Ownership Structure, Limits to Arbitrage, and Stock Returns: Evidence from Equity Lending Markets *

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Abstract

We examine how institutional ownership structure gives rise to limits to arbitrage through its impact on short-sale constraints. Stocks with lower, more concentrated, short-term, and less passive ownership exhibit lower lending supply, higher costs of shorting, and higher arbitrage risk. These constraints limit the ability of arbitrageurs to take short positions and delay the correction of mispricing. Stocks with more concentrated ownership exhibit smaller announcement day reactions, larger post-earnings announcement drift, and an additional negative abnormal return of -0.47% in the week following a positive shorting demand shock. (G10, G12, G14)

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Introduction

Arbitrageurs often use short selling as part of their trading strategy, borrowing securities they do not own to correct overvaluation. Short-sale constraints, such as the inability to locate shares to borrow, loan fees, and the risk that a lender recalls borrowed shares, increase limits to arbitrage by reducing investors' ability to sell stocks they do not own. Miller (1977) and Hong and Stein (2003) show that stock prices are higher in the presence of short-sale constraints because prices do not reflect bearish opinions; Diamond and Verrecchia (1987) argue that short-sale restrictions affect the speed of adjustment to new information; and Shleifer and Vishny (1997) show that limits to arbitrage, such as short-selling costs, hinder arbitrage activity and lead to mispricing and anomalies. However, much less is known about the sources of these constraints. In this paper, we examine how ownership composition affects short-sale constraints and gives rise to limits to arbitrage through its impact on the equity lending market.

Ownership typically comprises a diverse set of investors who have heterogeneous preferences about security lending based on their own investment philosophy. While institutional investors often lend shares for a fee to generate income, the decision on whether to lend is not inconsequential for them. In particular, investors might be concerned that lending their stock may lead to a decline in stock price and thus the value of their stake. Such a decline in the stock price can have real effects. Bakke and Whited (2010), Chen et al. (2010), and Edmans et al. (2012) find that stock prices feed back into management decisions about investment and takeovers, and Goldstein and Guembel (2008) show that a speculator may manipulate prices by short selling with the objective of distorting investment. Where short sellers reduce the price, the decline may influence firms' investment decisions and make creditors or counterparties lose confidence in the firm. This initial decline in stock price, even if speculative or uninformed, may become self-fulfilling, and, as a result, can affect prices permanently.[1]

[1]There is anecdotal evidence that institutions make lending decisions in active fund portfolios based on potential price and real effects, even when they actively lend stock from their passive fund portfolios. Fidelity is active in lending

Another drawback of equity lending is that lending stock to a third party might limit the lender's ability to govern management through the proxy voting process (otherwise known as "voice"). Aggarwal et al. (2015) show that owners restrict lending supply to exercise voting rights. Furthermore, investment philosophy, time horizon, fiduciary responsibility, and the ability or incentives to monitor management should affect the decision to provide governance rather than to lend (Maug 1998; Kahn and Winton 1998; Edmans 2009).[2] Investors may trade off the income from lending with the potential risks of losing monitoring control through transferring shares to the equity lending market.[3] Thus, investors with larger stakes may prefer to withhold their shares from the equity lending market due to their greater ability to influence prices and/or management, in the hope that the value of their holdings is lowered by short selling.

The decision to lend stock is also likely influenced by investment philosophy. Evans et al. (2014) find that passive institutional investors, such as index funds, are more likely to lend securities. Lending fees increase fund returns, but index fund managers face no adverse impact in performance from providing lending supply, because of the lack of managerial discretion over the fund's asset allocation. However, active managers should prefer to retain stocks that matter to their trading strategy because making them available for lending might lead to lower stock prices and fund value. Similarly, the investment horizon might affect equity lending. Prior work shows that investors' investment horizon influences corporate investment, proxy fights, going-private transactions, and self-tender offers (Gaspar et al. 2005; Chen et al. 2007). Those with a shorter horizon

securities both from their index funds and clients' holdings through their brokerage, Fidelity Prime Services. However, in describing Fidelity's lending practice for their actively managed funds, Chief Investment Officer Dominic Rossi told a U.K. government select committee in 2013, "The idea that we would lend the stock that we obviously like, otherwise we would not own it, to someone who is then going to short it does not really make much sense. It is not in the interests of our clients to have to foster that short selling, nor is it in the interests of the company in which we invest."("Fidelity eyes stock loans exit", www.ft.com/intl/cms/s/0/487527f2-9de7-11e2-9ccc-00144feabdc0.html#axzz3UgTHruB9, accessed March 17, 2015.)

[2]The threat of share lending might provide governance in a manner similar to exit, whereby an investor threatens to sell stock (and provide downward price pressure) if the manager underperforms (see, Admati and Pfleiderer 2009; Edmans 2009; Edmans and Manso 2011). However, unlike selling stock, lending stock allows the investor to participate in the upside should the manager improve performance.

[3]This trade-off has been recognized by BlackRock, which offers investors both regular funds, in which stock can be lent, and nonlendable funds, in which stock cannot be lent.

are more likely to trade on short-term signals and consequently should prefer not to lend while holding a long position.

In summary, we hypothesize that investors, such as blockholders, active investors, or those with short-term horizons, might withhold stock from the equity lending market because of concerns that short selling may lead to a decline in price, have negative feedback effects on corporate policies, and may lead to an increase in the risk of losing monitoring control. Consequently, stocks with ownership tilted towards larger holdings, investors with short-term horizons, or active investors should exhibit lower lending supply and greater short-sale constraints.

To understand the impact of ownership composition on short selling, we examine the type of institutional investor and the degree to which the investor's actions might influence the stock price. For each of the 4,487 U.S. stocks in our sample, we compute total institutional ownership, ownership concentration, the proportion of short-term investors, and portfolio concentration using institutional investment management ownership data from the Thomson Reuters CDA/Spectrum S34 database from SEC's 13F filings. We identify passive ownership by matching SEC N-SAR filings on fund operations to the Thomson Reuters CDA/Spectrum S12 database of mutual fund holdings. To examine how these ownership composition measures affect lending supply and limits to arbitrage, we use a proprietary dataset on equity lending.

We start by examining how ownership concentration affects short-sale constraints. Consistent with the hypothesis that investors with larger holdings prefer not to lend stock, we find that stocks with more concentrated institutional ownership are associated with lower lending supply, greater borrowing costs, and greater arbitrage risk.[4] Next, we examine how the preference to lend stock varies with the investment horizon of the five largest institutional holdings in a stock. We find that stocks with larger holdings by short-term investors also exhibit higher limits to arbitrage. Finally, we find that stocks with lower levels of passive ownership or higher levels of active ownership,

[4]We use the term "lending supply" to refer to the "potential supply" since most of these shares are not actually lent and hence not actually supplied.

identified as investors who allocate relatively larger portfolio weightings to the stock, exhibit lower supply, higher loan fees, and higher limits to arbitrage in the cross-section of stocks.

One concern in interpreting our analysis is that stocks with different ownership composition might differ along some unobserved dimensions endogenously related to limits to arbitrage. To ensure our results are not driven by such a bias, we employ propensity score-matched sample analysis, and find similar results. A second concern is reverse causality. To mitigate this concern we examine SEC 13D filings and show that the announcement of higher ownership by activist shareholders with large holdings leads to a lower supply and higher limits to arbitrage. Finally, evidence from dual-class listings provide further support for our results. While dual-class shares have identical cash-flow rights, the class with the greater voting rights typically has more concentrated ownership (e.g., Facebook). We exploit this difference to show that greater concentration of ownership is associated with lower lending supply and greater short-sale constraints within the same firm at the same time.

To investigate the consequences of the short-sale constraints we document on stock prices, we examine whether stock returns following an increase in shorting demand vary with ownership structure. Short-sale constraints related to ownership characteristics may limit the ability of arbitrageurs to take short positions, and this, in turn, would lead to larger delays in incorporating pessimistic investors' opinions. We show that abnormal returns following shocks to shorting demand are restricted to firms with high ownership concentration. Stocks in the top quartile of ownership concentration have average abnormal returns after an outward loan demand shock equal to -0.47% per week, relative to stocks with a dispersed ownership facing a similar shock. This effect is unrelated to the level of total institutional ownership. Our findings are robust to firm and calendar fixed effects, are robust to differences in investor sentiment, are robust to the inclusion of liquidity variables, and hold for abnormal returns based on the four-factor model using calen-

dar portfolio regressions. Overall, the constraints we describe are associated with slower price adjustment, which can help to explain the predictability found by previous researchers.[5]

The short-sale constraints we describe also affect the speed at which prices adjust to new information revealed in earnings announcements. Stocks with more concentrated ownership exhibit smaller announcement-day reactions and larger post-earnings announcement drift. This result is mostly concentrated in negative news events, consistent with the relation between informed short selling and future returns found by Boehmer et al. (2008) and Engelberg et al. (2012). Combined with the findings for returns, these results provide evidence that ownership concentration affects the speed of information flows by constraining short selling.

Our paper contributes to the literature that examines how short selling affects stock prices. While most papers study the affect of a change in demand for borrowing stock (e.g., short interest) on stock prices, only a few use the price to borrow shares (e.g., Asquith et al. 2005; Lamont 2012; Nagel 2005; Akbas et al. 2008; Kolasinski et al. 2013). However, examining demand and fee as proxies for short-sale constraints suffers from the usual identification challenge that short-sale constraints might be due to unobserved lending supply. Cohen et al. (2007) address this challenge by indirectly identifying shifts in demand and supply from observed changes in prices and quantities. They show that shifts in supply alone do not explain returns, but cannot identify how supply-side constraints on short selling affect returns. A couple of papers examine the impact of the supply channel on fees. Kolasinski et al. (2013) study the loan supply schedule and find that the presence of search frictions results in higher fees. Kaplan et al. (2013) examine a lender-specific shock to the supply of lendable shares and find that lending supply impacts short-sale constraints, such as fees. We provide direct evidence on the effects of lending supply on short-sale constraints and returns and show that, via the equity lending market, institutional ownership structure is one source of these limits to arbitrage.

[5] Autore et al. (2015) and Blocher et al. (2013) show that hard-to-borrow stocks can become highly overvalued and Stambaugh et al. (2012) and Avramov et al. (2013) find that profits from anomaly-based strategies reside mostly on the short-side of the trade.

1 The Market for Borrowing Stock

We use a proprietary dataset of equity lending supply and loans from Markit, which collects this information from many of the largest custodians and prime brokers in the securities lending industry.[6] The data comprise security-level daily information from August 1, 2006 to December 31, 2010. As of December 2010, of the $5.7 trillion in stocks available to borrow, $387 billion was actually lent. This corresponds to an utilization level (i.e., amount lent, divided by amount available to borrow) of around 15%. Equity loans are not a perfect measure of short-selling activity, since stock loans might be used as part of tax-arbitrage strategies (see, for example, Christoffersen et al. 2005), however the vast majority of stock loans are undertaken with the purpose of shorting.

Equity supply postings contain the dollar value of shares available for borrowing on a given day. We define lending supply as the dollar value of lendable shares relative to a firm's market capitalization. Similarly, loan quantity is the dollar value of shares on loan on a given day relative to market capitalization. Loan fees are set in two different ways, depending on the type of collateral placed by the borrower. If borrowers use cash—the dominant form of collateral in the United States—then the loan fee is defined as the difference between the risk-free interest rate and the rebate rate. The rebate rate is the portion of the interest rate on the collateral the borrower receives. If, instead, the transaction uses other securities as collateral, like U.S. Treasuries, the fee is directly negotiated between the borrower and the lender. The contract-type variable examines whether equity loan transactions are open or fixed term. Open-term loans are renegotiated every day, and fixed-term loans have predefined clauses and maturities. The overnight risk-free rate of the collateral's currency is used for open-term loans. Because ownership data are reported quarterly, we compute quarterly averages of daily equity lending variables for each firm. Variables are winsorized at the 1% level to reduce the impact of outliers.

[6]The information is collected daily from 125 custodians and 32 prime brokers. Markit estimates that the data represent 85% of global equity lending and 90% of the U.S. lending market. See Saffi and Sigurdsson (2011) for a detailed description.

