The effect of stock liquidity on cash holdings: The repurchase motive[1]

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ABSTRACT

We show that enhanced stock liquidity increases a firm's propensity to hold cash using tick-size decimalization for identification. Our finding is surprising in light of the view that improved stock liquidity reduces financial constraints. As an explanation, we propose that there is a repurchase motive for holding cash. Higher stock liquidity strengthens this incentive. Consistent with this perspective, we show that firms with more liquid stock increase cash holdings relatively more around the introduction of safe harbor rules for repurchases. With respect to the effect of stock liquidity on cash holdings, therefore, our findings suggest that the repurchase motive dominates the real investments motive. We also show that this effect is not influenced by a firm's relative ability to access to credit markets.

Keywords: Corporate cash holdings, Stock liquidity, Repurchases, Credit lines
JEL: G32, G35, G10

1. Introduction

How stock liquidity affects corporate policies and valuations is an important issue in corporate finance, but still not fully understood. Increased liquidity may reduce the cost of equity and, thereby, improve firm value (Amihud and Mendelson, 1986; Diamond and Verrecchia, 1991; Fang, Noe, and Tice, 2009) and reduce leverage (Lipson and Mortal, 2009). In this paper, we argue and provide evidence that enhanced stock liquidity also increases a firm's propensity to hold cash. The logic we have in mind relates to stock repurchases and, in particular, to the ideas that firms may engage in this activity to take advantage of undervalued equity (Brav, Campbell, Harvey, and Michaely, 2005; Peyer and Vermaelen, 2009; Dittmar and Field, 2015) or to stabilize stock prices relative to fundamentals (Hong, Wang, and Yu, 2008). In turn, this can motivate cash accumulation. The repurchase motive for holding cash should be stronger for firms with more liquid stock. If the underlying motive is to benefit from undervalued shares, more dollars can be spent profitably the more liquid is the stock. If it is to move the stock price up to reflect fundamentals, more cash is needed for higher levels of liquidity. Thus, under either form of the repurchase motive, the prediction is that cash holdings are increasing in stock liquidity, ceteris paribus. The evidence is supportive. What we are saying in this paper, therefore, is that increased stock liquidity raises a firm's capacity to benefit from repurchases and, as a consequence, its incentive for holding cash.

To the best of our knowledge, this is the first paper to emphasize the repurchase motive for holding cash. Tax payments and disbursements apart, in the extant literature, identified motives for corporate cash holdings typically relate to real investments (Myers and Majluf, 1984; Huberman 1984; Jensen, 1986; Opler, Pinkowitz, Stulz, and Williamson, 1999; Bates, Kahle, and Stulz, 2009). In particular, the precautionary motive says that firms hold cash as a hedge against excessive costs of external capital (financial constraints) in the future, while the agency motive says that entrenched managers may choose to build up cash reserves to spend or invest in ways that favor themselves, for example as discussed by Jensen and Meckling (1976). The precautionary perspective has substantial empirical support (Opler, Pinkowitz, Stulz and Williamson, 1999; Almeida, Campello, and

Weisbach, 2004; Han and Qiu, 2007; Acharya, Almeida, and Campello, 2007; Bates, Kahle and Stulz, 2009; Sufi, 2009; Lins, Servaes, and Tufano 2010; Harford, Klasa, and Maxwell, 2014), and there is also support for the agency perspective (Jensen, 1986; Harford, 1999; Gao, Harford, and Li, 2013; Nikolov and Whited, 2014). In contrast, the repurchase motive for holding cash relates to financial rather than real investments. We will sometimes refer to it as the "cash as ammunition" hypothesis, which reflects the idea that firms may hold cash to buy back shares in response to market sell-offs.

The finding that enhanced stock liquidity increases the propensity to hold cash may seem at odds with the idea that firms with more liquid stocks are less financially constrained and, as a consequence, would be expected to hold less cash. Our explanation is that with respect to the effect of stock liquidity on cash holdings, the repurchase motive dominates the precautionary, real investments motive. Warusawitharana and Whited (2016) show that "misvaluation induces larger changes in financial policies than investment" (p. 603). Viewed in this light, our finding can be interpreted as saying that stock liquidity is more important with respect to addressing, or benefiting from, misvaluations through buybacks than with respect to raising funds for real investments.

