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The Effect of Stock Liquidity on Debt-Equity Choices

Abstract

We examine the effect of stock liquidity on a firm's choice between debt and equity when funding its investment activities. Using two tick size-related policy changes and Russell index reconstitutions as shocks to liquidity, we show that stock liquidity increases a firm's propensity to raise debt capital rather than equity capital. We also find support for two economic mechanisms underlying the positive impact of stock liquidity on debt financing: exposure to hostile takeovers and the fact that the cost of debt capital is more sensitive to stock liquidity than the cost of equity capital is. These findings provide new insights into the effect of stock liquidity on capital structure.

Keywords: Stock liquidity; Debt issuance; Equity issuance; Capital structure
JEL Code: G12; G32

1. Introduction

Financial market liquidity is key to efficient capital allocation. How capital is allocated depends not only on the selection of investment projects but also on the choice of capital structure.[1] Although a large body of literature links stock liquidity to a firm's investment decisions, there is slight and mixed evidence about the effect of stock liquidity on corporate financing choices. By employing three quasi-natural experiments, we study how stock liquidity affects a firm's choice between debt and equity when raising capital.

The conventional view is that stock liquidity increases a firm's propensity to raise equity capital rather than debt capital. We call this statement the *equity preference hypothesis*, which builds on the equity pricing implication that stock liquidity lowers a firm's cost of equity capital (e.g., Amihud and Mendelson, 1986; Brennan and Subrahmanyam, 1996; Amihud, 2002; Acharya and Pedersen, 2005; Butler, Grullon, and Weston, 2005). Consistent with this notion, Frieder and Martell (2006) and Lipson and Mortal (2009) show that firms with more liquid equity have lower leverage and prefer equity financing. At the aggregate market level, stock market liquidity promotes equity issuance (Baker and Stein, 2004; Corwin, Harris and Lipson, 2004; Stulz, Vagias, and van Dijk, 2013).

Despite the above evidence that overwhelmingly supports the *equity preference hypothesis*, firms with more liquid stocks may prefer debt to equity. We refer to this view as the *debt preference hypothesis*. First, higher stock liquidity also reduces the cost of debt capital. Indirect findings show that firms with higher stock liquidity enjoy higher credit ratings (Odders-White and Ready, 2006) and have lower default risk (Brogaard, Li, and Xia, 2016). Chen, Gong, and Muckley (2016) and Francis, Hasan, Mani, and Yan (2016) directly document that firms with

[1] The literature has documented the relation between financing choices and investment decisions. For example, Acharya and Subramanian (2009) show that when bankruptcy code is creditor friendly, levered firms shun corporate innovation. Hall and Lerner (2010) find that while small and young innovative firms experience high costs of capital that are only partly mitigated by the presence of venture capital, large firms prefer internal funds for financing innovation.

liquid stocks pay lower loan spreads. If the cost of debt capital is more sensitive to the level of stock liquidity than the cost of equity capital is, then we expect higher stock liquidity to induce firms to choose relatively more debt financing. We regard this mechanism underlying the positive effect of stock liquidity on leverage as the *cost of capital differential channel*.

Second, stock liquidity increases the probability of hostile takeovers. In the Kyle and Vila (1991) model of takeovers, high stock liquidity allows an outsider to camouflage her intention to buy a firm's stocks in an attempt to take over the firm. With the fear of takeover risk, managers use debt as a tool for takeover defense (e.g., Harris and Raviv, 1988; Stulz, 1988; Israel, 1991; Garvey and Hanka, 1999; Safieddine and Titman, 1999). For example, using a sample of 328 targets of failed takeovers, Safieddine and Titman (1999) show that target firms' leverage ratio increases from 59.8% one year before the unsuccessful takeover attempt to 71.5% one year after. Thus, to be shielded from hostile takeovers, firms with liquid stocks are willing to issue more debt than equity. We view this mechanism as the *anti-takeover channel*.

The two competing hypotheses should be tested empirically. The greatest challenge to the analysis lies in identifying a causal effect because of two types of endogeneity: i) both stock liquidity and capital structure are likely to be driven by unobservable missing factors, and ii) reverse causality is possible, as capital structure decisions may affect stock liquidity (Frieder and Martell, 2006; Andres, Cumming, Karabiber, and Schweizer, 2014). To overcome these identification issues, we implement three quasi-natural experiments based on exogenous shocks to stock liquidity.

Our first experiment exploits the Decimalization Act adopted in 2001. Specifically, the Securities and Exchange Commission (SEC) reduced the minimum tick size for quotes and trades on the AMEX, NASDAQ, and NYSE from a sixteenth of a dollar to a hundredth of a dollar. Decimalization largely improves stock liquidity. For example, Bessembinder (2003) shows that quoted bid–ask spreads fall following decimalization, especially spreads for the most actively traded stocks. This experiment has been widely used in previous studies to identify the causal effect of stock liquidity (e.g., Chordia, Roll, and Subrahmanyam, 2008; Fang, Noe, and Tice, 2009; Edmans, Fang, and Zur, 2013; Fang, Tian and Tice, 2014; Brogaard, Li, and Xia, 2016).

The second experiment is based on a similar reduction in tick sizes in 1997. Following the Common Cents Stock Pricing Act of 1997, the AMEX, NASDAQ, and NYSE lowered the minimum price variation for quoting and trading stocks from an eighth of a dollar to a sixteenth of a dollar. The reduction in tick sizes substantially enhances stock liquidity. For example, using limit order data provided by the NYSE, Goldstein and Kavajecz (2000) show that quoted spreads decline by 14.3% and quoted depth declines by 48%. For both tick size experiments, we conduct tests during periods surrounding the event year using a difference-in-differences (hereafter, DiD) approach.

We use the annual reconstitutions of the Russell 1000 and 2000 indices in the third experiment. Specifically, the Russell indices are formed based on the stock market capitalization on May 31 of each year. The largest 1,000 stocks are included in the Russell 1000 index, and the next largest 2,000 stocks are in the Russell 2000 index. Therefore, close to the Russell 1000/2000 threshold, inclusion in one of the two Russell indices is quasi-random with respect to corporate policies.[2] However, because the Russell indices are value weighted, stocks just included and just excluded in the Russell 1000 index differ greatly in their index weights. Stocks with relatively smaller market capitalization are listed at the top of the Russell 2000 index, while stocks with relatively larger market capitalization are at the bottom of the Russell 1000 index. This large discontinuity in Russell index weights produces a substantial difference in stock liquidity (e.g., Madhavan, 2003; Dass, Huang, Maharjan, and Nanda, 2016).

[2] See, for example, Chang, Hong, and Liskovich (2014); Crane, Michenaud, and Weston (2016); Bird and Karolyi (2016); and Appel, Gormley, and Keim (2016).

Using the Russell index reconstitutions, we employ a regression discontinuity design (RDD) to identify the effect of stock liquidity on debt-equity choices.

Three measures of debt-equity choices are considered: debt issuance, equity issuance, and the change in the leverage ratio. Specifically, we construct the debt issuance variable as the long-term debt issuance net of debt retirement divided by the cash used for net capital expenditures and acquisitions, and we construct the equity issuance variable as the sale of common and preferred stock net of the purchase of common and preferred stock divided by the cash used for net capital expenditures and acquisitions. Following the spirit of the two issuance measures, we also calculate the annual change in the leverage ratio. We employ the reciprocal of Amihud's (2002) price impact ratio as the main proxy for stock liquidity.

Consistent with the *debt preference hypothesis*, all our analyses uniformly show that stock liquidity positively affects firms' propensity to raise debt capital but not their propensity to raise equity capital. First, in the baseline regression for the full sample stocks over the 1988–2013 period, we observe a positive relation between stock liquidity and debt issuance but a non-significant relation between stock liquidity and equity issuance. For example, a one-standard-deviation increase in stock liquidity is associated with a 28% increase in debt issuance relative to its sample standard deviation. One may argue that firms do not raise external capital every year in the absence of large investment demand. This possibility potentially tilts our debt and equity issuance measures towards zero. To alleviate this concern, we focus on a subsample of stocks that have investment spikes and obtain the same findings.

Second, the three quasi-natural experiments offer causal evidence that stock liquidity has a positive effect on the propensity to raise debt capital and a non-significant effect on the propensity to raise equity capital. For example, compared with control firms, firms in the treatment group experience a 25.6% (14.2%) higher increase in the propensity to raise debt capital, measured by debt issuance, relative to its sample standard deviation after the 2001

Decimalization Act (the 1997 Common Cents Stock Pricing Act), but the change in the propensity to issue equity, measured by equity issuance, does not differ significantly. The RDD result shows that a one-standard-deviation increase in stock liquidity is associated with a 33% increase in debt issuance relative to its standard deviation for Russell 1000 firms.

Finally, we increase the understanding of the *debt preference hypothesis* by investigating the two underlying channels: the *cost of capital differential channel* and the *anti-takeover channel*. To compare the stock-liquidity sensitivity of the cost of debt capital with that of the cost of equity capital, we calculate two cost-of-capital measures: bank loan spreads and the implied cost of equity capital. Although stock liquidity is priced in both debt and equity financing, the firm's cost of debt capital is more sensitive to the level of stock liquidity than its cost of equity capital is. To test the *anti-takeover channel*, we examine whether the increase in stock liquidity is associated with a positive change in the probability of takeover, especially hostile takeover. Indeed, our baseline regression and experiment results provide consistent evidence. We further employ the three quasi-natural experiments to test the two economic mechanisms, and obtain consistent evidence.

We contribute to two strands of the literature. The primary contribution is to the literature on how stock liquidity affects the choice of external financing. Previous studies document a negative effect of stock liquidity on leverage in the U.S. (Frieder and Martell, 2006; Lipson and Mortal, 2009) and non-U.S. countries, such as China (Chen, Gu, and Wan, 2011), India (Sharma and Paul, 2015), Jordan (Haddad, 2012), and Thailand (Udomsirikul, Jumreornvong, and Jiraporn, 2011). Relying on three natural experiments, this paper is the first to provide contrasting evidence that stock liquidity increases the firm's propensity to issue debt but not equity.[3] Because our analysis is conducted based on cross-sectional variation, our firm-level evidence should not be

[3] There is also a debate on how the liquidity of a firm's assets affects leverage. For example, Williamson (1988), Shleifer and Vishny (1992), and Sibilkov (2009) predict that asset liquidity increases leverage, while Morellec (2001) and Myers and Rajan (1998) argue that its effect should be negative or curvilinear.

viewed as inconsistent with the time-series market findings indicating that stock liquidity promotes equity issuance (Baker and Stein, 2004; Corwin, Harris and Lipson, 2004; Stulz, Vagias, and van Dijk, 2013).

More broadly, our study contributes to the literature that links stock liquidity to the efficiency of capital allocation. Empirical evidence shows that stock liquidity improves firm performance by creating an efficient feedback effect from the stock price (Fang, Noe, and Tice, 2009). This finding is consistent with the governance effect of stock liquidity that increases both the likelihood of block formation and the threat of exit by blockholders (Edmans, Fang, and Zur, 2013; Bharath, Jayaraman, and Nagar, 2013; Norli, Ostergaard, and Schindele, 2014). However, Fang, Tian, and Tice (2014) show that an increase in stock liquidity reduces future innovation. This interesting evidence might be jointly explained by our finding that stock liquidity increases a firm's propensity to raise debt capital, and Acharya and Subramanian's (2009) result that levered firms shun corporate innovation when bankruptcy code is creditor friendly. Given that capital allocation consists of both investment and financing decisions, our study contributes to the understanding of the effect of stock liquidity on capital allocation.

The structure of the remainder of this paper is as follows. In Section 2, we describe our sample selection, variable construction, and descriptive statistics. Section 3 reports our empirical results. Section 4 explores the possible underlying mechanisms. Finally, Section 5 concludes the paper.

2. Sample selection, variable construction, and descriptive statistics

2.1. Sample selection

We construct the main dataset used in our analysis from CRSP and Compustat. We obtain daily stock return data from CRSP and annual financial statement data from Compustat. Our sample is from 1988 to 2013. The data start from 1988 because in that year, "*cash flow* *statements*" replaced "*cash statements by sources and uses of fund*" by the Financial Accounting Standards Boards (FASB) #5. We use the information contained in "*cash flow statements*" to investigate how corporate investment is financed. We exclude firms with Standard Industrial Classification (SIC) codes between 6000 and 6999 or between 4900 and 4999; hence, firms whose main activities are financial services or regulated utilities are omitted to construct the final sample. We also exclude firms whose stocks are not traded on the three major U.S. stock exchanges (i.e., NYSE, NASDAQ, and AMEX).

We then perform a minimum level of data cleaning. First, we exclude firm-year observations with missing values for the variables used in baseline regressions. Given that "missing" sometimes does not mean "unaccounted for", we replace a missing item for a component of a financing source with zero if other components of the financing source are reported. For example, net debt issuance can be calculated as "the issuance of long-term debt (*dltis*)" less "the reduction of long-term debt (*dltr*)". If both *dltis* and *dltr* are missing, then we leave net debt issuance undefined.[4] If only one of them is missing, then we replace the missing item with zero. Second, to avoid errors and outliers in the data, we winsorize all the ratio variables used in the baseline regressions of Table 2 at the 1st and 99th percentiles. The final sample is an unbalanced panel of 49,139 firm-year observations corresponding to 7,123 unique firms.

One may argue that firms do not raise external capital every year in the absence of large investment demand. This possibility potentially tilts our debt and equity issuance measures towards zero. To alleviate this concern, we also focus on a subsample of stocks that exhibit investment spikes. Following Im, Mayer, and Sussman (2017), we define an investment spike as a firm-year observation whose investment amount ($INV_{i,t}$) is statistically significantly greater than the investment amount predicted by a linear trend during the five-year period ($t-2, t-1, t, t+1,\ t+2$) at a conventional significance level, such as 5%.

[4] Our results remain unchanged even if we replace both items with zero.

2.2. Variable construction

2.2.1. Measuring stock liquidity

To measure how illiquid firm i's stocks are, we employ Amihud's (2002) illiquidity measure (also known as Amihud's price impact measure). The Amihud measure that reflects the ability of investors to purchase additional stocks with little impact on prices is particularly relevant when we examine the effects of stock liquidity on the propensities to raise debt and equity to meet firms' external financing requirements.[5] Moreover, Goyenko, Holden, and Trzcinka (2009) and Hasbrouck (2009) find that Amihud's illiquidity measure is the most reliable price impact measure based on the annual data. For the sake of presentation, we convert Amihud's illiquidity measure into a liquidity measure ($LIQ_{i,t}$): first, we multiply Amihud's illiquidity measure by 1,000,000; second, we take the natural logarithm of its reciprocal. A higher value of $LIQ_{i,t}$ indicates higher stock liquidity. Our stock liquidity measure is defined as follows:

$$LIQ_{i,t} = -\ln\left(10^6 \times \frac{1}{D_{i,t}} \sum_{d=1}^{D_{i,t}} \frac{|R_{i,t,d}|}{DVOL_{i,t,d}}\right), \tag{1}$$

where $D_{i,t}$ is the number of days (for which data are available) for stock i in year t, $R_{i,t,d}$ is firm i's stock return on day d in year t, and $DVOL_{i,t,d}$ is firm i's dollar volume in millions on day d in year t. The average is calculated over all positive-volume days, since the ratio is undefined for zero-volume days. Note that the ratio measures the absolute percentage price change per dollar of daily trading volume, representing the daily price impact of the order flow as defined in Kyle (1985).

[5] Amihud (2002) shows that his illiquidity measure is positively and strongly related to two microstructure estimates of illiquidity: Kyle's (1985) price impact and Brennan and Subrahmanyam's (1996) fixed-cost component related to the bid–ask spread.

2.2.2. Measuring debt and equity issuance

We construct three variables to measure the propensity to raise debt and equity capital: debt issuance ($DI_{i,t}$), equity issuance ($EI_{i,t}$), and the change in the leverage ratio ($\Delta LEV_{i,t}$). The debt issuance variable is defined as the long-term debt issuance net of retirement divided by the cash used for net capital expenditures and acquisitions if the denominator is positive. The equity issuance variable is measured as the sale of common and preferred stock net of the purchase of common and preferred stock divided by the cash used for net capital expenditures and acquisitions if the denominator is positive. We leave both debt issuance and equity issuance measures undefined if the denominator is non-positive.[6] When we calculate the change in firm i's leverage ratio, this ratio is defined as the book value of debt divided by the sum of the book value of debt and the market value of equity. Detailed variable definitions with formulas in Compustat item codes can be found in Appendix A.

2.2.3. Measuring control variables

Following the capital structure literature, we control for a vector of firm characteristics that may affect a firm's corporate financing decisions: firm size, $Size_{i,t}$, measured as the natural logarithm of the book value of total assets; profitability, $EBIT_{i,t}$, calculated as the book value of total assets divided by the book value of total assets measured at the beginning of year t; the market-to-book ratio, $MB_{i,t}$, calculated as the sum of the book value of debt, the liquidating value of preferred shares, and the market value of equity divided by the book value of total assets; asset tangibility, $Tanglibility_{i,t}$, measured as total property, plant and equipment net of accumulated depreciation divided by the book value of total assets; depreciation and amortization, $Depreciation_{i,t}$, calculated as depreciation and amortization expenses divided

[6] Our results are very similar when both debt and equity issuance measures are set to zero, rather than missing or undefined, if the denominator is not positive.

by the book value of total assets measured at the beginning of fiscal year t; a R&D dummy, $R\&D_{i,t}$, which equals one if firm i has positive R&D expenses in year t and zero otherwise; R&D intensity, $R\&DIntensity_{i,t}$, defined as R&D expenses divided by the book value of total assets measured at the beginning of fiscal year t; a positive dividend payout dummy, $Dividend_{i,t}$, which equals one if firm i has reported positive dividend in year t and zero otherwise; the dividend payout ratio, $DPayout_{i,t}$, defined as the dividend paid divided by net income if it is not missing and zero if it is missing; and the percentage of institutional holdings, $IO_{i,t}$, defined as total shares held by institutions divided by total shares outstanding.[7] All these variables are computed for firm i over its fiscal year t. Detailed variable definitions with formulas in Compustat item codes are presented in Appendix A.

