits $\geq 5\%$	0.15***	0.13***	0.36***	0.33***	0.36***	0.31***	0.28***	0.24***
	(0.033)	(0.034)	(0.047)	(0.027)	(0.045)	(0.026)	(0.048)	(0.028)
ΔMutual Fund Holdings	0.36***	0.37***	0.25***	0.25***	0.28***	0.26***	0.16***	0.15***
	(0.044)	(0.058)	(0.058)	(0.050)	(0.054)	(0.046)	(0.052)	(0.042)
ΔLendable shares	0.065	0.050	-0.027	-0.10	-0.020	-0.12	-0.100	-0.15
	(0.041)	(0.048)	(0.134)	(0.074)	(0.137)	(0.084)	(0.157)	(0.093)
Log (Market Cap)	-0.16***	-0.16***	-0.17***	-0.22***	-0.20***	-0.25***	-0.15***	-0.21***
	(0.008)	(0.009)	(0.008)	(0.011)	(0.011)	(0.013)	(0.009)	(0.012)
Book-to-market ratio	-0.038**	-0.018	-0.044**	-0.048**	-0.059***	-0.066***	-0.038**	-0.048**
	(0.014)	(0.016)	(0.017)	(0.018)	(0.017)	(0.017)	(0.015)	(0.017)
Past 6-month return	0.086***	0.096**	0.32***	0.14***	0.34***	0.13***	0.35***	0.096***
	(0.030)	(0.039)	(0.032)	(0.019)	(0.027)	(0.021)	(0.031)	(0.017)
Observations	88,658	64,140	91,126	64,994	91,119	64,987	91,126	64,994
Adjusted R2	0.146	0.146	0.387	0.396	0.347	0.395	0.253	0.298
Time FE	Y	Y	Y	Y	Y	Y	Y	Y

Table X: Lender exits, firm stock issuance, and insider sales

This table estimates the effect of the position exits of a stock's equity lenders on firm and insider trading. The first measure is used in Da et al. (2022), Net Firm Trading (NFT), computed as the change in the split-adjusted shares outstanding over a month relative to its past 12-month average, scaled by the 12-month average. The second measure is based on Daniel and Titman (2006), composite equity issuance (CEI), defined as the amount of equity a firm issues (or retires) in exchange for cash or services (i.e., percentage change in market equity value minus the return over the same period). The third measure is Net Insider Sale (NIS) used in Da et al. (2022), computed as the negative change in the insider holdings over a month relative to insiders' past 12-month average holdings, scaled by the 12-month average. All firm and insider trading measures are standardized. The observations are at the stock–month level. The sample period spans 2019Q4 and 2022Q2. The variable $LenderExits \geq 5\%$ is a binary indicator. The variable $LenderExits$ for each month t is defined as the the number of shares lent out (measured at the last quarter) by mutual funds that exit its position between the current quarter and the last quarter, scaled by the stock's total number of shares on loan at the end of last quarter. Control variables are measured at the same month as $LenderExits$. Standard errors are double-clustered at the stock and the month level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

	Firm Issuance				Insider Sales	
	NFT_t	$NFT_{t+1,t+6}$	CEI_t	$CEI_{t+1,t+6}$	NIS_t	$NIS_{t+1,t+6}$
	(1)	(2)	(3)	(4)	(5)	(6)
LenderExits $\geq 5\%$	0.26***	0.21***	0.26***	0.21***	0.13***	0.13***
	(0.037)	(0.037)	(0.044)	(0.039)	(0.040)	(0.035)
ΔMutual Fund Holdings	0.99***	0.64***	1.02***	0.88***	0.21***	0.20***
	(0.091)	(0.075)	(0.127)	(0.099)	(0.038)	(0.039)
ΔLendable shares	0.0083	-0.20	0.24	0.21	0.25*	0.48**
	(0.055)	(0.126)	(0.144)	(0.126)	(0.126)	(0.210)
Log(Market Cap)	-0.10***	-0.13***	-0.073***	-0.097***	0.032***	0.020***
	(0.007)	(0.009)	(0.006)	(0.009)	(0.006)	(0.006)
Book-to-market ratio	-0.073***	-0.082***	-0.070***	-0.065***	-0.085***	-0.092***
	(0.021)	(0.023)	(0.022)	(0.022)	(0.020)	(0.022)
Past 6-month return	0.031***	0.021***	0.22***	0.16***	0.055***	0.068***
	(0.010)	(0.007)	(0.024)	(0.020)	(0.015)	(0.016)
Observations	89,661	87,143	89,658	87,098	85,010	83,471
Adjusted R2	0.158	0.138	0.207	0.179	0.033	0.031
Time FE	Y	Y	Y	Y	Y	Y

Table XI: Monthly portfolio returns conditioning on lender concentration

This table presents monthly returns, alphas, and lagged short ratios for portfolios calculated over the period April 2006 through December 2022. The portfolios are formed by first sorting into quintiles using the previous month's average daily short ratio and then sorting into terciles using the previous three months' average lender concentration (Markit's *LenderConcentration*). All portfolios are equal weighted and are held for one month. The last column in each panel (High - Low) shows differences between the high-concentration portfolio and the low-concentration portfolio. Panel A presents results using raw returns of portfolios. Panel B presents results using Fama-French four-factor alphas that account for market, size, value, and momentum factors. *t*-statistics are shown in parentheses.