In Figure 1, we show lending supply and shares on loan as a fraction of market capitalization (left) and the average loan fee (right). The average loan fee in December 2010 was around 116 basis points (bps) a year, similar to the figures reported by D'Avolio (2002) and Kolasinski et al. (2013). Lending supply was around 20%-25% for most of the period, but we can see the noticeable reduction in shares available to borrow that takes place in the final quarter of 2008 after the financial crisis.

[Insert Figure 1 HERE]

In Figure 2, we plot the total lending supply and total loaned shares in billions of dollars (right axis) and the average utilization (left axis) in a given quarter. After 2008, the utilization rate fell from 24% in September 2008 to 14.6% in December 2010, because of deleveraging after the financial crisis.

[Insert Figure 2 HERE]

2 Empirical Methodology

2.1 Data

Our explanatory variables describe the structure of institutional ownership. The data come from the Thomson Reuters CDA/Spectrum database on SEC 13F filings. Form 13F is filed quarterly by institutional investors who exercise investment discretion over accounts holding at least $100 million in eligible equity securities. They report the total long positions in each eligible security aggregated across all accounts over which they exercise investment discretion. The data are available from August 1, 2006 until December 31, 2010, for approximately 5,000 stocks. For each stock, we calculate the ownership by each institution and total institutional ownership, both as a percentage of market capitalization.

Equity lending characteristics, including lendable supply and borrowing fee, are available at the stock level and are taken from Markit. We match firms in the equity lending database with those in CRSP. The final sample has 59,276 firm-quarter observations for 4,487 firms. From CRSP data, we compute market capitalization, turnover, share price, cumulative quarterly returns, the standard deviation of daily returns, and cumulative abnormal returns based on the Daniel et al. (1997) characteristics-matched factor and arbitrage risk. Following Wurgler and Zhuravskaya (2002), we define arbitrage risk as the standard deviation of the residuals based on the Carhart (1997) four-factor model of returns, which measures the volatility of the portion of returns that cannot be hedged by standard risk factors. Throughout, we only use common shares with prices larger than \$1.[7]

2.2 Ownership composition

Because stock ownership may influence lending supply in a variety of ways, we focus on four measures of ownership composition: ownership concentration, the investment horizon of investors, holdings by passive investors, and the weighting in investors' portfolios.

First, we consider the concentration of institutional ownership, measured as the Hirschman-Herfindahl Index (normalized to be between 0 and 1) of institutions' holding of the stock using 13F filings. A more concentrated ownership structure, or a structure including larger single institutional investors, such as block holders, results in shareholders having a greater influence in the equity lending market vis-à-vis a highly dispersed ownership structure.[8] The role for ownership concentration is also motivated by Duffie et al. (2002), who present a dynamic model of asset valuation in which short selling requires searching for security lenders and bargaining over the lending fee. Stocks for which ownership, and thus lending capacity, is concentrated within a few

[7]Our results are also robust to the following additional filters: (1) stocks with prices above \$5, (2) including only firms with more than ten institutional investors, and (3) excluding stocks in the smallest market capitalization decile.

[8]This measure of concentration clearly captures blockholdings of more than 5%, but it also captures significant ownership by one or more investors below the blockholding cutoff.

institutions should exhibit steeper supply curves and higher loan fees because lenders have greater bargaining power.

Second, we examine the investment horizon of the firm's institutional investors with significant holdings following Chen et al. (2007). Using 13F filings we classify long-term investors as those largest five investors who have held the stock for more than twelve months. Given their investment horizons, long-term investors are less likely to be affected by short-term price fluctuations and can earn higher returns by lending their shares.

Third, we focus on passive ownership, following Evans et al. (2014), by using N-SAR filings on a fund's operations and investment strategy to identify index funds. Specifically, we use question 69 of the N-SAR form, "Is the Registrant/Series an index fund? (Y/N)", to identify whether a given fund is an index fund.[9] Because N-SAR filings identify index funds and 13F filings are only reported at the fund management level, we are unable to map N-SAR filings onto 13F holdings where fund management companies report both active and passive funds in 13F filings (e.g., Blackrock). Instead, we match index funds with holdings using the Thomson Reuters CDA/Spectrum S12 file on individual mutual fund holdings and aggregate holdings of matched index funds to measure the fraction of passive ownership for each specific stock.

Fourth, we study the relationship between equity lending and the exposure of institutional portfolios to individual stocks. If investors are less likely to lend stocks in which they hold large positions, either because they actively trade these stocks or because shorting price pressure may reduce portfolio value, then we should observe a lower lending supply. We measure portfolio concentration for each stock by examining each institution's holding in a stock relative to the mean stock holding in their portfolio. For each institution-stock pair, we use holdings data from the Thomson Reuters CDA/Spectrum S34 database to measure the difference between the portfolio

[9]The N-SAR data are reported at the fund series level. Typically, a series is a single fund. However, where it includes more than one fund, the filing is common for all funds in the series. Results are robust to using the index flag in CRSP directly or a text search for the word "index" in the fund name.

weight for the stock and the mean portfolio weight for that institution and then take the dollar-value-weighted sum of this difference across all institutions for a particular stock.[10]

The decision to lend shares is typically made at the institution or management company level, with either an internal lending desk or a custodian pooling holdings. Therefore, we study the trade-off facing the investor when deciding to lend shares at the management company level. However, the decision may lie with the fund manager.[11] To mitigate this concern, we also constrain the ownership to mutual funds only and estimate the concentration measures at the fund level using the Thomson mutual fund holdings database. The ownership and portfolio measures have correlations of 0.69 and 0.41, respectively, compared with the management-level variables, and the main results of our paper are unchanged (see Internet Appendix Table 3).

2.3 Descriptive statistics

Table 1 presents descriptive statistics for our main variables. The average firm has 20% of its market capitalization available to lend (*Supply*), and 4.7% of its capitalization is on loan (*On loan*), with the shares costing 70.6 bps per year to be borrowed (*Fee*). In our sample, 13.9% of firm-quarter observations are *Special*, that is, they have lending fees above 100 bps. Average total institutional ownership (*Total*) is 58.3%, and average ownership concentration (*HHI*) is 12.11%, with 141 institutions being shareholders of the average firm (*Breadth*).[12] The largest five institutional investors (*Top 5*) own 54.6% of total institutional ownership, with approximately two-thirds of this being held by investors with a long-term horizon (*Top 5–LT*). Our portfolio concentration measure (*Port. conc.*) has a mean of 0.34% on a value-weighted basis.[13] The average stock's index

[10]We set the difference between the stock portfolio weight and mean portfolio weight to zero for institutions comprised solely of index funds because there is no discretion over portfolio weights.

[11]In conversations wth Markit, the data provider, they confirmed that the decision to lend shares is made at the management company level, but individual fund managers might be able to opt out.

[12]For illustration purposes, the median *HHI* of 6.56% can be described by the median of 90 investors, where the *Top 5* investors combined hold approximately half of the total institutional holdings, and the remaining 85 investors each hold 0.33% of total holdings.

[13]The mean portfolio concentration is zero at the institution-stock level, where we measure the difference between the portfolio weight for the stock and the mean portfolio weight for the institution. At the stock level, the mean

ownership (*%Index*) is 5.4%. Throughout our tests, we also include the change in the number of institutional investors (Δ*(Breadth)*) as a control variable for investor sentiment (see Chen et al. (2002)).

[Insert Table 1 HERE]

Given our focus on lending supply, in Table 2 we report the sample's main characteristics sorted by lending supply quintiles. In panel A, we find that the difference in lending supply moving from the lowest and highest quintiles corresponds to about 36% of market capitalization. The number of shares loaned out (as a percentage of total shares outstanding) increases with lending supply. As expected, loan fees are decreasing in supply. Firms with low supply are about seven times more expensive to borrow (187 bps per year) than those in the highest lending supply quintile (26 bps per year). These resemble those reported by D'Avolio (2002), though shares in our database are slightly more expensive and are lent much more often. Both reflect the growth in the equity lending market in recent years and the fact that our data cover a much larger number of data providers.

In examining institutional ownership variables in panel B, we find that total ownership grows with lending supply, consistent with its use as a proxy for lending supply as in Nagel (2005). Ownership concentration (*HHI*), the fraction of total ownership held by the largest 5 holdings (*Top 5*), and the fraction held by long-term investors (*Top 5–LT*) decrease with lending supply. Broadly speaking, *%Index*, *Port. conc.*, and *Breadth* increase with *Supply* through low to middle quintiles. In panel C, we find that firms with higher supply tend to be larger and have higher stock turnover, but lower arbitrage risk.

[Insert Table 2 HERE]

portfolio concentration is positive, which is likely because portfolio weights tend to be greater when there are fewer institutions invested in the stock.

3 Empirical Results

3.1 How does institutional ownership composition affect equity lending supply?

We apply multivariate regression analysis to study the impact of ownership structure on lending supply by using pooled OLS regressions with quarterly data. All models include stock fixed effects (to absorb time-invariant stock-specific effects) and year-quarter dummy variables (to absorb time-varying effects). Following Petersen (2009), standard errors are double clustered at the firm and year-quarter levels. In each quarter, we standardize all variables to have zero mean and unit standard deviation. We apply this transformation to allow for an easier comparison of each variable's impact on supply, with estimated coefficients denoting the impact of a one-standard-deviation change in the explanatory variable. We include change in breadth (Δ*(Breadth)*); firm market capitalization (*Mkt. cap*); an indicator variable equal to one if the stock price is below \$5 ($D_{P<5}$); Amihud's *ILLIQ*; stock turnover (*Turnover*); book-to-market ratio (*B/M*); a S&P 500 index membership indicator ($D_{S\&P500}$); the natural logarithm of the number of analysts following the stock (*No. of analysts*); and the cumulative return in the previous two quarters as control variables (*Momentum*).[14]

Table 3 presents evidence on lending supply and ownership structure. We first examine how total institutional ownership influences lending supply in Column (1). The coefficient for total ownership (*Total*) on equity lending supply is positive and statistically significant. A one-standard-deviation increase in total ownership is associated with lending supply being 0.447 standard deviations higher, which is equivalent to a 28.8% ($= \frac{0.447*0.129}{0.200}$) increase relative to mean lending supply. In Column (2), we examine institutional ownership concentration. The estimated coefficient for *HHI* is negative and statistically significant. A one-standard-deviation increase in ownership con-

[14]The number of observations falls from 59,276 to 59,055 because of singletons.

centration is associated with a decrease in the lending supply of 0.043 standard deviations, which is equivalent to a 3.0% ($= \frac{-0.043*0.129}{0.200}$) decrease relative to the average lending supply. We also find that smaller firms and firms with low turnover, low book-to-market ratios, and prices below $5 tend to have smaller lending supply. Overall, our results show that ownership concentration is significant in explaining the availability of stocks to borrow, consistent with the hypothesis that investors do not lend stocks when their actions have greater price effects.

[Insert Table 3 HERE]

In Column (3), we examine the investment horizon of institutional investors. We include both the fraction of ownership concentrated in the largest five holdings (*Top 5*) and the share of the largest five holdings held by investors with a long-term investment horizon (*Top 5–LT*). The results for *Top 5* mirror those of *HHI* in Column (2). While higher institutional ownership is associated with higher lending supply, concentrated institutional ownership has the opposite effect. Both measures of institutional concentration, *HHI* and *Top 5*, capture the effects of concentration and institutional influence. Larger institutional investors are more likely to interact with the firm's management, and this fact in itself may determine whether an institutional owner is willing to lend shares.[15] Our results suggest that concentrated and influential ownership structures both reduce equity lending supply. However, the positive coefficient on *Top 5–LT* in Column (3) suggests that large holders that are short term in nature are less likely to lend stock. This could be due to two effects. First, these investors have short-term horizons and thus would be more affected by a price decrease following short selling. Second, changes in the investment horizon of large holders might be due to activist shareholders taking a stake in the firm. Such investors hold stock to strategically intervene or trade, rather than to earn lending fees. We examine this possibility in Section 3.3.4.

In Column (4), we examine how a passive investor base influences lending supply. In line with Evans et al. (2014), we find that *%Index*, measured as the fraction of index-fund ownership

[15]Prior literature has used measures of investor influence to show that firms with more influential institutional investors have higher CEO pay for performance and lower compensation (Hartzell and Starks (2003)).

of the specific stock, relates positively to lending supply. Finally, in Column (5), we examine if institutional investors are concerned about lending out holdings that are a significant part of their portfolio. Portfolio concentration (*Port. conc.*) captures how overweight, on average, institutional investors are in a stock. The negative and significant coefficient found for *Port. conc.* is consistent with the lending supply decreasing for stocks for which institutions allocate a larger portfolio weight.