2.3. Descriptive statistics

Table 1 provides summary statistics for the main variables used in this study for the full sample in Panel A and for the investment spike sample in Panel B. Several findings are noteworthy. First, our key variables are well distributed. For example, the liquidity measure, $LIQ_{i,t-1}$, has a symmetric distribution with a mean value of 2.943 (3.341) and a median value of 3.067 (3.576) in the full sample (investment spike sample). Second, firms in the investment spike sample have a significantly greater increase in the leverage ratio than firms in the full sample, consistent with Im, Mayer, and Sussman (2017). Third, the standard deviations of debt and equity issuance variables are substantially higher in the full sample than in the investment spike sample because the denominator of the debt and equity issuance variables is smaller in the full sample than in the investment spike sample.[8] Finally, other variables do not show

[7] We are grateful to Brian Bushee for kindly sharing his database for the percentage of institutional holdings.
[8] The regression results based on the investment spike sample reported in Table 2 are particularly informative about how stock liquidity affects the financing of corporate investment. For details, please see Mayer and Sussman (2005), DeAngelo, DeAngelo, and Whited (2011), Elsas, Flannery, and Garfinkel (2014), and Im, Mayer, and Sussman (2017).

significant differences in the distribution between the full and investment spike samples. For example, in the full sample (investment spike sample), an average firm has total assets of \$256.72 million (\$275.34 million); a market-to-book ratio of 1.799 (2.080); property, plant, and equipment scaled by total assets of 27.1% (24.4%); depreciation expenses scaled by total assets of 5.2% (5.0%); an R&D dummy of 0.509 (0.532); R&D expenses scaled by total assets of 5.8% (5.6%); a positive dividend payout dummy of 0.300 (0.355); a dividend payout ratio of 13.0% (13.8%); and the percentage of institutional holdings of 3.6% (3.4%).

[INSERT TABLE 1 HERE]

3. Empirical results

3.1. The panel regression specification

To assess how firm i's stock liquidity affects its choice between debt and equity, we estimate the following regression equation:

$$DI_{i,t} \left(or\ EI_{i,t}\ or\ \Delta LEV_{i,t} \right)$$
$$= a + bLIQ_{i,t-1} + c'CONTROLS_{i,t-1} + YR_t + FIRM_i + e_{i,t}, \tag{2}$$

where i indexes firm and t indexes time. The dependent variables include debt issuance ($DI_{i,t}$), equity issuance ($EI_{i,t}$), and the increase in leverage ratio ($\Delta LEV_{i,t}$). The liquidity measure ($LIQ_{i,t-1}$) is measured for firm i over its fiscal year $t-1$. The vector $CONTROLS_{i,t-1}$ contains firm characteristics that could affect firm i's debt issuance, equity issuance and increase in leverage, as discussed in Section 2.2.3. We include year fixed effects (YR_t) to account for intertemporal variation that may affect corporate financing behavior and firm fixed effects ($FIRM_i$) to control for omitted firm characteristics that are constant over time. We cluster standard errors at the firm level.

The first three columns in Table 2 report the regression results for the full sample. The coefficient estimates on $LIQ_{i,t-1}$ in the equation for $DI_{i,t}$ and $\Delta LEV_{i,t}$ are positive and statistically significant at the 1% level, while the coefficient estimate in the equation for $EI_{i,t}$ is not significantly different from zero. In addition, the effect of stock liquidity on the propensity to raise debt capital is economically significant. A one-standard-deviation increase in stock liquidity is associated with a 28% (76%) increase in debt issuance (the change in leverage) relative to its sample standard deviation.

One potential concern about these results is that firms do not need external financing every year, given that corporate investment is known to have quite irregular patterns (Doms and Dunne, 1998; Mayer and Sussman, 2005; DeAngelo, DeAngelo, and Whited, 2011; Elsas, Flannery, and Garfinkel, 2014; and Im, Mayer, and Sussman, 2017).[9] To alleviate this concern, we conduct our analysis in a sample of firms with investment spikes. Recent studies show that episodes of major investments provide valuable opportunities to gain insight into firms' capital structure decisions because major investments typically entail external financing as opposed to the retained-earnings-dependent financing patterns for routine, replacement investments.[10] For instance, for all Compustat firms, more than two-thirds of capital expenditures and more than four-fifths of acquisitions are financed with externally raised funds, whereas less than one-third of smaller investments are financed by external funding (Elsas, Flannery, and Garfinkel, 2014).

The last three columns in Table 2 report the regression results for the investment spike sample. The coefficient estimates on $LIQ_{i,t-1}$ in the equation for $DI_{i,t}$ and $\Delta LEV_{i,t}$ are again positive and both economically and statistically significant, while the coefficient estimate in the equation for $EI_{i,t}$ is again not significantly different from zero. For example, a one-

[9] Scholars have attempted to explain lumpy investment patterns through non-convex capital adjustment costs (Rothschild, 1971), irreversibility of investment (Pindyck, 1991; Dixit, 1995; Dixit and Pindyck, 1994), and external financing costs arising from financing constraints (Whited, 2006).

[10] For more on this point, see Mayer and Sussman (2005); DeAngelo, DeAngelo, and Whited (2011); Elsas, Flannery, and Garfinkel (2014); and Im, Mayer, and Sussman (2017).

standard-deviation increase in stock liquidity is associated with an approximately 29% (56%) increase in debt issuance (the change in leverage) relative to its standard deviation.

Consistent with the *debt preference hypothesis*, these results suggest that stock liquidity has a positive effect on the propensity to raise debt finance but does not have a significant effect on the propensity to raise equity finance.

[INSERT TABLE 2 HERE]

3.2. The DiD approach

The greatest challenge to the above finding lies in identifying a causal effect because of two types of endogeneity problems. First, both stock liquidity and corporate financing decisions are likely to be driven by unobservable missing factors. For example, both stock liquidity and external financing dependence, particularly equity financing dependence, are likely to be higher when the economy is in a recovery or boom phase rather than a downturn or recession phase. Second, a reverse causality problem may arise. That is, capital structure decisions could affect stock liquidity (Frieder and Martell, 2006; Lesmond, O'Connor, and Senbet, 2008; Andres, Cumming, Karabiber, and Schweizer, 2014).[11] To address these endogeneity concerns, in this section we implement three quasi-natural experiments based on exogenous shocks to stock liquidity. Specifically, we use two tick size-related policy changes (i.e., the 2001 shift to decimalization and the 1997 shift from an eighth of a dollar to a sixteenth of a dollar) as exogenous shocks to stock liquidity, and we employ the DiD approach to identify the causal effect of stock liquidity on the firm's choice between debt and equity.

[11] For example, Lesmond, O'Connor, and Senbet (2008) propose a model regarding the effect of leverage changes on stock liquidity by extending Kyle's (1985) model, and they show that leverage-increasing firms experience a 1% increase in the bid–ask spread and that leverage-decreasing firms experience a 2% decrease in the bid–ask spread. These results hold because market makers respond more sensitively to bad trades because of the adverse selection of informed traders when firms have higher leverage.

3.2.1. The DiD approach exploiting decimalization in 2001

Our first experiment exploits the Decimalization Act adopted in 2001. Specifically, the SEC reduced the minimum tick size for quotes and trades on the AMEX, NASDAQ, and NYSE from a sixteenth of a dollar to a hundredth of a dollar. This experiment has been widely used in previous studies to identify the causal effect of stock liquidity (e.g., Chordia, Roll, and Subrahmanyam, 2008; Fang, Noe, and Tice, 2009; Edmans, Fang, and Zur, 2013; Fang, Tian and Tice, 2014; Brogaard, Li, and Xia, 2016).

Decimalization is selected in this study as an exogenous shock to liquidity for the following reasons. First, several studies, such as Furfine (2003) and Bessembinder (2003), have shown that stock liquidity significantly increased after decimalization and that the effect is more pronounced among actively traded stocks. Thus, the changes in stock liquidity surrounding decimalization vary in the cross-section of stocks. Second, decimalization of tick sizes is unlikely to directly influence corporate financing choices. Finally, corporate financing choices are unlikely to affect the variation in stock liquidity generated by decimalization.

Using a propensity score matching method, we start by constructing a treatment group and a control group of firms. Specifically, we consider a firm-year after (before) decimalization if fiscal year *t* ends after (before) January 29, 2001, for firms listed on the NYSE or AMEX, and April 9, 2001, for firms listed on the NASDAQ. We measure the change in our stock liquidity measure from the pre-decimalization year $(t-1)$ to the post-decimalization year $(t+1)$ ($\Delta LIQ_{i,t-1\rightarrow t+1} = LIQ_{i,t+1} - LIQ_{i,t-1}$), where year t indicates the calendar year during which firm *i* was affected by decimalization.

Based on terciles of $\Delta LIQ_{i,t-1\rightarrow t+1}$, we then divide 2,854 sample firms into three groups and use two out of the three groups.[12] The first group contains only the upper tercile firms, including 951 firms experiencing the largest surge in the stock liquidity measure, while the second group contains the bottom tercile firms, comprising 949 firms experiencing a modest increase or even a decline in the stock liquidity measure.[13] Finally, we employ a propensity score matching algorithm to identify matches between firms in the two groups.

To implement the propensity score matching, we first estimate a probit model based on the 1,900 sample firms in the two groups mentioned above. The dependent variable is equal to one if the firm-year belongs to the top-tercile group and zero to the bottom-tercile group. The probit model includes all control variables from Equation (2) measured in the year immediately preceding decimalization, and additional control variables such as the pre-decimalization three-year average level of debt issuance ($DI_{i,t-3\rightarrow t-1}$), the pre-decimalization three-year average level of equity issuance ($EI_{i,t-3\rightarrow t-1}$), the pre-decimalization three-year change in debt issuance ($\Delta DI_{i,t-3\rightarrow t}$), the pre-decimalization three-year change in equity issuance ($\Delta EI_{i,t-3\rightarrow t}$), and the Fama and French 48 industry dummies. Note that the additional control variables are included to help satisfy the parallel trends assumption as in Fang, Tian, and Tice (2014). Panel A of Table 3 provides definitions of the new variables used in Table 3.

The probit regression results are presented in Panel B of Table 3. Column (1) shows that the specification captures a significant amount of variation in the choice variable, as indicated by a pseudo-R^2 of 25.5% and a p-value of zero from the χ^2 test of overall model fitness. We then use the predicted probabilities or propensity scores to perform nearest-neighbor propensity score matching. In particular, each firm in the top-tercile group (labeled the treatment group)

[12] Furthermore, we exclude the firms that participated in the pilot program (those for which phase information is not missing) based on the Excel file containing information on the phase-in implementation of decimalization provided by Vivan Fang.

[13] We obtain similar results using the alternative empirical specification, in which the second group contains the other two tercile firms.

is matched to a firm from the bottom-tercile group (labeled the control group) with the closest propensity score. If a firm from the control group is matched to more than one firm in the treatment group, we retain the pair with the smallest distance between the two firms' propensity scores. We obtain 353 unique pairs of matched firms.[14]

Since the validity of the DiD estimate critically depends on the parallel trends assumption, we construct a number of diagnostic tests to verify that we do not violate the assumption. First, we re-run the probit model restricted to the matched sample. The probit regression results are presented in Column (2). None of the independent variables is statistically significant. In addition, the pseudo-R^2 decreases drastically from 25.5% prior to the matching to 1.0% following the matching, and a χ^2 test for overall model fitness shows that we cannot reject the null hypothesis that all of the coefficient estimates on independent variables are zero (with a *p*-value of 0.993).

Second, we examine the difference between the propensity scores of treatment firms and those of the matched control firms. Panel C of Table 3 demonstrates that the difference is rather trivial. For example, the maximum distance between two matched firms' propensity scores is only 0.014, while the 95th percentile of the distance is only 0.002.

Finally, we report the univariate comparisons between the treatment and control firms' pre-decimalization characteristics and their corresponding *t*-statistics in Panel D of Table 3. As shown, none of the observed differences between treatment and control firms' characteristics is statistically significant in the pre-decimalization regime. In particular, the two groups of firms have similar levels of stock liquidity prior to decimalization, even though they are affected by decimalization differently. Moreover, the univariate comparisons for the increase

[14] Because of the nature of lumpy investment and intermittent external financing (Whited, 2006; Leary and Roberts, 2005), financing measures are likely to be inflated if the denominator (i.e., investment) is very small. To minimize the effects of extreme values in debt issuance and equity issuance that could arise when the denominator is extremely small, we winsorize $DI_{i,t}$ and $EI_{i,t}$ at -20 and 20 such that $DI_{i,t}$ and $EI_{i,t}$ cannot be greater than 20 or smaller than -20.

in debt issuance prior to decimalization ($\Delta DI_{i,t-3\rightarrow t}$) and the increase in equity issuance prior to decimalization ($\Delta EI_{i,t-3\rightarrow t}$) suggest that the parallel trends assumption is not violated.

Overall, the diagnostic tests reported above suggest that the propensity score matching removes significant observable differences (other than the difference in the change in liquidity surrounding decimalization). This method increases the likelihood that the changes in debt and equity issuance surrounding decimalization are caused only by the exogenous change in stock liquidity because of decimalization.

Panel E of Table 3 presents the DiD estimates in the univariate analysis. Column (2) reports the mean differences (After-Before) of the three-year average debt issuance ($DI_{i,t}$), the three-year average equity issuance ($EI_{i,t}$), and the three-year average change in the leverage ratio($\Delta LEV_{i,t}$) for the treatment group. These numbers are computed by first subtracting the average of the corresponding financing measure calculated over the three-year period immediately preceding decimalization from the average of the corresponding financing measure calculated over the three-year period immediately following decimalization for each treatment firm. Similarly, we calculate the mean differences (After-Before) of the three-year average of each financing measure for the control group and report them in Column (3). In Columns (4) and (5), we report the DiD estimates and the corresponding two-tailed *t*-statistics testing the null hypothesis that the DiD estimates are zero. The univariate result shows that stock liquidity has a positive DiD effect on the propensity to raise debt capital measured by debt issuance and the increase in leverage ratio, while it has a negative DiD effect on the propensity to raise equity capital measured by equity issuance.

These trends are shown more clearly in Figures 1 and 2. Figure 1 depicts debt issuance for the treatment and control groups over a seven-year period with the decimalization year (denoted as year 0) centered, and Figure 2 depicts equity issuance for both groups of firms over the sample period. As shown, the two lines representing debt issuance and equity issuance for the treatment and control groups trend closely in parallel in the three years leading up to decimalization. After decimalization, the difference in debt issuance between the treatment and control groups starts to increase, indicating a positive causal effect of stock liquidity on the propensity to raise debt capital. However, after decimalization, the difference in equity issuance between the treatment and control groups starts to increase in the opposite direction, indicating a negative causal effect of stock liquidity on the propensity to raise equity capital.

[INSERT FIGURES 1 AND 2 HERE]

We also show the dynamics of our main DiD results in a multivariate regression framework. Specifically, we retain firm-year observations for both treatment and control firms for a seven-year window surrounding the decimalization year and estimate the following regression model:

$$DI_{i,t}\ (or\ EI_{i,t}\ or\ \Delta LEV_{i,t}) = a + bTREAT_i \times POST_t + cPOST_t$$
$$+d'CONTROLS_{i,t-1} + FIRM_i + e_{i,t}, \quad (3)$$

where the variable $TREAT_i$ is a dummy variable that equals one if firm i belongs to the treatment group and zero otherwise. The variable $POST_t$ is a dummy variable that equals one if a firm-year observation is from the three-year period following decimalization ($t+1$, $t+2$, and $t+3$) and zero otherwise. Therefore, the benchmark group comprises the observations from the three-year period before decimalization and the year of decimalization ($t-3$, $t-2$, $t-1$, and t). The key coefficient of interest is b, the coefficient for the interaction term $TREAT_i \times POST_t$.

We report the regression results in Panel F of Table 3. We observe that the coefficient estimates of $TREAT_i \times POST_t$ for both debt issuance ($DI_{i,t}$) and the change in leverage ratio ($\Delta LEV_{i,t}$) are positive and significant at the 1% level. Thus, surrounding decimalization treatment firms, compared to control firms, have a 25.6% (46.6%) higher increase in $DI_{i,t}$

($\Delta LEV_{i,t}$) relative to its sample standard deviation.[15] However, we observe a negative but non-significant coefficient for equity issuance ($EI_{i,t}$), indicating that treatment and control firms have almost parallel changes in equity issuance in the years following decimalization.

Overall, these results based on decimalization suggest that stock liquidity has a positive causal effect on the propensity to raise debt finance, but it does not have a significant causal effect on the propensity to raise equity finance.

[INSERT TABLE 3 HERE]

3.2.2. The DiD approach exploiting the tick-size shift in 1997

One concern with the use of one shock is that an unobservable factor could affect the treatment and control groups differently and could plausibly be correlated with corporate financing choices. In this section, we repeat our DiD analysis using another tick size-related policy change that occurred over the period of May 7, 1997, to June 24, 1997, when the minimum tick size was reduced from an eighth of a dollar to a sixteenth of a dollar on the NYSE, AMEX, and NASDAQ. The reduction in tick sizes substantially enhances stock liquidity. For example, using limit order data provided by the NYSE, Goldstein and Kavajecz (2000) show that quoted spreads decline by 14.3% and that quoted depth declines by 48%.

We repeat the propensity score matching and the DiD approach outlined above for the 1997 tick-size shock. We use the same procedure but in a different sample. Specifically, we divide 3,311 sample firms into terciles according to $\Delta LIQ_{i,t-1\rightarrow t+1}$, where year t indicates the calendar year during which the 1997 shock occurred for firm i. Two out of three terciles are used in the experiment. The first group contains only the upper tercile firms, including 1,103

[15] We compute the additional increase in $DI_{i,t}$ as follows: 1.205/4.712=0.256, where the full sample standard deviation of $DI_{i,t}$ equals 4.712. We compute the additional increase in $\Delta LEV_{i,t}$ as follows: 0.054/0.116=0.466, where the full sample standard deviation of $\Delta LEV_{i,t}$ equals 0.116.

firms experiencing the largest surge in the stock liquidity measure, while the second group contains the bottom tercile firms, comprising 1,103 firms experiencing the smallest increase in the stock liquidity measure. By using the same propensity score matching algorithm with the same covariates as in the previous section, we obtain 479 matched treatment-control pairs. As in the previous section, we conduct a number of diagnostic tests to verify that the parallel trends assumption is not violated.