Panel A: Monthly portfolio returns (%)

	Low Lender Concentration	Mid Lender Concentration	High Lender Concentration	High - Low
Short Interest:				
1 (Low)	0.88	0.78	0.54	-0.34
	(2.71)	(2.57)	(2.16)	(-1.93)
2	0.82	0.82	0.49	-0.33
	(2.29)	(2.12)	(1.27)	(-2.14)
3	0.78	0.78	0.49	-0.30
	(2.05)	(1.90)	(1.20)	(-2.29)
4	0.59	0.58	0.28	-0.31
	(1.46)	(1.33)	(0.62)	(-2.67)
5 (High)	0.35	0.39	0.42	0.07
	(0.70)	(0.81)	(0.84)	(0.53)

Panel B: Monthly portfolio Fama-French 4-factor alphas (%)

	Low Lender Concentration	Mid Lender Concentration	High Lender Concentration	High - Low
Short Interest:				
1 (Low)	0.29	0.33	0.20	-0.09
	(2.80)	(2.46)	(1.33)	(-0.65)
2	0.12	0.16	-0.13	-0.25
	(1.56)	(1.57)	(-0.82)	(-1.69)
3	0.06	0.09	-0.17	-0.24
	(0.98)	(1.19)	(-1.63)	(-2.01)
4	-0.15	-0.16	-0.46	-0.31
	(-2.07)	(-2.19)	(-4.65)	(-3.14)
5 (High)	-0.47	-0.39	-0.37	0.10
	(-3.09)	(-3.66)	(-2.94)	(0.74)

Appendix

Table A1: Determinants of position-level securities lending

This table shows the determinants of the fraction of a mutual fund's stock holding that is on loan. If a position is not on loan, the dependent variable is set to zero. The observations are at the fund–stock–quarter level. The sample contains all domestic equity funds' stock holdings between 2019Q3 and 2022Q2. In column (4), only stocks with a lending fee greater than 100 basis points are included. In column (5), only stocks with a utilization ratio greater than 50 percent are included. The first three explanatory variables are binary indicators. Standard errors are double-clustered at the stock level and the fund level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Dependent variable: Fraction of position value on loan					
Sample		Full sample		Fee >100bps	Utilization >50%
	(1)	(2)	(3)	(4)	(5)
Same fund lent out the stock last quarter	0.268***	0.230***	0.238***	0.250***	0.260***
	(0.007)	(0.006)	(0.006)	(0.013)	(0.012)
Same fund held the stock but not lent last quarter	-0.0110***	-0.0127***	-0.00930***	-0.0991***	-0.195***
	(0.001)	(0.001)	(0.001)	(0.012)	(0.013)
Same fund lent out the stock two quarters ago		0.0876***			
		(0.004)			
Stock's weight in fund portfolio (%)	0.000239	0.000267	0.00131***	0.00882	0.00551
	(0.001)	(0.001)	(0.000)	(0.006)	(0.007)
Percentage ownership fund holds in the company	-0.0148***	-0.0158***	-0.0116***	-0.0250***	-0.0264***
	(0.002)	(0.002)	(0.002)	(0.005)	(0.006)
Stock's style distance to fund average style	-0.000137	-0.0000469	-0.000322	0.000744	-0.00100
	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)
Past 12-month fund return	-0.0225**	-0.0163**		-0.197***	-0.169***
	(0.009)	(0.008)		(0.065)	(0.064)
Ln(Fund TNA)	0.00161**	0.00130**		0.0136***	0.0136***
	(0.001)	(0.001)		(0.005)	(0.004)
Ln(Fund family TNA)	-0.00180***	-0.00169***		-0.00466	-0.00520*
	(0.000)	(0.000)		(0.003)	(0.003)
Fund expense ratio	-0.924*	-0.840*		-4.061	-5.883*
	(0.496)	(0.464)		(2.933)	(3.038)
Fund portfolio turnover	-0.000882	-0.000548		0.00528	0.00356
	(0.002)	(0.002)		(0.014)	(0.012)
D(Fund is an index fund (non-ETF))	-0.000154	-0.000208		0.0205	0.0238
	(0.004)	(0.004)		(0.020)	(0.022)
D(Fund is an ETF)	0.00248	0.00182		-0.00700	-0.0157
	(0.004)	(0.004)		(0.022)	(0.023)
Observations	6982134	6982134	6982134	281132	167087
Adjusted R^2	0.385	0.392	0.421	0.423	0.383
Stock-by-quarter FE	Y	Y	Y	Y	Y
Fund style-by-quarter FE	Y	Y	NA	Y	Y
Fund-by-quarter FE	N	N	Y	N	N

