The Rise of the Equity Lending Market: Implications for Corporate Financial Policies

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Abstract

Ever increasing competition and search for yield have prompted institutional investors to routinely lend their equity holdings, making them the largest suppliers of stocks used for short selling. Shorting depresses stock prices, making it harder for firms to plan their payout policies, investments, merger deals, and employee compensation. We exploit the framework of institutional investing to show how shifts in the supply of lendable (shortable) stocks affect corporate policies. Firms react promptly to increases in lendable stocks by repurchasing shares and building cash reserves. The relations we document appear to be causal and consistent with the argument that firms shore up defenses against shorting activity. To fund their responses, firms pay fewer dividends, issue debt, and reduce investment spending. Firm responses are more pronounced when stocks are ex-ante more liquid, relatively overvalued, have higher pent-up shorting demand, and whose managers' personal compensation is more sensitive to stock prices.

Keywords: Equity lending market, cash holdings, share repurchases, short sales constraints, institutional ownership, instrumental variables.

JEL classification: G23, G32, G35.

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1 Introduction

It is based on equity prices that managers estimate their companies' cost of capital, plan merger deals, establish payout policies, and even design employee compensation schemes. Unsurprisingly, managers dislike events that devalue their companies' stock or that add volatility to the price formation process. Indeed, the vast majority of managers say they initiate repurchase programs when their companies' stock trade at depressed price levels (Brav et al. (2008)), and evidence shows that firms buy back their shares to reduce price volatility (Hong et al. (2008)). As shown in theoretical work, price manipulation — especially by short sellers — can significantly distort the allocation of corporate resources (Goldstein and Guembel (2008) and Khanna and Mathews (2012)). Managers will be concerned with the development of market institutions and practices that facilitate stock price manipulation (Edmans et al. (2015)).

While managers cannot control stock prices, they can influence the trading of their companies' shares. Like central bankers in currency markets, corporate managers have near-monopoly power over the supply of (own-)company stocks going into the market: they are uniquely entitled to issue fresh stocks. They can also repurchase existing stocks under large company-sponsored programs. Yet, managers' influence over their firms' stocks is limited. In particular, their ability to influence float depends on the existing pool of "lendable stocks" — stocks that are placed by company investors in the equity lending market. Interests in those stocks can be borrowed by speculators and other traders, enabling short selling strategies.[1] While the institutional framework regulating shorting has remained stable over recent years, the supply of lendable stocks has significantly increased, together with the unprecedented growth of institutional investing (Lewellen (2011)).

This study assesses the impact of the equity lending market on corporate financial policies, adding insight into how evolving market institutions shape firm behavior. It does so exploiting trends, rules, and ad hoc practices in institutional investing. Recent research establishes a strong connection between outward shifts in the supply of lendable stocks and the relaxation of short sales constraints (e.g., Kolasinski et al. (2013), Prado et al. (2014), and Aggarwal et al. (2015)).[2] Our analysis shows that firms respond to shifts in the supply of lendable stocks with policies that shore up their defenses against shorting. Among other responses,

[1] Boehmer and Wu (2013) document that short selling now accounts for almost one quarter of all trading in the U.S. stock market.

[2] Kolasinski et al. (2013), for example, show that when more shares are available to lend, speculators locate them more easily and pay lower borrowing fees, prompting shorting activity.

firms promptly repurchase stocks and hoard cash following increases in the supply of lendable stocks. In all, not only do firms act directly in reducing stock float, but also build reserves that enable them to sustain such policy across time. The relations we report appear to be causal and the economic magnitudes involved are significant. The various corporate policy responses we document seem coordinated and internally consistent. As we explain in detail, the tests we perform are informed and guided by the setting we consider, where well-identified shifts in institutional ownership generate pronounced, discrete changes in the supply of lendable stocks. To our knowledge, our study is the first to show the impact of the equity lending market on corporate financial management.

We start our investigation with standard models of the determinants of corporate stock repurchases and cash savings (e.g., Dittmar (2000), Grullon and Michaely (2002), Almeida et al. (2004), and Bates et al. (2009)). Performing fixed-effects (FE) estimations, we add a measure of *net lendable* (shortable) stock supply to models used in prior literature. In every estimation, we find a positive, statistically significant coefficient for the lendable supply measure. Conservative estimates in this basic set of tests suggest that a one-interquartile range (IQR) increase in a company's supply of lendable stocks is associated with 0.14% more stock repurchases and a 1.44% increase in cash holdings (both as a fraction of total assets) in the subsequent quarter. These figures are equivalent to 23.3% and 7.1% of the sample mean repurchase and cash holdings, respectively.

To tease out causality in the relations above, we implement test strategies that reflect the setting in which our investigation takes place. The growth of institutional ownership and the intensive use of trading strategies that rely on short selling have become the major drivers of activity in equity lending. A notable phenomenon that accompanies the growth in lendable stock supply is the surge of passive investing, attributed to the emergence of index funds and exchange-traded funds (ETFs). These funds are concerned with a firm's performance for as long as it belongs to their targeted benchmark portfolio — their goal is to minimize "tracking errors." They trade high volumes and buy large amounts of stocks in the firms they target. The figures involved are significant, with some 42% of all equity mutual funds in the U.S. today being dedicated to index investing (see Cremers et al. (2015)). Critically, one key aspect of index investing has become a concern to corporate managers. As a means to lower their investment costs and improve reported performance, index funds and ETFs customarily lend the stocks they own to other investors; primarily to investors interested in implementing shorting strategies (see Evans et al. (2014)). They do so indiscriminately, lending high quantities of

stocks at very low fees.[3] The supply of lendable stocks grew over 10-fold in the last decade.[4]

Passive investors' portfolio choices follow "style" and "diversification" strategies that can be used to help identify causal effects in our tests. To wit, increases in passive ownership lead to increases in lendable supply (*inclusion restriction*). Yet, these shifts are born out of developments in the competition for funds in the index investment industry and are otherwise independent from individual firm policies (*exclusion restriction*).[5] These observations allow us to propose and experiment with our first IV test strategy. We identify passive investors' holdings in firms and use this measure of ownership as an instrument for the supply of lendable stocks.[6] In this way, we pinpoint the effects of lendable supply on firm policies that are driven exclusively by variation in the ownership of passive institutional investors. As it turns out, this IV test also shows that outward shifts in the supply of lendable stocks prompt corporate managers to repurchase stocks and save cash.

The setting we explore allows us to consider additional strategies to identify the relation between the supply of lendable stocks and corporate policies. Because the composition of indices followed by index investors change discretely on a regular basis, one can use index reconstitutions as surrogates for "local shifts" in the supply of lendable stocks. Specifically, as firms are dropped and included in different indices, index funds are forced to reshuffle their investment in stocks affected by reconstitution. As the investment portfolio of those funds change, so does the supply of lendable stocks of the affected firms. In this setting, we focus on the annual reconstitutions of the Russell 1000 and Russell 2000 indices, whose memberships are composed of firms ranked according to their market capitalization. The indices are value-weighted so that stocks at the top of the index exhibit heavy buying by index funds, whereas stocks at the bottom receive close to none.

Transitions across the Russell 1000 and Russell 2000 indices allow for a two-sided approach to identifying changes in the supply of lendable stocks. As firms on the margin of the capitalization ranking cut-off switch from the very bottom of the Russell 1000 index to the very top of the Russell 2000 index, index investors need to buy large amounts of those firms' stocks to

[3]Blocher and Whaley (2015) estimate that ETFs earn 28 basis points per year from security lending.

[4]As of 2012, out of the $11 trillion U.S. stock market capitalization, $2.6 trillion (or 24%) were reported as being available for lending.

[5]Wurgler (2011) argues that index-based investing causes prices to be divorced from firms' fundamentals, lowering managers' incentives to gather and act upon firm-specific fundamental information. Grossman and Stiglitz (1980) provide the foundations for this argument in a general-equilibrium framework.

[6]We follow Bushee (1998) in identifying and classifying institutional investors into distinct style groups based on factor analysis. This approach has been used by, among others, Fang et al. (2014), Crane et al. (2014), Roosenboom et al. (2014), and Asker et al. (2015) to gauge the holdings of passive investors.

adjust their portfolios. As they do so, they make those stocks available in the equity lending market. Analogous dynamics occur when a stock moves from the top of the Russell 2000 index to the bottom of the Russell 1000 index. That is, this migration leads to a drop in ownership by index investors, triggering a decline in the supply of lendable stocks. We use this process to capture shifts in the supply of lendable stocks in our tests. These dynamics are outside of firm managers' control and, as we demonstrate, lead to sharp, localized shifts in the net supply of lendable stocks.

Using the Russell indexing reconstitution process, we follow Crane et al. (2014) and Appel et al. (2014) in designing a "local IV" test that allows us to identify the effects of changes in the supply of lendable stocks.[7] In a first-stage estimation, we recover the change in lendable supply that is induced by membership switching across Russell indices. In the second stage, we regress stock repurchases and cash on the component of lendable supply that is explained by membership changes across indices. This distinct IV strategy, too, shows that increases in the supply of lendable stocks prompt firms to repurchase stocks and build up reserves.

We extend our analysis in several ways to verify the robustness of our results and their internal logic. We show, for example, that the estimated effect of lendable supply on stock repurchases varies negatively with the amount of cash the firm saves. This is consistent with the logic of a binding budget constraint that forces managers to substitute between share buybacks and cash hoarding in responding to surges in the supply of lendable stocks. In other words, firms respond to a relaxation in shorting constraints by either immediately repurchasing shares or by accumulating cash war chests that allow them to respond to the threat of shorting in a time-consistent fashion. In that vein, we also show that an expansion in lendable supply increases the probability that firms publicly announce the authorization of repurchase programs in the following quarter. This is notable since such announcements enable firms to signal a response to the threat of shorting, yet they do not imply that firms immediately spend resources.[8] We further examine how other corporate policies are modified in order to fund increases in repurchases and cash. Firms pay fewer dividends, issue debt, and cut their investment following increases in the supply of lendable stocks.

Beyond mapping out how firms optimize resources in responding to shifts in the supply of

[7]To help organize our overall identification strategy, we call this test the "local IV" approach, in contrast to the "global IV" approach that uses passive ownership as an instrument described previously.