3.2 How does institutional ownership composition affect short-sale constraints?

An important issue when analyzing the effects of ownership on equity lending is measuring the extent to which ownership affects short-sale constraints. While ownership effects may be large for lending supply, they may be irrelevant if they do not affect the cost of borrowing stock, which, in turn, constrains short selling and affects asset prices. We investigate the relation between institutional ownership structure and short-sale constraints by focusing on loan fee and arbitrage risk.

The fee reflects the cost of borrowing stock and is the most direct form of short-sale constraint. If the profits from a short-sale trade are smaller than the loan fee, investors face limits to arbitrage, and anomalies may persist for a longer period. Table 4 presents evidence that loan fees tend to be higher where institutional ownership is more concentrated or when investors have shorter investment horizons. Once again, we employ pooled ordinary least-squares (OLS) regressions with stock and time fixed effects and include the same set of control variables used in Table 3. In the first two Columns, we test for the effects of total ownership (*Total*) and ownership concentration (*HHI*) on borrowing fee. A one-standard-deviation increase in *Total* is associated with a decrease in fees of 5.6 bps, and a one-standard-deviation increase in *HHI* is associated with an increase in fee of 5.2 bps, both economically significant when compared with the mean lending fee of 71 bps.

In Columns (3)–(5) we examine whether institutions' investment horizon (*Top 5–LT*) and philosophy (*%Index* and *Port. conc.*) relate to borrowing fees. Short-term investors and investors who

are overweight in the stock are more likely to withhold lending supply, which should relate to a higher cost of borrowing stock. This is consistent with the negative coefficient found for *Top 5–LT* in Column (3) and the positive coefficient for *Port. conc.* in Column (5). However, we find no such result for stocks with a relatively larger passive investor base (*%Index*) in Column (4). This may stem from passive funds' preference for stocks with higher lending fees, and this can provide extra lending revenues and help increase total returns (Prado (2015); Blocher and Whaley (2015)).

[Insert Table 4 HERE]

In Columns (7) to (12) of Table 4, we investigate the effects of ownership on arbitrage risk, measured as the mean squared error of daily stock returns' residuals from the Carhart (1997) four-factor model regression (as in Wurgler and Zhuravskaya (2002)). Greater idiosyncratic variability limits arbitrageurs' ability to trade on mispricing. For our sample, arbitrage risk has a mean of 2.99% and a standard deviation of 2.65%. In Columns (7) and (8), we find that total ownership is associated with a decrease in arbitrage risk and that ownership concentration relates positively to arbitrage risk. The coefficient on *HHI* (0.049) has an opposite relation to arbitrage risk than total ownership (-0.110), illustrating that ownership concentration should be accounted for by investors concerned with arbitrage risk. When we turn to investment horizon, we find similar results to those found for loan fee. While concentrated ownership is associated with an increase in arbitrage risk, the effect is amplified when the investors take a short-term investment horizon. For passive ownership, unlike for loan fee, we find that stocks with greater index ownership exhibit lower arbitrage risk. Finally, portfolio concentration is positively associated with arbitrage risk.

A valid concern in interpreting the results in Table 4 is that, while ownership structure can limit arbitrage due to its effect on lending supply, there might be alternative channels through which ownership affects limits to arbitrage. Lending supply might affect limits to arbitrage independently of ownership structure, or it may be that ownership structure limits arbitrage through channels other than lending supply. We address these concerns by computing a forecast of lending supply

as a linear function of total institutional ownership (*Total*) and ownership concentration (*HHI*). In Columns (6) and (12), we use this forecast instead of the actual observed *Supply*. We find that loan fee and arbitrage risk still negatively relate to the component of lending supply explained by ownership structure.

3.3 Propensity score-matched sample results

Stocks with high ownership concentration and stocks with low ownership concentration may differ along some other dimensions correlated with lending supply and limits to arbitrage. To ensure our results are not driven by such a bias, we employ a propensity score-matched sample specification. For each of the four ownership characteristics–ownership concentration, investor horizon, passive investing, and portfolio concentration–we identify a treatment and control group that are similar along each given characteristic.

For ownership concentration, we match on the propensity of a stock having highly concentrated ownership, where highly concentrated ownership is classified as being in the top quartile of concentration. The matching attempts to randomize the treatment of ownership structure across the high concentration (treatment) stocks and non-high-concentration (control) stocks by ensuring that the two groups are comparable on observed covariates that might explain ownership concentration. In the first stage of the match, we compute propensity scores using a probit regression predicting high ownership concentration with firm characteristics other than ownership concentration (i.e., the observed covariates) as controls. In the full sample, the treatment and control groups have very different probabilities of being in the top quartile of ownership concentration. The propensity score is 0.091 for the untreated sample in the unmatched sample and 0.729 for the treated sample, with the difference being significant at the 1% level. When we examine the propensity-matched sample, we find that both the treatment and control groups are equally likely to be in the top ownership con-

centration quartile. The matching algorithm results in a propensity equal to 0.407 for the control group and 0.404 for the treated group, with the difference not being statistically significant.[16]

Using the propensity-matched sample, we re-estimate the regressions shown in Column (2) of Table 3 and Columns (2) and (8) of Table 4. Panel A of Table 5 presents the results. For brevity, we show only the coefficients on *Total* and *HHI* and suppress the coefficient on the set of controls common to Tables 3 and 4. Even when compared with similar stocks, ownership concentration remains significantly negative related to lending supply and positive related to loan fees and arbitrage risk.

In panel B of Table 5, we repeat the exercise for *Top 5–LT*. This time, we match on the propensity of being in the top quartile of *Top 5–LT*. The propensity score is 0.139 for the untreated sample in the unmatched sample and 0.583 for the treated sample, with a significant difference at the 1% level. In the matched sample, the propensity is equal to 0.500 for both the treatment and control group, with a nonsignificant difference. Consistent with our earlier results, we find that stocks with investors with a short-term investment horizon have lower supply and higher limits to arbitrage, measured as the lending fee.

[Insert Table 5 HERE]

In panels C and D, we focus on passive ownership and portfolio concentration. For each characteristic, we re-match and estimate the effects of ownership on supply, fee, and arbitrage risk. While we find significance for lending supply, we find little evidence that *%Index* and *Port. conc.* affect short-sale constraints. The results suggest that stocks with low passive ownership or high portfolio concentration might differ along some unobservable dimension and that this plays a role in explaining the relation we document.

[16] We employ a flexible specification for the propensity score (see Imbens (2014)) and include the set of controls used in Table 3, total ownership, and interactions and higher orders of these variables. The match is completed using the nearest neighbor without replacement based on the covariates and interactions, with a 0.01 caliper. Of the 14,819 treatment observations, we find matches for 5,280. In total, 10,560(=2*5,280) observations comprise the propensity-matched sample.

3.4 Evidence from 13D filings

Concentrated ownership might be associated with active investors taking large positions in a stock. These investors hold the stock strategically and thus should be less likely to lend because they may choose to exit or use voice to exert control. We examine how large active investors influence equity lending supply by examining SEC 13D filings. Schedule 13D, commonly referred to as a beneficial ownership report, is filed with the SEC when an investor acquires ownership of more than 5% of a voting class of a company's equity securities. In particular, a 13D must be filed if the investor aims to change or influence control, that is, activism.

We identify 326 firms associated with SEC 13D filings in our sample using the SharkRepellant database. We focus on the first filing in our sample for each firm and identify the event date of the acquisition of stock. We can match 223 of the 326 filings with firms in our sample. For this matched sample, we examine ownership composition in the four quarters before and after the SEC 13D filing. In panel A of Table 6, we present univariate tests of the differences in ownership around the filing. Unsurprisingly, the fraction of institutional ownership held by block holders (i.e., holdings $\geq 5\%$) increases post-filing as does ownership concentration. The fraction of stock held by institutional investors and index funds is unchanged. Overall, the 13D filing event is associated with an increase in activist holdings that increases concentration.

[Insert Table 6 HERE]

Additionally, we provide univariate tests of the differences in lending supply and limits to arbitrage. In support of our earlier findings, the increase in activist holdings leads to lower lending supply and higher limits to arbitrage. Finally, we formally examine this relation in a regression framework. Since the 233 13D filings are staggered through our sample period, we estimate a difference-in-differences test with stock and time fixed effects, in which the treated stocks are those with a 13D filing in the quarter and the control group includes all remaining stocks. The difference-in-differences absorbs the stock-specific ownership characteristics, as well as factors

common to all stocks each quarter. We present the evidence in panel B of Table 6. The coefficient on *Post*, which is a dummy variable equal to one in the four quarters post-filing, is negative for supply and positive for both fee and arbitrage risk. Hence, the results on 13D filings not only support our main findings on lending supply and limits to arbitrage, but they also help shed light on activist behavior. The decision to lend shares appears to be negatively influenced by the intent of institutional investors to engage in shareholder activism or monitoring.

3.5 Evidence from dual-class listings

Dual-class listings provide further evidence in support of our results. While dual-class shares have identical cash-flow rights, the class with the greater voting rights typically has more concentrated ownership. We exploit this to show that ownership concentration matters for lending supply and short-sale constraints within the same firm at the same time, which mitigates the concern that our results are driven by variation in bearish sentiment and demand for short selling. For example, Molson Coors Brewery has class A voting shares and class B nonvoting shares. For class A (B) shares, the average *HHI* is 0.77 (0.04), the average *Supply* is 0.3% (11.3%), and the average loan fee is 90 bps (10 bps), illustrating our hypothesis that more concentrated ownership constrains supply and increases limits to arbitrage.

We test this formally by identifying all dual-class stocks in our sample. For each firm identifier (i.e., CUSIP6), we examine how many share classes (i.e., CUSIP8) are traded in a given year-quarter. There are fifty-six firms with available data on class A shares with voting rights and class B shares with no or limited voting rights. For each firm class, we estimate the average *HHI*, *Supply*, *Fee*, and *Arbitrage risk* in our sample period and then take the difference between the share classes within each firm, thereby absorbing any firm-specific and time-specific effects. This results in fifty-six observations of the class difference, one for each firm with dual-class shares. The class difference in HHI equals 0.21 and is significant at the 1% level. The class difference in *Supply* is

-17.2%, the class difference in *Fee* is 57 bps, and the class difference in *Arbitrage risk* is 0.469, all significant at the 1% level. Thus, even controlling for the underlying cashflows of the stock, greater ownership concentration seems associated with higher limits to arbitrage.

3.6 Ownership structure, limits to arbitrage, and stock returns

3.6.1 Stock returns and borrowing demand shifts: Portfolio analysis

The results in the previous sections describe the effects of ownership structure on equity lending supply, loan fees, and arbitrage risk. If ownership concentration results in higher short-sale constraints and increases arbitrage risk, arbitrageurs face greater limits to arbitrage. Thus, one should expect mispricing to build up and subsequent returns to short selling to be more negative as prices take longer to adjust. In essence, greater limits to arbitrage result in a delay in price correction because of a lack of timely arbitrage. Another possibility described by Cohen et al. (2007), Engelberg et al. (2013), and Drechsler and Drechsler (2014) is that shorting stocks is riskier for investors speculating on negative price information because of the higher borrowing costs and arbitrage risks. Hence, short sellers require more negative returns in compensation. Under both explanations, we should observe more negative returns following increases in the demand for short selling for stocks with more concentrated ownership.

We employ the methodology proposed by Cohen et al. (2007) to test sensitivity of returns, conditional on an outward demand shift, to ownership structure. The identification strategy consists of constructing price-quantity pairs from the equity lending market to isolate clear shifts in supply and demand. For example, an increase in the loan fee (i.e., price), coupled with an increase in the percentage of shares on loan (i.e., quantity), corresponds to an increase in shorting demand, as would be the case for any increase in price coupled with an increase in quantity.