Table A2: The effect of loan termination on securities lending market: continuous *LenderExits*

This table estimates the effect of the position exits of equity lenders on securities lending outcomes. The observations are at the stock–quarter level. The sample period spans 2019Q4 and 2022Q2. The variable *LenderExits* is defined as the the number of shares lent out (measured at quarter $t-1$) by mutual funds that exit its position between quarters $t-1$ and t, scaled by the stock's total number of shares on loan in quarter $t-1$. All outcome variables, *LenderExits*, and *NonLenderExits* are measured at quarter t. Other control variables are measured at quarter $t-1$. In column (6), only stock–quarters with lagged utilization ratio below 10% are included. Standard errors are clustered at the stock level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Panel A: *LenderExits* scaled by lagged total shares on loan

Dependent variable Δy	ΔSupply	ΔUtilization	ΔShortRatio	ΔDCBS	ΔFee
	(1)	(2)	(3)	(4)	(5)
LenderExits	-5.242***	0.980	-0.387**	0.247**	0.745**
	(0.520)	(2.403)	(0.184)	(0.117)	(0.340)
NonLenderExits	-6.878***	1.208	0.0850	0.00661	0.569***
	(0.346)	(0.976)	(0.101)	(0.057)	(0.200)
Mutual fund ownership	5.325***	-9.780***	-0.468***	-0.131***	-0.113
	(0.473)	(0.966)	(0.114)	(0.034)	(0.104)
Ownership by index funds	-10.41***	-15.82	-0.00632	1.436***	1.730
	(3.177)	(10.515)	(1.343)	(0.462)	(1.690)
Ownership by ETFs	7.708***	-9.281***	-0.254	-0.761***	-1.033**
	(0.914)	(2.714)	(0.331)	(0.119)	(0.425)
Log(Market Cap)	0.290***	-1.319***	0.000806	-0.0386***	-0.0607***
	(0.017)	(0.074)	(0.005)	(0.003)	(0.011)
Book-to-market ratio	-0.0198	-1.258***	-0.0240	-0.00512	0.0770*
	(0.033)	(0.192)	(0.016)	(0.010)	(0.046)
Gross profitability	0.146*	-2.688***	0.0311	-0.0617***	-0.0519
	(0.076)	(0.482)	(0.039)	(0.023)	(0.081)
Past 6-month return	0.222***	-3.845***	-0.0808**	-0.202***	-0.527***
	(0.056)	(0.288)	(0.033)	(0.018)	(0.073)
Monthly stock turnover	0.156**	7.526***	-0.135***	0.190***	0.344***
	(0.065)	(0.385)	(0.045)	(0.027)	(0.122)
Bid-ask spread	-20.36***	115.5***	-1.107	6.639***	24.27***
	(2.014)	(25.427)	(0.873)	(1.177)	(4.107)
Change in lendable shares		0.0149	0.146***	0.00682***	0.00730
		(0.027)	(0.007)	(0.002)	(0.006)
Observations	36077	36045	36077	36077	36077
Adjusted R^2	0.158	0.176	0.091	0.120	0.221
Control for lagged y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y

Table A2: The effect of loan termination on securities lending market: continuous *LenderExits* (continued)