We also explicitly examine share repurchases as a mechanism through which stock liquidity and cash holdings are related. Thus, the paper relates to the general literature on stock liquidity and payout policy (Barclay and Smith, 1988; Banerjee, Gatchev, and Spindt, 2007; Hillert, Maug, and Obernberger, 2016). Our main contribution with respect to repurchases is that firms with more liquid stock increase their cash holdings relatively more when constraints to buybacks are eased. The interpretation is that firms accumulate cash to buy back stock in the future and the more so the more liquid is their stock.

As further supportive evidence, we show that there is a positive relation between stock liquidity and buyback activity that is stronger for firms that may be viewed as being undervalued. This expands on Brockman, Howe, and Mortal's (2008) finding that the usage of buybacks relative to dividends is increasing in stock liquidity. To capture undervaluation, we lean on the repurchase literature. Ikenberry, Lakonishok, and Vermaelen (1995) show that long-run abnormal returns following announcements of open-market repurchase programs are especially large for low market-to-book (MTB) firms, and Dittmar (2000) finds an inverse relation between repurchase activity and MTB. Thus, in the context of repurchases, low MTB may be viewed as a proxy for undervaluation. We find that the effect of stock liquidity on buyback intensity is inversely related to MTB. Our finding makes sense given the growing evidence that firms are able to buy on dips (Vermaelen, 1981; Comment and Jarrell, 1991; Stephens and Weisbach, 1998; Dittmar, 2000; Peyer and Vermaelen, 2009; Ben-Raphael, Oded, and Wohl, 2014; Dittmar and Field, 2015) and firms with more liquid stocks have more to gain from this, ceteris paribus.

A study of the repurchase motive for holding cash is arguably incomplete without considering the alternatives. The literature on corporate liquidity management specifically emphasizes credit lines as a close, but not perfect, substitute for cash (Boot, Thakor, and Udell, 1987; Holmström and Tirole, 1998; Sufi, 2009; Acharya, Almeida, Ippolito, and Perez, 2014; Almeida, Campello, Cunha, and Weisbach, 2014). Firms with good access to debt markets could also finance buybacks by issuing fresh debt. However, these forms of financing may be unattractive in states-of-the-world where equity is undervalued. Kwan (1996) shows that same-firm stock returns and bond yields are negatively correlated, suggesting that equity and debt comove with respect to misvaluation.[1] Credit lines are not necessarily immune to this because firms may seek to replace drawn credit, which may be on relatively unfavorable terms if markets have a negative outlook on the firm.

In addition, credit lines are subject to covenants and may be renegotiated in firms' disfavor when these are violated (Sufi, 2009). In his random sample of 300 firms, Sufi finds that 35% of firms with credit lines break financial covenants, and the most important predictor of this is drops in cash flow. This may be a concern with respect to buying back undervalued stock. Peyer and Vermaelen (2009) find that profitable buyback opportunities typically arise after overly severe analyst downgrades following disappointing earnings releases. Hence, firms may be at risk of breaking cash-flow based covenants, and facing renegotiations to worse credit terms, exactly when these profit opportunities arise. As a result, it may be better to rely on cash when buying back stock that is undervalued or under pressure.

Consistent with these ideas, we find that the ability to tap credit markets, as captured

[1]See Section 5.1 for further discussion.

by measures of debt constraints or access to credit lines, do not affect firms' reactions, as regards cash holdings, to changes in stock liquidity. Our findings suggest that cash and credit are not close substitutes when it comes to buying back undervalued shares.

There are four parts to our empirical analysis. As a preliminary first step, we examine correlations by running fixed-effects panel regressions of US industrial firms' cash ratios on lagged measures of stock liquidity and a number of control variables, based for the most part on the standard references of Opler, Pinkowitz, Stulz, and Williamson (1999) and Bates, Kahle, and Stulz (2009). We employ two standard measures of stock liquidity, namely Amihud's (2002) *ILLIQ* measure of price impact and the relative effective bid-ask spread (Chordia, Roll, and Subrahmanyam, 2001). Because stock liquidity is highly correlated with size and because size has been shown in the literature to be an important explanatory variable with respect to cash holdings, we orthogonalize the stock-liquidity measures to firm size in most specifications. Regardless of which time period, stock liquidity measure, or set of control variables and fixed effects we use, we find that firms' cash ratios are positively correlated with stock liquidity.