Panel A of Table 4 presents the DiD estimates based on the 1997 shock in the univariate framework. Consistent with the results from the 2001 decimalization shock, stock liquidity has a positive DiD effect on the propensity to raise debt capital but a negative but non-significant DiD effect on the propensity to raise equity capital. The mean DiD estimates for both debt issuance ($DI_{i,t}$) and the increase in leverage ($\Delta LEV_{i,t}$) are positive and statistically significant at the 5% and 1% levels, respectively: the *t*-statistics are 2.542 and 5.800, respectively. However, the mean DiD estimate for equity issuance ($EI_{i,t}$) is negative but statistically non-significant: the *t*-statistic (*p*-value) is -0.248 (0.804).

Panel B of Table 4 shows the dynamics of our DiD results based on the 1997 shock in the multivariate regression framework. Specifically, we retain firm-year observations for both the treatment and control firms for a seven-year window surrounding the 1997 shock and estimate the regression model specified in Equation (3). The dependent variable and control variables are defined in the same way. $TREAT_i$ is a dummy variable that equals one if firm i belongs to the treatment group and zero otherwise. The variable $POST_t$ is a dummy variable that equals one if a firm-year observation is from the three-year period following the 1997 shock ($t+1$, $t+2$, and $t+3$) and zero otherwise. Therefore, the benchmark group comprises the observations from the three-year period before the shock and the year of the shock ($t-3$, $t-2$, $t-1$, and t). In Panel B, we again observe positive and significant coefficient estimates for both debt issuance ($DI_{i,t}$) and the change in leverage ratio ($\Delta LEV_{i,t}$). This result suggests that treatment firms, compared to control firms, have a 14.2% (28.4%) higher increase in $DI_{i,t}$ ($\Delta LEV_{i,t}$) relative to its sample standard deviation around the 1997 shock.[16] However, we observe a positive but non-significant coefficient for equity issuance ($EI_{i,t}$), indicating that treatment and control firms have almost parallel changes in equity issuance in the years following the 1997 shock.

In 1997 tick sizes declined from $1/8 to $1/16 while in 2001 they decreased further from $1/16 to $1/100. Because the latter change is much more severe, we expect that the effect of the 2001 shift to decimalization is greater than that of the 1997 shift. In terms of economic significance, the regression DiD estimate for $DI_{i,t}$ ($\Delta LEV_{i,t}$) in the natural experiment based on the 2001 shift is 80% (64%) larger than the regression DiD estimate in the natural experiment based on the 1997 shift.

Overall, the DiD results based on the two natural experiments are consistent with the *debt preference hypothesis* that stock liquidity has a positive, causal effect on the propensity to raise debt, but does not have a significant causal effect on the propensity of equity finance.

[INSERT TABLE 4 HERE]

3.3. The RDD approach

We use the annual reconstitutions of the Russell 1000 and 2000 indices in the third experiment to identify the causal effect of stock liquidity on the firm's choice between debt and equity. We closely follow a RDD approach used by Chang, Hong, and Liskovich (2014) and Crane, Michenaud, and Weston (2016). In the RDD, unlike in the DiD approach, an assignment to treatment and control groups is not purely random but instead depends on a

[16] We compute the additional increase in $DI_{i,t}$ as follows: 0.671/4.712=0.142, where the full sample standard deviation of $DI_{i,t}$ equals 4.712. We compute the additional increase in $\Delta LEV_{i,t}$ as follows: 0.033/0.116=0.284, where the full sample standard deviation of $\Delta LEV_{i,t}$ equals 0.116.

known cutoff that is a function of an observable variable that we call a forcing variable (Roberts and Whited, 2013). This cutoff generates a discontinuity in receiving treatment at that cutoff point. Subjects whose forcing variable is on one side of the cutoff are assigned to one group, the *treatment* group, and those on the other side of the cutoff are assigned to another group, the *control* group. An advantageous feature of the RDD is that one need not assume that the cutoff generates randomized variation. Lee (2008) shows that if subjects cannot perfectly manipulate the forcing variable around the likelihood of the cutoff, then randomized variation is in fact a consequence of RDD.

In our context, subjects are firms within the Russell universe, the forcing variable is firm size, and the cutoff is the size of a hypothetical firm that might be ranked between the 1000th and 1001st positions in the Russell universe based on market capitalization on the last trading day of May in each year. The largest 1,000 stocks are included into the Russell 1000 index, and the next largest 2,000 stocks are in the Russell 2000 index. Because firms cannot perfectly control their rankings, the assignment of an index ranking close to the cutoff is nearly random.[17] This quasi-random index assignment induces significant differences in index weights for firms close to the cutoff with tiny differences in firm sizes. In 2005, the ten smallest firms in the Russell 1000 index had a combined index weight of 0.0004%, and the next ten largest firms in the Russell 2000 index had a combined index weight of 2.3%. These significant differences in index weights around the cutoff create an exogenous shock to stock liquidity (e.g., Madhavan, 2003; Chang, Hong, and Liskovich, 2014; Dass, Huang, Maharjan, and Nanda, 2016).

3.3.1. Issues in identification

[17] Even if one assumes that a firm could manipulate its own size, it cannot manipulate the sizes of firms that are close to the cutoff, especially when these firms are also manipulating.

Our underlying assumption is that stock liquidity varies around the Russell index threshold because of mechanical weighting differences that are orthogonal to firm characteristics. To satisfy this assumption, assignment to an index cannot be based on corporate financing policy or any determinant of corporate financing policy outside of its effect on index inclusion. However, it is clear that large firms have financing policies different from small firms, and index assignment is based on market capitalization rankings. Thus, we need to focus only on variation in a neighborhood close to the threshold in which firms are similar enough so that the variation in stock liquidity is plausibly exogenous to debt and equity issuance.

To isolate variation near the index threshold, we follow a method similar in spirit to the regression discontinuity design. However, the Russell index inclusion setting is not perfectly suited to a simple regression discontinuity design because Russell Investments makes adjustments to their index construction. First, Russell Investments adopted the banding policy in 2007 to reduce unnecessary trading arising from changes in index constituents by maintaining some continuity in the indices.[18] Exclusion restriction could be violated because the selection of firms into Russell 1000 and 2000 indices is related to not only market capitalization rankings but also firm characteristics. Second, Russell Investments makes a proprietary adjustment based on the available public float (the number of investable shares) to construct the June 30th market capitalization rankings used to construct index weights. One

[18] A blog written by Mat Lystra on April 27, 2016, that appears on the FTSE Russell website describes the banding policy as follows: "*As passive index-linked funds seek to track the performance of their underlying index, changes in index constituents can result in a large volume of trading by passive funds and ETFs. FTSE Russell and many other index providers publicly announce planned index changes considerably in advance of index reconstitution. While such notice allows passive managers and liquidity providers to prepare for index changes, it can also give rise to the possibility that liquidity providers are able to make large profits from the known trades that passive managers will make. Recognizing this possibility, Russell implemented an important index methodology change in 2007. Banding was introduced to reduce unnecessary trading, both in the number of different stocks traded and total trading volume. Banding reduces turnover in the Russell indexes by not moving a stock between two indexes unless the percentage difference between company market capitalization and the relevant market capitalization breakpoint exceeds 5%*" (Source: http://www.ftserussell.com/blog/russell-2000-recon-banding-results-lower-turnover).

potential problem is that the weights Russell Investments uses may be correlated with unobservable firm characteristics due to the float adjustment.

Crane, Michenaud, and Weston (2016) argue that to satisfy our identification assumptions we need to make sure *i)* that Russell index assignment is solely a function of market capitalization rankings (Condition 1), and *ii)* that we can identify firms close to the threshold at the time of index inclusion (Condition 2). To satisfy Condition 1, we drop all years after 2006 because Russell Investments adopted the banding policy in 2007. We construct the sample from 1991 to 2006. To satisfy Condition 2, we only use the May 31st unadjusted market capitalization rankings based on data from CRSP.[19] To control for the variation in index weights caused by Russell's float adjustment made at the end of June, we include a proxy for the float adjustment by Russell, computed as the difference between the rank implied by the May 31st market capitalization and the actual rank assigned by Russell in June.

In the following subsections, we closely follow Crane, Michenaud, and Weston's (2016) empirical framework. First, we establish the relevance of the Russell index reconstitution as a source of exogenous variation in stock liquidity. Second, we empirically investigate the effect of stock liquidity on debt and equity issuance using a two-stage least-squares approach.

3.3.2. Stock liquidity around the cutoff of Russell 1000/2000 indices

To establish the relevance of the Russell index reconstitution as a source of exogenous variation in stock liquidity, we estimate the following regression model:

$$LIQ_{i,t-1} = a + bRus2000_{i,t-1} + cRank_{i,t-1} + dRus2000_{i,t-1} \times Rank_{i,t-1}$$

$$+eFloatAdj_{i,t-1} + f'CONTROLS_{i,t-1} + YR_{t-1} + IND_j + \omega_{i,t-1}, \qquad (4)$$

[19] Firms are assigned to Russell 1000 and 2000 indices at the end of May, but index weights are determined at the end of June. These index assignments and weights hold until the following June. Refer to Crane, Michenaud, and Weston (2016) for detailed background of Russell indices.

where $LIQ_{i,t-1}$ is stock liquidity as detailed in Section 2.2.1; $Rus2000_{i,t-1}$ is the binary instrumental variable that equals to one if firm i is included in the Russell 2000 index in year $t-1$ and zero otherwise; and $Rank_{i,t-1}$ is based on the rank implied by the firm's market capitalization within the assigned index as of May 31st.[20] The Russell rank is defined such that the smallest Russell 1000 firm (the largest Russell 2000 firm) has a value of -1 (+1), the second smallest Russell 1000 firm (the second largest Russell 2000 firm) has a value of -2 (+2), and so forth. The inclusion of $Rank_{i,t-1}$ and $Rus2000_{i,t-1} \times Rank_{i,t-1}$ allows us to control for the mechanical relationship with market capitalization ranking on either side of the threshold and thus isolate any discontinuity in stock liquidity around the threshold, where $Rank_{i,t-1} = 0$. To control for the variation in index weights caused by Russell's float adjustment made at the end of June, we also include $FloatAdj_{i,t-1}$, a proxy for the float adjustment by Russell, computed as the difference between the rank implied by the May 31st market capitalization and the actual rank assigned by Russell in June. For the vector of control variables ($CONTROLS_{i,t-1}$), we include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), an R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), the dividend payout ratio ($DPayout_{i,t-1}$), and institutional ownership ($IO_{i,t-1}$). Year fixed effects and industry fixed effects are included. Our focus is b, the coefficient of $Rus2000_{i,t-1}$.

Table 5 reports the estimated coefficients and firm-clustered standard errors of the regression model stated in Equation (4). Columns (1) and (2) report the results for a small bandwidth with 100 firms on each side of the cutoff. In the model with (without) control

[20] The timing of stock liquidity should be the same as the timing of the Russell 2000 indicator, because firms that enter the Russell 2000 index may well exit the index a year later. In order to keep notational consistency with the instrumental variable regression model in Section 3.3.3, we use the subscript $t-1$ for all the variables in this model.

variables, the estimated treatment effect, $\hat{b}$, of the Russell 2000 index inclusion on stock liquidity is 0.476 (0.492), and this value is statistically significant at the 1% level. This is economically significant as the difference between stock liquidity of the largest firms in the Russell 2000 index and that of the smallest firms in the Russell 1000 index is 27% (28%) as large as the standard deviation of stock liquidity in the Russell 1000 sample (1.740). Columns (3) to (4) report the point estimates of the treatment effect for a wider bandwidth with 750 firms on each side of the cutoff. Columns (5) and (6) report the estimation results based on the full sample consisting of all Russell 1000 and 2000 firms. The results are robust to the changes in the bandwidth.

[INSERT TABLE 5 HERE]

Regardless of the choice of a bandwidth, Russell 2000 firms around the cutoff have significantly higher stock liquidity than Russell 1000 firms around the cutoff. The reported point estimates are slightly smaller with a larger bandwidth, consistent with the RDD theory that an increasing distance from the cutoff would increase the power of the test but also bring a bias into the estimated treatment effect. However, this discontinuity in stock liquidity around the threshold is more pronounced when the full sample is used compared to when the larger bandwidth of 750 is used. The gain from the increase in the power seems to be greater than the loss from the increase in the bias. Therefore, we report the results based on the full sample for subsequent analyses.

Figure 3 presents a graphical analysis of float-adjusted stock liquidity around the threshold. The float-adjusted stock liquidity is computed as the residual from the regression of our stock liquidity measure against a proxy for the float adjustment made by Russell Investments as well as industry and year dummies. The horizontal axis represents the relative Russell rank based on the rankings implied by the firm's market capitalization on May 31st in each year. The relative Russell rank is defined such that the smallest Russell 1000 firm (the largest Russell 2000 firm) has a value of -1 (+1), the second smallest Russell 1000 firm (the second largest Russell 2000 firm) has a value of -2 (+2), and so forth. This graph shows strong evidence of the discontinuity in the float-adjusted stock liquidity around the Russell 1000/2000 threshold. Stock liquidity adjusted for free float increases with firm size in each set of Russell index firms. However, right at the hypothetical Russell 1000/2000 threshold, the slightly smaller firms (the largest firms among the Russell 2000 firms) have much higher float-adjusted stock liquidity than the slightly larger firms (the smallest firms among the Russell 1000 firms) because of the index membership effect.

[INSERT FIGURE 3 HERE]

Overall, both our regression and figure results suggest that the Russell reconstitution serves as a valid exogenous shock to stock liquidity given the clear evidence of discontinuity in stock liquidity around the threshold.

3.3.3. The instrumental variable analysis

To examine the impact of stock liquidity on debt and equity issuance, we employ a two-stage least-squares test. This approach is equivalent to a fuzzy RDD framework. In the first stage, we estimate the effect of Russell 2000 membership on stock liquidity, as in Section 3.3.2, without any constraints on the bandwidth. In the second stage, we use the instrumented stock liquidity to model debt issuance, equity issuance, or the change in leverage ratio for firm i in year t, $Y_{i,t}$:

$$LIQ_{i,t-1} = a_1 + b_1 Rus2000_{i,t-1} + c_1 Rank_{i,t-1} + d_1 Rus2000_{i,t-1} \times Rank_{i,t-1}$$

$$+e_1 FloatAdj_{i,t-1} + f_1' CONTROLS_{i,t-1} + YR_{t-1} + IND_j + \omega_{i,t-1}, \tag{5}$$

$$Y_{i,t} = a + b\widehat{LIQ_{i,t-1}} + cRank_{i,t-1} + dRus2000_{i,t-1} \times Rank_{i,t-1} + eFloatAdj_{i,t-1}$$

$$+f' CONTROLS_{i,t-1} + YR_t + IND_j + \epsilon_{i,t}. \tag{6}$$

The first-stage regression is comparable to a sharp RDD. $Rus2000_{i,t-1}$ is the binary variable that equals one if firm i is included in the Russell 2000 index in year $t-1$ and zero firm i is included in the Russell 1000 index in year $t-1$. $Rank_{i,t-1}$ is the Russell rank based on the May 31st market capitalization, which is defined such that the smallest Russell 1000 firm (the largest Russell 2000 firm) has a value of -1 (+1), the second smallest Russell 1000 firm (the second largest Russell 2000 firm) has a value of -2 (+2), and so forth. The inclusion of $Rank_{i,t-1}$ and $Rus2000_{i,t-1} \times Rank_{i,t-1}$ allows us to control for the mechanical relationship with market capitalization ranking on either side of the threshold and thus isolate any discontinuity in stock liquidity around the threshold, where $Rank_{i,t-1} = 0$. Therefore, our instrument is $Rus2000_{i,t-1}$, conditional on $Rank_{i,t-1}$ and $Rus2000_{i,t-1} \times Rank_{i,t-1}$.

To control for the variation in index weights caused by Russell's float adjustment made at the end of June, we also include $FloatAdj_{i,t-1}$, a proxy for the float adjustment by Russell, computed as the difference between the rank implied by market capitalization on May 31st and the actual rank assigned by Russell Investments on June 30th. In addition, we control for institutional ownership ($IO_{i,t-1}$) to make sure that the discontinuity in stock liquidity around the index threshold is not driven by the discontinuity in institutional ownership. Other control variables that might influence a firm's debt issuance and equity issuance are included.

In the second-stage regression, Equation (6), we estimate the effect of instrumented stock liquidity, $\widehat{LIQ_{i,t-1}}$, on debt issuance, equity issuance, and the change in leverage. As in Crane, Michenaud, and Weston (2016), all three dependent variables are measured in the next available fiscal year-end after the year of index assignment. The second-stage model includes the instrumented stock liquidity and the control variables defined above and included in the first-stage model. Year fixed effects and industry fixed effects are included in both regression models. Note that $Rus2000_{i,t-1}$ is not included in the second-stage regression model because it is the instrumental variable in our empirical framework. See Crane, Michenaud, and Weston (2016) for a discussion about how our setting and empirical specification lead to valid assumptions for causal inference, given that our setting and empirical specification is almost identical to theirs.

Table 6 reports the estimation results. Column (1) reports the result of the first-stage regression described in Equation (5). Consistent with Table 5, firms in the Russell 2000 index have more liquid stocks than do firms in the Russell 1000 index. The coefficient estimate is 0.481 with statistical significance at the 1% level. This is economically significant because the difference between the stock liquidity of Russell 2000 firms and that of Russell 1000 firms is 28% of the standard deviation of stock liquidity in the Russell 1000 sample. Column (2) reports the results of the second-stage regression as described in Equation (6), with debt issuance as the dependent variable. Debt issuance increases with the instrumented stock liquidity at the 5% significance level. A one-standard-deviation increase in stock liquidity is associated with a 33% increase in debt issuance relative to its standard deviation.[21] Column (3) reports the results of the second-stage regression with equity issuance as the dependent variable. The instrumented stock liquidity has no significant impact on equity issuance. Column (4) reports the result of the second-stage regression with the change in leverage ratio as the dependent variable. We find that the change in leverage ratio increases with the instrumented stock liquidity at the 5% significant level. A one-standard-deviation increase in stock liquidity leads to a 39% increase in the change in the leverage ratio relative to the sample standard deviation.[22]

[21] 0.525×1.740/2.762=33.1%, where the standard deviation of stock liquidity based on the Russell 1000 sample is 1.740 and that of debt issuance is 2.762.
[22] 0.016×1.740/0.071=39.2%, where the standard deviation of the change in leverage based on the Russell 1000 sample is 0.071.

[INSERT TABLE 6 HERE]

Overall, our results suggest that the use of debt capital increases with stock liquidity, while the use of equity capital does not.