We define *DOUT* and *DIN* in the following way:

$$DOUT_{i,t-1} = \begin{cases} 1 & \text{if } \textit{Fee score}_{t-1} - \textit{Fee score}_{t-2} > 0 \text{ and } \textit{On loan}_{t-1} - \textit{On loan}_{t-2} > 0 \\ 0 & \text{otherwise,} \end{cases}$$

$$DIN_{i,t-1} = \begin{cases} 1 & \text{if } \textit{Fee score}_{t-1} - \textit{Fee score}_{t-2} < 0 \text{ and } \textit{On loan}_{t-1} - \textit{On loan}_{t-2} < 0 \\ 0 & \text{otherwise,} \end{cases}$$

where *i* stands for stock, *t* for week, and *On loan* is the amount of shares on loan. *Fee score* is a measure of daily borrowing costs computed by Markit. This variable captures the loan-weighted fee charged by lenders based on Markit's proprietary benchmark rate, where 1 indicates the cheapest and 10 the most expensive stocks to borrow. It is designed to measure levels of fee that differ economically from each other. We employ *Fee score*, rather than *Fee*, to avoid incorrectly categorizing demand shifts because of changes in the Fed Open Rate or small changes in the rebate rate. In our sample, more than 80% of the stocks have a score equal to 1, with only 3% having values greater than or equal to 5.

Each of the shifts has an economic interpretation. *DOUT* captures the case in which there is an increase in both the cost of shorting (i.e., loan fee) and the amount that investors are willing to short at this higher cost. Effectively, more capital is betting that the price will decrease, despite the higher explicit cost of betting. *DIN* captures the case in which both shorting costs and the amount that investors borrow at this lower price decrease. The effect of *DIN* on returns is likely to be smaller than the one from *DOUT* because if investors have positive expectations about the stock they can purchase it in the spot market. Cohen et al. (2007) show that *DOUT* is a strong predictor of negative abnormal returns. Our hypothesis is that this effect on returns is related to a tightening of short-sale constraints due to ownership characteristics. For example, cross-sectionally, we should observe that abnormal returns conditional on an outward demand shock are more negative for high-concentration stocks.

In Table 7, we examine average returns of portfolios conditional on an outward demand shock and institutional ownership. We place all stocks into two demand-shift portfolios, *DOUT*=1 and *DOUT=0*, and further sort on quartiles of *HHI*, *%Index*, and *Port. Conc*. Demand shift portfolios are formed in week $t-1$, ownership quartiles are based on the prior quarter (the most recent data available), and the stocks are held in the portfolios during week *t* and rebalanced every week. For ownership characteristics, we sort stocks into quartiles each period and define an indicator variable equal to 1 if the stock is in the top quartile and 0 otherwise. We present results for abnormal returns, measured as the difference between the weekly stock return and the return on a characteristics-matched benchmark portfolio sorted on market capitalization, book-to-market, and momentum following Daniel et al. (1997).

Panel A examines abnormal returns for ownership concentration. Comparing the abnormal returns across $DOUT = 1$ and $DOUT = 0$ shows that an outward demand shift is associated with a negative future return, as documented by Cohen et al. (2007). The average difference is statistically significant at 1% and equal to -0.469% per week (-1.98% per month). However, when we further sort returns by ownership concentration, we find that the abnormal return for high concentration stocks (*Top HHI=1*) that experience an outward demand shift is -0.475% in the following week (relative to those that experience no outward demand shock), compared with the abnormal return for low-concentration stocks that experience an outward demand shift of -0.005% a week (relative to those that experience no outward demand shock). The difference-in-differences abnormal return (across ownership structure and $DOUT$) is -0.470% a week and significant at the 1% level. The results suggest that the impact of outward demand shocks on returns varies with ownership concentration.

A natural concern in panel A is that, if ownership concentration is correlated with total ownership, our documented results may stem from total ownership. We address this concern in panel B. Rather than sort on *HHI*, we first regress *HHI* on *Total* and then sort stocks on the residuals of this regression, which reflects the component of ownership concentration orthogonal to total

ownership. The results are qualitatively and quantitatively similar: the difference-in-differences abnormal return (across ownership structure and $DOUT$) is -0.482% a week and significant at the 1% level.

[Insert Table 7 HERE]

In panels C and D, we examine how returns following an outward demand shift vary with *%Index* and *Port. conc.*, where once again we apply the component not explained by total ownership. We find little evidence that passive ownership or investors' relative portfolio concentration impact returns through tightening short-sale constraints, consistent with the findings in Section 3.3.3, where we found that *%Index* and *Port. conc.* do not affect short-sale constraints once we employ a propensity-matched sample of stocks.

While these returns in panels A and B look large, they do not take into account any transaction costs needed to rebalance the portfolio every week. Every week, the trade involves new short positions and reversing existing short positions. In our sample, 2.61% of stocks are estimated to have an outward demand shock in the last week (i.e., $DOUT = 1$) and no observed shock in the prior week (i.e., lagged $DOUT = 0$). Similarly, 2.63% of stocks have $DOUT = 0$ and lagged $DOUT = 1$. Thus, the estimated weekly turnover in the portfolio is around 5.24%. If we follow a conservative approach and take the average total trading costs shown by Keim and Madhavan (1998) for Nasdaq stocks in the middle quintile of firms ranked by market capitalization, we estimate weekly trading costs for the $DOUT = 1 - DOUT = 0$ portfolio to be equal to $2 * 0.524 * 0.92\% = 0.1\%$ per week.[17] This would reduce the estimated abnormal returns by almost a quarter, from 0.48% per week to 0.38% per week. Another source of costs are the lending fees paid to borrow shares required to implement short leg of the $DOUT = 1$ strategy. The average lending fee of the $DOUT = 1$ portfolio is 3.5% a year or 0.07% a week. This would reduce the weekly return of the $DOUT = 1 - DOUT = 0$ portfolio in Column 1 by $0.07/2 = 0.035\%$, with

[17] Keim and Madhavan (1998) use trades by twenty-one institutions between January 1991 and March 1993. Given the reduction in transaction costs over time, the trading costs during our sample period are likely to be even lower.

average abnormal returns further decreasing from -0.38% to -0.34% per week. Overall, trading costs reduce the profitability of the strategy by approximately 30%, but its net performance is still economically and statistically significant.

3.6.2 Stock returns and borrowing demand shifts: cross-sectional estimations

Next, we determine the effect of ownership concentration on returns following outward demand shifts in a full multivariate regression setting, controlling for a wide array of variables. We estimate cross-sectional pooled regressions using weekly abnormal returns, including calendar month dummies, and double-clustered standard errors at the firm and time level. The baseline specification takes the form:

$$\begin{aligned} R_{i,t} &= \alpha + \theta_t + \beta_1 DOUT_{t-1} + \beta_2 Top(OWN_{i,q-1}) + \beta_3 Total_{i,q-1} \\ &\quad + \beta_4 DOUT_{t-1} * Top(OWN_{i,q-1}) + \beta_6 CTRLS_{i,t-1} + \varepsilon_{i,t}, \end{aligned} \tag{1}$$

where R_{it} is the abnormal return on stock i in week t, $DOUT_{t-1}$ is a dummy variable equal to 1 if there was an outward demand shift in the prior week and 0 otherwise, $Top(OWN_{i,q-1})$ is a dummy variable equal to one if the ownership characteristic of interest is above the 75th percentile in the previous quarter, and $Total_{i,q-1}$ is institutional ownership. We employ previous quarter's data such that all variables are known to investors when forecasting returns. Finally, $CTRLS$ denotes the set of additional controls used, which includes the prior week's abnormal returns, an indicator variable that equals one if the stock is part of the S&P 500 index, Amihud's (2002) *ILLIQ* measure, average daily turnover, an indicator variable equal to one if the share price is below $5 in the previous week, and the number of analysts following the stock to control for visibility. Diether et al. (2009) show that short selling increases after higher returns in the previous week. Firms with high concentration may be even more affected by overreaction, and our main result could then be

due to spurious correlation between lending demand shocks and reversals. Thus, we also include abnormal returns in the previous week to control for momentum effects.

We present the results in Table 8. In Column (1), we show that outward demand shifts convey negative information for returns, similar to the results presented by Cohen et al. (2007). The coefficient on *DOUT* of -0.199 implies that an outward demand shock decreases abnormal returns by approximately 0.2% per week (0.8% per month). [18]

[Insert Table 8 HERE]

If constraints on lending supply affect prices, then we should observe that the price adjustment associated with short selling a stock is larger where lending supply is lower. This is expected because tighter constraints result in delays in incorporating the beliefs of pessimistic investors. In Column (2) of Table 8, we test this by focusing on ownership concentration. If a more concentrated ownership structure poses greater limits to arbitrage, then an outward demand shock in firms with concentrated ownership is expected to have relatively more negative abnormal returns. This is precisely what we find. The negative and significant coefficient on *DOUT* $*$ *Top(HHI)* implies that an outward demand shock decreases abnormal returns by approximately 0.452% per week (1.92% per month) in more concentrated firms, similar to the findings presented in Table 7.

In Column (2), we also control for the effects of total ownership and limits to arbitrage. Higher total ownership relieves supply constraints, as we showed earlier, and Pontiff (2006) argues that idiosyncratic risk is the largest cost face by arbitrageurs. Stocks in the top quartile of idiosyncratic risk (*Top(Arb. risk)*) have an abnormal return following a shorting demand shock of -0.436% per week. This is consistent with Duan et al. (2010), who show how idiosyncratic risk forecasts lower abnormal returns only for stocks with high short interest. However, the coefficient on *DOUT* $*$ *Top(HHI)* remains negative and significant, which illustrates that the impact of concentrated

[18] Cohen et al. (2007) find returns of 3.27% per month associated with outward demand shifts. However, once transaction costs, this value reduces to 0.37% per month.

ownership following shorting demand shocks is not simply due to high concentration stocks having high arbitrage risk.

Next, in Column (3), we investigate the role of investment horizon. The coefficients of -0.398 and 0.332 on *DOUT* $*$ *Top(Top 5)* and *DOUT* $*$ *Top(Top 5–LT)*, respectively, show that abnormal returns are more negative after an outward demand shock for stocks that have a greater *Top 5* holding but that this effect diminishes with investment horizon. Hence, combined with the results for short-sale constraints, investors with short-term objectives restrict lending supply and raise limits to arbitrage, which in turn results in larger negative returns for outward demand shocks. Finally, in Columns (5) and (6), we examine *%Index* and *Port. conc.*. Similar to the results presented in Table 7, we find little evidence that greater index ownership or fund-level portfolio concentration impact stock returns.

3.7 Earnings announcements, stock price reactions, and concentration

An alternative test of the impact of ownership structure composition on returns and price delay is to examine stock price reactions to earnings announcements. A large academic literature attempts to explain why stock prices underreact to news, that is, why they continue to increase (decrease) following good (bad) news (Bernard and Thomas 1990). Mendenhall (2004) argues that the magnitude of the drift increases with arbitrage risk, and Pontiff (2006) claims that arbitrage risk "appears to be the single largest cost faced by arbitrageurs." If ownership structure generates impediments to arbitrage through short-sale constraints, we would expect to find lower announcement-day reactions and larger post-earnings drift for firms with more concentrated ownership and that these effects are concentrated in *Bad* news announcements.

Following Livnat and Mendenhall (2006), we compute standardized unexpected earnings (*SUE*) as the actual earnings announcement value minus the median of IBES analyst forecasts made less than ninety days before the announcement, scaled by share price on the announcement day. We

only include firms in the extreme quintiles of earnings news, with those in the top quintile of *SUE* in a given quarter defined as those with *Good* earnings news, while those in the bottom quintile are those with *Bad* earnings news. We define the indicator variable D^{SUE}, to be equal to 1 if *SUE* is in the bottom quintile in a given quarter and 0 if in the top quintile, excluding all others from the estimation. We also sort stocks into quintiles according to measures of ownership concentration in the previous quarter. For each measure, we define an indicator variable, $D^{\text{"X"}}$, to be equal to 1 if the stock is in the top quintile of the distribution of *"X"* and 0 otherwise. As further controls, we also include indicators variables for arbitrage risk ($D^{\textit{Arbitrage risk}}$) and total institutional ownership (D^{Total}), constructed in similar fashion.