Second, to address endogeneity concerns, our main analysis employs matching and regression difference-in-differences (DiD) methodologies to test for the effect of an exogenous shock to liquidity on cash holdings. A potential source of endogeneity in our setting is reverse causality, since asset liquidity may affect stock liquidity (Gopalan, Kadan, and Pevzner, 2012). For identification, we follow Chordia, Roll, and Subrahmanyam (2008) and Fang, Noe, and Tice (2009) by using the introduction of tick-size decimalization on the New York Stock Exchange (NYSE), American Stock Exchange (AMEX), and NASDAQ in 2001 as an exogenous improvement to stock liquidity. As in Fang, Noe, and Tice (2009), we use the insight that decimalization enhances liquidity especially for more actively traded stocks (Bessembinder, 2003; Furfine, 2003) to assign treatment. Thus, firms are classified based on trading activity in their stock in the year prior to decimalization. Matched control firms are drawn from the same industry based on the Mahalanobis metric (see, e.g., Abadie and Imbens, 2011) on a parsimonious set of variables. The matching DiD approach as well as industry×year fixed effects in the regression DiD analysis should go some way toward allaying concerns about industry-level, time-varying effects, that may arise, for example, because of the dot-com crash and the recession in 2001. Placebo tests are used to assess the validity of the exclusion restriction. Under both the matching and the regression DiD approaches, the results show that cash holdings are increasing in stock liquidity.

The first two parts of our empirical analysis show that stock liquidity and cash holdings are positively correlated and support the specific hypothesis that enhanced stock liquidity strengthens the propensity for holding cash. In the third part, we examine the plausibility of the repurchase motive as an explanation for these findings. Our primary test uses the Securities and Exchange Commission's (SEC) adoption of Rule 10b-18 in 1982, which eased regulatory constraints on stock repurchases by clarifying the circumstances under which firms can buy back shares without running the risk of being charged with market manipulation. This led to a significant increase in overall share buyback levels (Grullon and Michaely, 2002). We construct matching and regression DiD tests around this event based on the idea that the treatment with respect to repurchases is stronger for firms with more liquid stock. The results show that treated firms increase cash holdings relatively more. This supports the view that the positive effect of stock liquidity on cash holdings relates to future stock buybacks.

We also explore the repurchase motive further by running tobit panel regressions of stock repurchases on size-orthogonalized stock-liquidity measures and a number of controls. We find a positive relation between stock liquidity and repurchase activity that is amplified by low MTB. Given the findings on MTB and long-run abnormal returns (Ikenberry, Lakonishok, and Vermaelen, 1995) and repurchase volume (Dittmar, 2000) discussed above, this provides additional support for the relevance of the repurchase motive for holding cash.

In the fourth piece of analysis, we return to the decimalization event. To examine whether firms with worse access to credit markets react relatively more strongly to a positive shock to stock liquidity, we run triple-difference regressions using four different measures of debt constraints and a dummy variable indicating whether or not the firm has access to a credit line in the year prior to decimalization. The latter is obtained from Sufi's (2009) extended credit-line data, augmented by 10-K filings for forty missing firms selected by our procedures as treated or matched controls. We find that the triple-difference estimator is insignificant in all specifications. Thus, the effect of stock liquidity on cash holdings is not influenced by access to credit markets.

The rest of the paper is organized as follows: Section 2 describes the data and the variables and reports on correlations between cash holdings and stock liquidity. Section 3 contains the main analysis, namely the investigation into the effect of stock liquidity on cash holdings using the introduction of tick-size decimalization for identification. Section 4 examines the repurchase motive as the mechanism behind the link between stock liquidity and cash holdings. Section 5 reports on the triple-difference investigation into the potential effects of the ability to tap credit markets. Section 6 concludes. The Appendix contains detailed descriptions of all variables, including data sources. An internet appendix contains supplementary results.

2. Data, variables, and correlations

This section describes the data and the variables. It also carries out preliminary correlations analyses, focusing on the relation between stock liquidity and cash holdings.