4. Possible Channels

In this section, we test two plausible channels underlying the *debt preference hypothesis*. High stock liquidity may increase a firm's propensity to raise debt capital but not equity capital by i) lowering the cost of debt capital more sensitively than the cost of equity capital—the *cost of capital differential channel*—and ii) increasing the probability of a hostile takeover and thus lowering the incentive of issuing more equity—the *anti-takeover channel*. In the following subsections, we examine each channel using fixed effects (FE) regressions as well as the DiD and RDD approaches.

4.1. The cost of capital differential channel

4.1.1. The cost of capital differential channel: the FE regression

If the cost of debt capital is more sensitive to the change in stock liquidity than the cost of equity capital is (Butler and Wan, 2010), one would expect a higher level of stock liquidity to lead to an increased use of debt rather than equity and to result in a higher increase in leverage ratio. Accordingly, we examine whether stock liquidity exerts a differential impact on the costs of debt and equity capital.

Our cost of debt measure is constructed based on the information on corporate syndicated loans obtained from the Thompson Reuters DealScan database.[23] Specifically, we use bank

[23] In an untabulated test, we also construct the cost of debt measure using the Thompson One Banker database and the Thompson Reuters Securities Data Company (SDC) Platinum database for corporate bond issuance. To compute the cost of corporate bond, we subtract the London Interbank Offered Rate (LIBOR) swap rate matched

loans' all-fees-in spread as the cost of debt measure ($COD_{i,t}$). As a measure for the cost of equity ($COE_{i,t}$), we use Pástor, Sinha, and Swaminathan's (2008) implied cost of equity capital measure, which is defined as the internal rate of return that equates the present value of future dividends with the current stock price. Future dividends are calculated based on the earnings forecast information from the I/B/E/S database.

To compare the sensitivities of two types of financing costs to stock liquidity, we first run FE regressions in which the dependent variable $C_{i,t}$ is the cost of debt standardized by the within-firm mean cost of debt ($COD^*_{i,t}$), the cost of equity standardized by the within-firm mean cost of equity ($COE^*_{i,t}$), the standardized cost of capital differential ($COE^*_{i,t} - COD^*_{i,t}$), and the relative cost of equity ($COE_{i,t}/COD_{i,t}$), respectively:

$$C_{i,t} = a + bLIQ_{i,t-1} + c'CONTROLS_{i,t-1} + YR_t + FIRM_i + \epsilon_{i,t}, \tag{7}$$

where $LIQ_{i,t-1}$ is our stock liquidity measure, $CONTROLS_{i,t-1}$ is a set of time-variant control variables, $FIRM_i$ and YR_t are error components reflecting the firm FE and the year FE, respectively.[24] YR_t is replaced by year dummies. Our coefficient of interest is b. We first estimate Equation (7) using the sample with non-missing observations for both the costs of debt and equity.

Table 7 reports the FE regression results. Column (1) reports the regression of the cost of debt ($COD^*_{i,t}$) against stock liquidity. The estimated coefficient of stock liquidity is -0.082 and significant at the 1% level, suggesting that a one-standard-deviation increase in a firm's stock liquidity is associated with a reduction in the cost of debt capital of 17.4% of its mean cost of

by maturity from each bond's yield-to-maturity at issuance. The LIBOR swap rate data at different maturities are obtained from the Federal Reserve Bank St. Louis via the Thompson Reuters Datastream.

[24] We can simply measure the differential impact of stock liquidity on the costs of equity and debt as proportions of the corresponding mean costs by including the standardized cost of equity or debt ($COE^*_{i,t}$ or $COD^*_{i,t}$) as the dependent variable. We also use as the dependent variable the differential between standardized costs of equity and debt ($COE^*_{i,t} - COD^*_{i,t}$) and the relative cost of equity calculated using the raw costs of equity and debt ($COE_{i,t}/COD_{i,t}$).

debt.[25] Column (2) reports the regression of the cost of equity ($COE_{i,t}^{*}$) against stock liquidity. The estimated coefficient of stock liquidity is not significant. Column (3) reports the regression of the cost of capital differential ($COE_{i,t}^{*} - COD_{i,t}^{*}$) on stock liquidity. The estimated coefficient of stock liquidity is 0.081 and significant at the 1% level. Column (4) reports the regression of the relative cost of equity ($COE_{i,t}/COD_{i,t}$) against stock liquidity. The estimated coefficient of stock liquidity is 0.597 with significance at the 1% level. Both columns suggest that an increase in stock liquidity is associated with an increase in the gap between the cost of equity and the cost of debt. The differential effect of stock liquidity on the costs of debt and equity is economically meaningful. A one-standard-deviation increase in stock liquidity is associated with an increase in the cost of capital differential (the relative cost of equity) of 46.3% (15.7%) relative to its standard deviation, 0.372 (8.086). This suggests that, compared with the cost of equity, the cost of debt is much more sensitive to the variation in stock liquidity.

[INSERT TABLE 7 HERE]

4.1.2. The cost of capital differential channel: the DiD approach

In this subsection, we test the cost of capital differential channel using the DiD approach based on the two tick size-related regulation changes. First, we test this channel using the 2001 tick-size shift to decimalization. To do so, we compare the changes in the four measures defined above around the 2001 tick-size shift to decimalization between two groups of firms: firms with a larger liquidity increase (i.e., the treatment group) and firms with a smaller liquidity increase (i.e., the control group).

[25] If stock liquidity increases by one standard deviation (2.126), $COD_{i,t}^{*}$ drops by 17.4% (-0.082×2.126=-0.174), implying that $COD_{i,t}$ drops by 17.4% of its mean cost of debt.

Panel A of Table 8 reports the univariate DiD test results for the the two cost of capital measures and the two cost of capital gap measures. The average treatment effect for the cost of debt ($COD_{i,t}^{*}$) is -0.215 with significance at the 1% level. In other words, a treatment firm's cost of debt drops by an additional 21.5% of its mean cost of debt compared to a control firm. The average treatment effect for the cost of equity ($COE_{i,t}^{*}$) is -0.103 with significance at the 1% level. This number implies that a treatment firm's cost of equity drops by an additional 10.3% of its mean cost of equity compared to a control firm.

More importantly, the average treatment effect for the cost of capital differential ($COE_{i,t}^{*} - COD_{i,t}^{*}$) is 0.211 and significant at the 10% level. In addition, the average treatment effect for the relative cost of equity ($COE_{i,t}/COD_{i,t}$) is 1.660 with significance at the 5% level. These suggest that an exogenous increase in stock liquidity driven by decimalization significantly increases the gap between the cost of equity and the cost of debt. The regression DiD results reported in Panel B show similar evidence that the increase in stock liquidity lowers the cost of debt significantly at the 1% level but has no significant impact on the cost of equity, thereby increasing the gap between the costs of equity and debt at the 5% level.

The trend of the cost of capital differential ($COE_{i,t}^{*} - COD_{i,t}^{*}$) is shown clearly in Figure 4. The figure depicts the gap between the standardized costs of equity and debt capital for treatment and control firms over a seven-year period with the decimalization year (denoted as year 0) centered. As shown, the two lines representing the cost of capital differential for the treatment and control groups trend closely in parallel in the three years leading up to decimalization. After decimalization, the difference in the cost of capital differential between the treatment and control groups starts to increase.

[INSERT FIGURE 4 HERE]

Second, we test this channel using the 1997 tick-size shift. Panel C of Table 8 reports the univariate DiD test results for the four measures. The average treatment effect for the cost of debt is -13.9% with significance at the 10% level, while that for the cost of equity is negative but not significant. In addition, the average treatment effect for the cost of capital differential is 0.379 and significant at the 10% level. This also suggests that an increase in stock liquidity significantly increases the gap between the cost of equity and cost of debt. As in Panel B, the regression DiD results reported in Panel D also show a similar finding. The increase in stock liquidity lowers the cost of debt significantly at the 1% level but has no significant impact on the cost of equity, thereby increasing the gap between the costs of equity and debt measured by $COE_{i,t}^{*} - COD_{i,t}^{*}$ and $COE_{i,t}/COD_{i,t}$ at the 5% level.

Taken together, our DiD analyses based on both tick size-related regulation changes provide consistent evidence supporting the *cost of capital differential channel* by showing that the cost of debt capital, compared with the cost of equity capital, is more sensitive to stock liquidity, and that a firm with more liquid stocks, compared to a firm with less liquid stocks, tend to have a larger positive gap between the costs of equity and debt.

[INSERT TABLE 8 HERE]

4.1.3. The cost of capital differential channel: the RDD Approach

In this subsection, we use the instrumental variable approach presented in Section 3.3.3 to provide further evidence pertaining to the relative sensitivities of financing costs to stock liquidity. In the second-stage, we estimate the following model with the two cost of capital measures ($COE_{i,t}^{*}$ and $COD_{i,t}^{*}$) and the two cost of capital gap measures ($COE_{i,t}^{*} - COD_{i,t}^{*}$ and $COE_{i,t}/COD_{i,t}$) as the dependent variable, $C_{i,t}$:

$$C_{i,t} = a + b\widehat{LIQ_{i,t-1}} + cRank_{i,t-1} + dRus2000_{i,t-1} \times Rank_{i,t-1}$$

$$+eFloatAdj_{i,t-1} + f'CONTROLS_{i,t-1} + YR_t + IND_j + \epsilon_{i,t}, \quad (8)$$

where all variables are defined in the same way as in Equation (4), and $\widehat{LIQ_{i,t-1}}$ is obtained by estimating the first-stage model presented in Equation (5). The inclusion of $Rank_{i,t-1}$ and $Rus2000_{i,t-1} \times Rank_{i,t-1}$ allows us to control for the mechanical relationship with market capitalization ranking on either side of the threshold and thus isolate any discontinuity in the dependent variable around the threshold, where $Rank_{i,t-1} = 0$. Our focus is b, the coefficient of $Rus2000_{i,t-1}$.

Table 9 reports the estimated coefficients and firm-clustered standard errors of the regression model stated above. Column (1) reports the result of the first-stage regression described in Equation (5). The coefficient estimate for the Russell 2000 indicator is 0.489 with significance at the 1% level. Column (2) reports the result of the second-stage regression as described in Equation (8), with the standardized cost of debt ($COD^*_{i,t}$) as the dependent variable. The cost of debt measure decreases with the instrumented stock liquidity at the 10% significance level. A one-standard-deviation increase in a firm's stock liquidity is associated with a reduction in the cost of debt capital of 11.6% of its mean cost of debt.[26] Column (3) reports the result of the second-stage regression with the standardized cost of equity ($COE^*_{i,t}$) as the dependent variable. The impact of the instrumented liquidity on the cost of equity capital is also negative with significance at the 5% level. The magnitude of the coefficient is, however, much smaller than the coefficient in the cost of debt model, and the effect is less significant economically. A one-standard-deviation increase in a firm's stock liquidity is associated with a reduction in the cost of equity capital of 3.9% of its mean cost of equity.[27] Columns (4) and (5) report the results of the second-stage regressions with the differential between the

[26] If stock liquidity increases by one standard deviation (1.447 in the sample consisting of Russell 1000 firms with complete information for the costs of debt and equity), $COD^*_{i,t}$ drops by 11.6% (-0.080×1.447=-0.116), implying that $COD_{i,t}$ drops by 11.6% of its mean cost of debt.

[27] If stock liquidity increases by one standard deviation, $COE^*_{i,t}$ drops by 3.9% (-0.027×1.447=-0.039), implying that $COD_{i,t}$ drops by 3.9% of its mean cost of debt.

standardized costs of equity and debt capital and the relative cost of equity capital as the dependent variable, respectively. We find that the estimated treatment effect, $\hat{b}$, of the Russell 2000 index inclusion on the relative cost of equity measure is 2.187, and is statistically significant at the 1% level. This is economically significant as the difference between the relative cost of capital of the largest firms in the Russell 2000 index and that of the smallest firms in the Russell 1000 index is 35% as large as the standard deviation of the relative cost of equity capital in the Russell 1000 sample.[28]

We find that firms with a larger cost of capital differential, or firms with a larger gap between the cost of equity and the cost of debt, are the firms that derive the effect we observe in the overall sample. This result supports the *cost of capital differential channel* in which a firm with more liquid stocks rely more on debt issuance since a firm with more liquid stocks tends to have a larger (positive) gap between the costs of equity and debt capital.

Overall, our results suggest that the cost of debt capital, compared with the cost of equity capital, is more sensitive to stock liquidity, and that a firm with more liquid stocks, compared to a firm with less liquid stocks, tend to have a larger positive gap between the costs of equity and debt. Therefore, the RDD analysis, together with the DiD analyses and FE regressions, provides evidence supporting the *cost of capital differential channel*.

[INSERT TABLE 9 HERE]

4.2. The anti-takeover channel

4.2.1. The anti-takeover channel: the FE regression

[28] 2.187×1.447/9.170=34.5%, where the standard deviations of stock liquidity and the relative cost of equity measure based on the sample consisting of Russell 1000 firms with complete information for the costs of debt and equity are 1.447 and 9.170, respectively.

If stock liquidity increases the probability of becoming a takeover target, a firm with liquid shares may prefer debt financing to equity financing simply to avoid being a target of a takeover. To test this hypothesis, we examine whether an increase in stock liquidity leads to an increase in the probability of a takeover, especially that of a hostile takeover. Following Billett and Xue (2007), Cremers, Nair, and John (2009), and Chen, Hsu, and Huang (2016), we use a logit regression model with heteroscedasticity-consistent standard errors and estimate the *ex ante* likelihood that a firm will be acquired by another firm:

$$P(T_{i,t} = 1|X_{i,t-1}) = g(\alpha + \beta' X_{i,t-1} + \epsilon_{i,t}), \tag{9}$$

where the variable $T_{i,t}$ equals one if firm i receives a takeover bid in year t and zero otherwise; $P(T_{i,t} = 1|X_{i,t-1})$ is the probability that $T_{i,t}$ equals one given a vector of observable covariates $X_{i,t-1}$; $g(\cdot)$ is the inverse of the logistic function; and $X_{i,t-1}$ is a set of observable covariates that have been used in the existing literature (e.g., Hasbrouck, 1985; Palepu, 1986; Billett, 1996; Billett and Xue, 2007; Cremers, Nair, and John, 2009; Chen, Hsu, and Huang, 2016) for firm i in year $t-1$, including an indicator variable that measures whether a takeover attempt occurred in the same industry in the year prior to the acquisition, return on assets, market value of equity, leverage, cash, size, Tobin's Q, asset structure, and a blockholding dummy. All of these covariates are measured at the end of the previous fiscal year. Definitions of these variables are provided in Appendix B. We also include industry and year fixed effects. Acquisition data are obtained from the Thomson Reuters SDC Platinum database. We consider fully completed takeovers, and our dataset includes both friendly and hostile takeover bids.

To test the sensitivity of the likelihood of a takeover to stock liquidity, we first run an FE regression in which the dependent variable $\widehat{Logit(P(T_{i,t} = 1|X_{i,t-1}))}$ is the predicted logit-transformed probability of a takeover for firm *i* in year *t*:

$$\widehat{Logit(P(T_{i,t} = 1|X_{i,t-1}))} = a + bLIQ_{i,t-1} + c'CONTROLS_{i,t-1} + YR_t + FIRM_i + e_{i,t}, \tag{10}$$

where $LIQ_{i,t-1}$ is stock liquidity, $CONTROLS_{i,t-1}$ is a set of time-variant control variables measured for firm i in year $t-1$, YR_t and $FIRM_i$ are error components representing year fixed effects and firm fixed effects, respectively. The year fixed effects are replaced by year dummies. Our coefficient of interest is b.

Table 10 reports our FE regression results. Column (1) reports the estimation result of the regression of the logit-transformed probability of a hostile takeover against stock liquidity, while Column (2) reports the estimation result for a takeover of any type. The estimated coefficients of stock liquidity reported in both columns are positive (0.116 and 0.058, respectively) and statistically significant at the 1% level. This result suggests that an increase in stock liquidity is associated with an increase in the probabilities of a hostile takeover and a takeover of any type. Moreover, a larger coefficient in Column (1) implies that the probability of a hostile takeover is more sensitively influenced by stock liquidity than the probability of a takeover of any type is.

[INSERT TABLE 10 HERE]

4.2.2. The anti-takeover channel: the DiD approach

In this section, we test the *anti-takeover channel* using the DiD approach similar to that presented in Section 3.2, which allows us to address the endogeneity issue concerning the regression of the probability of a takeover against stock liquidity.[29] First, we test the channel using the 2001 tick-size shift to decimalization. To do so, we compare the change in the probability of a (hostile) takeover around the 2001 tick-size shift to decimalization between

[29] The FE regression is subject to two common endogeneity concerns: reverse causality and simultaneity. First, stock liquidity tends to be higher when there is a takeover. Transaction volume is likely to be larger around takeovers. Second, both stock liquidity and the probability of a takeover are likely to be higher when the economy is in a recovery or boom phase rather than a downturn or recession phase.

firms with a larger liquidity increase (i.e., the treatment group) and firms with a smaller liquidity increase (i.e., the control group).

Panel A of Table 11 reports the results of the univariate DiD tests for hostile and any takeover exposures. We find that the mean DiD estimate for the logit-transformed probability of a hostile takeover is 0.613 and statistically significant at the 1% level. We repeat the DiD analysis using the logit-transformed probability of a takeover of any type, i.e., both hostile and friendly. The mean DiD estimate for the logit-transformed probability of a takeover of any type is 0.377 and statistically significant at the 1% level.

We find similar results using the regression DiD analyses reported in Panel B of Table 11. The average treatment effect for hostile takeover exposure is 0.358 with significance at the 1% level, while that for any takeover exposure is 0.211 with significance at the 1% level. Both panels suggest that stock liquidity increases both hostile and any takeover exposures, and the liquidity effect on a hostile takeover is more pronounced than that on a general takeover.

The trend of hostile takeover exposure is shown in Figure 5. Figure 5 depicts the hostile takeover probability for treatment and control groups over a seven-year period with the decimalization year (denoted as year 0) centered. As shown, the two lines representing the hostile takeover probability for treatment and control groups trend closely in parallel in the three years leading up to decimalization. After decimalization, the difference in the hostile takeover probability between the treatment and control groups starts to increase.

[INSERT FIGURE 5 HERE]

Second, we test this channel using the 1997 tick-size shift. Panels C and D of Table 11 report the univariate and regression results, respectively. As in Panels A and B, both panels show that an increase in stock liquidity leads to the increase in both hostile and any takeover exposures, but hostile takeover exposure is more significantly influenced by the shock. For example, in Panel D, the regression DiD estimates for hostile takeover exposure and any takeover exposure are 0.287 and 0.128, respectively, and both are statistically significant at the 1% level.