Our estimation framework examines how cumulative abnormal return measures vary with the type of news and ownership concentration measures. We implement a differences-in-differences framework using three alternative measures of abnormal returns. *CAR1* is the announcement-day reaction, defined as the cumulative abnormal returns during the [t-1,t+1] window around the Compustat announcement date. *CAR2* is defined as the cumulative abnormal returns during the [t+2,t+10] window and captures the post-earnings announcement drift (PEAD) up to 10 trading days after the announcement. *CAR3* is defined as cumulative returns over the period from two days after the announcement (i.e., t+2) through the following quarter's earnings announcement and aims to capture the long-term PEAD. Our estimated equation is the following:

$$\begin{aligned} CAR_{i,t} &= \beta_1 + \beta_2 D^{SUE}_{i,t} + \left(\beta_3 + \beta_4 D^{SUE}_{i,t}\right) * D^{Conc}_{i,t-1} \\ &\quad + \left(\theta_1 + \theta_2 D^{SUE}_{i,t}\right) * D^{\textit{Arbitrage risk}}_{i,t-1} + \left(\gamma_1 + \gamma_2 D^{SUE}_{i,t}\right) * D^{Total}_{i,t-1} + \epsilon_{i,t}, \end{aligned} \quad (2)$$

The interpretation of these coefficients is straightforward. For each stock *i* and earnings announcement event at time *t*, the intercept β_1 captures the mean abnormal return for *Good* earnings-announcements conditional on low concentration (i.e., $D^{Conc} = 0$), which we expect to be positive. $\beta_1+\beta_2$ is the abnormal return for *Bad* news observed for low concentration firms. β_3 is the marginal

difference for high concentration stocks conditional on $Good$ news. And β_4 captures the incremental impact of high concentration for Bad news (D^{SUE}=1). If stock price reactions are delayed due to high concentration for Bad news only, we expect β_4 (but not β_3) to be positive for *CAR1* (i.e., under-reaction) and negative for *CAR2* and *CAR3* (i.e., delayed reaction).

We report our results in Table 9. In Columns (1) to (4), we analyze announcement-window returns (*CAR1*). Estimates for β_1 show that the reaction on the [t-1,t+1] announcement window is positive for *Good* earnings announcements, and estimates for $\beta_1 + \beta_2$ shows that the reaction is negative for *Bad* news, similar to previous research. Higher institutional ownership is also associated with a larger reaction following *Good* news (γ_1) and *Bad* news ($\gamma_1 + \gamma_2$) in all cases. Focusing on *HHI* in Column (2), we find that the reaction to earnings news varies asymmetrically with ownership concentration. β_3 is insignificant, which illustrates that ownership concentration does not affect announcement returns for *Good* news. However, the β_4 coefficient equals 2.17% and is significant at the 1% level, which shows that stocks with concentrated ownership tend to under-react to *Bad* news, consistent with price delay.

Next, we examine the post-earnings announcement drift. Both *CAR2* and *CAR3* are even more negative after *Bad* news for stocks with high *HHI*, consistent with price delay following the underreaction documented in Column (1). In Column (6), the value of β_4 for $CAR2$ implies that the PEAD observed in the [t+2,t+10] period is -2.76% lower when $D^{SUE} = 1$ for stocks in the top *HHI* quintile. In Column (10), we find that this effect equals to -4.70% for *CAR3*. Overall, we find that higher ownership concentration stocks tend to have a lower speed of adjustment to news due to stronger limits to arbitrage, which in turn lead to smaller price reactions on the announcement day and bigger PEAD.

We find similar results for stocks with higher ownership among the largest five shareholders (*Top 5*). The value of the β_4 coefficient is 2.430 in Column (3), -2.997 in Column (6), and -8.786 in Column (10), all statistically significant at the 5% level. However, we do not find any effects related to *Top 5–LT*. Similar to results in Table 8, we do not find any effects of passive ownership

or portfolio concentration on abnormal returns, apart from $D^{Port.conc.}$ being significant at the 10% level in Column (4).

4 Robustness Checks

We present robustness tests in the Internet Appendix. In Table IA.1, we examine the effects of nonlinearity. Results resemble those in Tables 3 and 4, where we include squared and cubic terms for each of the ownership measures and for market capitalization. We address the concern that our results are due to spurious correlation caused by nonstationarity of dependent variables and explanatory variables in Table IA.2. We repeat our tests using first differences regressions. For *Total*, *HHI*, and *Top 5* the effects endure. However, *%Index* is no longer significant in explaining *Fee* and *Arbitrage risk*, while *Port. conc.* is no longer significant for *Fee* when we use first-differences. In Table IA.3, we present evidence that results are similar if we measure ownership characteristics of individual mutual funds (i.e., based on the CDA/Spectrum S12 file) rather than management-companies (i.e., based on the CDA/Spectrum S34 file).

Options may provide an alternative market to arbitrage away mispricing.[19] In Table IA.4, we show that our results on ownership structure are robust to the inclusion of options' open interest. In Table IA.5, we also show that our return results are unaffected by option liquidity and stock liquidity. We re-estimate regressions in Table 8 and show that our main results on returns are unaffected by the inclusion of the interaction of *DOUT* with turnover, fee, bid-ask spread, Amihud's ILLIQ, breadth, and indicator variables equal to 1 if firms are, respectively, in the top quartile of fee, bid-ask spread, Amihud's ILLIQ, change in breadth, and options' open interest.

Our final robustness test estimates calendar-time regressions instead of panel regressions. In Table IA.6, we show regressions of weekly portfolio returns as a function of the Fama-French factors and momentum. In Column (1) of panel A, we form a portfolio that is long stocks where

[19] Grundy et al. (2012) show that the availability of put options depends on the ability to hedge by shorting the stock.

DOUT=0 and *Top(HHI)=0* and short for those stocks for which *DOUT=1* and *Top(HHI)=1*. The long-short difference is statistically significant at the 5% level and equal to 0.464% per week, similar to our findings using cross-sectional regressions. In Columns (2)–(4), this result is unaffected by controlling for the market (MKT), size (SMB), book-to-market (HML), and momentum (UMD) factors. In panels B and C, we examine a portfolio that is long stocks where *DOUT=0* and short for those stocks for which *DOUT=1*, for *Top(HHI)=0* and *Top(HHI)=1* stocks, respectively. The results once again illustrate that the abnormal returns associated with demand shocks arise only for those stocks with high ownership concentration.

5 Concluding Remarks

Arbitrageurs often use short selling as part of their trading strategy, borrowing securities they do not own to correct overvaluation. Short selling entails various costs and risks, such as locating shares to borrow, loan fees, and the risk that the short position is closed because of a recall by the lender of the borrowed shares. We hypothesize that institutional investors' lending preferences over individual stocks will vary with their own investment philosophy and time horizon and therefore that ownership composition affects limits to arbitrage. We argue and show that their decision to withhold a stock raises short-sale constraints and limits the ability of arbitrageurs to take short positions and exploit inefficiencies, which, in turn, results in both higher prices and delays in incorporating pessimistic investors' opinions.

The abnormal returns following an outward demand shock tend to be more negative for stocks with concentrated ownership, consistent with short-sale constraints limiting negative information from being impounded in prices. We find that stocks in the top quartile of ownership concentration earn an average abnormal return following an outward demand shock of -0.47% per week, or -2% per month, relative to a similar demand shock for stocks with dispersed ownership. These results suggest a link between the limits to arbitrage and ownership structure, which, to the best of our

knowledge, has not been explored previously. Results on lending supply also hold in tests that use 13D filings for investor activism and when comparing dual-class shares. The return results are robust to several alternative explanations, including liquidity, price reversals, time-series portfolio returns regressions, and changes in investor sentiment among others.

Ownership structure also affects the stock price reaction to earnings announcements. Stocks with more concentrated ownership exhibit smaller announcement-day reactions and larger post-earnings announcement drift. Moreover, this result is driven by negative news events, which reinforces the impact of ownership structure on short-sale constraints. Combined with the findings on returns, these results suggest that ownership concentration affects the speed of information flow.

Our contribution is also methodological in nature. We show that institutional ownership is not a sufficient statistic to proxy for lending supply as is often assumed in the literature (see Asquith et al. 2005; Lamont 2012; Nagel 2005; Akbas et al. 2008; Kolasinski et al. 2013 among others). Instead, both institutional ownership levels and the structure of institutional ownership should be considered.

Our results are important in showing how a firm's ownership structure can be associated with limits to arbitrage through the impact on the equity lending market. Furthermore, our approach can be used by practitioners to better identify the subset of firms that experience abnormal negative returns following increases in short-selling demand.

Appendix

Variable	Definition
Supply	Quarterly average fraction of market capitalization available to lend
On loan	Quarterly average fraction of market capitalization effectively lent
Fee	Value-weighted average loan fee in annualized basis points
Fee score	A measure of fee computed by Markit that ranges from 1 (cheapest to borrow) to 10 (hardest to borrow)
Utilization	*On loan* divided by *Supply*
Total	Total institutional ownership
HHI	Concentration of institutional ownership measured by the Hirschman-Herfindahl index
Top 5	Percentage held by the largest five shareholders
Top 5–LT	Percentage of Top 5 held by investors with a long investment horizon, as in Chen et al. (2007)
%Index	Fraction of the stock held by index funds based on replies to question 69 of the N-SAR filing using the data from Evans et al. (2014). After classifying each index fund, we aggregate holdings of index funds using the Thomson mutual fund holdings database (CDA/Spectrum S12)
Port. conc.	Difference between a stock's portfolio weight and the portfolio mean for each institution holding the stock, averaged across all institutions using the dollar amount invested as weight and assigning 0 to management companies that only manage passive funds
Breadth	Number of institutional investors as in Chen et al. (2002)
Δ*(Breadth)*	Percentage change of *Breadth* relative to the previous quarter
Price	Average quarterly price
Mkt. cap	Firm size in USD billions
μ(Ret)	Average quarterly return
σ(Ret)	Standard deviation of returns
Arb. risk	Mean squared error of residuals (RMSEs) from Carhart's (1997) four-factor model using daily stock returns within a quarter
$\beta_{mkt}(FF3)$	Market returns' beta from the same regression above
Turnover	Average daily stock turnover within a quarter (x100)
Amihud's ILLIQ	Average absolute return over dollar volume within a quarter
B/M	Book-to-market ratio
$D_{S\&P500}$	Indicator variable equal to 1 if the stock is a member of the S&P 500 index, 0 otherwise
No. of analysts	Natural log of 1, plus the number of analyst estimates in IBES in that quarter. Missing values are set to 0
$D_{P<5}$	Dummy variable equal to one if the quarterly average price is below five dollars, 0 otherwise
Momentum	Cumulative return in the six months prior to the current one (i.e., months *t-7* to *t-1*)

Figure 1: **Loan fees and equity lending quantities scaled by market capitalization**

For each quarter between August 2006 and December 2010, the figure shows the average lendable supply as a fraction of market capitalization (*Supply*), shares on loan as a fraction of firm capitalization (*On loan*), and value-weighted annualized loan fee (*Fee*).

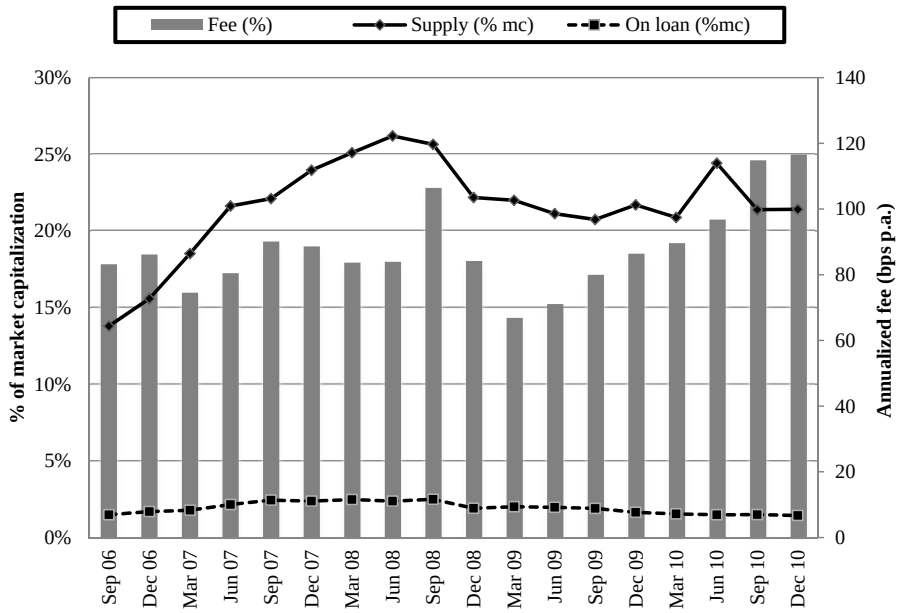

Figure 2: **Equity lending market: Total size and utilization**

For each quarter between August 2006 and December 2010, the figure shows the average *Utilization*, the aggregate dollar value of lendable supply, and the aggregate dollar value of stocks on loan.