2.1. Data

Corporate accounting variables are collected from Compustat for the period 1964 to 2015. Daily and monthly stock data are from CRSP. High-frequency intra-day stock data are from NYSE Trade and Quote (TAQ). Institutional investor holding data are from Thomson Reuters 13F. Financial analyst data are from the Institutional Brokers' Estimate System (IBES). Financials (SIC code between 6000 and 6999) and utilities (SIC code between 4900 and 4999) are excluded. We only keep firm-years with positive total assets, positive sales, a ratio of total debt (long-term debt plus current liabilities) to total assets that is between 0 and 1, and a listing of common stock (CRSP share code 10 or 11) on NYSE, AMEX, or NASDAQ. Furthermore, stocks need to trade on no less than 100 days within the year, not change exchanges, and have prices not exceeding USD 999 per share. In the case of two classes of common shares for a given firm-year, we take the one with the higher turnover.

We delete firm-years with more than two classes of common shares. Following Acharya, Almeida, and Campello (2007), we drop firm-years with asset or sales growth larger than 100% and market-to-book larger than 10. Over the 1964 to 2015 sample period, we are left with 98,323 firm-year observations. Non-CRSP/Compustat variables are available over shorter time periods, described below and in more detail in the Appendix. The dependent variable in most of our analysis is the cash ratio, defined as cash and short-term investment (CHE) over total book assets (AT) [Compustat variable names in parentheses].

2.2. Stock-liquidity variables

We use two stock-liquidity measures, one using low-frequency and one using high-frequency data. The low-frequency measure is Amihud's (2002) *ILLIQ*,[2] originally defined as

$$ILLIQ\_\text{Amihud}_{i,t} = \frac{1}{N_{i,t}} \sum_{d=1}^{N_{i,t}} \frac{|r_{i,t,d}|}{DVol_{i,t,d}}, \tag{1}$$

where $r_{i,t,d}$ is stock i's rate of return on day d in year t, $DVol_{i,t,d}$ is the corresponding dollar volume (in USD millions), and $N_{i,t}$ is the number of trading days of stock i in year t. Returns and volume data are from CRSP.

Atkins and Dyl (1997) and Anderson and Dyl (2007) note that the dealer structure on NASDAQ leads to a double-counting problem of trading volume. As suggested by Atkins and Dyl (1997) and Nagel (2005), we address this double-counting problem by dividing the reported dollar volume of NASDAQ stocks by two. Furthermore, following Nyborg and Östberg (2014), we exclude daily CRSP observations with positive volume but no recorded closing price on either day d or $d-1$ and a zero return on day d, as this is highly suggestive of stale prices and spurious volume. Finally, following Acharya and Pedersen (2005), we adjust Amihud's *ILLIQ* by stock price "inflation," cap it to reduce the impact of extreme

[2]In their tests of liquidity measures, Goyenko, Holden, and Trzcinka (2009) find that *ILLIQ* is the best performing low-frequency price-impact measure.

values, and bound it away from zero, leaving us with the following final measure:[3]

$$ILLIQ_{i,t} = \min\left(0.25 + 0.30 \times ILLIQ\_\text{Amihud}_{i,t} \times P^M_{t-1},\ 71.9\right), \quad (2)$$

where P^M_{t-1} is the ratio of the capitalizations of the CRSP market portfolio at the end of fiscal year $t-1$ and July 1962. *ILLIQ* is available for the full period.

The high-frequency liquidity measure is the relative effective bid-ask spread (Chordia, Roll, and Subrahmanyam, 2001; Fang, Noe, and Tice, 2009). The effective spread is defined as the difference between the execution price and the mid-point of the prevailing bid-ask quote. The relative effective bid-ask spread is the effective spread divided by the mid-point of the prevailing bid-ask quote. Using TAQ, we proceed in the usual way to compute this.

In particular, quotes established before the opening of the market or after the close of the market are excluded. Quotes are also discarded if the offer price is lower than the bid price. The trade record is excluded if it does not have a positive price or trading size. The Lee and Ready (1991) algorithm is then used to match trades and quotes: for a trade between 1993 and 1998, the five-second rule is used; for a trade between 1999 and 2015, the trade is matched to the first quote before the trade. The same matching methodology is used by Chordia, Roll, and Subrahmanyam (2008) and Fang, Noe, and Tice (2009). To eliminate potential errors in trades and quotes, following Chordia, Roll, and Subrahmanyam (2001), after the matching process, we exclude observations which satisfy the following four conditions: (i) Quoted spread $>$ \$5, (ii) Effective spread/Quoted spread $>$ 4.0, (iii) Relative effective spread/Relative quoted spread $>$ 4.0, (iv) Quoted spread/Transaction price $>$ 0.4, where quoted spread is the difference between the prevailing quoted bid and ask, and the relative quoted spread is the quoted spread divided by the mid-point of the corresponding quoted bid and ask.