[8]A detailed study by Simkovic (2009) reveals that, on average, only 40% of the amount authorized under a buyback program is repurchased within one quarter after the announcement. Over a full year after the announcement, only 71% of the stocks are repurchased. The percentage of firms that fulfill their program authorization within one year of the announcement is only 44% (see also Stephens and Weisbach (1998)).

lendable stocks, we exploit firm heterogeneity that helps shore up our inferences. We show, for example, that shifts in lendable stock supply trigger stronger responses from those firms whose stocks are more liquid and easier to trade. That is, the degree by which investors can trade shares is rationally taken into account by managers when deciding how to respond to increases in lendable supply. We also find that companies respond with more aggressive repurchase policies when their stocks have higher pent-up short sales demand prior to shifts in lendable stocks. Likewise, stock repurchases are more sensitive to changes in lendable supply for firms whose stocks seem overvalued; that is, those that are expected to face a higher demand for shorting following a relaxation in short sales constraints. Finally, consistent with agency considerations, repurchase programs are particularly aggressive when managers' personal wealth (compensation) is sensitive to the market price of their companies' stock.

The precipitous growth of the equity lending market has sparked several new research agendas. Kolasinski et al. (2013) and Prado et al. (2014) describe relations between the supply of lendable stocks, institutional ownership, and limits to arbitrage. Massa et al. (2015) study whether the threat of shorting (measured by lendable supply) curbs earnings management, while Christoffersen et al. (2007) and Aggarwal et al. (2015) investigate voting behavior around shareholder meetings using lent equity. Our paper adds to this line of research showing how firm financial policies are shaped by the evolving nature of the equity lending market.

Research on financial management proposes several motivations for firms' repurchase and cash policies. Empirical work by Stephens and Weisbach (1998) and Dittmar (2000) shows that firms repurchase shares to take advantage of undervalued equity, to change their leverage ratios, and to prevent takeovers. Research on the drivers of corporate cash run a gamut ranging from the need to minimize the impact financing constraints on investment (Almeida et al. (2004)) to concerns about cash flow risk (Bates et al. (2009)) and product market competition (Fresard (2010)). Notably, existing papers have not examined how share repurchase programs and cash savings policies can be used as safeguard against shorting, nor the extent to which firm policies jointly conform to changes in the supply of shortable stocks.

Methodologically, our study builds on recent literature looking at the impact of index investing and index reconstitution. Appel et al. (2014) use the annual reconstitution of the Russell indices to study whether ownership by passive mutual funds affects corporate governance, while Crane et al. (2014) use the same index discontinuity to study whether ownership by institutions affects payout. Ferreira et al. (2010) consider revisions of the MSCI World index's country weights to estimate the intensity of cross-border activity. We follow these papers

in using instrumental variables to estimate the impact of index discontinuity on outcomes of interest. None of these papers, however, looks at how firms change their policies in response to shifts in the supply of lendable stocks.

The remainder of the paper is organized as follows. Section 2 discusses the growth of the equity lending market. Section 3 describes the data we use. Section 4 contains the baseline, fixed-effects regression results for the relation between corporate policies and the supply of lendable stocks. Section 5 presents results from an instrumental variables approach that uses passive institutional ownership as an instrument for the supply of lendable stocks. Section 6 implements an alternative instrumental estimation approach derived from rules dictating membership in the Russell indices. Section 7 provides a number of tests designed to check the robustness and logic of our main results. Section 8 use cross-firm heterogeneity to corroborate and extend our findings. Section 9 concludes.

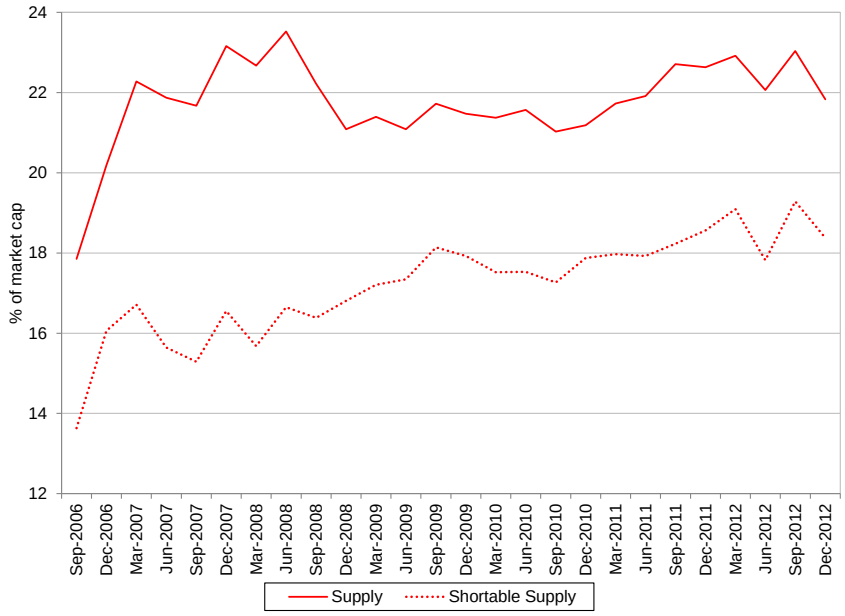
2 The Equity Lending Market

Investors wishing to short a company's stock must borrow shares in the equity lending market. Borrowers pay a fee and put up collateral (usually 102% of the position's size) in exchange for their desired shares. The collateral is invested by the lenders, who return a certain fraction of the proceeds (called the rebate rate) back to the borrowers. The implied loan fee is defined as the difference between the risk-free interest rate and the rebate rate. Borrowers in this market are mostly investors setting up short positions, such as hedge funds.[9]

The growth of the equity lending market has been remarkable. Massa et al. (2015) report that the fraction of U.S. equities available for lending has increased from 0.4% in 2002 to 19.3% in 2009. An important feature of this growth is the role institutions play in the market: they are the largest suppliers of lendable stocks. Indeed, lending out equity holdings to secure extra revenues has become standard in the industry. CalPERS, for example, reports having earned $1.2 billion in revenues from security lending between 2000 and 2008; an additional 30 basis points to the pension fund's overall return performance (see also Blocher and Whaley (2015)). While stock lending is widespread among institutional investors, it is more pronounced among passive investors such as index funds and ETFs; vehicles that have become extraordinarily popular worldwide in recent years (see Cremers et al. (2015)).

[9]Stocks can also be borrowed for tax-arbitrage strategies or voting in shareholder meetings (see Christoffersen et al. (2005) and Aggarwal et al. (2015)).

Figure 1. Equity Lending Market Dynamics over Time



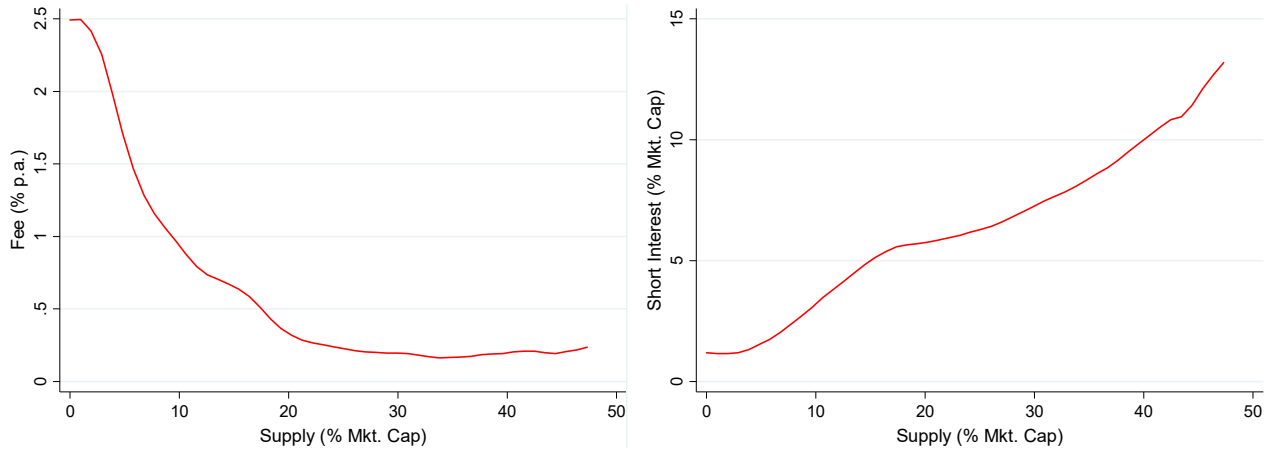
This figure shows quarterly averages of lendable supply measures of U.S. stocks. *Supply* is the number of shares available to lend as a fraction of total shares outstanding. *Shortable Supply* is the difference between shares available to lend and shares lent out as a fraction of total shares outstanding.

Data on the U.S. equity lending market is available from Markit for the 2006–2012 period. The Markit database covers over 90% of that market and contains firm-level information on the supply of lendable shares for the majority of stocks (see Saffi and Sigurdsson (2011)). Using these data, we define *Supply* as the value of a firm's lendable shares divided by its total market capitalization. At any point in time, some of the firm's lendable stocks are already lent out to other borrowers (*On Loan*), thus unavailable for shorting.[10] As such, we compute a measure of *net supply* (*Shortable Supply*), defined as the difference between *Supply* and *On Loan*.

Figure 1 depicts the time series evolution of supply in the equity lending market. The numbers are based on stocks available in the Markit dataset with information on CRSP; an average of 2,202 stocks in each quarter. The figure shows quarterly averages of the total fraction of firm stocks put up for lending (*Supply*) as well as the proportion of stocks available for immediate shorting (*Shortable Supply*). *Supply* increased from 17.8% of market capitalization in September 2006 to a peak of 23.5% in June 2008, right before the Lehman Brothers bankruptcy. Growth continued over time, nonetheless, reaching 21.9% of the market capitalization at the end of 2012, or $ 2.6 trillion. From September 2006 to September 2012, *Shortable Supply* grew

[10] *On Loan* is highly correlated with short interest, the fraction of shares held short and reported by Compustat. In our sample, the correlation between these two variables equals 0.81.