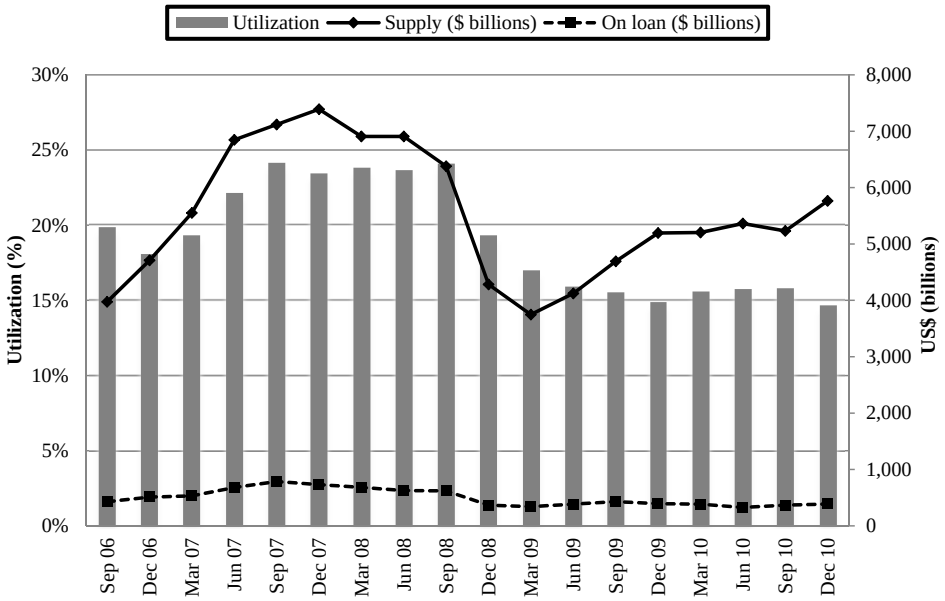

Table 1: Descriptive Statistics

The table shows the quarterly descriptive statistics between August 2006 and December 2010. Equity lending data are provided by Markit; price data are from CRSP; ownership data are from the SEC's 13F holdings (CDA/Spectrum s34); index fund ownership is constructed from mutual fund holdings data (CDA/Spectrum s12); and accounting data are from Compustat. Obs. is the number of firm-quarter observations available. Panel A reports the equity lending characteristics. Panel B reports the institutional ownership and portfolio characteristics. Panel C reports the price data. The variable definitions are defined in the Appendix.

Variable	Obs.	Mean	Median	SD	Min	Max	Skewness	Kurtosis
				A. Equity lending				
Supply	59,276	20.02	20.14	12.89	0.00	53.69	0.30	2.40
On loan	59,276	4.69	2.51	5.77	0.00	27.81	186.51	648.90
Fee (bps p.a.)	59,276	70.58	13.36	184.85	-6.83	1301	4.52	25.88
Fee score	59,276	1.37	1.00	1.12	1.00	10.00	3.90	20.12
Specialness	59,276	13.86	0.00	34.55	0.00	100	209.20	537.65
Utilization	59,276	19.25	11.84	20.49	0.00	84.61	1.34	4.10
				B. Institutional ownership				
Total	59,276	58.34%	63.80%	30.37%	0.00%	100%	-0.34	1.86
HHI	59,276	12.11%	6.56%	13.99%	1.27%	100%	2.90	13.35
Top 5	59,276	54.56%	47.72%	22.40%	15.25%	100%	0.63	2.18
Top 5–LT	59,276	37.03%	30.34%	24.81%	0.00%	100%	0.86	2.92
Breadth	59,276	141.10	90.00	179.92	1.00	1,683	3.37	18.66
Δ(Breadth)	59,276	0.98%	0.00%	3.06%	-4.28%	18.57%	1.42	3.73
% Index	59,276	5.35%	2.92%	6.18%	0.00%	26.21%	1.36	4.41
Port. conc.	59,276	0.34%	0.06%	1.35%	-2.37%	9.28%	0.04	0.26
				C. Pricing and other variables				
Price	59,276	22.79	15.44	40.38	0.04	2432.34	22.83	897.57
Mkt. cap	59,276	3,687	403	16,311	0.31	513,362	12.51	226.94
μ(Ret)	59,276	2.47%	0.57%	34.18%	-94.23%	1,833%	8.70	273.59
σ(Ret)	59,276	3.52%	2.84%	2.80%	0.15%	244.79%	14.87	992.37
Arb. risk	59,276	2.99	2.35	2.65	0.15	230.90	15.49	998.00
Turnover	59,276	0.90	0.65	1.03	0.00	33.72	5.73	96.37
Amihud's ILLIQ	59,276	2.66	0.01	12.80	0.00	112.15	6.91	54.05
B/M	59,276	0.76	0.58	0.70	-0.07	4.43	2.66	12.32
S&P 500	59,276	1.44%	0.00%	11.93%	0.00%	100%	8.14	67.26
Number of analysts	59,276	1.19	1.10	0.98	0.00	3.81	0.20	1.85

Table 2: Descriptive statistics: Lending supply quintiles

The table shows quarterly descriptive statistics for U.S. stocks sorted by equity lending supply quintiles between August 2006 and December 2010. Equity lending data are provided by Markit; price data are from CRSP; ownership data are from SEC's 13F holdings (CDA/Spectrum s34); index fund ownership is constructed from mutual fund holdings data (CDA/Spectrum s12); and accounting data are from Compustat. Panel A reports the equity lending characteristics: Obs_{Supply} is the number of firm-quarter observations for which lending supply data are available. Panel B reports the institutional ownership and portfolio characteristics. Panel C reports the price data. The variable definitions are defined in the Appendix.

A. Equity lending

Quintile	Obs_{Supply}	Supply	On loan	Fee	Specialness	Utilization	Fee score
1	11,856	2.83%	0.62%	186.98	0.41	14.45%	2.01
2	11,855	11.32%	2.85%	81.63	0.16	20.37%	1.47
3	11,855	20.04%	4.78%	34.71	0.05	20.01%	1.17
4	11,855	27.28%	5.99%	23.46	0.03	18.88%	1.10
5	11,855	38.65%	9.19%	26.13	0.03	22.53%	1.12
Total	59,276	20.02%	4.69%	70.59	0.14	19.25%	1.38

B. Institutional ownership

Quintile	Total	HHI	Top 5	Top 5–LT	% Index	Port. conc.	Breadth
1	17.5%	30.4%	85.7%	61.9%	1.1%	0.04%	21
2	42.8%	13.3%	63.1%	44.2%	3.7%	0.51%	79
3	65.1%	7.0%	46.2%	30.4%	6.2%	0.56%	202
4	78.4%	5.1%	39.7%	25.0%	7.4%	0.39%	227
5	87.9%	4.7%	38.1%	23.7%	8.5%	0.20%	176
Total	58.3%	12.1%	54.6%	37.0%	5.4%	0.34%	141

C. Pricing and other variables

Quintile	Price	Mkt. cap (bil.)	μ(Ret)	σ(Ret)	Arb. risk	Turnover	β_{mkt}
1	10.74	261	6.40%	4.60%	4.46	0.33	0.36
2	18.03	2,535	5.40%	3.70%	3.28	0.59	0.76
3	26.54	7,463	5.40%	3.10%	2.46	0.97	1.00
4	31.14	5,841	3.10%	2.90%	2.23	1.19	1.06
5	27.48	2,334	-8.00%	3.30%	2.53	1.43	1.08
Total	22.79	3,687	2.50%	3.50%	2.99	0.90	0.85

Table 3: Lending supply and ownership structure

The table displays regressions of equity lending supply as a function of corporate ownership measures, with quarterly stock data between August 2006 and December 2010 for U.S. firms. All explanatory variables are standardized each quarter such that they have zero mean and unit standard deviation. All regressions include year-quarter dummies, and standard errors are double-clustered at the stock and quarterly level. The variable definitions are defined in the Appendix. We report standard errors in brackets, and the significance levels are indicated as follows: ** and *** indicate significance at the 5% and 1% level, respectively.

	Lending supply				
	(1)	(2)	(3)	(4)	(5)
Total	0.447***	0.441***	0.411***	0.443***	0.460***
	[0.027]	[0.027]	[0.027]	[0.027]	[0.027]
HHI		-0.043***			
		[0.009]			
Top 5			-0.159***		
			[0.017]		
Top 5–LT			0.029***		
			[0.007]		
% Index				0.026***	
				[0.004]	
Port. conc.					-0.091***
					[0.006]
Δ(Breadth)	-0.008	-0.007	-0.003	-0.007	-0.007
	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]
Mkt. cap	0.388***	0.373***	0.316***	0.382***	0.418***
	[0.051]	[0.051]	[0.052]	[0.051]	[0.051]
$D_{P<5}$	-0.049**	-0.047*	-0.045*	-0.049**	-0.048**
	[0.024]	[0.024]	[0.025]	[0.024]	[0.024]
Amihud's ILLIQ	-0.002	-0.001	-0.004*	-0.002	-0.002
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Turnover	0.029***	0.027***	0.022***	0.029***	0.026***
	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]
B/M	0.191***	0.190***	0.190***	0.189***	0.184***
	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]
$D_{S\&P500}$	0.017	0.023	0.075	0.017	0.042
	[0.445]	[0.445]	[0.440]	[0.450]	[0.442]
Number of analysts	0.015***	0.015***	0.013***	0.015***	0.014***
	[0.005]	[0.005]	[0.004]	[0.005]	[0.005]
Momentum	-0.001	-0.001	-0.001	-0.001	-0.001
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
Obs.	59,055	59,055	59,055	59,055	59,055
Firms	4,266	4,266	4,266	4,266	4,266

Table 4: Short-sale constraints and ownership structure

The table displays a regression of short-sale constraints as a function of ownership structure, with quarterly stock data between August 2006 and December 2010 of U.S. firms. Columns (1)-(6) present evidence for *Fee*, and Columns (7) - (12) present evidence for arbitrage risk (*Arb. risk*), defined as the mean squared error of residuals from Carhart's (1997) four-factor model. For predicted supply, we decompose lending supply as a function of total ownership (*Total*) and ownership concentration (*HHI*). *Predicted supply* is the predicted component from this regression of *Supply* on institutional ownership (*Total*) and (*HHI*). The variable definitions are defined in the Appendix. We report standard errors in brackets, and the significance levels are indicated as follows: ** and *** indicate significance at the 5% and 1% level, respectively.