Taken together, our DiD analyses provide further evidence supporting the *anti-takeover channel*.

[INSERT TABLE 11 HERE]

4.2.3. The anti-takeover channel: the RDD approach

In this subsection, we use the instrumental variable approach presented in Section 3.3.3 to provide further evidence supporting the *anti-takeover channel*. In the first stage, we estimate stock liquidity as a function of the Russell 2000 indicator:

$$LIQ_{i,t-1} = a_1 + b_1 Rus2000_{i,t-1} + c_1 Rank_{i,t-1} + d_1 Rus2000_{i,t-1} \times Rank_{i,t-1}$$
$$+ e_1 FloatAdj_{i,t-1} + f_1' CONTROLS_{i,t-1} + YR_t + IND_j + \omega_{i,t},$$

(11)

where all variables are defined in the same way as in Equation (4). In the second stage, we use the instrumented stock liquidity, $\widehat{LIQ_{i,t-1}}$, to model the logit-transformed probability of a takeover prevailing for firm i in year t:

$$Logit(P(\widehat{T_{i,t}} = 1 | X_{i,t-1}) = a + b\widehat{LIQ_{i,t-1}} + cRank_{i,t-1} + dRus2000_{i,t-1} \times Rank_{i,t-1}$$
$$+ eFloatAdj_{i,t-1} + f' CONTROLS_{i,t-1} + YR_t + IND_j + \epsilon_{i,t}, \quad (12)$$

The inclusion of $Rank_{i,t-1}$ and $Rus2000_{i,t-1} \times Rank_{i,t-1}$ allows us to control for the mechanical relationship with market capitalization ranking on either side of the threshold and thus isolate any discontinuity in takeover exposure around the threshold, where $Rank_{i,t-1} = 0$. Our focus is again b, the coefficient of $Rus2000_{i,t-1}$.

Table 12 reports the estimated coefficients and firm-clustered standard errors of the regression model stated in Equations (11) and (12). Column (1) reports the result of the first-stage regression described in Equation (11). The coefficient estimate for the Russell 2000 dummy is 0.524 with statistical significance at the 1% level. The dependent variable in Columns (2) is the logit-transformed probability of a hostile takeover ($P\_Hos\_Takeover_{i,t}$), while the dependent variable in Columns (3) is the logit-transformed probability of a takeover of any kind ($P\_Any\_Takeover_{i,t}$). The estimated treatment effect of the Russell 2000 index inclusion on hostile takeover exposure is positive (0.236) and statistically significant at the 1% level, but that on any takeover exposure is not statistically significant. The effect is economically significant because the difference between hostile takeover exposure of the largest firms in the Russell 2000 index and that of the smallest firms in the Russell 1000 index is 42.5% as large as the standard deviation of the hostile takeover exposure measure in the Russell 1000 sample.[30] We find that firms with larger hostile takeover exposure are the firms that derive the effect we observe in our main RDD analysis. This result supports the anti-takeover channel in which a firm with more liquid stocks rely more on debt issuance since a firm with more liquid stocks tends to have more exposure to hostile takeovers.

Overall, our findings support the *anti-takeover channel*, in which takeover exposure, particularly hostile takeover exposure, increases significantly with stock liquidity. To avoid being a hostile takeover target, firms may be tempted to use more debt financing rather than equity financing when facing an exogenous surge in stock liquidity.

[INSERT TABLE 12 HERE]

[30] 0.236×1.739/0.966=42.5%, where the standard deviations of stock liquidity and the logit-transformed hostile takeover probability based on the sample consisting of Russell 1000 firms with complete information for the logit-transformed hostile takeover probability are 1.739 and 0.966, respectively.

5. Conclusion

Although a large body of literature links stock liquidity to a firm's investment decisions, evidence regarding the effect of stock liquidity on corporate financing choices is limited and mixed. In this study, we examine the effect of stock liquidity on a firm's debt-equity choices by evaluating two contrasting hypotheses: the *equity preference hypothesis* and the *debt preference hypothesis*.

Using natural experiments based on tick size-related regulations in 1997 and 2000 and the Russell index reconstitutions, we document a positive effect of stock liquidity on debt issuance but a non-significant effect on equity issuance. This finding is consistent with the *debt preference hypothesis*. Moreover, we find support for two economic mechanisms that underlie the positive effect of stock liquidity on debt issuance; namely, firms may be exposed to hostile takeovers, and the cost of debt capital is more sensitive to stock liquidity than the cost of equity capital is. Our work thus sheds light on how stock liquidity affects capital structure and provides avenues for further research on the financing impact of stock liquidity.

Appendix

A. Definition of main variables

The following table provides definitions for our debt and equity issuance measures, our stock liquidity measure, and control variables. The italicized codes in brackets are Compustat item codes.

Variable	Definition
$DI_{i,t}$	Debt issuance, measured as the long-term debt issuance net of retirement [*dltis-dltr*] divided by the cash used for net capital expenditures and acquisitions [*capx-sppe+aqc*]
$EI_{i,t}$	Equity issuance, measured as the sale of common and preferred stock net of the purchase of common and preferred stock [*sstk-prstkc*] divided by the cash used for net capital expenditures and acquisitions [*capx-sppe+aqc*]
$\Delta LEV_{i,t}$	Change in firm i's market leverage ratio, which is measured as the book value of debt [*dltt+dlc*] divided by the sum of the book value of debt and the market value of equity [*prcc_f* × *csho*]
$LIQ_{i,t}$	Firm i's liquidity measure, defined as (-1) times the natural logarithm of (1,000,000×*Amihud*), where *Amihud* is Amihud's illiquidity measure
$Size_{i,t}$	Natural logarithm of the book value of total assets [*at*]
$EBIT_{i,t}$	Firm i's profitability, defined as earnings before interest expenses and taxes [*ib+xint+txt*] divided by the book value of total assets [*at*] measured at the beginning of fiscal year t
$MB_{i,t}$	Firm i's market-to-book ratio during fiscal year t, calculated as the sum of the book value of debt [*dltt+dlc*], liquidating value of preferred shares [*pstkl*], and market value of equity [*prcc_f* × *csho*] divided by the book value of total assets [*at*]
$Tangibility_{i,t}$	Tangibility of firm i's assets, measured as total property, plant and equipment net of accumulated depreciation [*ppent*] divided by the book value of total assets [*at*]
$Depreciation_{i,t}$	Depreciation and amortization, measured as depreciation and amortization [*dp*] divided by the book value of total assets [*at*] measured at the beginning of fiscal year t
$R\&D_{i,t}$	R&D dummy that equals 1 if firm i has reported positive R&D expenses in year t and 0 otherwise
$R\&DIntensity_{i,t}$	R&D intensity, defined as R&D expenses [*xrd*] divided by the book value of total assets [*at*] measured at the beginning of fiscal year t (0 if missing)
$Dividend_{i,t}$	Positive dividend payout dummy that equals 1 if firm i has reported positive dividend in year t and 0 otherwise
$DPayout_{i,t}$	Dividend payout ratio, defined as the dividend paid [*dvc*] divided by net income [*ni*] (0 if missing)
$IO_{i,t}$	Percentage of institutional holdings, defined as total shares held by institutions divided by total shares outstanding

B. Definition of variables used to estimate the likelihood of a takeover

The following table shows the definition of additional variables used to estimate the likelihood of a takeover, as defined in Section 4.2.

Variable	Definition

Block	An indicator variable that equals one if there exist any institutional shareholders that have more than a 5% ownership stake in the firm's outstanding shares and zero otherwise.
Industry takeover indicator	An indicator variable that equals one if at least one takeover attempt occurred in the same industry in the year prior to the acquisition and zero otherwise.
Cash	The ratio of cash and short-term investments to total assets
Firm size	The natural logarithm of market capitalization
Asset structure	The ratio of property, plant, and equipment to total assets
Tobin's Q	The ratio of the market value of equity plus the book value of total debt to the book value of total assets
Leverage	The ratio of the book value of total debt to the book value of total assets
Return on assets	The ratio of net income to total assets

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Table 1: Variable definitions and descriptive statistics

Panel A: Summary statistics—Full sample

Variables	N	Mean	SD	P5	P25	Median	P75	P95
$DI_{i,t}$	47,522	-0.208	4.712	-4.347	-0.393	0.000	0.246	2.380
$EI_{i,t}$	47,522	2.226	15.940	-2.130	-0.075	0.010	0.206	6.417
$\Delta LEV_{i,t}$	49,052	0.007	0.116	-0.170	-0.035	0.000	0.042	0.214
$LIQ_{i,t-1}$	49,139	2.943	3.519	-2.814	0.227	3.067	5.647	8.514
$Size_{i,t-1}$	49,139	5.548	1.979	2.504	4.094	5.440	6.879	9.054
$EBIT_{i,t-1}$	49,139	0.039	0.311	-0.382	0.008	0.086	0.153	0.301
$MB_{i,t-1}$	49,139	1.799	2.116	0.515	0.849	1.234	1.994	4.866
$Tangibility_{i,t-1}$	49,139	0.271	0.222	0.026	0.097	0.206	0.384	0.756
$Depreciation_{i,t-1}$	49,139	0.052	0.041	0.012	0.029	0.044	0.064	0.120
$R\&D_{i,t-1}$	49,139	0.509	0.500	0.000	0.000	1.000	1.000	1.000
$R\&DIntensity_{i,t-1}$	49,139	0.058	0.126	0.000	0.000	0.002	0.066	0.266
$Dividend_{i,t-1}$	49,139	0.300	0.458	0.000	0.000	0.000	1.000	1.000
$DPayout_{i,t-1}$	49,139	0.130	0.328	0.000	0.000	0.000	0.113	0.638
$IO_{i,t-1}$	49,139	0.036	0.063	0.002	0.008	0.018	0.044	0.125

Panel A provides summary statistics for our debt and equity issuance measures, change in leverage measure, stock liquidity measure, and control variables based on the full sample.

Panel B: Summary statistics—Investment spike sample

Variables	N	Mean	SD	P5	P25	Median	P75	P95
$DI_{i,t}$	3,608	0.329	1.588	-0.538	-0.002	0.196	0.640	1.205
$EI_{i,t}$	3,608	0.413	5.133	-0.805	-0.038	0.005	0.079	1.321
$\Delta LEV_{i,t}$	3,601	0.070	0.126	-0.076	0.000	0.032	0.127	0.318
$LIQ_{i,t-1}$	3,608	3.341	3.348	-2.248	0.861	3.576	5.899	8.610
$Size_{i,t-1}$	3,608	5.618	1.905	2.673	4.234	5.503	6.911	8.959
$EBIT_{i,t-1}$	3,608	0.094	0.281	-0.242	0.057	0.114	0.182	0.358
$MB_{i,t-1}$	3,608	2.080	2.503	0.599	0.965	1.424	2.321	5.367
$Tangibility_{i,t-1}$	3,608	0.244	0.200	0.022	0.088	0.188	0.344	0.684
$Depreciation_{i,t-1}$	3,608	0.050	0.037	0.011	0.027	0.042	0.061	0.113
$R\&D_{i,t-1}$	3,608	0.532	0.499	0.000	0.000	1.000	1.000	1.000
$R\&DIntensity_{i,t-1}$	3,608	0.056	0.119	0.000	0.000	0.006	0.067	0.236
$Dividend_{i,t-1}$	3,608	0.355	0.479	0.000	0.000	0.000	1.000	1.000
$DPayout_{i,t-1}$	3,608	0.138	0.317	0.000	0.000	0.000	0.169	0.609
$IO_{i,t-1}$	3,608	0.034	0.045	0.003	0.008	0.018	0.041	0.122

Panel B provides summary statistics for our debt and equity issuance measures, change in leverage measure, stock liquidity measure, and control variables based on the investment spike sample.

Table 2: Regressions of debt issuance, equity issuance and the change in leverage on stock liquidity

	Full sample			Investment spike sample		
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	$DI_{i,t}$	$EI_{i,t}$	$\Delta LEV_{i,t}$	$DI_{i,t}$	$EI_{i,t}$	$\Delta LEV_{i,t}$
$LIQ_{i,t-1}$	**0.373*** **	**0.007**	**0.025*** **	**0.136*** **	**-0.046**	**0.021*** **
	(0.031)	**(0.087)**	**(0.001)**	**(0.036)**	**(0.087)**	**(0.005)**
$Size_{i,t-1}$	-1.034***	-3.352***	-0.032***	-0.306***	-0.364	-0.050***
	(0.086)	(0.315)	(0.002)	(0.088)	(0.269)	(0.011)
$EBIT_{i,t-1}$	0.264	-1.912**	0.014***	0.306	0.552	-0.009
	(0.210)	(0.885)	(0.003)	(0.384)	(1.330)	(0.026)
$MB_{i,t-1}$	0.040	0.487***	-0.000	-0.049*	0.135*	-0.007***
	(0.026)	(0.125)	(0.000)	(0.029)	(0.073)	(0.002)
$Tangibility_{i,t-1}$	1.738***	5.344***	-0.013	0.848**	-0.646	0.164***
	(0.406)	(1.279)	(0.010)	(0.349)	(0.867)	(0.059)
$Depreciation_{i,t-1}$	-2.896**	1.243	0.089***	-0.186	-0.495	-0.167
	(1.368)	(4.019)	(0.033)	(1.083)	(4.511)	(0.205)
$R\&D_{i,t-1}$	0.205	0.159	0.002	0.211	0.375	0.023
	(0.165)	(0.322)	(0.005)	(0.247)	(0.237)	(0.024)
$R\&DIntensity_{i,t-1}$	1.884***	2.273	0.004	0.047	-0.062	-0.013
	(0.635)	(3.389)	(0.008)	(0.537)	(5.044)	(0.061)
$Dividend_{i,t-1}$	0.731***	0.463***	0.029***	0.332**	-0.177	0.037**
	(0.111)	(0.152)	(0.003)	(0.157)	(0.134)	(0.015)
$DPayout_{i,t-1}$	-0.071	-0.049	-0.005***	-0.165*	0.238*	-0.022**
	(0.082)	(0.082)	(0.002)	(0.091)	(0.126)	(0.010)
$IO_{i,t-1}$	-0.554	-0.349	0.024**	-1.550**	2.206	-0.007
	(0.512)	(1.024)	(0.010)	(0.766)	(2.363)	(0.108)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	47,522	47,522	49,052	3,608	3,608	3,601
R-squared	0.020	0.027	0.135	0.069	0.038	0.151

This table reports the results of the fixed effects regression analyses estimating the effects of stock liquidity on our corporate financing measures using the sample over the 1988–2013 period. Columns (1) through (3) report the regression results based on the full sample. Columns (4) through (6) report the regression results based on the investment spike sample. The dependent variables are *i)* debt issuance ($DI_{i,t}$) measured as the long-term debt issuance net of retirement divided by the cash used for net capital expenditures and acquisitions, *ii)* equity issuance ($EI_{i,t}$) measured as the sale of common and preferred stock net of the purchase of common and preferred stock divided by the cash used for net capital expenditures and acquisitions, and *iii)* the increase in leverage ratio ($\Delta LEV_{i,t}$), where the leverage ratio is measured as the book value of debt divided by the sum of the book value of debt and the market value of equity. The stock liquidity measure ($LIQ_{i,t-1}$) is measured for firm i over the fiscal year $t-1$. For control variables, we include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), an R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), a dividend payout ratio ($DPayout_{i,t-1}$), and institutional ownership ($IO_{i,t-1}$). We also include year fixed effects to account for intertemporal variation that may affect corporate financing behavior and firm fixed effects to control for omitted firm characteristics that are constant over time. Standard errors clustered by firm are reported in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Table 3: Difference-in-differences (DiD) analysis using the 2001 shift to decimalization

Panel A: New variable definitions

Variable	Definitions
$\Delta LIQ_{i,t-1\rightarrow t+1}$	Change in stock liquidity from the pre-decimalization year (year $t-1$) to the post-decimalization year (year $t+1$), where year t indicates the calendar year during which decimalization occurred for a firm
$\Delta DI_{i,t-3\rightarrow t}$	Change in debt issuance (DI) over the three-year period before the decimalization year, defined as DI in year t minus DI in year $t-3$
$\Delta EI_{i,t-3\rightarrow t}$	Change in equity issuance (EI) over the three-year period before the decimalization year, defined as EI in year t minus EI in year $t-3$
$DI_{i,t-3\rightarrow t-1}$	Pre-decimalization three-year average value of firm i's debt issuance (DI)
$EI_{i,t-3\rightarrow t-1}$	Pre-decimalization three-year average value of firm i's equity issuance (EI)

Panel A reports the definitions of additional variables used to implement the propensity score matching.

Panel B: Pre-match propensity score regression and post-match diagnostic regression

Variable	(1) Pre-match	(2) Post-match
$LIQ_{i,t-1}$	-0.119***	0.010
	(0.022)	(0.032)
$Size_{i,t-1}$	0.344***	-0.051
	(0.038)	(0.055)
$EBIT_{i,t-1}$	0.272***	0.081
	(0.079)	(0.096)
$MB_{i,t-1}$	0.084***	0.003
	(0.012)	(0.016)
$Tangibility_{i,t-1}$	0.376**	0.117
	(0.180)	(0.262)
$Depreciation_{i,t-1}$	-0.820	-1.135
	(0.734)	(1.129)
$R\&D_{i,t-1}$	0.058	-0.088
	(0.096)	(0.144)
$R\&DIntensity_{i,t-1}$	-0.374	0.494
	(0.289)	(0.461)
$Dividend_{i,t-1}$	0.980***	0.190
	(0.125)	(0.187)
$DPayout_{i,t-1}$	-0.473***	-0.132
	(0.164)	(0.229)
$\Delta DI_{i,t-3\rightarrow t}$	0.000	-0.008
	(0.007)	(0.010)
$\Delta EI_{i,t-3\rightarrow t}$	0.016**	0.002
	(0.007)	(0.011)
$DI_{i,t-3\rightarrow t-1}$	-0.036**	-0.021
	(0.016)	(0.023)
$EI_{i,t-3\rightarrow t-1}$	-0.047***	-0.010
	(0.014)	(0.021)
Chi-square statistic	670.7	9.624
p-value	0	0.993
Observations	1,900	706
Pseudo R-squared	0.255	0.010

Panel B presents parameter estimates from the probit model used to estimate propensity scores for firms in the treatment and control groups. The dependent variable equals one if the firm-year belongs to the treatment group and zero otherwise. Standard errors are displayed in parentheses. Industry fixed effects are included in both columns. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Panel C: Estimated propensity score distributions

Propensity scores	Obs.	Min	P5	P50	Mean	SD	P95	Max
Treatment	353	0.010	0.134	0.523	0.512	0.214	0.871	0.966
Control	353	0.010	0.134	0.523	0.512	0.215	0.873	0.980
Difference	353	0.000	0.000	0.000	0.001	0.001	0.002	0.014

Panel C reports the distribution of estimated propensity scores for the treatment and control firms and the difference in estimated propensity scores after matching treatment-control pairs.