Figure 2. Supply of Lendable Shares and Short Selling Activity



This figure shows a kernel-weighted local polynomial regression of short selling activity measures (*Fee* and *Short Interest*) as a function of lendable supply (*Supply*). We use the Epanechnikov kernel to calculate estimates based on end-of-quarter stock data. *Fee* is the annualized stock loan fee and *Short Interest* is the number of shares shorted as a fraction of total shares outstanding. *Supply* is the number of shares available to lend as a fraction of total shares outstanding.

from 13.6% to 19.3% of the total market capitalization. These series showcase the significant increase in the amount of shares available shorting in a brief six-year period.

Figure 2 stresses the economic connection between the supply of lendable shares and measures of short selling activity. Using an Epanechnikov kernel-weighted local polynomial regression, we show that higher levels of lendable supply are associated with lower loan fees (*Fee*) and more short interest (*Short Interest*). These explicit connections are important in supporting the mechanism underlying our hypotheses: a higher supply of lendable shares eases short sales constraints, prompting shorting activity.

3 Sample Formation and Variable Construction

3.1 Sample Formation

We merge our Markit dataset with data from CRSP and Compustat. In conducting our tests, we follow prior literature and exclude firms that have total assets smaller than $10 million, firms that have missing entries for sales or cash holdings, and firms that have annual asset or sales growth in excess of 100%. We also exclude non-profits and governmental firms. Our final sample contains 53,875 firm-quarter observations from 3,100 unique firms.

3.2 Variables

Our analysis starts with standard empirical models of stock repurchase and cash savings. This section describes the variables used in our estimations. Variables are winsorized at the 1%-level to reduce the impact of outliers. Additional details on variable construction are given in the Appendix.

3.2.1 Dependent Variables

Our main dependent variables measure a firm's stock repurchases and cash holdings. We define *Repurchases* as the ratio of stock repurchases by a firm in a given quarter (Compustat's mnemonic *prstkc*) scaled by the firm's total assets (*atq*) in the prior quarter. Similarly, we compute *Cash* by dividing a firm's cash holdings in quarter *t* (*cheq*) by total assets in quarter *t–1*.[11]

3.2.2 Control Variables

Our basic set of control variables comes from a parsimonious model that includes *Cash Flow* (computed as *ibq* + *dpq*), *Market-to-Book* ((*prcc* × *csho* + *taq* – *ceq*)/*atq*), and log *Size* (*atq*), similar to Almeida et al. (2004). Following other studies in the stock repurchase and cash literatures (Dittmar (2000), Grullon and Michaely (2002), and Bates et al. (2009)), we extend that base set by adding net working capital (*NWC*) (or, *actq* – *lctq* – *cheq*), *Investment* (*capx*), *R&D* (*xrdq*), and *Acquisitions* (*aqc*); where all variables are scaled by total assets. Other variables in this set include a control for industry cash flow risk (*Industry Sigma*), which is the standard deviation of cash flows of firms with similar 2-digit SIC codes, and an indicator variable (*IPO*) that equals to 1 if the firm had its IPO in the past five years.

3.3 Descriptive Statistics

Table 1 reports the descriptive statistics of our sample. *Supply* and *Shortable Supply* represent, on average, some 22% and 17%, respectively, of a firm's total market capitalization. The average quarterly amount of share repurchases corresponds to 0.59% of total assets, but over half of the firms do not buy back shares; similar to figures reported in Crane et al. (2014). Firms keep an average of about 20% of their total assets as cash; similar to values reported

[11] Our inferences are the same if we subtract the amount of shares issued from observed repurchases ("net repurchases"). Results are also robust to using a measure of "excess cash" that is computed relative to a size-BM-industry-adjusted benchmark value (cf. Pinkowitz et al. (2013)).

by Bates et al. (2009), among others. The statistics for the dependent and control variables in our study are similar to those of prior studies and we omit a detailed discussion for brevity.

Table 1 About Here

4 Lendable Stocks, Repurchases, and Cash: Baseline Fixed-Effects Estimations

We start our analysis by adding the supply of lendable stocks to standard corporate stock repurchase and cash models. Our panel data specifications have the following form:

$$Y_{i,t+1} = \alpha + \beta Shortable\ Supply_{i,t} + \gamma' \mathbf{X}_{i,t} + \psi_i + \theta_t + \epsilon_{i,t}. \quad (1)$$

The dependent variable Y is measured, alternatively, by *Repurchases* or *Cash* in the following quarter; while the independent variable of interest, *Shortable Supply*, captures the excess lendable supply available for borrowing at the end of the current quarter. Two alternative sets of control variables are considered in the matrix $\mathbf{X}$. The first set contains *Size*, *Cash Flow*, and *Market-to-Book*. The second set further adds *NWC*, *Investment*, *R&D*, *Acquisitions*, *Industry Sigma*, and *IPO*. All models perform within-firm estimations where ψ_i captures firm-fixed effects. One can think of the results returned as describing within-firm changes in financial policies (*Repurchases* and *Cash*) following firm-specific changes in *Shortable Supply*. The models further account for time-fixed effects via θ_t, which absorbs year-quarter specific variation.

The OLS-FE estimations reported in Table 2 point to a positive response of stock repurchase activity and cash savings to shifts in the supply of lendable stocks. The results are economically and statistically significant. For repurchases, the 0.008 coefficient shown in column (1) implies that a one-interquartile range (IQR) change in *Shortable Supply* is associated with a 0.14% of total assets ($= 0.008 \times 17.08\%$) increase in stock repurchases in the following quarter. A similar coefficient is reported in column (2), when we control for a larger set of variables. Estimates in columns (3) and (4) also point to economically significant increases in cash holdings. A one-IQR change in *Shortable Supply* is associated with a 1.44% increase in cash-to-asset ratios, equivalent to 7.1% of the sample average for cash holdings.

Table 2 About Here

The results from Table 2 are consistent with the argument that firms increase their stock repurchases and cash balances when there are more stocks available for shorting; that is, when short sellers face fewer constraints. Inferences based on estimates reported in the table are, nevertheless, limited by the lack of exogenous variation in the supply of lendable stocks. In the remainder of the analysis, we strive to identify the impact of exogenous shifts in lendable supply on share repurchases and cash policies.

5 "Global" Instrumental Variables Estimation using Passive Institutional Ownership

Our baseline estimations suggest that the supply of lendable stocks influences corporate repurchases and savings over and above traditional drivers of those activities. It is difficult, however, to rule out the possibility that endogenous biases may confound our inferences. For example, D'Avolio (2002) shows that institutional ownership is a key driver of lendable supply. At the same time, institutions could pick stocks based on characteristics that are related to repurchases and savings decisions. As such, one could argue that institutional ownership should be included in Eq. (1). Whether or not we include institutional ownership in our models, we still find a significant, positive impact of supply of lendable stocks on corporate repurchases and cash. Critically, however, the simple inclusion of institutional ownership (or other observable confounders) as a control variable in standard repurchase and cash regressions will not thoroughly address the issue of supply endogeneity. As we discuss in turn, understanding the dynamics of recent developments in institutional investing is useful for the purpose of identifying our tests.

5.1 Test Set-Up

Institutions have dramatically increased their corporate equity ownership in the last 20 years.[12] There has been, in particular, a substantial growth in *passive* institutional ownership. This form of ownership is driven by market preferences that dictate "investing styles" and make investment funds interested in particular stocks for as long as they belong to an index or fulfill a "profile." Notably, the stock selection processes of these investors make it unlikely that their holdings are driven by (costly) considerations such as active corporate monitoring

[12]The average institutional ownership of public companies in the U.S. grew from 40% in 1995 to 70% in 2012.

and disciplining; considerations more often correlated with observed firm financial policies (e.g. Ben-David et al. (2014) and Massa et al. (2015)). These very market dynamics are posited by original theoretical work by Grossman and Stiglitz (1980), where, in equilibrium, market investors prefer not to bear the cost of monitoring individual firms (see also Wurgler (2011)).

Passive investors like index funds and ETFs regularly engage in equity lending. Indeed, Evans et al. (2014) show that passive funds have a much higher propensity to lend in this market than active funds. In what follows, we exploit changes in passive institutional ownership to identify variation in the supply of lendable stocks within an instrumental variables framework that follows Aggarwal et al. (2015) and Massa et al. (2015). In particular, our instrument choice is motivated by two important features of passive investing. First, securities lending provides an important source of revenue that allows passive investors to improve their competitive performance through lower management fee charges. Second, their main investment objective is to replicate targeted benchmark returns, making it unlikely that passive ownership is affected by firm-specific policies. This setting naturally lends itself to the proposed IV approach. To wit, increases in passive ownership should lead to increases in the supply of lendable stocks (*inclusion restriction*). Yet, these shifts are born out of dynamics in the competition for funds in the index investment industry and are otherwise unrelated to individual firms' policies (*exclusion restriction*).

Thomson-Reuters institutional holdings data collected from SEC 13F filings allow us to compute institutional ownership for each stock in a given quarter. With these data, we adopt Bushee's (1998) investor classification methodology to gauge the fraction of the firm's stock held by "Quasi-Indexers" funds and use it as a proxy for passive ownership of the firm (*Passive IO*).[13] Passive investment funds are defined by the SEC as those that have "investment results corresponding to the movements of a specified index," without the need for managers to select stocks on an active basis.

Our IV system's first-stage regression is written as follows:

$$Shortable\ Supply_{i,t} = \alpha_1 + \delta Passive\ IO_{i,t} + \ \phi' \mathbf{X}_{i,t} + \kappa_i + \mu_t + \xi_{i,t}, \tag{2}$$

where *Shortable Supply* is instrumented by *Passive IO*. The second stage is written as:

$$Y_{i,t+1} = \alpha_2 + \beta \widehat{Shortable\ Supply}_{i,t} + \gamma' \mathbf{X}_{i,t} + \psi_i + \theta_t + \epsilon_{i,t}, \tag{3}$$

[13]Brian Bushee's classification is at `http://acct.wharton.upenn.edu/faculty/bushee/IIvars.html`.

where $\widehat{Shortable\ Supply}_{i,t}$ is the first-stage's estimate of *Shortable Supply*. Our IV regressions also include firm- and year-quarter-effects, with standard errors clustered at the firm level.

5.2 Results

Panel A of Table 3 displays the first-stage coefficients of our IV system. As expected, *Passive IO* is an important shifter of lendable supply. A 1% increase in *Passive IO*, for example, increases *Shortable Supply* by 0.33% (0.32%) for the sample of firms with *Repurchases* (*Cash*) data. Notably, the first-stage tests for weak identification (*Weak ID*) strongly reject the null hypothesis of weak instrumental power.