	Fee						*Arb. Risk*					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Total	-0.063**	-0.056**	-0.032	-0.063**	-0.063**		-0.117***	-0.110***	-0.108***	-0.116***	-0.116***	
	[0.028]	[0.028]	[0.028]	[0.028]	[0.028]		[0.018]	[0.018]	[0.017]	[0.018]	[0.018]	
HHI		0.052**						0.049**				
		[0.024]						[0.021]				
Top 5			0.154***						0.049***			
			[0.023]						[0.017]			
Top 5–LT			-0.052***						-0.019*			
			[0.011]						[0.012]			
% Index				0.003						-0.010**		
				[0.004]						[0.004]		
Port. conc.					0.015*						0.016**	
					[0.008]						[0.007]	
Predicted Supply						-0.161***						-0.279***
						[0.060]						[0.046]
Δ(Breadth)	-0.002	-0.003	-0.006	-0.002	-0.002	-0.003	-0.018	-0.020*	-0.020*	-0.018	-0.018	-0.020*
	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.011]	[0.012]	[0.012]	[0.011]	[0.011]	[0.011]
Mkt. cap	-0.363***	-0.345***	-0.304***	-0.364***	-0.368***	-0.296***	-0.925***	-0.907***	-0.907***	-0.922***	-0.930***	-0.812***
	[0.058]	[0.058]	[0.059]	[0.058]	[0.058]	[0.067]	[0.053]	[0.056]	[0.055]	[0.053]	[0.052]	[0.064]
$D_{P<5}$	-0.028	-0.030	-0.031	-0.028	-0.029	-0.037	0.240***	0.238***	0.239***	0.240***	0.239***	0.225***
	[0.028]	[0.028]	[0.028]	[0.028]	[0.028]	[0.029]	[0.029]	[0.029]	[0.029]	[0.029]	[0.029]	[0.030]
Amihud's ILLIQ	-0.016	-0.017*	-0.013	-0.016	-0.016	-0.016	0.074***	0.073***	0.075***	0.074***	-0.074***	-0.074***
	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]
Turnover	0.115***	0.116***	0.118***	0.115***	0.115***	0.119***	0.431***	0.433***	0.432***	0.431***	0.432***	0.439***
	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]	[0.021]	[0.020]	[0.020]	[0.021]	[0.021]	[0.021]
B/M	0.000	0.000	0.000	0.000	0.001	0.031*	-0.022	-0.022	-0.022	-0.022	-0.021	0.031*
	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]	[0.019]	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]	[0.018]
$D_{S\&P500}$	0.147*	0.140*	0.091	0.147*	0.143*	0.148	0.123	0.116	0.105	0.123	0.118	0.126
	[0.076]	[0.079]	[0.099]	[0.076]	[0.079]	[0.136]	[0.169]	[0.167]	[0.171]	[0.167]	[0.166]	[0.269]
No. of analysts	0.008	0.009	0.010*	0.008	0.009	0.011*	-0.011*	-0.011*	-0.011*	-0.011*	-0.011*	-0.007
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.006]	[0.007]	[0.007]	[0.007]	[0.006]	[0.006]	[0.007]
Momentum	0.009	0.009	0.009	0.009	0.008	0.008	0.003	0.003	0.003	0.003	0.003	0.002
	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.008]	[0.008]	[0.008]	[0.009]	[0.009]	[0.009]
Obs.	59,055	59,055	59,055	59,055	59,055	59,055	59,055	59,055	59,055	59,055	59,055	59,055
Firms	4,266	4,266	4,266	4,266	4,266	4,266	4,266	4,266	4,266	4,266	4,266	4,266

Table 5: Propensity score-matched sample results

The table shows the impact of ownership structure on lending supply, loan fee, and arbitrage risk on a propensity-score matched sample of U.S. stocks between August 2006 and December 2010. The propensity scores are computed from a 1:1 matching without replacement based on the covariates and interactions, with a 0.01 caliper. Panel A presents results for *HHI*; panel B presents results for *Top 5* and *Top 5–LT*; panel C presents results for *%Index*; and panel D presents results for *Port. conc.* respectively. The treatment variable is a dummy variable equal to 1 if firms are in the top quartile in a given quarter in all panels, with the exception of panel C, where we use the bottom quartile. In panel A, of the 14,819 treatment observations we can find matches for 5,280 observations, with the total sample comprising 10,560 observations (5,280 treatment and 5,280 matched control stocks). Similarly, in panel B, we find matches for 6,006 observations, in panel C we find matches for 11,899 observations, and in panel D we find matches for 11,942 observations. All variables are standardized each quarter such that they have zero mean and unit standard deviation. All regressions follow the same specifications as in Tables 3 and 4 and include stock characteristics, stock fixed effects, and year-quarter dummies. The variable definitions are defined in the Appendix. We report standard errors in brackets, and the significance levels are indicated as follows: ** and *** indicate significance at the 5% and 1% level, respectively.

A. HHI

	Supply	Fee	Arb. risk
Total	0.325***	-0.092	-0.122***
	[0.029]	[0.062]	[0.038]
HHI	-0.074***	0.099***	0.043*
	[0.014]	[0.036]	[0.027]
Obs.	10,560	10,560	10,560

B. Top 5 & Top 5–LT

	Supply	Fee	Arb. risk
Total	0.315***	-0.144**	-0.032
	[0.026]	[0.059]	[0.043]
Top 5	-0.140***	0.155***	0.059*
	[0.017]	[0.050]	[0.035]
Top 5–LT	0.012**	-0.043**	0.005
	[0.006]	[0.020]	[0.016]
Obs.	12,012	12,012	12,012

C. % Index

	Supply	Fee	Arb. risk
Total	0.416***	-0.093**	-0.104***
	[0.020]	[0.039]	[0.030]
% Index	0.010*	-0.004	-0.014**
	[0.005]	[0.006]	[0.007]
Obs.	23,798	23,798	23,798

D. Port. conc.

	Supply	Fee	Arb. risk
Total	0.447***	-0.031	-0.111***
	[0.022]	[0.036]	[0.021]
Port. conc.	-0.080***	0.009	0.008
	[0.007]	[0.009]	[0.006]
Obs.	23,884	23,884	23,884

Table 6: Evidence from SEC 13D filings

The table shows the impact of an activism-led ownership structure on lending supply, loan fee, and arbitrage risk using SEC 13D filings. For the 223 stocks associated with a SEC 13D filing, we examine ownership composition in the four quarters prior to filing and post-filing. In panel A, we present univariate tests of the differences in ownership characteristics, lendable supply, fee, and arbitrage risk (*Arb. risk*) around the filing. There are 723 observations in the pre-period and 783 observations in the post-period (1,506 stock-quarters in total). Block ownership is the fraction of institutional ownership held by investors with stakes greater than 5%. In panel B, we present evidence from the regression specification:

$$Y_{it} = \theta_i + \theta_t + \gamma Post_{it} + X'\beta + \varepsilon_{it}$$

where Y_{it} is one of the following: lending supply (*Supply*), loan fee (*Fee*), and arbitrage risk (*Arb. risk*),; $Post$ is an indicator variable equal to one in the post-13D filing period for stock i; and *X* is the set of control variables employed in Table 3, including $\Delta(Breadth)$, *Ln(Mkt. cap)*, $D_{P<5}$, *Amihud's ILLIQ*, $Turnover$, B/M, *No. of analysts*, $D_{S\&P500}$, and $Momentum$. All regressions include stock fixed effects, and year-quarter dummies. Standard errors are clustered at the stock level. The variable definitions are defined in the Appendix. We report standard errors in brackets, and the significance levels are indicated as follows: ** and *** indicate significance at the 5% and 1% level, respectively.

A. Univariate evidence

	Pre	Post	Diff.
Block ownership	0.221	0.241	0.020***
Total ownership	0.626	0.603	-0.023
HHI	0.105	0.118	0.013**
% index	0.052	0.052	0.000
Supply (%)	21.65	19.63	-2.02***
Fee (bps)	56.48	73.52	17.04**
Arb. risk	3.26	3.64	0.38**

B. Difference-in-differences evidence

	Supply	Fee	Arbitrage Risk
Post	-0.165***	0.086**	0.124*
	[0.032]	[0.042]	[0.073]
Obs.	1,506	1,506	1,506
Firms	223	223	223

Table 7: Stock concentration measures and abnormal returns after shorting demand shocks

The table shows the averages of weekly abnormal returns of portfolios sorted on outward demand shocks (DOUT) in the previous week and alternative measures of concentration in the previous quarter using U.S. stock data from August 2006 to December 2010. Abnormal returns are defined as the difference in weekly returns relative to a matched benchmark portfolio sorted by market capitalization, book-to-market, and momentum as in Daniel et al. 1997. *DOUT* captures outward equity lending demand shocks, and is equal to 1 if in the previous week there is an increase in the fee score and an increase in loaned amount and 0 otherwise. Within each value of *DOUT* in the previous week, we sort stocks into quartiles using alternative concentration measures and define an indicator variable equal to 1 if the stock is in the top quartile and 0 otherwise. Panel A (*HHI*) is based on the Hirschman-Herfindahl index of institutional ownership examines. Panel B (*Residual HHI*) uses the residuals of a regression of *HHI* on total institutional ownership. Panel C (*Residual % Index*) uses the residuals of a regression of (*%Index*) on total institutional ownership. Panel D (*Residual Port. conc.*) uses the residuals of a regression of (*Port. conc.*) on total institutional ownership. The variable definitions are defined in the Appendix. We report standard errors in brackets, and the significance levels are indicated as follows: ** and *** indicate significance at the 5% and 1% level, respectively.

A. HHI

	Top HHI		
DOUT	0	1	1–0
0	0.003	0.004	0.001
1	-0.002	-0.471	-0.469***
1–0	-0.005	-0.475***	-0.470***

B. Residual HHI

	Top residual HHI		
DOUT	0	1	1–0
0	0.010	0.049	0.039
1	0.008	-0.435	-0.443**
1–0	-0.002	-0.484***	-0.482***

C. Residual % index

	Top residual % index		
DOUT	0	1	1–0
0	0.015	0.017	0.002
1	-0.126	-0.044	0.082
1–0	-0.141	-0.061	0.080

D. Residual Port. conc.

	Top residual port. conc.		
DOUT	0	1	1–0
0	0.021	-0.052	-0.073***
1	-0.139	-0.053	0.086
1–0	-0.160***	-0.001	0.159

Table 8: Impact of ownership structure stock returns following shorting demand shocks

The table displays the regressions of abnormal returns as a function of equity lending market shocks and lagged ownership characteristics using weekly U.S. stock data between August 2006 and December 2010. Abnormal returns are based on a characteristics-matched benchmark portfolio sorted by market capitalization, book-to-market, and momentum as in Daniel et al. (1997). *DOUT* captures outward equity lending demand shocks, and is equal to 1 if in the previous week there is an increase in the fee score and an increase in loaned amount and 0 otherwise. *DIN* equals 1 if there is a decrease in both fee scores and loaned amount. For each variable *X*, we construct an indicator variable, $Top(X)$ ($Bottom(X)$), equal to 1 if the stock is in the top (bottom) quartile and 0 otherwise. *Total* is ownership by institutional holders, and *Arbitrage risk* is the mean squared error of residuals from Carhart's (1997) four-factor model. Stock concentration variables are defined in the appendix. All regressions include calendar-month dummies, prior week's abnormal returns, S&P 500 membership indicator, and a dummy variable equal to 1 if the share price is below $5 in the previous week, the log of previous quarter's analyst coverage, Amihud's ILLIQ, and average daily turnover. The variable definitions are defined in the Appendix. We report standard errors in brackets, and the significance levels are indicated as follows: ** and *** indicate significance at the 5% and 1% level, respectively.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
DOUT	-0.199**	-0.097	-0.025	-0.114	-0.097	-0.102
	[0.091]	[0.104]	[0.102]	[0.107]	[0.103]	[0.114]
DIN	-0.084	-0.092	-0.082	-0.080	-0.077	-0.076
	[0.079]	[0.076]	[0.075]	[0.075]	[0.075]	[0.075]
Bottom(Total)		-0.031	-0.025	-0.020	0.014	0.016
		[0.053]	[0.053]	[0.052]	[0.047]	[0.050]
DOUT*Bottom(Total)		0.105	0.144	0.103	-0.057	-0.018
		[0.198]	[0.200]	[0.200]	[0.198]	[0.202]
Top(Arb. risk)			-0.101	-0.098	-0.087	-0.090
			[0.062]	[0.062]	[0.061]	[0.060]
DOUT*Top(Arb. risk)			-0.436*	-0.418*	-0.496**	-0.494**
			[0.245]	[0.250]	[0.241]	[0.241]
Top(HHI)		0.096***	0.107***			
		[0.037]	[0.039]			
DOUT*Top(HHI)		-0.516**	-0.452**			
		[0.226]	[0.229]			
Top(Top 5)				0.090**		
				[0.040]		
DOUT*Top(Top 5)				-0.398*		
				[0.240]		
Top(Top 5–LT)				0.035		
				[0.028]		
DOUT*Top(Top 5–LT)				0.332*		
				[0.194]		
Top(% index)					0.020	
					[0.036]	
DOUT*Top(% index)					0.104	
					[0.181]	
Top(Port. conc.)						-0.019
						[0.030]
DOUT*Top(Port. conc.)						0.083
						[0.156]
Obs.	670,532	670,532	670,532	670,532	670,532	670,532
Firms	4,581	4,581	4,581	4,581	4,581	4,581

Table 9: Impact of ownership structure on returns following earnings announcements

The table displays regressions of cumulative abnormal returns following earnings announcements. The dependent variables are *CAR1*, defined as the cumulative abnormal returns during the *[t-1,t+1]* window around the Compustat announcement date as in Livnat and Mendenhall (2006); *CAR2* is the cumulative return during the *[t+2,t+10]* period; and *CAR3* is the cumulative returns from two days after the announcement to the following quarterly earnings announcement date (*CAR3*). *SUE* is the standardized unexpected earnings, based on the IBES analyst forecasts and scaled by announcement-day price. D^{SUE} is an indicator variable equal to 1 if, in a given quarter, the stock is in the bottom quintile and 0 if it is in the top quintile. For all other control variables *"X"*, D^{X} is defined as being equal to 1 if "*X*" in the top quintile in the previous quarter and 0 otherwise. *Arb. risk* is the mean squared error of residuals from Carhart's (1997) four-factor model, and *Total* is institutional ownership. Stock concentration variables are similar to those used in Table 8 and defined in the appendix. All regressions include year fixed effects and standard errors are clustered at the firm level. The variable definitions are defined in the Appendix. We report standard errors in brackets, and the significance levels are indicated as follows: ** and *** indicate significance at the 5% and 1% level, respectively.