Panel D: Differences in pre-decimalization characteristics

Variable	Treatment	Control	Difference	*t*-statistics
$LIQ_{i,t-1}$	1.937	2.056	-0.118	-0.532
$Size_{i,t-1}$	5.135	5.274	-0.139	-1.231
$EBIT_{i,t-1}$	0.026	-0.006	0.032	1.097
$MB_{i,t-1}$	2.054	1.936	0.118	0.448
$Tangibility_{i,t-1}$	0.262	0.272	-0.010	-0.672
$Depreciation_{i,t-1}$	0.059	0.063	-0.004	-1.200
$R\&D_{i,t-1}$	0.473	0.456	0.017	0.477
$R\&DIntensity_{i,t-1}$	0.069	0.062	0.008	0.735
$Dividend_{i,t-1}$	0.133	0.116	0.017	0.866
$DPayout_{i,t-1}$	0.058	0.059	-0.001	-0.038
$\Delta DI_{i,t-3 \to t}$	-0.895	-0.693	-0.202	-0.563
$\Delta EI_{i,t-3 \to t}$	0.272	0.027	0.245	0.697
$\mathrm{DI}_{i,t-3 \to t-1}$	-0.029	0.090	-0.120	-0.697
$EI_{i,t-3 \to t-1}$	1.011	1.044	-0.033	-0.176

Panel D reports the univariate comparisons between the treatment and control pre-decimalization firm characteristics and their corresponding *t*-statistics.

Panel E: DiD test

Variable	(1) No. of Pairs	(2) Mean Treatment Difference (After-Before)	(3) Mean Control Difference (After-Before)	(4) Mean DiD Estimate (Treat-Control)	(5) *t*-statistics for DiD Estimate
Avg. debt issuance	267	-0.437	-1.254	**0.817****	**2.523**
Avg. equity issuance	267	-0.505	0.040	**-0.545****	**-2.339**
Avg. change in leverage	234	-0.073	-0.262	**0.189*****	**7.753**

Panel E provides the DiD test results for the 2001 tick-size shift to decimalization. Average debt issuance is measured as the three-year average of debt issuances before or after decimalization. Average equity issuance is measured as the three-year average of equity issuances before or after decimalization. Average change in leverage ratio is measured as the three-year average change in the market leverage ratio before or after decimalization. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel F: Difference-in-differences (DiD) analysis for debt issuance, equity issuance, and change in leverage

Variable	(1) $DI_{i,t}$	(2) $EI_{i,t}$	(3) $\Delta LEV_{i,t}$
$TREAT_i \times POST_t$	**1.205*** **	**-0.020**	**0.054*** **
	(0.290)	**(0.216)**	**(0.009)**
$POST_t$	-0.939***	0.208	-0.073***
	(0.227)	(0.157)	(0.007)
$Size_{i,t-1}$	-0.522***	-1.084***	0.016***
	(0.178)	(0.187)	(0.006)
$EBIT_{i,t-1}$	-0.075	-0.043	0.022***
	(0.306)	(0.195)	(0.008)
$MB_{i,t-1}$	0.086*	0.078*	0.004***
	(0.052)	(0.041)	(0.001)
$Tangibility_{i,t-1}$	1.985*	2.262**	-0.059
	(1.163)	(0.901)	(0.039)
$Depreciation_{i,t-1}$	2.310	1.729	0.180**
	(2.574)	(2.458)	(0.085)
$R\&D_{i,t-1}$	0.704	0.709	0.031
	(0.688)	(0.508)	(0.022)
$R\&DIntensity_{i,t-1}$	-0.281	0.003	-0.003
	(0.831)	(1.447)	(0.029)
$Dividend_{i,t-1}$	1.526***	-0.338*	0.075***
	(0.448)	(0.189)	(0.016)
$DPayout_{i,t-1}$	-0.009	0.125	-0.015
	(0.330)	(0.080)	(0.014)
Firm fixed effects	Yes	Yes	Yes
Number of firms	706	706	706
Observations	4,406	4,406	4,394
R-squared	0.024	0.039	0.061

Panel F reports regression DiD estimates for the three corporate financing measures. The sample includes the 7-year window surrounding the 2001 shift. The dependent variable in Column (1) is debt issuance ($DI_{i,t}$), measured as the long-term debt issuance net of retirement divided by the cash used for net capital expenditures and acquisitions. The dependent variable in Column (2) is equity issuance ($EI_{i,t}$), measured as the sale of common and preferred stock net of the purchase of common and preferred stock divided by the cash used for net capital expenditures and acquisitions. The dependent variable in Column (3) is the change in leverage ratio ($\Delta LEV_{i,t}$), measured as the change in the market leverage ratio. For control variables, we include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), an R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), and the dividend payout ratio ($DPayout_{i,t-1}$). We also include firm fixed effects to control for unobserved firm heterogeneity that is constant over time. Standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Table 4: Difference-in-differences (DiD) analysis using the 1997 shift from 8ths to 16ths

Panel A: DiD test

Variable	(1) No. of Pairs	(2) Mean Treatment Difference (After-Before)	(3) Mean Control Difference (After-Before)	(4) Mean DiD Estimate (Treat-Control)	(5) t-statistics for DiD Estimate
Avg. debt issuance	332	0.477	-0.275	**0.752****	**2.542**
Avg. equity issuance	332	-0.994	-0.681	**-0.312**	**-0.248**
Avg. change in leverage	275	0.111	-0.020	**0.131*****	**5.800**

Panel A provides the DiD test results using the 1997 tick-size shift from 8ths to 16ths. Average debt issuance is measured as the three-year average of debt issuances before or after the shift. Average equity issuance is measured as the three-year average of equity issuances before or after the shift. Average change in leverage ratio is measured as the three-year average change in the market leverage ratio before or after the shift. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel B: DiD analysis for debt issuance, equity issuance, and the change in leverage

Variable	(1) $DI_{i,t}$	(2) $EI_{i,t}$	(3) $\Delta LEV_{i,t}$
$TREAT_i \times POST_t$	**0.671****	**0.143**	**0.033*****
	(0.306)	**(1.057)**	**(0.009)**
$POST_t$	-0.336	0.207	0.016***
	(0.237)	(0.913)	(0.006)
$Size_{i,t-1}$	-0.301	-2.123***	0.008
	(0.234)	(0.754)	(0.007)
$EBIT_{i,t-1}$	0.143	-4.868	0.046***
	(0.574)	(3.251)	(0.011)
$MB_{i,t-1}$	0.199***	1.061**	0.006***
	(0.075)	(0.492)	(0.001)
$Tangibility_{i,t-1}$	0.817	3.267	-0.057*
	(1.379)	(4.633)	(0.033)
$Depreciation_{i,t-1}$	-2.978	-2.768	-0.055
	(2.654)	(8.767)	(0.100)
$R\&D_{i,t-1}$	1.075**	0.875	0.017
	(0.461)	(1.773)	(0.016)
$R\&DIntensity_{i,t-1}$	-0.197	-16.146**	0.053**
	(1.092)	(7.810)	(0.023)
$Dividend_{i,t-1}$	0.036	0.127	0.023
	(0.325)	(0.408)	(0.015)
$DPayout_{i,t-1}$	0.266	-0.444*	-0.020
	(0.177)	(0.246)	(0.013)
Firm fixed effects	Yes	Yes	Yes
Number of firms	958	958	958
Observations	5,161	5,161	5,139
R-squared	0.010	0.032	0.043

Panel B reports regression DiD estimates for the three corporate financing measures. The sample includes the 7-year window surrounding the 1997 shift. The dependent variable in Column (1) is debt issuance ($DI_{i,t}$), measured as the long-term debt issuance net of retirement divided by the cash used for net capital expenditures and acquisitions. The dependent variable in Column (2) is equity issuance ($EI_{i,t}$), measured as the sale of common and preferred stock net of the purchase of common and preferred stock divided by the cash used for net capital expenditures and. The dependent variable in Column (3) is the change in leverage ratio ($\Delta LEV_{i,t}$), measured as the change in the market leverage ratio. For control variables, we include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), an R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), and the dividend payout ratio ($DPayout_{i,t-1}$). We also include firm fixed effects to control for unobserved firm heterogeneity that is constant over time. Standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Table 5: Differences in stock liquidity around the Russell 1000/2000 threshold

	(1)	(2)	(3)	(4)	(5)	(6)
Rank range	[-100, +100]		[-750, +750]		[-1000, +2000]	
Variables	$LIQ_{i,t-1}$	$LIQ_{i,t-1}$	$LIQ_{i,t-1}$	$LIQ_{i,t-1}$	$LIQ_{i,t-1}$	$LIQ_{i,t-1}$
$Rus2000_{i,t-1}$	**0.492*****	**0.476*****	**0.315*****	**0.300*****	**0.626*****	**0.479*****
	(0.122)	**(0.119)**	**(0.065)**	**(0.060)**	**(0.061)**	**(0.060)**
$Rank_{i,t-1}$	-0.004***	-0.003***	-0.003***	-0.002***	-0.004***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Rus2000_{i,t-1} \times Rank_{i,t-1}$	0.002***	0.002***	0.001***	0.001***	0.002***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$FloatAdj_{i,t-1}$	0.001***	0.002***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Size_{i,t-1}$		0.552***		0.452***		0.426***
		(0.200)		(0.136)		(0.077)
$EBIT_{i,t-1}$		1.069***		0.761***		0.589***
		(0.258)		(0.214)		(0.143)
$MB_{i,t-1}$		0.119**		0.086***		0.091***
		(0.060)		(0.028)		(0.017)
$Tangibility_{i,t-1}$		-0.044		-0.063		-0.220**
		(0.223)		(0.114)		(0.092)
$Depreciation_{i,t-1}$		-0.226		0.888		0.770
		(0.839)		(0.564)		(0.528)
$R\&D_{i,t-1}$		-0.137		0.102		0.095
		(0.124)		(0.093)		(0.061)
$R\&DIntensity_{i,t-1}$		1.772***		1.644***		1.325***
		(0.461)		(0.300)		(0.214)
$Dividend_{i,t-1}$		-0.228**		-0.283***		-0.311***
		(0.104)		(0.055)		(0.044)
$DPayout_{i,t-1}$		-0.157		-0.051		-0.068*
		(0.138)		(0.044)		(0.040)
$IO_{i,t-1}$		-2.433***		-2.497***		-1.959***
		(0.619)		(0.507)		(0.503)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,168	922	8,693	6,676	15,850	12,212
R-squared	0.593	0.687	0.693	0.776	0.807	0.868

This table reports the regression discontinuity test results, where b is estimated by fitting:

$$LIQ_{i,t-1} = a + bRus2000_{i,t-1} + cRank_{i,t-1} + dRus2000_{i,t-1} \times Rank_{i,t-1} + eFloatAdj_{i,t-1}$$
$$+f'CONTROLS_{i,t-1} + YR_{t-1} + IND_j + \omega_{i,t-1},$$

where $LIQ_{i,t-1}$ is stock liquidity as detailed in Section 2.2.1; $Rus2000_{i,t-1}$ is the binary instrumental variable that equals to one if firm i is included in the Russell 2000 index in year $t-1$ and zero otherwise; and $Rank_{i,t-1}$ is based on rankings implied by the firm's market capitalization within the assigned index as of May 31st. We also include $FloatAdj_{i,t-1}$, a proxy for the float adjustment by Russell, computed as the difference between the rank implied by the May 31st market capitalization and the actual rank assigned by Russell in June. For control variables, we include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), an R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), the dividend payout ratio ($DPayout_{i,t-1}$), and institutional ownership ($IO_{i,t-1}$). Year fixed effects and industry fixed effects are included. The results based on two subsamples and the full sample are reported. Standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Table 6: Stock liquidity and debt-equity choices: instrumental variable estimates

	First Stage	Second Stage		
	(1)	(2)	(3)	(4)
Variable	$LIQ_{i,t-1}$	$DI_{i,t}$	$EI_{i,t}$	$\Delta LEV_{i,t}$
$Rus2000_{i,t-1}$	**0.481*** **			
	(0.058)			
$\widehat{LIQ_{i,t-1}}$		**0.525** **	**-0.782**	**0.016** **
		(0.249)	**(0.524)**	**(0.007)**
$Rank_{i,t-1}$	-0.003***	0.001	-0.003*	-0.000
	(0.000)	(0.001)	(0.002)	(0.000)
$Rus2000_{i,t-1} \times Rank_{i,t-1}$	0.001***	-0.000	0.003**	0.000
	(0.000)	(0.000)	(0.001)	(0.000)
$FloatAdj_{i,t-1}$	0.001***	-0.001*	0.001*	-0.000
	(0.000)	(0.000)	(0.001)	(0.000)
$Size_{i,t-1}$	0.420***	-0.454***	-0.290	-0.024***
	(0.077)	(0.142)	(0.344)	(0.003)
$EBIT_{i,t-1}$	0.578***	-0.471*	-4.836***	-0.011*
	(0.142)	(0.253)	(1.703)	(0.006)
$MB_{i,t-1}$	0.089***	-0.029	0.315***	-0.003***
	(0.017)	(0.032)	(0.100)	(0.001)
$Tangibility_{i,t-1}$	-0.203**	0.475*	0.339	0.003
	(0.089)	(0.250)	(0.374)	(0.005)
$Depreciation_{i,t-1}$	0.692	-4.715***	-13.060***	0.018
	(0.527)	(1.339)	(3.346)	(0.032)
$R\&D_{i,t-1}$	0.090	-0.017	0.059	-0.006***
	(0.061)	(0.096)	(0.223)	(0.002)
$R\&DIntensity_{i,t-1}$	1.294***	0.882	14.115***	-0.029**
	(0.214)	(0.611)	(2.895)	(0.012)
$Dividend_{i,t-1}$	-0.318***	0.350***	-0.191	0.011***
	(0.043)	(0.119)	(0.238)	(0.003)
$DPayout_{i,t-1}$	-0.070*	-0.042	-0.080	-0.003
	(0.040)	(0.094)	(0.122)	(0.002)
$IO_{i,t-1}$	-1.598***	-0.138	0.360	0.017
	(0.457)	(1.516)	(2.966)	(0.024)
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	12,037	12,037	12,037	12,174
R-squared		0.006	0.123	0.070

This table presents an instrumental variable estimation based on Equations (5) and (6). In the first stage, we estimate stock liquidity as a function of the Russell 2000 indicator:

$$LIQ_{i,t-1} = a_1 + b_1 Rus2000_{i,t-1} + c_1 Rank_{i,t-1} + d_1 Rus2000_{i,t-1} \times Rank_{i,t-1}$$
$$+ e_1 FloatAdj_{i,t-1} + f_1' CONTROLS_{i,t-1} + YR_{t-1} + IND_j + \omega_{i,t-1}.$$

In the second stage, we use the instrumented stock liquidity to model debt issuance, equity issuance, or the change in leverage ratio for firm i in year t, $Y_{i,t}$:

$$Y_{i,t} = a + b\widehat{LIQ_{i,t-1}} + cRank_{i,t-1} + dRus2000_{i,t-1} \times Rank_{i,t-1}$$
$$+ eFloatAdj_{i,t-1} + f' CONTROLS_{i,t-1} + YR_t + IND_j + \epsilon_{i,t}.$$

The first-stage estimates are reported in Column (1). Columns (2) through (4) report the second-stage estimates for three dependent variables: debt issuance ($DI_{i,t}$), equity issuance ($EI_{i,t}$), and the change in leverage ratio ($\Delta LEV_{i,t}$). $\widehat{LIQ_{i,t-1}}$ is the instrumented stock liquidity. $Rus2000_{i,t-1}$ is the binary variable that equals one if firm i is included in the Russell 2000 index in year $t-1$ and zero otherwise. $Rank_{i,t-1}$ is based on the rank implied by the firm's market capitalization within the assigned index as of May 31st. We also include $FloatAdj_{i,t-1}$, a proxy for the float adjustment by Russell, computed as the difference between the rank implied by the May 31st market capitalization and the actual rank assigned by Russell in June. Control variables include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), an R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), the dividend payout ratio ($DPayout_{i,t-1}$), and institutional ownership ($IO_{i,t-1}$). Year fixed effects and industry fixed effects are also included. Standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Table 7: **Relative sensitivities of financing costs to stock liquidity**

Variable	(1) $COD^*_{i,t}$	(2) $COE^*_{i,t}$	(3) $COE^*_{i,t} - COD^*_{i,t}$	(4) $COE_{i,t}/COD_{i,t}$
$LIQ_{i,t-1}$	**-0.082*** **	**0.004**	**0.081*** **	**0.597*** **
	(0.011)	**(0.004)**	**(0.011)**	**(0.109)**
$Size_{i,t-1}$	-0.005	-0.005	0.000	0.415
	(0.027)	(0.009)	(0.027)	(0.345)
$EBIT_{i,t-1}$	-0.001	0.232***	0.248***	1.337**
	(0.061)	(0.032)	(0.070)	(0.644)
$MB_{i,t-1}$	-0.003	-0.011**	-0.008	-0.078*
	(0.004)	(0.005)	(0.006)	(0.044)
$Tangibility_{i,t-1}$	-0.226*	-0.068	0.194	1.060
	(0.127)	(0.045)	(0.128)	(1.733)
$Depreciation_{i,t-1}$	-0.094	-0.277*	-0.339	2.546
	(0.323)	(0.145)	(0.338)	(4.135)
$R\&D_{i,t-1}$	0.091	-0.002	-0.086	-1.067
	(0.061)	(0.016)	(0.060)	(0.688)
$R\&DIntensity_{i,t-1}$	0.129	0.289***	0.181	-0.949
	(0.168)	(0.053)	(0.185)	(1.466)
$Dividend_{i,t-1}$	-0.190***	0.007	0.191***	2.455***
	(0.037)	(0.011)	(0.038)	(0.424)
$DPayout_{i,t-1}$	0.031	-0.002	-0.042*	-0.986***
	(0.021)	(0.008)	(0.023)	(0.293)
$IO_{i,t-1}$	0.450	0.067	-0.476	-0.604
	(0.296)	(0.071)	(0.314)	(2.806)
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	7,057	7,135	7,065	7,137
R-squared	0.195	0.129	0.207	0.178