TABLE 3 ABOUT HERE

Panel B reports the second-stage estimation, using the instrumented values of lendable supply ($\widehat{Shortable\ Supply}$) as the main independent variable. Results from these estimations confirm our earlier inferences: increases in the supply of lendable stocks prompt firms to repurchase more stocks and save more cash. To illustrate the economic meaning of our results, we note that the 0.299 coefficient for $\widehat{Shortable\ Supply}$ in column (4) implies that a one-IQR increase in $\widehat{Shortable\ Supply}$ is associated with a 5.1% increase in *Cash*, equivalent to a 25.1% spread relative to the mean *Cash* value. The IV estimations of Table 3 imply a causal relation whereby a relaxation in short sales constraints leads to managerial actions aimed at shoring up company defenses against short sellers.

6 "Local" Instrumental Variables Using Index Reconstitutions

A remarkable trend in institutional investing in the last decade is the growth of "index investing." In this investment category, funds are solely concerned with the goal of having portfolio returns that mimic as closely as possible the returns of their benchmark indices. Those funds' managers pursue their desired style by minimizing "tracking errors," which is achieved by a careful, dynamic rebalancing of the stocks in their portfolios so as to reflect the stocks in the targeted index. Because the composition of market indices changes discretely on a regular basis, one may use index changes to gauge "locally exogenous shifts" in the supply of

lendable stocks. These dynamics are outside of firm managers' control and represent a sharp, localized shift in lendable supply. In this section, we use changes in index membership of a given stock as the exogenous source of variation in the supply of lendable stocks ("local IV").

6.1 Institutional Setting

On the last trading day of May of each year, Russell's equity indices are formed, with eligible stocks being ranked by Russell's proprietary measure of stock market capitalization. The largest 1,000 firms are included in the Russell 1000 index while the next 2,000 make up the Russell 2000. Small changes in the capitalization of firms ranked near the 1000^{th} position cut-off make stocks move between these indices. Following the May index assignment, portfolio weights are reconstituted on the last Friday in June and index weights computed based on a free-float measure of market capitalization estimated by Russell.

An estimated $186 billion were invested in passive funds targeting the Russell 1000 and 2000 indices in 2011 (Chang et al. (2015)). Critically, a stock at the bottom of the Russell 1000 index will have a very small weight in the index and will thus be ignored by index investors. If the stock, however, moves to the top of the Russell 2000, then any funds that benchmark the Russell 2000 will have to buy it to minimize the tracking error.[14] These stocks will witness sudden drops in passive institutional ownership.

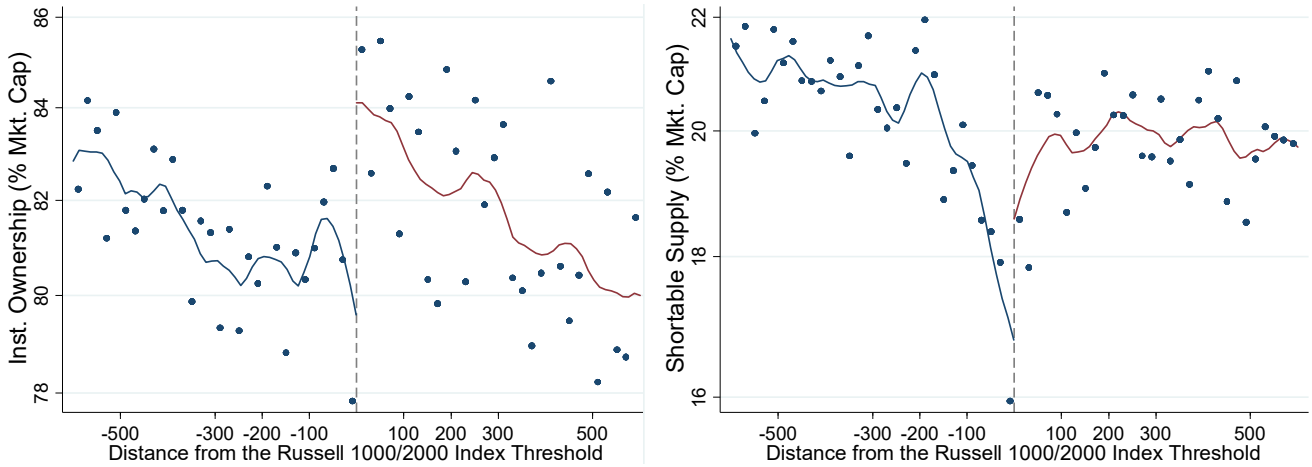
6.2 Graphical Analysis

We begin our examination of the joint discontinuity in institutional ownership and lendable supply with a graphical representation of what happens to variables of interest around the relevant index inclusion threshold. Figure 3 plots non-parametric polynomial splines estimated using an Epanechnikov kernel, with the bandwidth selected using the ROT method. The figure displays results for institutional ownership and the supply of lendable stocks around the Russell 1000/2000 threshold at the end of the quarter following index reconstitution.

The plot in the left panel of Figure 3 shows a pronounced upward jump in institutional ownership for stocks to the right of the Russell 1000/2000 threshold. Confirming our priors, this shift is explained by the sudden increase in the demand by investment funds that benchmark the Russell 2000. Indeed, stocks to the right of the Russell 1000/2000 threshold will have

[14]Chang et al. (2015) estimate that stocks that just made it into the Russell 2000 have 195 million more dollars of buying pressure than similar stocks that do not switch indices. Stocks around the index switch cut-off have an average market capitalization of $1.4 billion.

Figure 3. Russell 1000/2000 Membership Threshold: Institutional Ownership and Shortable Supply following Index Reconstitution



This figure displays polynomial-smoothed plots of institutional ownership and *Shortable Supply* in September around the Russell 1000/2000 threshold. The distance from the threshold is based on May's CRSP market capitalization, while index membership uses Russell's constituents list in June of a given year. *Shortable Supply* is defined as the difference between the number of shares available to lend and the number of shares lent out, scaled by total shares outstanding. The fitted lines are based on a non-parametric polynomial estimated separately on each side of the threshold using an Epanechnikov kernel, with the optimal bandwidth selected using the ROT method. Each dot corresponds to the average of observations within bins of size 20.

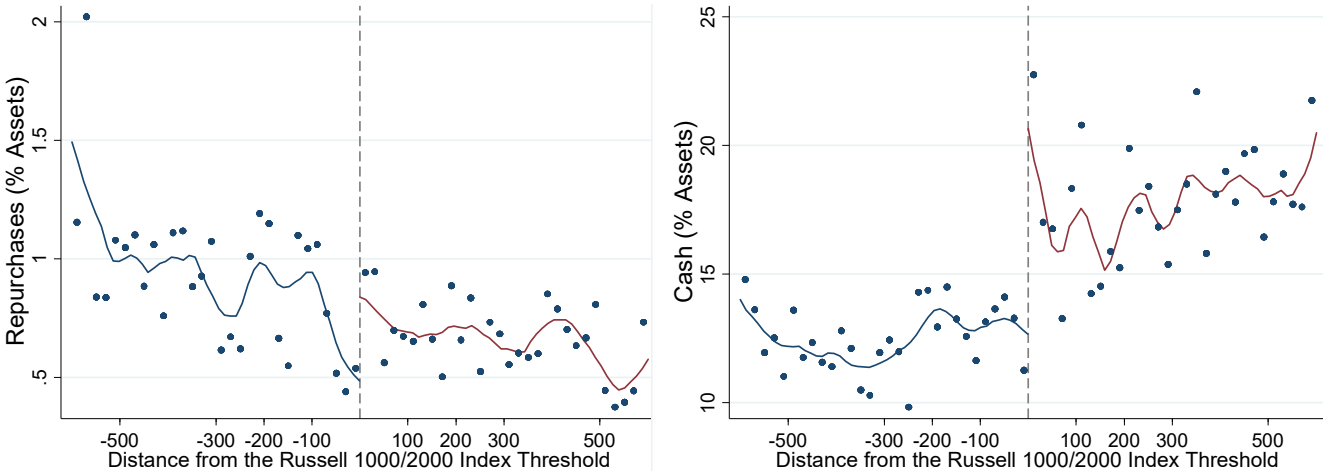
the biggest weights in institutional investors' portfolios. This pattern stands in stark contrast to that of the left of the threshold, which contains stocks with the smallest weights in the Russell 1000 index, thus lowest institutional ownership. The plot in the right panel of Figure 3 supports the hypothesis that index membership switches around the Russell 1000/2000 threshold drives pronounced shifts in the supply of lendable stocks.

In Figure 4, we look at *Repurchases* and *Cash*, the outcome variables of interest, around the Russell 1000/2000 threshold. Here, too, there is a sharp increase to the right of the threshold for both variables. Indeed, our earlier results that the supply of lendable stocks drives corporate repurchase and cash policies seem to be confirmed along these pre-determined, non-linear discontinuity rules for index assignment.

6.3 Test Set-Up

The tests we perform use changes in the extensive and intensive margins of index membership to measure the impact of stock supply on corporate stock repurchases and cash holdings. We collect constituent lists for the Russell 1000 and Russell 2000 indices in June of each year.

Figure 4. Russell 1000/2000 Membership Threshold: Stock Repurchases and Cash Holdings following Index Reconstitution



This figure displays polynomial-smoothed plots of *Repurchases* and *Cash* in September around the Russell 1000/2000 threshold. The distance from the threshold is based on May's CRSP market capitalization, while index membership uses Russell's constituents list in June of a given year. The fitted lines are based on a non-parametric polynomial estimated separately on each side of the threshold using an Epanechnikov kernel, with the optimal bandwidth selected using the ROT method. Each dot corresponds to the average of observations with bins of size 20.