Panel B: *LenderExits* scaled by lagged total shares outstanding

Dependent variable	ΔSupply (1)	ΔUtilization (2)	ΔShortRatio (3)	ΔDCBS (4)	ΔFee (5)
LenderExits (scaled by shares outstanding)	-0.230***	-0.140	-0.164**	0.0244***	0.121***
	(0.087)	(0.123)	(0.075)	(0.008)	(0.033)
NonLenderExits	-7.257***	-0.00626	0.0627	0.0234	0.775
	(0.342)	(1.054)	(0.101)	(0.058)	(0.533)
Mutual fund ownership	0.595***	-3.323***	-0.450***	0.0958***	0.231
	(0.208)	(0.511)	(0.114)	(0.027)	(0.288)
Ownership by index funds	-21.14***	-3.313	-0.288	0.428	-3.844
	(2.627)	(8.458)	(1.340)	(0.453)	(5.070)
Ownership by ETFs	-0.877	-2.157	-0.199	-0.0811	2.166*
	(0.679)	(2.035)	(0.331)	(0.110)	(1.132)
Log(Market Cap)	0.0977***	-0.121**	0.00272	0.00469*	0.0815***
	(0.009)	(0.054)	(0.005)	(0.003)	(0.022)
Book-to-market ratio	-0.184***	-0.0942	-0.0255	0.0511***	0.270***
	(0.030)	(0.125)	(0.016)	(0.009)	(0.057)
Gross profitability	-0.169**	-0.509*	0.0365	0.0459**	0.308
	(0.072)	(0.304)	(0.039)	(0.019)	(0.174)
Past 6-month return	0.293***	-2.525***	-0.0774**	-0.185***	-0.594***
	(0.058)	(0.283)	(0.033)	(0.018)	(0.170)
Monthly stock turnover	0.105	1.963***	-0.126***	-0.143***	-1.368***
	(0.068)	(0.329)	(0.045)	(0.024)	(0.294)
Bid-ask spread	-5.285***	-48.16**	-0.858	2.543**	8.592
	(1.704)	(23.442)	(0.877)	(1.030)	(6.583)
Change in lendable shares		-0.0753***	0.146***	0.00442***	0.00306
		(0.029)	(0.007)	(0.002)	(0.009)
Observations	36077	36045	36077	36077	36077
Adjusted R^2	0.105	0.024	0.092	0.030	0.050
Time FE	Y	Y	Y	Y	Y

Table A3: The effect of lender exits on securities lending market: Instrumented by lender fund flows

This table estimates two-stage-least-squared (2SLS) regressions, where $LenderFlow$ is used as an instrumental variable (IV) for the continuous variable $LenderExits$. The variable $LenderExits$ is defined as the the number of shares lent out (measured at quarter $t-1$) by mutual funds that exit its position between quarters $t-1$ and t, scaled by the stock's total number of shares on loan in quarter $t-1$. The variable $LenderFlow$ is measured as weighted-average quarterly fractional flows to all mutual funds that lent their holdings of stock i, where the weight is each fund's on-loan shares. All outcome variables are measured as changes between quarters $t-1$ and t. Control variables (except $LenderFlow$, $LenderExits$ and $NonLenderExits$) are measured at quarter $t-1$. Standard errors are clustered at the stock level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Dependent variable	$LenderExits$	ΔSupply	ΔUtilization	ΔShortRatio	ΔDCBS	ΔFee
	(1)	(2)	(3)	(4)	(5)	(6)
Fund flows to securities lenders	-3.072***					
	(0.303)					
$LenderExits \geq 5\%$		-5.097***	16.09***	-1.222*	0.972***	2.665***
		(0.994)	(5.044)	(0.680)	(0.263)	(0.813)
$NonLenderExits$	0.345***	-5.652***	-4.354**	-0.591**	-0.355***	-0.330
	(0.017)	(0.496)	(1.976)	(0.251)	(0.108)	(0.337)
Mutual fund ownership	0.0212	5.808***	-10.28***	-0.338***	-0.151***	-0.195*
	(0.016)	(0.500)	(1.001)	(0.118)	(0.038)	(0.116)
Ownership by index funds	0.464**	-8.519***	-23.85**	-2.510*	0.804	0.236
	(0.217)	(3.268)	(11.168)	(1.408)	(0.518)	(1.759)
Ownership by ETFs	-0.125***	7.619***	-7.219**	-0.571	-0.592***	-0.565
	(0.048)	(0.931)	(2.875)	(0.347)	(0.133)	(0.453)
Log(Market Cap)	-0.0131***	0.250***	-1.118***	-0.000566	-0.0233***	-0.0221
	(0.001)	(0.020)	(0.099)	(0.010)	(0.005)	(0.017)
Book-to-market ratio	-0.00506*	-0.0286	-1.219***	-0.0547***	-0.000320	0.0903*
	(0.003)	(0.034)	(0.192)	(0.017)	(0.010)	(0.046)
Gross profitability	-0.0277***	0.0672	-2.305***	-0.0230	-0.0345	0.0203
	(0.007)	(0.085)	(0.516)	(0.044)	(0.025)	(0.086)
Past 6-month return	-0.0520***	-0.00372	-3.034***	-0.0993**	-0.150***	-0.392***
	(0.005)	(0.074)	(0.389)	(0.050)	(0.023)	(0.087)
Monthly stock turnover	0.0463***	0.344***	6.887***	-0.0702	0.133***	0.185
	(0.005)	(0.081)	(0.441)	(0.056)	(0.031)	(0.130)
Bid-ask spread	-1.770***	-28.67***	145.4***	-3.946***	8.058***	28.30***
	(0.178)	(2.872)	(27.403)	(1.481)	(1.237)	(4.356)
Observations	36077	36077	36045	36077	36077	36077
Adjusted R^2	0.094	0.116	0.144	0.018	0.068	0.193
Time FE	Y	Y	Y	Y	Y	Y