This table reports the estimation results for Equation (7), a fixed effects regression model of financing costs and their gaps on stock liquidity based on the sample period 1988–2013. Columns (1) through (4) report the regression results based on the sample with non-missing observations for both the costs of bank loans and equity. The dependent variable is the cost of debt standardized by the within-firm mean cost of debt ($COD^*_{i,t}$) in Column (1), the cost of equity standardized by the within-firm mean cost of equity ($COE^*_{i,t}$) in Column (2), the standardized cost of capital differential ($COE^*_{i,t} - COD^*_{i,t}$) in Column (3), and *iv)* the relative cost of equity ($COE_{i,t}/COD_{i,t}$) in Column (4). Stock liquidity ($LIQ_{i,t-1}$) is measured for firm i over the fiscal year $t-1$. For control variables, we include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), an R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), the dividend payout ratio ($DPayout_{i,t-1}$), and institutional ownership ($IO_{i,t-1}$). We also include year fixed effects to account for intertemporal variation that may affect financing costs and firm fixed effects to control for unobserved firm heterogeneity that is constant over time. Standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Table 8: Testing the cost of capital differential channel using difference-in-differences (DiD) approaches

Panel A. Univariate DiD tests based on decimalization

Variable	(1) No. of Pairs	(2) Mean Treatment Difference (After-Before)	(3) Mean Control Difference (After-Before)	(4) Mean DiD Estimate (Treat-Control)	(5) *t*-statistics for DiD Estimate
Avg. cost of debt capital	109	0.092	0.307	**-0.215*****	**-3.963**
Avg. cost of equity capital	65	-0.150	-0.047	**-0.103*****	**-3.557**
Avg. capital cost differential	43	-0.176	-0.387	**0.211***	**1.812**
Avg. relative cost of equity	49	-1.239	-2.899	**1.660****	**2.292**

Panel A provides the results for the DiD analysis based on the 2001 tick-size shift to decimalizations designed to test the cost of capital differential channel. Average cost of debt capital is measured as the three-year average of the standardized costs of bank loans before or after decimalization. Average cost of equity capital is measured as the three-year average of the standardized costs of equity before or after decimalization. Average capital cost differential is measured as the three-year average of the difference between the standardized costs of equity and debt before or after decimalization. Average relative cost of equity is measured as the three-year average of the relative costs of equity capital before or after decimalization. The relative cost of equity is computed by dividing the cost of equity by the cost of debt. Standard errors are presented in parentheses below the mean differences in outcome variables. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel B. Regression DiD analyses based on Decimalization

Variable	(1) $COD^*_{i,t}$	(2) $COE^*_{i,t}$	(3) $COE^*_{i,t} - COD^*_{i,t}$	(4) $COE_{i,t}/COD_{i,t}$
$TREAT_i \times POST_t$	**-0.125*****	**-0.005**	**0.109****	**0.184**
	(0.032)	**(0.021)**	**(0.047)**	**(0.393)**
$POST_t$	0.197***	-0.067***	-0.265***	-1.708***
	(0.022)	(0.015)	(0.034)	(0.249)
$Size_{i,t-1}$	-0.052***	-0.020	0.033	0.339
	(0.020)	(0.015)	(0.033)	(0.213)
$EBIT_{i,t-1}$	-0.077*	0.032*	0.115***	0.398**
	(0.045)	(0.017)	(0.043)	(0.188)
$MB_{i,t-1}$	-0.009**	-0.006***	0.005	0.006
	(0.004)	(0.002)	(0.007)	(0.035)
$Tangibility_{i,t-1}$	-0.060	0.030	0.217	2.658*
	(0.132)	(0.082)	(0.165)	(1.377)
$Depreciation_{i,t-1}$	-0.368	0.021	0.399	-0.325
	(0.253)	(0.232)	(0.363)	(2.680)
$R\&D_{i,t-1}$	-0.030	-0.005	-0.086	-0.564
	(0.050)	(0.045)	(0.084)	(0.486)
$R\&DIntensity_{i,t-1}$	0.043	0.056	0.008	2.667
	(0.140)	(0.100)	(0.232)	(3.493)
$Dividend_{i,t-1}$	-0.265***	0.007	0.306***	3.078***
	(0.055)	(0.026)	(0.060)	(0.686)
$DPayout_{i,t-1}$	0.087	-0.002	-0.042	-0.423
	(0.054)	(0.023)	(0.063)	(0.667)
Firm fixed effects	Yes	Yes	Yes	Yes
Number of firms	546	486	404	403
Observations	2,796	2,368	1,904	1,914
R-squared	0.124	0.057	0.141	0.127

Panel B reports the results of the DiD regression analyses based on the 2001 tick-size shift to decimalization designed to test the cost of capital differential channel. The dependent variables are the cost of debt standardized by the within-firm mean cost of debt ($COD^*_{i,t}$), the cost of equity standardized by the within-firm mean cost of equity ($COE^*_{i,t}$), the standardized cost of capital differential ($COE^*_{i,t} - COD^*_{i,t}$), and the relative cost of equity

($COE_{i,t}/COD_{i,t}$) in Columns (1) – (4), respectively. The variable $TREAT_i$ is a dummy variable that equals one if firm i belongs to the treatment group and zero otherwise. The variable $POST_t$ is a dummy variable that equals one if a firm-year observation is from the three-year period following decimalization ($t+1$, $t+2$, and $t+3$) and zero otherwise. For control variables, we include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), an R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), and the dividend payout ratio ($DPayout_{i,t-1}$). Firm fixed effects are also included. Standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Panel C. Univariate DiD tests based on the 1997 tick-size shift

Variable	(1) No. of Pairs	(2) Mean Treatment Difference (After-Before)	(3) Mean Control Difference (After-Before)	(4) Mean DiD Estimate (Treat-Control)	(5) *t*-statistics for DiD Estimate
Avg. cost of debt capital	65	-0.193	-0.054	**-0.139***	**-1.903**
Avg. cost of equity capital	51	-0.048	-0.018	**-0.030**	**-0.704**
Avg. capital cost differential	12	0.390	0.011	**0.379***	**2.192**
Avg. relative cost of equity	13	2.440	-0.016	**2.456**	**1.076**

Panel C provides the results for the DiD analysis based on the 1997 tick-size shift designed to test the cost of capital differential channel. Average cost of debt capital is measured as the three-year average of the standardized costs of bank loans before or after the 1997 shift. Average cost of equity capital is measured as the three-year average of the standardized costs of equity before or after the 1997 shift. Average capital cost differential is measured as the three-year average of the difference between the standardized costs of equity and debt before or after the 1997 shift. Average relative cost of equity is measured as the three-year average of the relative costs of equity capital before or after the 1997 shift. The relative cost of equity is computed by dividing the cost of equity by the cost of debt. Standard errors are presented in parentheses below the mean differences in outcome variables. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel D. Regression DiD analyses based on the 1997 tick-size shift

Variable	(1) $COD^*_{i,t}$	(2) $COE^*_{i,t}$	(3) $COE^*_{i,t} - COD^*_{i,t}$	(4) $COE_{i,t}/COD_{i,t}$
$TREAT_i \times POST_t$	**-0.102***	**-0.005**	**0.097**	**0.919**
	(0.030)	**(0.021)**	**(0.042)**	**(0.466)**
$POST_t$	0.032*	0.022	-0.041	-0.222
	(0.018)	(0.016)	(0.028)	(0.284)
$Size_{i,t-1}$	-0.050***	0.001	0.095***	0.173
	(0.019)	(0.015)	(0.027)	(0.232)
$EBIT_{i,t-1}$	-0.073**	0.111**	0.235***	1.132**
	(0.036)	(0.052)	(0.077)	(0.521)
$MB_{i,t-1}$	-0.004	-0.004	0.004	0.074
	(0.003)	(0.005)	(0.009)	(0.055)
$Tangibility_{i,t-1}$	-0.149*	0.236**	0.525***	2.599**
	(0.090)	(0.101)	(0.146)	(1.315)
$Depreciation_{i,t-1}$	-0.308	-0.047	-0.215	-1.796
	(0.285)	(0.305)	(0.617)	(5.116)
$R\&D_{i,t-1}$	0.091**	0.044	-0.037	-1.264
	(0.039)	(0.031)	(0.071)	(0.776)
$R\&DIntensity_{i,t-1}$	0.223	0.097	-0.335	-1.513
	(0.143)	(0.112)	(0.232)	(1.700)
$Dividend_{i,t-1}$	-0.158***	-0.092**	0.168**	1.513***
	(0.049)	(0.038)	(0.074)	(0.572)
$DPayout_{i,t-1}$	-0.055*	-0.004	0.019	-0.234
	(0.033)	(0.018)	(0.042)	(0.585)
Firm fixed effects	Yes	Yes	Yes	Yes

Number of firms	686	598	476	475
Observations	3,261	2,803	2,026	2,030
R-squared	0.049	0.020	0.063	0.027

Panel D reports the results of the DiD regression analyses based on the 1997 tick-size shift designed to test the cost of capital differential channel. The dependent variables are the cost of debt standardized by the within-firm mean cost of debt ($COD^{*}_{i,t}$), the cost of equity standardized by the within-firm mean cost of equity ($COE^{*}_{i,t}$), the standardized cost of capital differential ($COE^{*}_{i,t} - COD^{*}_{i,t}$), and the relative cost of equity ($COE_{i,t}/COD_{i,t}$) in Columns (1) – (4), respectively. The variable $TREAT_i$ is a dummy variable that equals one if firm i belongs to the treatment group and zero otherwise. The variable $POST_t$ is a dummy variable that equals one if a firm-year observation is from the three-year period following the 1997 tick-size shift ($t + 1$, $t + 2$, and $t + 3$) and zero otherwise. For control variables, we include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), an R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), and the dividend payout ratio ($DPayout_{i,t-1}$). Firm fixed effects are also included. Standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Table 9: The difference in the cost of capital differential around the Russell 1000/2000 threshold

	First Stage	Second Stage			
	(1)	(2)	(3)	(4)	(5)
Variable	$LIQ_{i,t-1}$	$COD^*_{i,t}$	$COE^*_{i,t}$	$COE^*_{i,t} - COD^*_{i,t}$	$COE_{i,t}/COD_{i,t}$
$Rus2000_{i,t-1}$	**0.489*** **				
	(0.056)				
$\widehat{LIQ_{i,t-1}}$		**-0.080***	**-0.027** **	**0.060**	**2.187** **
		(0.041)	**(0.013)**	**(0.043)**	**(0.936)**
$Rank_{i,t-1}$	-0.003***	-0.000	-0.000**	0.000	-0.006**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
$Rus2000_{i,t-1} \times Rank_{i,t-1}$	0.001***	-0.000	0.000**	0.000	0.008***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
$FloatAdj_{i,t-1}$	0.001***	0.000*	0.000	-0.000	-0.002*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
$Size_{i,t-1}$	0.257***	0.063***	0.005	-0.058***	-0.868**
	(0.040)	(0.014)	(0.006)	(0.015)	(0.343)
$EBIT_{i,t-1}$	0.802***	0.014	0.148***	0.123**	0.106
	(0.142)	(0.057)	(0.025)	(0.062)	(1.100)
$MB_{i,t-1}$	0.062***	0.011***	-0.005*	-0.015**	-0.477***
	(0.014)	(0.004)	(0.003)	(0.006)	(0.112)
$Tangibility_{i,t-1}$	-0.189*	0.021	-0.006	-0.012	0.880
	(0.098)	(0.026)	(0.010)	(0.027)	(0.931)
$Depreciation_{i,t-1}$	0.298	-0.099	-0.052	-0.095	0.831
	(0.598)	(0.131)	(0.056)	(0.140)	(3.985)
$R\&D_{i,t-1}$	-0.036	0.012	-0.008**	-0.014	0.584
	(0.042)	(0.013)	(0.004)	(0.013)	(0.508)
$R\&DIntensity_{i,t-1}$	2.156***	0.229*	0.243***	-0.037	-7.347***
	(0.330)	(0.130)	(0.047)	(0.131)	(2.818)
$Dividend_{i,t-1}$	-0.235***	-0.051***	-0.009*	0.045***	4.707***
	(0.039)	(0.016)	(0.005)	(0.017)	(0.408)
$DPayout_{i,t-1}$	-0.023	0.004	0.002	-0.010	-0.221
	(0.036)	(0.017)	(0.007)	(0.018)	(0.421)
$IO_{i,t-1}$	-1.370***	0.115	-0.002	-0.122	3.238
	(0.432)	(0.247)	(0.055)	(0.257)	(4.219)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	7,057	7,057	7,135	7,065	7,137
R-squared		0.119	0.066	0.146	0.435

This table presents the results of the regression discontinuity analyses designed to test the cost of capital differential channel. In the first stage, we estimate stock liquidity as a function of the Russell 2000 indicator:

$$LIQ_{i,t-1} = a_1 + b_1 Rus2000_{i,t-1} + c_1 Rank_{i,t-1} + d_1 Rus2000_{i,t-1} \times Rank_{i,t-1}$$
$$+ e_1 FloatAdj_{i,t-1} + f_1' CONTROLS_{i,t-1} + YR_{t-1} + IND_j + \omega_{i,t-1}.$$

In the second stage, we use the instrumented stock liquidity to model the standardized cost of debt capital ($COD^*_{i,t}$), the standardized cost of equity capital ($COE^*_{i,t}$), the standardized cost of capital differential ($COE^*_{i,t} - COD^*_{i,t}$), or the relative cost of equity capital ($COE_{i,t}/COD_{i,t}$) for firm i in year t, $C_{i,t}$:

$$C_{i,t} = a + b\widehat{LIQ_{i,t-1}} + cRank_{i,t-1} + dRus2000_{i,t-1} \times Rank_{i,t-1}$$
$$+ eFloatAdj_{i,t-1} + f' CONTROLS_{i,t-1} + YR_t + IND_j + \epsilon_{i,t}.$$

The first-stage regression results are reported in Column (1). Columns (2) through (5) report the second-stage estimates for the four dependent variables. $\widehat{LIQ_{i,t-1}}$ is the instrumented stock liquidity. $Rus2000_{i,t-1}$ is the binary variable that equals one if firm i is included in the Russell 2000 index in year $t-1$ and zero otherwise. $Rank_{i,t-1}$ is based on rankings implied by the firm's market capitalization within the assigned index as of May 31st. We also include $FloatAdj_{i,t-1}$, a proxy for the float adjustment by Russell, computed as the difference between the rank implied by the May 31st market capitalization and the actual rank assigned by Russell in June. Control variables include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), an R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), the dividend payout ratio ($DPayout_{i,t-1}$), and institutional ownership ($IO_{i,t-1}$). Year fixed effects and industry fixed effects are also included. Standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Table 10: **Effect of stock liquidity on takeover exposure**

Variable	(1) $P\_Hos\_Takeover_{i,t}$	(2) $P\_Any\_Takeover_{i,t}$
$LIQ_{i,t-1}$	**0.116*** **	**0.058*** **
	(0.007)	**(0.008)**
$Size_{i,t-1}$	0.249***	0.390***
	(0.015)	(0.019)
$EBIT_{i,t-1}$	0.009	-0.180***
	(0.055)	(0.060)
$MB_{i,t-1}$	-0.056***	-0.152***
	(0.013)	(0.009)
$Tangibility_{i,t-1}$	-0.084	-0.081
	(0.076)	(0.094)
$Depreciation_{i,t-1}$	-0.186	1.091***
	(0.300)	(0.385)
$R\&D_{i,t-1}$	0.005	-0.016
	(0.030)	(0.034)
$R\&DIntensity_{i,t-1}$	0.041	-0.187
	(0.073)	(0.138)
$Dividend_{i,t-1}$	0.058***	-0.001
	(0.017)	(0.023)
$DPayout_{i,t-1}$	-0.028***	-0.007
	(0.010)	(0.013)
$IO_{i,t-1}$	-0.092	-0.146
	(0.072)	(0.146)
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	7,029	7,029
R-squared	0.945	0.729

This table reports the estimation results for Equation (10), a fixed effects regression model of the logit-transformed probability of a takeover on stock liquidity based on the sample period 1988–2013. Column (1) has the logit-transformed probability of a hostile takeover ($P\_Hos\_Takeover_{i,t}$) as the dependent variable, while Column (2) has the logit-transformed probability of a takeover of any type ($P\_Any\_Takeover_{i,t}$) as the dependent variable. The stock liquidity measure ($LIQ_{i,t-1}$) is measured for firm i over the fiscal year $t-1$. Control variables include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), an R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), the dividend payout ratio ($DPayout_{i,t-1}$), and institutional ownership ($IO_{i,t-1}$). We also include year fixed effects to account for the intertemporal variation that may affect the probability of a takeover and firm fixed effects to control for the unobserved firm heterogeneity that is constant over time. Standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Table 11: Testing the anti-takeover channel using DiD approaches

Panel A. Univariate DiD tests based on decimalization

Variable	(1) No. of Pairs	(2) Mean Treatment Difference (After-Before)	(3) Mean Control Difference (After-Before)	(4) Mean DiD Estimate (Treat-Control)	(5) t-statistics for DiD Estimate
$Avg.\ P\_Hos\_Takeover_{i,t}$	130	0.406	-0.207	**0.613*** **	**14.161**
$Avg.\ P\_Any\_Takeover_{i,t}$	130	0.123	-0.254	**0.377*** **	**8.728**

Panel A provides the results for the DiD analysis based on the 2001 tick-size shift to decimalization designed to test the anti-takeover channel. $Average\ P\_Hos\_Takeover_{i,t}$ is measured as the three-year average of the logit-transformed hostile takeover probabilities before or after decimalization. $Average\ P\_Any\_Takeover_{i,t}$ is measured as the three-year average of the logit-transformed takeover probabilities before or after decimalization. Standard errors are presented in parentheses below the mean differences in outcome variables. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel B. Regression DiD analyses based on decimalization