These lists contain the latest membership reconstitutions. Index ranks are based on firm size information, which we gather from May's market capitalization in CRSP.[15]

We take advantage of the Russell indexing reconstitution process and follow Crane et al. (2014) and Appel et al. (2014) in designing a "local IV" test strategy. In it, we use index membership and distance to threshold to instrument our lendable supply measures in a first-stage estimation. We thus recover the change in the supply of lendable stocks that is directly induced by membership switching across the Russell 1000/2000 indices and the distance from the threshold. We use that projected measure to gauge the effect of lendable stocks on repurchases and cash. The estimation is performed via two-stage least squares, including firm- and time-fixed effects. We show results within alternative windows around the Russell 1000/2000 threshold (based on 150, 300, and 500 firms on each side of the threshold). To mitigate concerns that other variables could confound our tests, we include the extensive set of controls used in previous tables, all measured in the quarter before each index reconstitution.

Define $D_{i,t}$ as a dummy variable that equals one if firm i is included in the Russell 2000 in June of year t, and $R_{i,t}$ is the rank distance from the Russell 1000/2000 threshold based on the

[15]Chang et al. (2015) show that using June-based weights lead to severe biases and advocate computing rankings based on May's CRSP-based market capitalization.

CRSP market capitalization in May (centered at zero around the index threshold). Our first-stage regression estimates *Shortable Supply* as a function of Russell 2000 membership dummy, $D_{i,t}$, and distance from the Russell 1000/2000 threshold, $R_{i,t}$. The specification also includes a term for the interaction of $D_{i,t}$ and $R_{i,t}$, as well as a set $\mathbf{X}$ of control variables. Standard errors are clustered at the firm level. The model can be written as:

$$Shortable\ Supply_{i,t} = \alpha_i + \mu_t + \tau_0 D_{i,t} + \tau_i R_{i,t} + \kappa_i D_{i,t} * R_{i,t} + \gamma' \mathbf{X}_{i,t} + \xi_{i,t}. \tag{4}$$

In the second stage, we regress stock repurchases and corporate cash on the component of excess supply that is explained by index membership changes and index rankings from the first stage. The model can be written as follows:

$$Y_{i,t} = \psi_i + \theta_t + \gamma' \widehat{Shortable\ Supply}_{i,t} + \beta' X_{i,t} + \xi_{i,t}, \tag{5}$$

where $Y_{i,t}$ is the relevant corporate outcome variable $\in \{Repurchases; Cash\}$ in the quarter following index reconstitution (October-end data).

Panel A of Table 4 reports the first-stage results. Estimates in this panel show that *Shortable Supply* becomes significantly higher as firms switch from the Russell 1000 into the Russell 2000 index. The coefficients for $D_{i,t}$ imply that if a firm migrates from the Russell 1000 index to the Russell 2000 index, there is a sharp positive shock to the supply of lendable stocks, with all the coefficients being positive and statistically significant. In addition, estimates returned for $R_{i,t}$ and $D_{i,t} * R_{i,t}$ imply that *Shortable Supply* is also a function of whether the stock is to the left or right of the threshold *and* of the distance from the threshold between the Russell 1000 and the Russell 2000 indices (weight ranking). In particular, the lower is the firm's rank position in the Russell 2000, the smaller is the increase in the firm's *Shortable Supply*, since the less important it is for index investors to add the firm's stock to their portfolios.

TABLE 4 ABOUT HERE

Panel B presents the second-stage estimation results. Notably, similarly to the "global IV" regressions that use *Passive IO* as an instrument in Table 3, the alternative "local IV" regressions of Table 4 yield positive and statistically coefficients for the impact of instrumented *Shortable Supply* on *Repurchases* and *Cash*. To gauge the economic impact of a hypothetical shift in the supply of lendable stocks, we compare the expected difference in stock repurchases and cash

holdings due to the predicted differences in lendable supply between a firm ranked 150 places below the Russell 1000/2000 threshold and another ranked 150 places above that threshold. Using the first-stage estimates shown in column (1) of Panel A, we can show that the predicted difference in *Shortable Supply* is equal to 3.37%. Combining this value with the 0.097 coefficient in column (1) of Panel B results in a difference in *Repurchases* equal to 0.33% of total assets; equivalent to 55% of the sample average. An equivalent calculation for *Cash* using estimates in column (4) predict a difference in *Cash* of 2.62%; equivalent to 13% of the sample average.

Taken altogether, results built on index reconstitutions ("local IV") confirm our more general (fixed-effects and "global IV") model estimates of a strong, positive impact of the supply of lendable stocks on stock repurchases and cash savings. These results suggest that managers modify companies' financial policies preempting relaxations in shorting constraints.

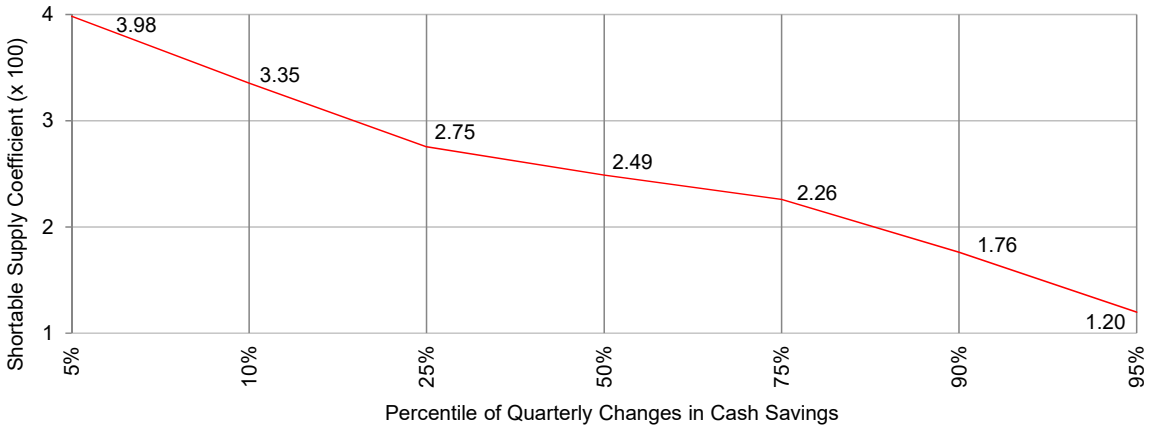
7 Managing Resources in Response to Shifts in Lendable Stock Supply

7.1 Substitution Effect between Repurchases and Cash

Our results show that firms *both* repurchase stocks and save cash following outward shifts in the supply of lendable stocks. Naturally, corporate resources are limited, and for our proposed mechanism to be warranted repurchase and savings should show some degree of substitution in achieving the same goal. In particular, it is likely that managers substitute share buybacks with increases in cash balances to deter short sellers, leading to a differential impact of *Shortable Supply* on *Repurchases* conditional on the amount of cash the firm has saved (binding budget constraint).

In Figure 5, we depict this policy mechanism by plotting the coefficients of a model of *Repurchases* that is similar to that of Eq. (3) ("global IV"), but that adds changes in cash holdings and its interaction term with *Shortable Supply* as additional explanatory variables. For different percentiles of the cash savings distribution, we compute the total impact of *Shortable Supply* on *Repurchases*. The figure confirms the existence of a significant substitution effect between repurchases and cash holdings. The impact of an increase in *Shortable Supply* on stock repurchases is lower for firms that register a large increase in cash balances. For firms in the first decile of quarterly changes in cash savings ($\Delta Cash$), the estimated effect on next quarter's

Figure 5. Estimated *Shortable Supply* Coefficients in IV Repurchase Regressions



This figure shows the total impact of *Shortable Supply* on stock repurchases conditional on changes in cash savings. For different percentiles of the distribution of quarterly changes in cash between quarters t and $t+1$, we compute the impact of $Shortable\ Supply_t$ on $Repurchases_{t+1}$. We estimate an IV model similar to the one shown in column (2) of Table 3, adding the quarterly change in cash savings and its interaction term with $Shortable\ Supply_t$.

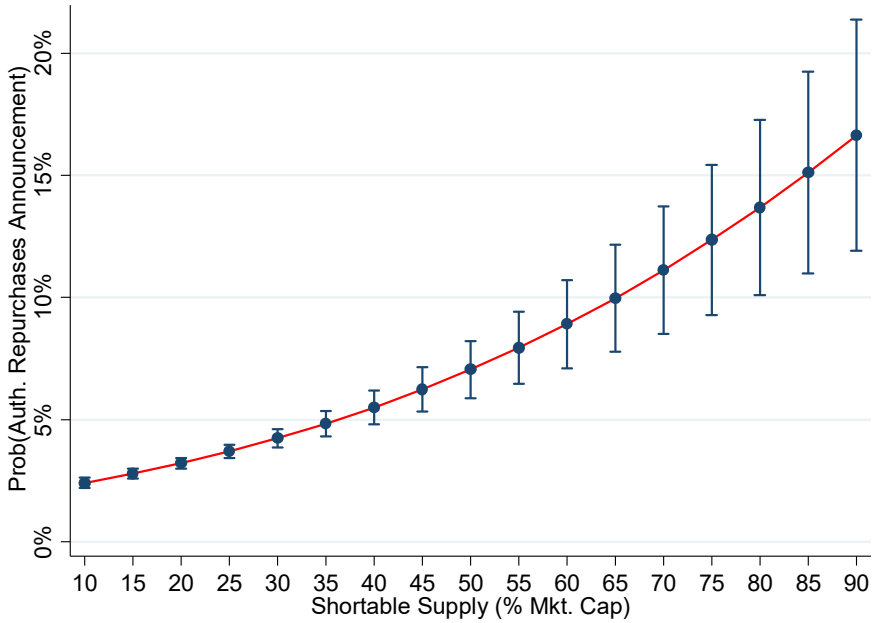
stock repurchases following a one-IQR increase of lendable supply is 0.6% ($= (0.024 + 0.008) \times 16.92\%$), while the same effect for firms in tenth decile of $\Delta Cash$ is cut in half; only 0.3%.

7.2 Authorization of Stock Repurchase Programs

Before repurchases can take place, a firm needs to set up a program to buy back shares, have it authorized by the board, and announced to the market. The announcement alone can act as a signal to short sellers that the firm is willing to support its stock, becoming a deterrent to shorting. While this signal is not costless, it does not require the company to immediately spend resources. Notably, the non-binding structure of program authorizations gives managers the flexibility they need to fine-tune their responses to shorting across time. One would expect firms facing an increase in the supply of lendable stocks to authorize stock repurchase programs if managers want to preempt shorting activity. We set out to test this idea in turn.