The daily relative effective bid-ask spread is calculated by taking the arithmetic mean of the transaction-level relative effective bid-ask spreads over the day. The annual relative

[3]The cap of 71.9 winsorizes *ILLIQ* at the 90^{th} percentile in our sample. Acharya and Pedersen (2005) use a cap of 30, which would winsorize our sample approximately at the 85^{th} percentile. Our results are not qualitatively sensitive to which of these two bounds we use.

effective bid-ask spread is the average of daily relative effective bid-ask spreads within the relevant fiscal year. Following Fang, Noe, and Tice (2009), we use the logarithm of the annual relative effective bid-ask spread in our analysis, which we denote by Log_resprd. TAQ data, and therefore Log_resprd, is available from 1993.

Because *ILLIQ* and Log_resprd are highly negatively correlated with firm size (-0.57 and -0.83, respectively), which is a key determinant of cash holdings (Opler, Pinkowitz, Stulz, and Williamson, 1999; Bates, Kahle and Stulz, 2009), we size-orthogonalize these variables. In particular, for each year t, we run OLS across firms, i, as follows:

$$X_{i,t} = \gamma_0 + \gamma_1 \text{Firm size}_{i,t} + \eta_{i,t}, \tag{3}$$

where X is either liquidity measure. The size-orthogonalized variables, the residuals from estimating Eq. (3), are denoted ILLIQ_res and Log_resprd. The correlations of *ILLIQ* and Log_resprd with their respective size-orthogonalized versions are 0.75 and 0.47, respectively, showing that removing size from the liquidity measures leaves them reasonably well intact.

2.3. Control variables

As control variables, following Opler, Pinkowitz, Stulz, and Williamson (1999), we use Firm size, MTB (market-to-book ratio), Leverage (debt over assets), Net working capital, a Dividend dummy, R&D, Capital expenditure, Acquisition expenditure, Cash flow, and Industry sigma. In addition, following Bates, Kahle, and Stulz (2009), we include Net equity issuance, Net debt issuance, and dummies for the number of years that have passed since a firm's IPO. These variables are denoted IPON, where N runs from 2-5. IPON is 1 if the difference between the year of the fiscal year-end and the year of the first occurrence in CRSP is N, and zero otherwise.[4] Dollar denominated variables such as R&D are normalized by total assets. Net equity and debt issuance and acquisition expenditures are available from 1971. See the Appendix for further details on all variables.

We also use institutional turnover (Gaspar, Massa, and Matos, 2005; Yan and Zhang, 2009) and product-market fluidity (Hoberg, Phillips, and Prabhala, 2014). Data on in-

[4] We do not include IPO1 because liquidity measures are used with a lag of one year.

stitutional investors' stock holdings are from Thomson Reuters (13F), which is available from 1980. Fluidity is downloaded from the Hoberg-Phillips data library for the years 1997 to 2015.[5] Both of these variables can be thought of as relating to the repurchase motive for holding cash. Firms that face more product-market competition may be more exposed to negative cascades from sliding stock prices, along the lines of Subrahmanyam and Titman (2001). To protect themselves from this, such firms may hold relatively more cash in order to support their stock price should the need arise. Similarly, larger institutional turnover indicates a less stable shareholder base and, therefore, a greater potential benefit from price-stabilizing share repurchases.