	CAR1				**CAR2**				**CAR3**			
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Intercept	3.995***	2.774***	2.559***	3.962***	1.126***	0.766**	1.079*	1.091***	0.555	2.414**	2.036	-0.114
	[0.194]	[0.433]	[0.870]	[0.420]	[0.183]	[0.360]	[0.654]	[0.396]	[0.464]	[0.947]	[1.793]	[1.006]
D^{SUE}	-7.789***	-7.396***	-8.493***	-7.172***	-2.272***	-0.324	-0.712	-2.499***	-3.224***	-0.680	0.276	-2.737***
	[0.203]	[0.463]	[0.984]	[0.446]	[0.189]	[0.469]	[1.011]	[0.441]	[0.453]	[1.132]	[2.306]	[1.056]
$D^{Arb.\ risk}$	-0.122	0.514	0.076	-0.723	-0.202	-0.782	-1.448	0.05	2.607***	3.041**	-0.340	3.313***
	[0.321]	[0.556]	[0.789]	[0.458]	[0.301]	[0.575]	[0.882]	[0.476]	[0.711]	[1.339]	[2.114]	[1.081]
$D^{SUE} * D^{Arbitrage\ risk}$	0.119	-1.202	-0.376	0.666	0.869**	1.619**	2.037*	0.707	-1.289	-1.771	2.971	-2.323
	[0.429]	[0.759]	[1.187]	[0.590]	[0.426]	[0.801]	[1.234]	[0.639]	[1.048]	[1.991]	[3.049]	[1.527]
D^{TOTAL}	0.888***	0.74	0.433	1.101**	-0.715***	0.067	-0.302	0.086	-0.666	0.502	1.662	1.055
	[0.302]	[0.481]	[0.709]	[0.536]	[0.240]	[0.406]	[0.681]	[0.451]	[0.600]	[1.046]	[1.800]	[1.156]
$D^{SUE} * D^{TOTAL}$	-1.887***	-1.846**	0.304	-1.359*	1.096***	-0.955	0.079	0.812	1.548	-0.350	0.799	-0.883
	[0.448]	[0.759]	[1.274]	[0.755]	[0.360]	[0.679]	[1.203]	[0.705]	[1.002]	[1.835]	[2.800]	[1.837]
D^{HHI}		-0.606				0.988**				-0.002		
		[0.461]				[0.446]				[1.153]		
$D^{SUE} * D^{HHI}$		2.168***				-2.761***				-4.703***		
		[0.665]				[0.691]				[1.677]		
D^{TOP5}			0.057				1.402**				3.676*	
			[0.751]				[0.715]				[1.954]	
$D^{SUE} * D^{TOP5}$			2.430**				-2.997***				-8.786***	
			[1.166]				[1.162]				[2.751]	
$D^{TOP5--LT}$			0.712				0.753				3.324**	
			[0.714]				[0.538]				[1.665]	
$D^{SUE} * D^{TOP5--LT}$			-0.562				0.629				-3.403	
			[1.058]				[0.943]				[2.483]	
$D^{Port.conc.}$				-0.782*				-0.131				0.154
				[0.408]				[0.383]				[0.938]
$D^{SUE} * D^{Port.conc.}$				0.250				0.037				-0.822
				[0.545]				[0.533]				[1.305]
Obs.	14,037	4,080	1,596	5,866	14,037	4,080	1,596	5,866	14,037	4,080	1,596	5,866
Firms	2,720	1,387	840	1,763	2,720	1,387	840	1,763	2,720	1,387	840	1,763

References

Admati, A. R., and P. Pfleiderer. 2009. The "Wall Street Walk" and shareholder activism: Exit as a form of voice. *Review of Financial Studies* 22:2445–85.

Aggarwal, R., P. A. C. Saffi, and J. Sturgess. 2015. The role of institutional investors in voting: Evidence from the securities lending market. *The Journal of Finance* 70:2309–46.

Akbas, F., E. Boehmer, B. Erturk, and S. M. Sorescu. 2008. Why do short interest levels predict stock returns? Working Paper .

Asquith, P., P. A. Pathak, and J. R. Ritter. 2005. Short interest, institutional ownership and stock returns. *Journal of Financial Economics* 78:243–76.

Autore, D. M., T. J. Boulton, and M. V. Braga-Alves. 2015. Failures to deliver, short sale constraints, and stock overvaluation. *Financial Review* 50:143–72.

Avramov, D., T. Chordia, G. Jostova, and A. Philipov. 2013. Anomalies and financial distress. *Journal of Financial Economics* 108:139–59.

Bakke, T.-E., and T. M. Whited. 2010. Which firms follow the market? An analysis of corporate investment Decisions. *Review of Financial Studies* 23:1941–80.

Bernard, V. L., and J. K. Thomas. 1990. Evidence that stock prices do not fully reflect the implications of current earnings for future earnings. *Journal of Accounting and Economics* 13:305–40.

Blocher, J., A. V. Reed, and E. D. Van Wesep. 2013. Connecting two markets: An equilibrium framework for shorts, longs, and stock loans. *Journal of Financial Economics* 108:302–22.

Blocher, J., and R. E. Whaley. 2015. Passive investing: The role of securities lending. Vanderbilt Owen Graduate School of Management Research Paper no. 2474904 .

Boehmer, E., C. M. Jones, and X. Zhang. 2008. Which shorts are informed? *Journal of Finance* 63:491–527.

Carhart, M. M. 1997. On persistence in mutual fund performance. *Journal of Finance* 52:57–82.

Chen, J., H. Hong, and J. C. Stein. 2002. Breadth of ownership and stock returns. *Journal of Financial Economics* 66:171–205.

Chen, Q., I. Goldstein, and W. Jiang. 2010. Payoff complementarities and financial fragility: Evidence from mutual fund outflows. *Journal of Financial Economics* 97:239–62.

Chen, X., J. Harford, and K. Li. 2007. Monitoring: Which institutions matter? *Journal of Financial Economics* 86:279–305.

Christoffersen, S. E., C. C. Geczy, D. K. Musto, and A. V. Reed. 2005. Crossborder dividend taxation and the preferences of taxable and nontaxable investors: Evidence from Canada. *Journal of Financial Economics* 78:121–144.

Cohen, L., K. B. Diether, and C. J. Malloy. 2007. Supply and demand shifts in the shorting market. *Journal of Finance* 62:2061–2096.

Daniel, K., M. Grinblatt, S. Titman, and R. Wermers. 1997. Measuring mutual fund performance with characteristic-based benchmarks. *Journal of Finance* 52:1035–58.

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

Diamond, D. W., and R. E. Verrecchia. 1987. Constraints on short-selling and asset price adjustment to private information. *Journal of Financial Economics* 18:277–311.

Diether, K. B., K.-H. Lee, and I. M. Werner. 2009. Short-sale strategies and return predictability. *Review of Financial Studies* 22:575–607.

Drechsler, I., and Q. F. S. Drechsler. 2014. The shorting premium and asset pricing anomalies. Working Paper, NYU Stern .

Duan, Y., G. Hu, and R. D. McLean. 2010. Costly arbitrage and idiosyncratic risk: Evidence from short sellers. *Journal of Financial Intermediation* 19:564–79.

Duffie, D., N. Gârleanu, and L. H. Pedersen. 2002. Securities lending, shorting, and pricing. *Journal of Financial Economics* 66:307–39.

Edmans, A. 2009. Blockholder trading, market efficiency, and managerial myopia. *Journal of Finance* 64:2481–513.

Edmans, A., I. Goldstein, and W. Jiang. 2012. The Real effects of financial markets: The impact of prices on takeovers. *Journal of Finance* 67:933–71.

Edmans, A., and G. Manso. 2011. Governance through trading and intervention: A theory of multiple blockholders. *Review of Financial Studies* 24:2395–428.

Engelberg, J. E., A. V. Reed, and M. C. Ringgenberg. 2012. How are shorts informed? Short sellers, news, and information processing. *Journal of Financial Economics* 105:260–78.

–, –, –. 2013. Short selling risk. Working Paper.

Evans, R., M. A. Ferreira, and M. P. Prado. 2014. Equity lending, investment restrictions, and fund performance. Working Paper.

Gaspar, J. M., M. Massa, and P. Matos. 2005. Shareholder investment horizons and the market for corporate control. *Journal of Financial Economics* 76:135–65.

Goldstein, I., and A. Guembel. 2008. Manipulation and the allocational role of prices. *Review of Economic Studies* 75:133–64.

Grundy, B. D., B. Lim, and P. Verwijmeren. 2012. Do option markets undo restrictions on short sales? Evidence from the 2008 short-sale ban. *Journal of Financial Economics* 106:331–48.

Hartzell, J. C., and L. T. Starks. 2003. Institutional investors and executive compensation. *Journal of Finance* 58:2351–74.

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

Imbens, G. 2014. Matching methods in practice: Three examples. NBER Working Paper.

Kahn, C., and A. Winton. 1998. Ownership structure, speculation, and shareholder intervention. *Journal of Finance* 53:99–129.

Kaplan, S. N., T. J. Moskowitz, and B. A. Sensoy. 2013. The Effects of stock lending on security prices: An experiment. *Journal of Finance* 68:1891–936.

Keim, D. B., and A. Madhavan. 1998. The cost of institutional equity trades. *Financial Analysts Journal* 54:50–69.

Kolasinski, A. C., A. V. Reed, and M. C. Ringgenberg. 2013. A multiple lender approach to understanding supply and search in the equity lending market. *Journal of Finance* 68:559–95.

Lamont, O. A. 2012. Go down fighting: Short sellers vs. firms. *Review of Asset Pricing Studies* 2:1–30.

Livnat, J., and R. R. Mendenhall. 2006. Comparing the post-earnings announcement drift for surprises calculated from analyst and time series forecasts. *Journal of Accounting Research* 44:177–205.

Maug, E. 1998. Large shareholders as monitors: Is there a trade-off between liquidity and control? *Journal of Finance* 53:65–98.

Mendenhall, R. R. 2004. Arbitrage risk and post-earnings-announcement drift. *Journal of Business* 77:875–94.

Miller, E. M. 1977. Risk, uncertainty, and divergence of opinion. *Journal of Finance* 32:1151–68.

Nagel, S. 2005. Short sales, institutional investors and the cross-section of stock returns. *Journal of Financial Economics* 78:277–309.

Petersen, M. A. 2009. Estimating standard errors in finance panel data sets: Comparing approaches. *Review of Financial Studies* 22:435–80.

Pontiff, J. 2006. Costly arbitrage and the myth of idiosyncratic risk. *Journal of Accounting and Economics* 42:35–52.

Prado, M. P. 2015. Future lending income and security value. *Journal of Financial and Quantitative Analysis*, 4:869–902.

Saffi, P. A. C., and K. Sigurdsson. 2011. Price efficiency and short-selling. *Review of Financial Studies* 24:821–52.

Shleifer, A., and R. W. Vishny. 1997. The limits of arbitrage. *Journal of Finance* 52:35–55.

Stambaugh, R., J. Yu, and Y. Yuan. 2012. The short of it: Investor sentiment and anomalies. *Journal of Financial Economics* 104:288–302.

Wurgler, J., and E. Zhuravskaya. 2002. Does arbitrage flatten demand curves for stocks? *Journal of Business* 75:583–608.