Using data from SDC Platinum, we collect the dates of all open-market stock repurchase programs authorizations announced for firms in our sample. We create an indicator variable, *D(Authorized Repurchases)*, that is equal to 1 if the firm announces the authorization of a buy-back program in a given quarter and 0 otherwise. On average, we observe 347 announcements per year, corresponding to 3.3% of the firm-quarter observations in our sample. Among firms announcing buyback programs in our sample, some 20% (10%) report *no* repurchase activity

Figure 6. Probability of Authorized Repurchases



This figure shows the marginal probability of authorized repurchase program announcements in a given quarter across different values of *Shortable Supply*. The estimated probabilities are derived from the probit model estimated in column (1) of Table 5. 95% confidence intervals are shown.

over one quarter (year) following the announcement. Only 20% (56%) of the amount authorized under the program is ever repurchased within one quarter (year) of the announcement. These figures speak directly to the idea that while repurchase programs may at times appear to be large, they are need not be binding nor fully implemented, committing firm resources. Their announcement, nonetheless, gives managers the leverage they need in responding to shifts in lendable supply.

In Table 5, we estimate three alternative probit models to examine if the likelihood of announcing a repurchase program is driven by *Shortable Supply*. Column (1) displays estimates from a standard probit model, column (2) refers to a population-average model that accounts for firm-specific effects, and column (3) shows results using an IV probit model that borrows from our "global IV" specification. All regressions have year-quarter-fixed effects. In all cases, we find positive and statistically significant coefficients for *Shortable Supply*.

TABLE 5 ABOUT HERE

To provide economic intuition for the estimates in Table 5, we compute the marginal probability of a repurchase program announcement for various levels of *Shortable Supply* and place

the results in Figure 5. The coefficients shown in column (1) imply that the marginal announcement probability for a firm in the 25^{th} percentile of *Shortable Supply* is around 4%. Firms in the 75^{th} percentile, in contrast, have marginal probabilities that are almost three times larger, around 12%. Managers are likely to request the immediate authorization of share repurchase programs when their firms face an increase in lendable supply.

7.3 Alternative Uses and Sources of Funds

If shifts in the supply of lendable stocks lead to increases in stock repurchases and cash, they must be negatively related to other corporate policies that can be used as a source of funds. For example, managers may pay fewer dividends, issue debt, or cut investments as a way to fund the increase in buybacks and cash holdings. In this section, we follow Dasgupta et al. (2011) in investigating how firms choose between various uses and sources of funds when financing their responses to shifts in the supply of lendable stocks. Using our "global IV" model, we estimate the impact of lendable supply on dividend payments, debt issuance, and capital expenditures.

TABLE 6 ABOUT HERE

Column (1) of Table 6 shows that an increase in *Shortable Supply* is associated with a decrease in dividend payments. A one-IQR change in *Shortable Supply* is associated with 1.4% lower dividend payments as a fraction of assets. This effect should be expected since firms choosing to pay investors via dividends may do so in lieu of repurchases. Notably, however, this finding further corroborates the logic of our argument. In particular, unlike repurchases, stock prices are likely to drop following the payment of cash dividends. This is the least desirable outcome for managers attempting to shore up prices in response to increases in the supply of lendable stocks. As such, our findings are hard to be reconciled by a general, alternative argument suggesting that firms will simply choose to "pay out more" to their investors following increases in lendable stocks.

Estimations under columns (2) and (3) consider additional sources and uses of funds used by firms when responding to shifts in lendable stocks. Consistent with expectations, firms are more likely to raise debt in funding their responses to increases in the supply of lendable stocks. The 0.024 coefficient reported for *Shortable Supply* in column (2) implies that a one-IQR change in *Shortable Supply* is associated with 41% more net debt issuance as a fraction of assets; equivalent to 29% of the IQR for net debt issuance. The estimates in column (3) show

that firms are also more likely to reduce their investment spending, with the –0.02 coefficient found for *Shortable Supply* being associated with a 34% IQR drop in capital expenditures.

Taken altogether, the results in Table 6 suggest that the increases in stock repurchases and cash holdings shown in Table 3 are funded by reductions in dividend payments, increases in debt issuance, and cuts in capital expenditures. These various policies seem coordinated and internally consistent with the idea that firms significantly alter the management of their resources in responding to shifts in the supply of lendable stocks.

8 Effect Heterogeneity

Our inferences can be further evaluated by investigating if the relationship between the supply of lendable stocks and corporate policies change with respect to certain firm characteristics. For example, the amount of repurchases needed to support share prices may vary with stock liquidity (see Cesari et al. (2012)) or with the sensitivity of CEO compensation to stock prices (Edmans et al. (2009)). Indeed, there are several dimensions by which the effects we report should vary across firms. In this section, we investigate four such dimensions: (1) stock liquidity, (2) short sales demand, (3) stock price valuation, and (4) CEO wealth–performance sensitivity to stock prices. For brevity, we focus on *Repurchases* as the relevant policy variable, collecting all of our results in Table 7 below.

8.1 Stock Liquidity

Managers' reactions to a relaxation in short sales constraints should naturally depend on the price impact of company-sponsored stock repurchase programs. On this front, research shows that the price impact of stock repurchases is higher for illiquid stocks (Cesari et al. (2012)). This implies that for a given increase in *Shortable Supply*, managers of firms whose stocks are illiquid would need to repurchase fewer shares to generate desired price response to the threat of shorting. Exploring this logic, we use measures of ex-ante liquidity to test if firms react less strongly to increases in the supply of lendable stocks when trading shares is more difficult.

Our tests capture alternative dimensions of stock illiquidity by using three measures: Amihud's (2002) *ILLIQ*, bid-ask spreads (*Spread*), and stock turnover (*Turnover*). In each quarter, we sort firms according to a given measure and select those firms in the lowest and highest quintiles. We create an indicator variable, $D(Split)$, that is equal to 1 if the firm's stock is

"illiquid" in a quarter (i.e., in the top quintile of *ILLIQ* and *Spread*, or in the lowest quintile of *Turnover*) and equal to 0 if it is "liquid" (in the bottom quintile of *ILLIQ* and *Spread*, or in the top quintile of *Turnover*). We estimate an instrumental variables model similar to that presented in Table 3 ("global IV"), but including $D(Split)$ and the *Shortable Supply*D(Split)* interaction term as additional variables. Accordingly, the second-stage regression is given by:

$$\begin{aligned} Repurchases_{i,t+1} &= \alpha + \beta_1 \widehat{Shortable\ Supply}_{i,t} + \beta_2 D(Split) \\ &\quad + \beta_3 \widehat{Shortable\ Supply} * D(Split)_{i,t} + \gamma' \mathbf{X}_{i,t} + \psi_i + \theta_t + \epsilon_{i,t}. \end{aligned} \tag{6}$$

Across all of the illiquidity measures under columns (1)–(3) in Table 7, we find that more illiquid stocks exhibit a lower sensitivity of stock repurchases to changes in the supply of lendable stocks. The results are consistent with the idea that managers of firms with more illiquid stocks need to repurchases relatively fewer shares to achieve a given price impact. Column (3), for example, implies that a unit increase in *Shortable Supply* increases stock repurchases by 0.05 for firms in the top quintile of stock turnover, but by only 0.01 for those in the lowest quintile. Consistent with our story, the degree by which investors can trade shares is sensibly taken into account by managers when deciding how to respond to changes in the supply of lendable stocks.

Table 7 About Here

8.2 Demand for Shorting

An increase in the supply of lendable stocks may be meaningless if the demand for shorting is low. In particular, an increase in *Shortable Supply* may not lead to more shorting if short sales constraints were not binding in the first place. This suggests that the impact of *Shortable Supply* on repurchases should be higher for stocks facing ex-ante tighter short sales constraints. We explore this source of cross-sectional variation in turn.

Short Interest denotes the short interest for the firm's shares, defined as the number of shares shorted reported in Compustat at the end of the quarter divided by the number of shares outstanding. This variable has been previously used as proxy of short sales constraints (see, e.g., Asquith et al. (2005)). Firms in the top quintile of short interest (i.e., $D(Split) = 1$) are likely to have a higher pent-up demand for shorting. Accordingly, for those firms, an increase in the supply of lendable stocks may significantly reduce short sales constraints and allow more shorting to take place, prompting managers to increase repurchases more aggres-

sively. This hypothesis is supported by the coefficients estimated in column (4) of Table 7, where the interaction between *Shortable Supply* and $D(Split)$ returns a positive and significant coefficient. A relaxation in short sales constraints for stocks with higher short sales demand enables more short selling to take place. As expected, managers in these firms, in particular, react by repurchasing relative more shares in an attempt to support prices. This dynamic supports the hypothesis that managerial decisions regarding stock repurchases are affected by lendable supply and are further modulated by the demand for shorting in place.

8.3 Price and Value Pressure

We also investigate how stock valuation modulates the impact of lendable supply on firm policies. When prices are at historically low levels, short-sellers are less likely to target a company (D'Avolio (2002) and Hanson and Sunderam (2013)). In this scenario, an increase in the supply of lendable stocks may not prompt shorting, nor prompt firms to hike their repurchase activity. Alternatively, when prices are high, short sellers may try to profit by shorting the stock. In this scenario, managers should be particularly interested in repurchasing stocks to preempt shorting.

In column (5) of Table 7, we use Q ratios to measure the extent to which shares are arguably overvalued. This measure has been used as a proxy of firm valuating in several prior studies (e.g., Lang et al. (1989), Baker et al. (2003), and Polk and Sapienza (2009)). In our empirical model, the indicator variable $D(Split)$ assigns the value of 1 (of 0) to firms in the top (bottom) quintile of the Q distribution. Similarly, in column (6) we use stock price momentum (MOM) in the previous 12 months to capture firms that experienced extreme price run-ups. Accordingly, $D(Split)$ assigns the value of 1 (of 0) to firms in the top (bottom) quintile of the MOM distribution.

The $D(Split)$ coefficients in columns (5)–(6) show that repurchases are smaller when firms have high Q ratios and high price increases in the past 12 months, consistent with the hypothesis that, generally, managers do not engage in buybacks when stocks seem overvalued. Notably, however, the coefficient for the interaction between *Shortable Supply* and $D(Split)$ is positive and statistically significant in both cases. The results imply that the effects of shifts in the supply of lendable stocks on repurchases are indeed greater for firms whose stocks are likely to be perceived as overvalued.