Other control variables are: (i) Analyst coverage, calculated from IBES with availability from 1976, which is shown by Chang (2012) to affect cash holdings. (ii) Blocks and Non-blocks, calculated using institutional ownership data from Thomson Reuters (13F). Blocks is the proportion of shares owned by institutional investors individually holding more than 5% of outstanding shares. This can be thought of as a proxy for corporate governance, as in Dittmar and Mahrt-Smith (2007). Better corporate governance can increase the value of cash holdings and thereby encourage more cash holdings (Dittmar and Mahrt-Smith, 2007; Harford, Mansi, and Maxwell, 2008). Non-blocks is the remaining institutional ownership. Smaller holdings may be less costly to unload, potentially making the stock price more vulnerable to negative news. Institutional ownership data is also used by Brown, Chen, and Shekhar (2011) to study cash holdings.[6] (iii) Firm age, which we expect to have a negative effect on cash holdings because young firms have relatively weak connections with corporate stakeholders, such as customers, suppliers, employees, and investors. So we think of this variable as relating to the potential for negative feedback from falling stock prices. (iv) Equity beta, which can be regarded as a proxy for the systematic risk of a business and is, therefore, expected to have a positive impact on cash holdings for precautionary reasons.

[5] http://hobergphillips.tuck.dartmouth.edu/.

[6] Because Analyst coverage and Non-blocks are highly correlated with Firm size (0.72 and 0.75, respectively), in the analysis below, we orthogonalize these variables to size using Eq. (3).

2.4. Descriptive statistics and correlations

Table 1 displays descriptive statistics of Cash ratio, *ILLIQ* , and Log_resprd (Panel A) and the control variables (Panel B) over different time periods, reflecting the availability of the control variables. The average Cash ratio ranges from 0.14 (1964-2015) to 0.18 (1998-2015). Over the same periods, average *ILLIQ* is 12.50 and 12.83, respectively. The average Log_resprd is -5.68. For the three main variables, standard deviations have the same order of magnitude as the respective means.

Insert Table 1 and Table 2 here.

Table 2 reports on the pairwise correlations of all variables over their respective overlapping sample periods. The variables with the largest positive correlations with Cash ratio are R&D (0.49), MTB (0.35), Industry sigma (0.33), and Fluidity (0.27). Those with the largest negative correlations are Leverage (-0.43), Cash flow (-0.28), Net working capital (-0.27), and Firm size (-0.22).

The correlations between Cash ratio and *ILLIQ* and Log_resprd are both 0.01. Thus, unconditionally, the relation between cash holdings and stock liquidity is weak. Yet, the correlations between ILLIQ_res and Log_resprd_res and Cash ratio are -0.20 and -0.28, respectively. Since higher values for both *ILLIQ* and Log_resprd reflect increased illiquidity, this means that controlling for size, firms with more liquid stocks hold more cash. This is a first, simple piece of evidence for a positive relation between stock liquidity, adjusted for size, and cash holdings. It also points to measures of liquidity capturing an economic factor that is unrelated to, and different in substance from, size.

2.5. Panel regressions

In this subsection, we study the relation between cash holdings and stock liquidity further by estimating panel regressions of Cash ratio on the stock-liquidity measures. We use the following basic specification over firm-years (i, t):

$$\text{Cash ratio}_{i,t} = \beta_0 + \beta_1 \text{Liquidity}_{i,t-1} + \mathbf{\Gamma}'\mathbf{Z}_{i,t} + \varepsilon_{i,t}, \qquad (4)$$

where Liquidity is either $ILLIQ$, ILLIQ_res, Log_resprd, or Log_resprd_res, $\mathbf{Z}$ is a vector of control variables, and $\mathbf{\Gamma}$ is the corresponding vector of regression coefficients. The control variables are as discussed in Section 2.3 and described in detail in the Appendix. We run variations of Eq. (4) over four time periods, namely, 1964-2015 (the full sample period), 1971-2015 (net equity and debt issuance and acquisition expenditures are available from 1971), 1981-2015 (analyst coverage and institutional holding data are available from 1976 and 1980, respectively), and 1998-2015 (lagged Log_resprd is available from 1994 and Fluidity from 1997).[7] For all time periods, the regressions are run with industry and year fixed effects. However, as an additional control for a potential time-invariant firm-specific omitted variable, regressions over the 1998-2015 period, which include the full set of controls, are also run with firm fixed effects. In total, we estimate twelve specifications. Standard errors are clustered at the firm level.

Insert Table 3 here.