Variable	(1) $P\_Hos\_Takeover_{i,t}$	(2) $P\_Any\_Takeover_{i,t}$
$TREAT_i \times POST_t$	**0.358*** **	**0.211*** **
	(0.025)	**(0.023)**
$POST_t$	-0.234***	-0.159***
	(0.022)	(0.017)
$Size_{i,t-1}$	0.276***	0.195***
	(0.030)	(0.022)
$EBIT_{i,t-1}$	0.227***	0.074***
	(0.050)	(0.026)
$MB_{i,t-1}$	-0.041***	0.028***
	(0.014)	(0.005)
$Tangibility_{i,t-1}$	0.101	0.694***
	(0.181)	(0.132)
$Depreciation_{i,t-1}$	0.300	1.096***
	(0.254)	(0.268)
$R\&D_{i,t-1}$	0.051	-0.011
	(0.053)	(0.064)
$R\&DIntensity_{i,t-1}$	0.174	0.013
	(0.126)	(0.111)
$Dividend_{i,t-1}$	0.038	0.050
	(0.041)	(0.034)
$DPayout_{i,t-1}$	0.002	-0.025
	(0.035)	(0.028)
Firm fixed effects	Yes	Yes
Number of firms	682	682
Observations	3,457	3,460
R-squared	0.265	0.229

Panel B reports the results for the regression DiD analyses based on the 2001 tick-size shift to decimalization designed to test the anti-takeover channel. The dependent variable in Column (1) is the logit-transformed hostile takeover probability estimated using the hostile takeover sample. The dependent variable in Column (2) is the logit-transformed takeover probability estimated using the sample of all takeovers. For control variables, we include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), the R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), and the dividend payout ratio ($DPayout_{i,t-1}$). Standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Panel C. Univariate DiD tests based on the 1997 tick-size shift

Variable	(1) No. of Pairs	(2) Mean Treatment Difference (After-Before)	(3) Mean Control Difference (After-Before)	(4) Mean DiD Estimate (Treat-Control)	(5) *t*-statistics for DiD Estimate
$Avg.\ P\_Hos\_Takeover_{i,t}$	119	0.773	0.330	**0.443*** **	**9.004**
$Avg.\ P\_Any\_Takeover_{i,t}$	119	0.396	0.050	**0.346*** **	**7.927**

Panel C provides the results for the DiD analysis based on the 1997 tick-size shift designed to test the anti-takeover channel. $Average\ P\_Hos\_Takeover_{i,t}$ is measured as the three-year average of the logit-transformed hostile takeover probabilities before or after the 1997 shift. $Average\ P\_Any\_Takeover_{i,t}$ is measured as the three-year average of the logit-transformed takeover probabilities before or after the 1997 shift. Standard errors are presented in parentheses below the mean differences in outcome variables. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel D. Regression DiD analyses based on the 1997 tick-size shift

Variable	(1) $P\_Hos\_Takeover_{i,t}$	(2) $P\_Any\_Takeover_{i,t}$
$TREAT_i \times POST_t$	**0.287*** **	**0.128*** **
	(0.023)	**(0.022)**
$POST_t$	0.216***	-0.051***
	(0.014)	(0.014)
$Size_{i,t-1}$	0.293***	0.255***
	(0.019)	(0.018)
$EBIT_{i,t-1}$	0.162***	0.070
	(0.044)	(0.043)
$MB_{i,t-1}$	-0.050***	0.032***
	(0.010)	(0.007)
$Tangibility_{i,t-1}$	-0.207**	0.678***
	(0.094)	(0.083)
$Depreciation_{i,t-1}$	0.014	0.385*
	(0.265)	(0.217)
$R\&D_{i,t-1}$	0.026	0.052
	(0.052)	(0.038)
$R\&DIntensity_{i,t-1}$	0.004	-0.056
	(0.128)	(0.110)
$Dividend_{i,t-1}$	0.044	0.064**
	(0.048)	(0.026)
$DPayout_{i,t-1}$	-0.028	-0.015
	(0.036)	(0.025)
Firm fixed effects	Yes	Yes
Number of firms	928	928
Observations	4,631	4,634
R-squared	0.450	0.307

Panel D reports the results for the regression DiD analyses based on the 1997 tick-size shift designed to test the anti-takeover channel. The dependent variable in Column (1) is the logit-transformed hostile takeover probability estimated using the hostile takeover sample. The dependent variable in Column (2) is the logit-transformed takeover probability estimated using the sample of all takeovers. For control variables, we include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), the R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), and the dividend payout ratio ($DPayout_{i,t-1}$). Standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

Table 12: The difference in takeover exposures around the Russell 1000/2000 threshold

	First Stage	Second Stage	
	(1)	(2)	(3)
VARIABLES	$LIQ_{i,t-1}$	$P\_Hos\_Takeover_{i,t}$	$P\_Any\_Takeover_{i,t}$
$Rus2000_{i,t-1}$	**0.524*********		
	(0.072)		
$\widehat{LIQ_{i,t-1}}$		**0.236*****	**-0.025**
		(0.037)	**(0.045)**
$Rank_{i,t-1}$	-0.003***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)
$Rus2000_{i,t-1} \times Rank_{i,t-1}$	0.001***	0.000***	0.000
	(0.000)	(0.000)	(0.000)
$FloatAdj_{i,t-1}$	0.001***	-0.000***	0.000***
	(0.000)	(0.000)	(0.000)
$Size_{i,t-1}$	0.468***	0.097***	0.444***
	(0.108)	(0.024)	(0.032)
$EBIT_{i,t-1}$	0.840***	-0.095**	-0.048
	(0.158)	(0.045)	(0.081)
$MB_{i,t-1}$	0.099***	-0.074***	-0.149***
	(0.027)	(0.011)	(0.010)
$Tangibility_{i,t-1}$	-0.252**	0.116***	-0.369***
	(0.107)	(0.032)	(0.049)
$Depreciation_{i,t-1}$	0.878	-0.513**	1.628***
	(0.680)	(0.212)	(0.283)
$R\&D_{i,t-1}$	0.113	0.018	-0.002
	(0.081)	(0.016)	(0.027)
$R\&DIntensity_{i,t-1}$	1.714***	0.143	-0.539***
	(0.217)	(0.092)	(0.147)
$Dividend_{i,t-1}$	-0.370***	0.119***	0.004
	(0.050)	(0.019)	(0.026)
$DPayout_{i,t-1}$	-0.043	-0.003	-0.051**
	(0.053)	(0.014)	(0.022)
$IO_{i,t-1}$	-1.744***	0.428**	0.314
	(0.526)	(0.205)	(0.207)
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	7,029	7,029	7,029
R-squared		0.945	0.886

This table presents the results of the regression discontinuity analyses designed to test the anti-takeover channel. In the first stage, we estimate stock liquidity as a function of the Russell 2000 indicator:

$$LIQ_{i,t-1} = a_1 + b_1 Rus2000_{i,t-1} + c_1 Rank_{i,t-1} + d_1 Rus2000_{i,t-1} \times Rank_{i,t-1}$$
$$+ e_1 FloatAdj_{i,t-1} + f_1{}' CONTROLS_{i,t-1} + YR_{t-1} + IND_j + \omega_{i,t-1}.$$

In the second stage, we use the instrumented stock liquidity to model the logit-transformed probability of a takeover for firm i in year t:

$$Logit(P(\widehat{T_{i,t}} = 1 | X_{i,t-1}) = a + b\widehat{LIQ_{i,t-1}} + cRank_{i,t-1} + dRus2000_{i,t-1} \times Rank_{i,t-1}$$
$$+ eFloatAdj_{i,t-1} + f' CONTROLS_{i,t-1} + YR_t + IND_j + \epsilon_{i,t}.$$

The first-stage regression results are reported in Column (1). Columns (2) through (3) report the second-stage estimates for two dependent variables: the logit-transformed probability of a hostile takeover ($P\_Hos\_Takeover_{i,t}$) and the logit-transformed probability of a takeover of any kind ($P\_Any\_Takeover_{i,t}$). $\widehat{LIQ_{i,t-1}}$ is the instrumented stock liquidity. $Rus2000_{i,t-1}$ is the binary variable that equals one if firm i is included in the Russell 2000 index in year $t-1$ and zero otherwise. $Rank_{i,t-1}$ is based on the ranks implied by the firm's market capitalization within the assigned index as of May 31st. We also include $FloatAdj_{i,t-1}$, a proxy for the float adjustment by

Russell, computed as the difference between the rank implied by the May 31st market capitalization and the actual rank assigned by Russell in June. Control variables include firm size ($Size_{i,t-1}$), profitability ($EBIT_{i,t-1}$), the market-to-book ratio ($MB_{i,t-1}$), asset tangibility ($Tangibility_{i,t-1}$), depreciation and amortization ($Depreciation_{i,t-1}$), an R&D indicator ($R\&D_{i,t-1}$), R&D intensity ($R\&DIntensity_{i,t-1}$), a payout indicator ($Dividend_{i,t-1}$), the dividend payout ratio ($DPayout_{i,t-1}$), and institutional ownership ($IO_{i,t-1}$). Year fixed effects and industry fixed effects are also included. Standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate the statistical significance of coefficients at the 1%, 5%, and 10% levels, respectively.

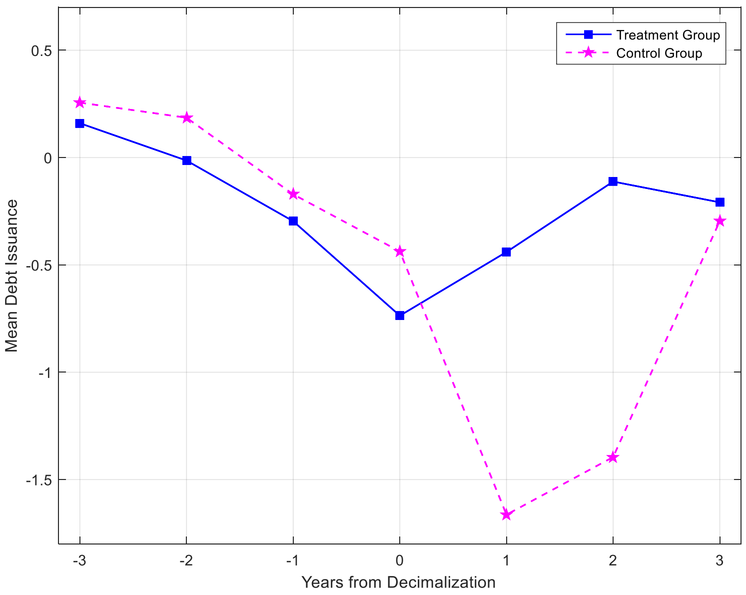

Figure 1. Debt issuance surrounding decimalization. This figure shows the mean debt issuance measured as the mean value of the long-term debt issuance net of retirement divided by the cash used for net capital expenditures and acquisitions, from three years before decimalization to three years after decimalization. The year of decimalization is denoted as year 0. The sample comprises 353 treatment firms and 353 control firms matched based on the procedures described in Section 3.2.1.

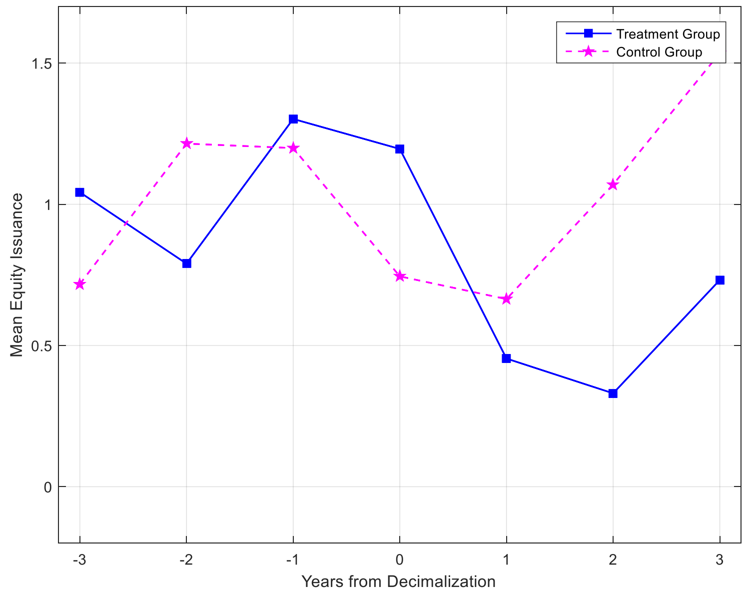

Figure 2. Equity issuance surrounding decimalization. This figure shows the mean equity issuance measured as the mean value of the sale of common and preferred stock net of the purchase of common and preferred stock divided by the cash used for net capital expenditures and acquisitions, from three years before decimalization to three years after decimalization. The year of decimalization is denoted as year 0. The sample comprises 353 treatment firms and 353 control firms matched based on the procedures described in Section 3.2.1.

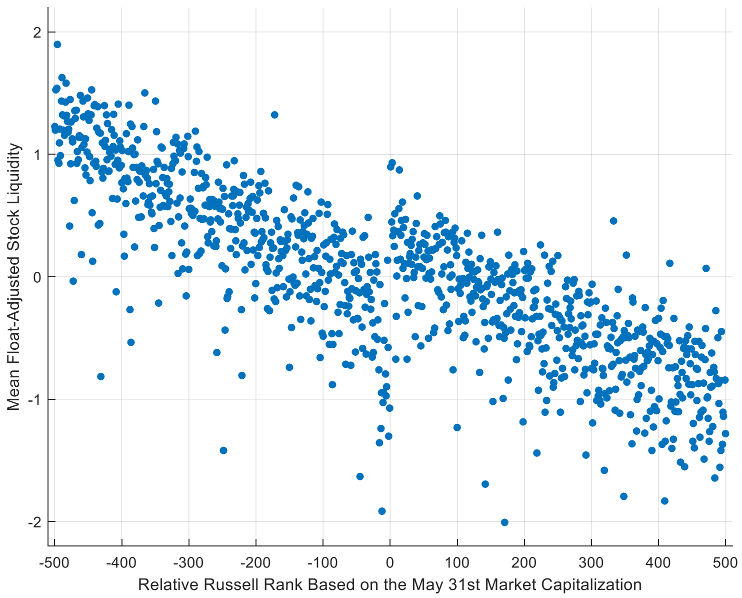

Figure 3. Russell rank and float-adjusted stock liquidity. This figure shows the mean float-adjusted stock liquidity against the relative Russell rank for 1000 firms around the Russell 1000/2000 threshold from 1991 to 2006. The float-adjusted stock liquidity is computed as the residual from the regression of our stock liquidity measure against a proxy for the float adjustment made by Russell as well as industry and year dummies. The proxy for the float adjustment made by Russell is computed as the difference between the rank implied by the May 31st market capitalization and the actual rank assigned by Russell in June. The horizontal axis represents the relative Russell rank based on the May 31st market capitalization, which is defined such that the smallest Russell 1000 firm (the largest Russell 2000 firm) has a value of -1 (+1), the second smallest Russell 1000 firm (the second largest Russell 2000 firm) has a value of -2 (+2), and so forth. The vertical axis represents the mean float-adjusted stock liquidity for firm-years with each relative Russell rank.

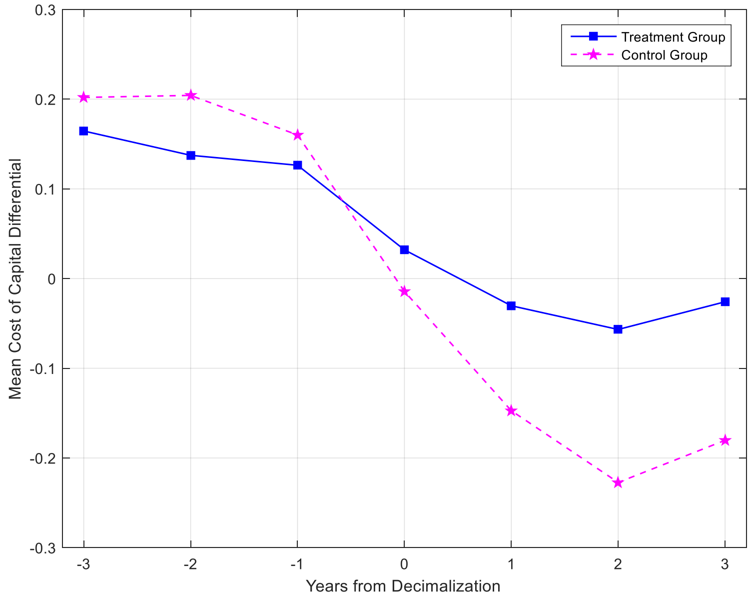

Figure 4. Cost of capital differential surrounding decimalization. This figure shows the mean cost of capital differential measured as the mean value of the difference between the cost of equity capital (standardized by the within-firm mean cost of equity capital) and the cost of debt capital (standardized by the within-firm mean cost of debt capital), from three years before decimalization to three years after decimalization. The year of decimalization is denoted as year 0. The figure is drawn using the data of the firms matched based on the procedures described in Section 3.2.1.

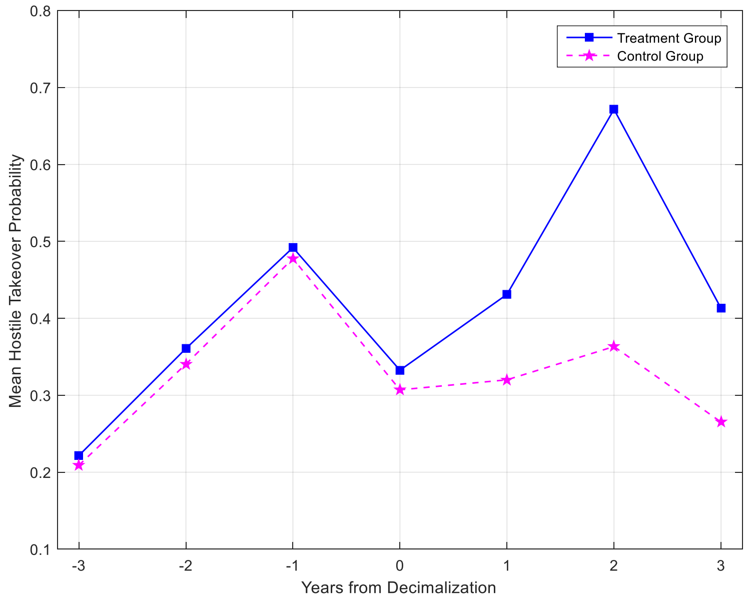

Figure 5. Hostile takeover probability surrounding decimalization. This figure shows the mean hostile takeover probability measured as the mean value of the probability of a hostile takeover described in Equation (9), from three years before decimalization to three years after decimalization. The figure is drawn using the data of the firms matched based on the procedures described in Section 3.2.1.