8.4 Managerial Incentives

One could argue that managers whose wealth is more sensitive to stock prices may have more incentives to repurchase stocks following an increase in the supply of lendable stocks. Accordingly, we evaluate how the impact of *Shortable Supply* varies with managerial wealth sensitivity to stock prices. We do so using the wealth–performance sensitivity measure, *CEO WPS*, computed by Edmans et al. (2009). This measure is only available for the 2006–2009 period and is defined as the dollar change in CEO wealth for a one percent change in firm value, divided by annual flow compensation. The estimated 0.029 coefficient for the *Shortable Supply*D(Split)* interaction in column (7) shows that high (top quintile) *CEO WPS* firms repurchase more than twice as many shares as firms in the bottom quintile of *CEO WPS*. In other words, managers are far more likely to initiate stock repurchase programs when the value of their personal compensation packages are threatened by (shorting) activity that is facilitated by increases in the supply of lendable stocks.

The results from this section are important in corroborating our inferences. They show that increases in the supply of lendable stocks lead company managers to conduct more aggressive buyback policies when their stocks are ex-ante more liquid and have higher demand for shorting. Corporate responses are also more pronounced when stocks have observed an increase in their values prior to shifts in the supply of lendable stocks. Notably, managers are more aggressive in their responses when their wealth is more sensitive to stock price.

9 Concluding Remarks

We examine whether the rise of equity lending and short selling have shaped managerial actions consistent with the notion of supporting share prices. Short selling activity and its impact on share prices can alter expectations and affect corporate policies. We find that managers react to an increase in the ease of shorting shares in their companies by increasing repurchase activity and accumulating cash war chests. These actions seem to be financed by debt issuance as well as investment cuts and reductions in dividend payments.

In designing our tests, we combine several unique datasets and techniques. Those tests are informed and guided by the unique institutional setting we study. We use variation in stock ownership by passive investors to identify shifts to the supply of lendable stocks that are unrelated to changes in corporate financial policies. We also consider the reconstitution

of Russell indices as an alternative — albeit more local — identification strategy and find similar conclusions. The effects we document are stronger for firms whose stocks are ex-ante more liquid, have higher pent-up demand for shorting, are relatively overvalued, and whose managerial compensation is more sensitive to stock prices. Our results uncover important, new effects that capital markets and institutions exert on corporate policies. We believe that understanding these effects is important for researchers, managers, and policymakers alike as capital markets evolve and present new challenges to all of its participants.

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Appendix A: Variables Definition

Variable	Definition
Repurchases	(Purchase of Common and Preferred Stock) ÷ Lagged Book Assets
Cash	(Cash & Short-term Equivalents) ÷ Lagged Book Assets.
Dividends	Total dividends paid to common and preferred shares in a quarter ÷ Lagged Book Assets
Net Debt Issuance	Quarterly changes of short-term and long-term debt (Compustat's $DLCQ + DLTTQ$) ÷ Lagged Book Assets
Supply	End-of-quarter fraction of market capitalization available to lend
On Loan	End-of-quarter fraction of market capitalization effectively lent out.
Shortable Supply	Supply – On Loan.
Fee	Value-weighted loan fee at the end of the quarter (in annualized %)
Total IO	Fraction of the firm held by institutional investors computed from 13f files.
Passive IO	Fraction of the firm held by quasi-indexers institutions as in Bushee (1998).
Utilization	On Loan divided by Supply.
Size	Firm assets in US$ billions.
Market-to-Book	Market value of common shares ÷ Book Assets.
Cash Flow	(Income Before Extraordinary Items + Depreciation and Amortization) ÷ Lagged Book Assets.
NWC	(Current Assets – Current Liabilities – Cash & Equivalents) ÷ Lagged Book Assets.
Investment	(Capital Expenditures) ÷ Lagged Book Assets.
R&D	(Research & Development Expenses) ÷ Lagged Book Assets.
Industry Sigma	Standard deviation of *Cash Flow* of all firms in the same 2-digit SIC code across the whole sample (Bates et al. (2009)).
Acquisitions	Acquisitions ÷ Lagged Book Assets.
IPO	Indicator variable equal to 1 if firm did its IPO in the past 5 years.
ILLIQ	Daily absolute return divided by dollar volume (Amihud (2002)) averaged over a quarter.
Spread	Bid-ask spread at the end of a trading day averaged over a quarter.
Turnover	Daily number of shares traded divided by total shares outstanding averaged over a quarter.
Short Interest	End-of-quarter short positions held by investors as a fraction of total shares outstanding reported in Compustat.
Q Ratio	(Market Value of Equity + Book Value of Debt) ÷ Book Assets.
MOM	Cumulative return in the previous twelve months (i.e. months *t-13* to *t-1*).
CEO WPS	Edmans et al.'s (2009) measure of wealth-performance sensitivity, given by the dollar change in CEO wealth for a 1% point change in firm value, divided by annual flow compensation

Table 1
Descriptive Statistics
This table shows quarterly descriptive statistics of the main variables used in the analysis. Equity lending data are provided by Markit, price data come from CRSP, ownership data from SEC's 13F holdings, and accounting data from Compustat. The variable definitions are in Appendix A.

Variable	Mean	Median	St. Dev.	25th Pct.	75th Pct.	Obs.
Repurchases (% assets)	0.59%	0.00%	2.13%	0.00%	0.10%	57,167
Cash Holdings (% assets)	20.34%	11.83%	22.53%	3.57%	29.86%	57,167
Supply (% mktcap)	21.65%	22.84%	11.71%	12.30%	30.14%	57,181
On Loan (% mktcap)	4.72%	2.52%	5.79%	0.69%	6.53%	57,180
Shortable Supply(% mktcap)	16.92%	17.37%	10.57%	7.95%	25.03%	57,180
Utilization (% Supply)	18.43%	10.85%	20.00%	3.58%	26.63%	57,181
Short Interest (% mktcap)	5.70%	3.58%	6.69%	1.23%	7.73%	56,217
Fee (% p.a.)	0.61	0.11	1.79	0.07	0.20	57,022
Total IO (% mktcap)	63.31%	70.07%	28.19%	42.34%	87%	57,181
Passive IO (% mktcap)	40.20%	43.08%	20.33%	23.90%	56%	57,181
Size (US$ bil)	4,190	561	15,040	145	2,273	57,181
Market-to-Book	2.72	1.90	2.83	1.19	3.18	57,173
Cash Flow (% assets)	116.83%	204.74%	511.06%	72%	334%	57,173
NWC (% assets)	7.80%	6.45%	17.12%	-2.72%	17.86%	55,873
Investment (% assets)	1.34%	0.75%	1.87%	0.34%	1.56%	56,044
Industry Sigma	4.61%	4.49%	2.40%	2.82%	5.59%	57,167
R&D (% assets)	1.32%	0.00%	2.65%	0.00%	1.69%	57,181
Acquisitions (% assets)	0.58%	0.00%	2.76%	0.00%	0.00%	57,172
IPO	0.13%	0.00%	0.34%	0.00%	0.00%	57,167
CEO WPS	62.76	4.22	563.39	1.53	11.65	15,687

Table 2
Equity Lending, Stock Repurchases and Cash Holdings: OLS-FE Estimations
This table displays regressions of next quarter's cash holdings and stock repurchases as a function of equity lending variables with quarterly stock data. The variable definitions are in Appendix A. All regressions have year-quarter-fixed effects. We report standard errors clustered at the firm level in brackets.

Dep. Var.:	$Repurchases_{t+1}$		$Cash_{t+1}$	
	(1)	(2)	(3)	(4)
$Shortable\ Supply_t$	0.008***	0.008***	0.084***	0.090***
	[0.002]	[0.002]	[0.017]	[0.017]
$Ln(Size_t)$	0.124***	0.126***	-5.151***	-5.113***
	[0.038]	[0.039]	[0.525]	[0.535]
$Market\text{-}to\text{-}Book_t$	0.005	0.006	0.355***	0.358***
	[0.004]	[0.005]	[0.061]	[0.061]
$Cash\ Flow_t$	0.009***	0.008***	0.107***	0.127***
	[0.002]	[0.002]	[0.023]	[0.023]
NWC_t		-0.001		-0.114***
		[0.001]		[0.016]
$Investment_t$		-0.005		-0.273***
		[0.006]		[0.053]
$Industry\ Sigma_t$		0.019		0.392*
		[0.033]		[0.232]
$R\&D_t$		-0.014**		-0.207**
		[0.006]		[0.100]
$Acquisitions_t$		-0.008***		-0.235***
		[0.002]		[0.016]
IPO_t		-0.026		1.521***
		[0.041]		[0.537]
Constant	-0.355	-0.390	51.310***	50.843***
	[0.238]	[0.290]	[3.404]	[3.677]
Obs.	53,875	52,843	53,875	52,843
Firms	3,100	3,046	3,100	3,046
Adj. R^2	0.028	0.029	0.046	0.059

*** p-value<0.01, ** p-value<0.05, * p-value<0.10

Table 3
Global IV Regressions: Passive IO as an Instrument for Shortable Supply
This table shows estimates of instrumental variables regressions of next quarter's stock repurchases and cash holdings as a function of equity lending variables with quarterly stock data. In Panel A we report the 1st-stage coefficients using quasi-indexers (passive) institutional ownership as an instrument for *Shortable Supply*. Column (1) and (2) use, respectively, the same set of control variables as columns (1) and (2) of Table 2. In Panel B, we report the coefficients on the instrumented *Shortable Supply*. The other variable definitions are in Appendix A. All regressions have year-quarter fixed effects. The *Weak ID* statistic tests for the null hypothesis of weak instruments. We report standard errors clustered at the firm level in brackets.