For all specifications in Table 3, the coefficients on the liquidity variables are negative and statistically significant at the 1% level. Since stock liquidity is decreasing in $ILLIQ$ and Log_resprd, this means that firms with more liquid stocks hold more cash, ceteris paribus. For each of the four liquidity measures, the regression coefficients are of similar magnitude across specifications. For ILLIQ_res, for example, the coefficient ranges from -0.043×10^{-2} (1998-2015 period, firm fixed effect) to -0.087×10^{-2} (1964-2015 period, industry fixed effect). In terms of economic magnitudes, over the 1964-2015 (1998-2015) period, a one standard deviation decrease in ILLIQ_res increases the cash ratio by 1.42 (1.11) percentage points (pps). This represents an increase of approximately 10% (6.2%) of the average cash ratio of 14% (18%) over this period.[8] The corresponding numbers for Log_resprd_res (over the 1998-2015 period) are similar, namely 1.54 pps and 8.5%. Thus, the evidence shows that enhanced stock liquidity is associated with statistically and

[7] IPON is included in the regressions over the last three time periods. This has no noteworthy effect on the results.

[8] Over the different subperiods, the standard deviations of lagged ILLIQ_res are: 16.30 (1964-2015), 16.78 (1971-2015), 17.86 (1981-2015), 17.36 (1998-2015). The standard deviation of lagged Log_resprd_res is 0.64 (1998-2015). Economic magnitude estimates are based on the specifications with industry and year fixed effects.

economically significant increases in cash holdings.

The results on the control variables, which may be of independent interest, are provided in the Internet Appendix (Table A1). These are consistent with the extant literature (see Table A2). For example, Cash ratio is increasing in Firm size, Industry sigma, MTB, and R&D (Opler, Pinkowitz, Stulz, and Williamson, 1999; Bates, Kahle and Stulz, 2009). Consistent with the precautionary motive, we also find that it is increasing in Equity beta. The coefficient on Blocks is positive, consistent with the view that improved governance reduces the cost of holding cash (Dittmar and Mahrt-Smith, 2007; Harford, Mansi, and Maxwell, 2008). Supportive evidence on the cash as ammunition hypothesis is provided by the positive coefficients on Inst_turn, Fluidity, and Non-blocks_res and the negative coefficient on Firm age (see the discussion in Section 2.3).

3. Difference-in-differences analysis

While the basic findings above support the hypothesis that enhanced stock liquidity increases cash holdings, causality could flow the other way. Reverse causality can obscure both economic and statistical inference. If the variables are jointly determined, the panel regressions are subject to a simultaneity bias that is difficult to sign. To address this concern, we examine the effect of stock liquidity on cash holdings using a difference-in-differences (DiD) approach around the introduction of tick-size decimalization on the three major US exchanges in 2001, which is an exogenous shock to stock liquidity. For robustness, we use both matching and regression approaches. In addition, we run placebo tests to address potential concerns about the exclusion restriction.

3.1. Tick-size decimalization and basic empirical design

On January 29, 2001, the New York Stock Exchange (NYSE) and American Stock Exchange (AMEX) changed the minimal tick size from 1/16th of a dollar (6.25 cents) to 1 cent. NASDAQ decimalized on April 9, 2001. This event has been used previously to study the effect of liquidity in other contexts by Chordia, Roll, and Subrahmanyam (2008) and Fang, Noe, and Tice (2009). As in the latter, we draw on the findings of Furfine (2003) and Bessembinder (2003) that more actively traded stocks improved their liquidity more than less actively traded stocks as a result of decimalization, in line with the prediction of Harris (1999). Thus, we want to test whether firms with more actively traded stocks had relatively larger changes in cash holdings after the introduction of decimalization.

Using TAQ, we measure how actively a stock is traded in the year prior to decimalization (year 2000) by the total number of trades. Based on this, stocks are divided into terciles. The indicator variable Treat_i is set to one if firm i is in the upper tercile and zero otherwise. Matching and regression difference-in-differences estimators are then used to test whether treated firms ($\text{Treat}_i = 1$) have abnormally large Cash ratio changes over the test period. Pre-event values of covariates are used in the matching procedure and as controls in the regression approach to allay endogeneity concerns. Details are provided in the respective subsections below.

Our empirical design relies on trading activity before decimalization to be a valid instrument for stock liquidity. For this to be the case, it is also necessary that active trading does not affect cash holdings through channels other than stock liquidity. In the context of our DiD analysis, we are not aware of any such alternative channel. To further assess the plausibility of the exclusion restriction, we perform placebo analysis using time periods to the left and right of the main decimalization test period in addition to checking the parallel-trends condition.