Panel A: First stage

Instrumented Var.:	*Shortable Supply*$_t$	
	(1)	(2)
Passive IO$_t$	0.326***	0.316***
	[0.007]	[0.007]
Obs.	55,864	54,792
Firms	3,100	3,046
Firm Controls	Y	Y
Weak ID	2,274***	2,092***

Panel B: Second stage

Dep. Var.:	*Repurchases*$_{t+1}$		*Cash*$_{t+1}$	
	(1)	(2)	(3)	(4)
$\widehat{Shortable\ Supply}_t$	0.025***	0.025***	0.238***	0.299***
	[0.003]	[0.003]	[0.053]	[0.048]
Ln(Size$_t$*)*	0.010	0.010	-4.020***	-3.482***
	[0.011]	[0.013]	[0.204]	[0.199]
Market-to-Book$_t$	0.084***	0.074***	2.010***	0.677***
	[0.007]	[0.007]	[0.122]	[0.099]
Cash Flow$_t$	0.036***	0.046***	-0.903***	0.224***
	[0.003]	[0.003]	[0.069]	[0.055]
NWC_t		-0.005***		-0.258***
		[0.001]		[0.017]
Investment$_t$		-0.049***		-1.365***
		[0.007]		[0.100]
Industry Sigma$_t$		0.009		1.451***
		[0.007]		[0.140]
$R\&D_t$		0.017**		3.210***
		[0.007]		[0.154]
Acquisitions$_t$		-0.015***		-0.486***
		[0.002]		[0.026]
IPO_t		-0.120***		4.606***
		[0.030]		[0.759]
Adj. R^2	0.043	0.055	0.201	0.454

*** p-value<0.01, ** p-value<0.05, * p-value<0.10

Table 4
Local IV Regressions: Using Russell Index Membership as an Instrument for Shortable Supply
This table shows the impact of equity lending and institutional ownership on cash holdings and stock repurchases using an instrumental variable estimation based on Russell 2000 index membership reconstitution for alternative windows around the threshold. The first stage estimates instruments equity lending variables as a function of Russell 2000 inclusion and the distance from the Russell 1000/2000 threshold:

$$Shortable\ Supply_{i,t} = \alpha_i + \alpha_t + \tau_0 D_{i,t} + \tau_i R_{i,t} + \kappa_i D_{i,t} R_{i,t} + X'\delta + \xi_{i,t},$$

where *Shortable Supply*) is the variable being instrument, $R_{i,t}$ is the rank distance from the Russell 1000/2000 threshold based on May CRSP's market capitalization, $D_{i,t}$ is a dummy variable equal to one if firm i is included in the Russell 2000 in June of year t, and X is the set of controls used in Table 2 plus institutional ownership. The second stage regressions present results for *Repurchases* and *Cash* in the following quarter ($Y_{i,t}$) as a function of instrumented proxies for equity lending variables ($Z_{i,t}$):

$$Y_{i,t} = \theta_i + \theta_t + \gamma' \widehat{Shortable\ Supply}_{i,t} + X'\beta + \varepsilon_{i,t}$$

Dependent variables ($Y_{i,t}$) are measured in the quarter immediately after Russell index reconstitution, while control variables are measured in the quarter before. In Panel A, we only report the coefficients for Russell 2000 inclusion ($D_{i,t}$), the distance from the threshold ($R_{i,t}$), and their interaction. In Panel B, we report the coefficients using the instrumented values for *Shortable Supply*. The variable definitions are in Appendix A. The *Weak ID* statistic tests for the null hypothesis of weak instruments. J-Stat(p) reports the p-value of the Sargan-Hansen test for overidentification. Standard errors are clustered at the firm level.

Panel A: First stage

	Instrumented Var.: *Shortable Supply*$_t$		
Window Size	[-150,150]	[-300,300]	[-500,500]
	(1)	(2)	(3)
D_{it}	4.874***	4.373***	3.556***
	[1.585]	[1.095]	[0.844]
R_{it}	-0.029***	-0.016***	-0.009***
	[0.011]	[0.005]	[0.002]
$R_{it}D_{it}$	0.022*	0.011*	0.005**
	[0.012]	[0.006]	[0.002]
Obs.	1,123	2,381	4,149
Firms	354	598	904
Weak ID	3.202	6.353	10.03

Panel B: Second stage

Dep. Var.:	*Repurchases*$_{t+1}$			*Cash*$_{t+1}$		
Window Size	[-150,150]	[-300,300]	[-500,500]	[-150,150]	[-300,300]	[-500,500]
	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{Shortable\ Supply}_t$	0.097**	0.117*	0.139**	0.780**	0.860***	1.027***
	[0.040]	[0.064]	[0.063]	[0.387]	[0.280]	[0.254]
J-Stat(p)	0.232	0.125	0.104	0.411	0.560	0.618

*** p-value<0.01, ** p-value<0.05, * p-value<0.10

Table 5
Equity Lending and Authorized Stock Repurchases Announcements
This table shows coefficients from probit regression models as a function of equity lending variables with quarterly stock data. The dependent variable, *D(Authorized Repurchases)*, is equal to one if the firm makes an announcement of a stock repurchase program in a given quarter, zero otherwise. The variable definitions are in Appendix A. Panel A is based on a standard probit model, Panel B on a firm-averaged probit, and Panel C an instrumental variables (Global IV) probit model using quasi-indexers (passive) institutional ownership as an instrument for *Shortable Supply*. All regressions have year-quarter-fixed effects. We report standard errors clustered at the firm level in brackets.

Dep. Var.:	$D(Authorized\ Repurchases)_{t+1}$		
Probit Type:	Standard	Population Avg.	Global IV
	(1)	(2)	(3)
$Shortable\ Supply_t$	0.013***	0.013***	0.015***
	[0.001]	[0.001]	[0.003]
$Ln(Size_t)$	0.056***	0.060***	0.050***
	[0.009]	[0.009]	[0.010]
$Market\text{-}to\text{-}Book_t$	0.006	0.004	0.007
	[0.005]	[0.005]	[0.005]
$Cash\ Flow_t$	0.042***	0.035***	0.041***
	[0.005]	[0.005]	[0.005]
NWC_t	-0.001	-0.000	-0.001
	[0.001]	[0.001]	[0.001]
$Investment_t$	-0.055***	-0.045***	-0.055***
	[0.009]	[0.009]	[0.009]
$Industry\ Sigma_t$	0.002	0.004	0.002
	[0.006]	[0.006]	[0.006]
$R\&D_t$	-0.004	-0.007	-0.005
	[0.007]	[0.007]	[0.007]
$Acquisitions_t$	-0.004	-0.002	-0.004
	[0.004]	[0.004]	[0.004]
IPO_t	-0.131***	-0.120***	-0.120***
	[0.041]	[0.039]	[0.042]
Obs.	52,843	51,474	51,474
Firms	3,046	3,046	3,046

*** p-value<0.01, ** p-value<0.05, * p-value<0.10

Table 6
Global IV Regressions (2^{nd} Stage): Alternative Uses and Sources of Funds
This table shows instrumental variables regressions of alternative uses and sources of corporate cash funds in quarter *t+1* as a function of equity lending variables at time *t*, using quarterly stock data. The first-stage use quasi-indexers (passive) institutional ownership (Bushee (1998)) as an instrument for *Shortable Supply*, based on regressions similar to those shown in Table 3. All regressions have year-quarter fixed-effects. We report standard errors clustered at the firm level in brackets.

Dep. Var.:	$Dividends_{t+1}$	$Net\ Debt\ Issuance_{t+1}$	$Investments_{t+1}$
	(1)	(2)	(3)
$\widehat{Shortable\ Supply}_t$	-0.008***	0.024**	-0.020***
	[0.003]	[0.005]	[0.004]
$Ln(Size_t)$	0.023***	-0.046	0.110***
	[0.011]	[0.016]	[0.018]
$Market\text{-}to\text{-}Book_t$	0.034***	0.040**	0.015**
	[0.006]	[0.018]	[0.007]
$Cash\ Flow_t$	0.029***	-0.090***	0.053***
	[0.003]	[0.011]	[0.004]
Obs.	54,190	52,972	54,190
Firms	3,102	3,075	3,102
Adj. R^2	0.056	0.002	0.033

*** p-value<0.01, ** p-value<0.05, * p-value<0.10

Table 7
Global IV Regressions (2^{nd} Stage): Stock Repurchases and Alternative Sample Splits
This table shows instrumental variables regressions of stock repurchases in quarter *t+1* as a function of equity lending variables at time *t*, using quarterly stock data. The first-stage use quasi-indexers (passive) institutional ownership (Bushee (1998)) as an instrument for *Shortable Supply*, based on regressions similar to those shown in 3. Column (1) displays coefficients for the full sample. Other columns present results with the interaction of *Shortable Supply* with a dummy variable, *D(Split)* for alternative several splits. *D(Split)* is equal to, respectively, 1 if the stock is in the highest quintile of *ILLIQ*, *Bid-Ask Spread*, short interest (*Short Interest*), CEO pay-sensitivity (*CEO WPS*) from Edmans et al. (2009), *Q* ratios, and price momentum (*MOM*); 0 if the stock is in the lowest quintile.For *Turnover*, *D(Split)* is equal to 1 for stocks in the lowest quintile; 0 for those in the highest quintile. All regressions have year-quarter fixed-effects. *Weak ID* statistic tests for the null hypothesis of weak instruments. We report standard errors clustered at the firm level in brackets.

D(Split)=1	*High ILLIQ* (1)	*High Spread* (2)	*Low Turnover* (3)	*High Short Interest* (4)	*High Q* (5)	*High MOM* (6)	*High CEO WPS* (7)
$\widehat{Shortable\ Supply}_t$	0.037***	0.037***	0.045***	0.026***	0.002	0.022***	0.027***
	[0.007]	[0.006]	[0.006]	[0.004]	[0.003]	[0.004]	[0.009]
$\widehat{Shortable\ Supply}$*D(Split)$_t$	-0.026***	-0.026***	-0.031***	0.014**	0.055***	0.010***	0.029*
	[0.006]	[0.006]	[0.005]	[0.005]	[0.006]	[0.003]	[0.016]
D(Split)	-0.012	0.242**	0.285***	-0.210**	-0.242**	-0.180***	-0.236
	[0.119]	[0.111]	[0.078]	[0.087]	[0.098]	[0.053]	[0.347]
Obs.	31,001	30,894	30,999	30,085	31,329	21,798	8,738
Firms	2,867	2,910	2,877	2,603	2,773	2,824	1,151
Adj. R^2	0.100	0.085	0.055	0.082	0.119	0.062	0.069
Weak ID	222.9	281.6	243.2	453.2	430	739.4	61.72

*** p-value<0.01, ** p-value<0.05, * p-value<0.10