3.2. Matching approach

The basic idea is to compare the effect of decimalization on the treated firms to a set of matched control firms. Specifically, we use the Abadie and Imbens (2011) bias-corrected matching estimator to measure the effect of the treatment on the treated firms. The outcome variable is the change in the Cash ratio from the end of 2000 to the end of 2002. A two-year window to capture the effect of decimalization is also used by Fang, Noe, and Tice (2009). Thus, we compare the mean change in treated firms' cash ratios from 2000 to 2002 to the mean change in matched control firms' cash ratios over the same period, adjusted with the Abadie and Imbens (2011) bias correction for continuous covariates. Inference is based on Abadie and Imbens (2006) robust standard errors. Under the hypothesis that improved stock liquidity increases the benefits from holding cash, we expect the estimator to be positive, that is, treated firms are expected to experience abnormally large increases in cash ratios as a result of the decimalization liquidity shock.

The set of matched control firms are drawn from the full set of nontreated firms ($\text{Treat}_i = 0$) using a nearest neighbor approach. Specifically, for each treated firm, we select the nontreated firm within the same industry (Fama-French twelve) that provides the closest match, in terms of the Mahalanobis metric (see, e.g., Abadie and Imbens, 2011), in the closest pre-event year (2000) based on a set of matching characteristics.

We employ a parsimonious set of matching variables, namely ΔNWC (change in Net working capital), Acquisition, Net equity issuance, Capex, Cash flow, and Net debt issuance. These are chosen because of their direct, almost mechanical effect on cash savings. The first five of these variables also represent the control variables with the largest pairwise correlations with the change in the Cash ratio, in absolute value terms. These range from $|-0.28|$ (ΔNWC) to 0.06 (Cash flow).[9]

Insert Table 4 and Fig. 1 here.

Table 4 provides summary statistics on the treated and matched control samples in the pre-shock year, 2000. As one would expect, these indicate that the marginal distributions of the individual variables in the two groups are similar. What is critical, however, is that the parallel-trends condition is satisfied. Fig. 1 plots the average Cash ratio for the treated and control groups over the period 1999 to 2002. While treated firms hold more cash, on average, the trends of the average cash ratios of the two groups are clearly parallel up to the event year.[10]

Fig. 1 also reveals a differential effect of decimalization on treated and control firms. Treated firms increase cash holdings relatively more than control firms from the pre-event

[9] All other control variables have smaller correlations. For example, Firm size, which is an important variable with respect to the level of cash holdings, only has a correlation of 0.02 with the change in the Cash ratio. In the Internet Appendix (Table A3), we carry out a robustness check where we include Firm size and other controls among the matching variables. This leads to a slightly larger DiD estimate. But because it also weakens the parallel-trends condition, we prefer proceeding with the more parsimonious set of matching variables, where each variable has a clear and direct effect on cash savings.

[10] A means test on the change in cash ratio for the treated and matched control groups from 1999 to 2000 has a t-statistic of 0.22 and a p-value of 0.83.

year (2000) to one year after decimalization (2002). This is consistent with the hypothesis that enhanced stock liquidity increases the incentive to hold cash, but needs to be tested formally.

Insert Table 5 here.

The matching-estimator test is in Table 5, Panel A. The Abadie and Imbens (2011) bias-corrected estimator is 0.024 and is statistically significant at the 1% level. In other words, the treatment effect on the treated firms is 2.4 pps on average. With respect to economic significance, this represents 16% of treated firms' mean pre-shock (year 2000) Cash ratio. In short, the evidence supports the view that improved stock liquidity leads to an increase in cash holdings that is both statistically and economically significant.

As a diagnostic procedure to assess the plausibility of the exclusion restriction, we run placebo tests over the years 1997 to 1999 and 2003 to 2005. The placebo tests follow the same procedure as for the main test, but with time being shifted three years to the left or right. In particular, the treatment variable is now based on the number of trades in the placebo pre-event years, 1997 or 2003, and the placebo matching estimator captures differences in the changes in the mean Cash ratio from 1997 to 1999 or 2003 to 2005 between the placebo treated and matching control groups. The results are in Table 5, Panels B (1997 to 1999) and C (2003 to 2005).

For the placebo test to serve its purpose, it is important that trading activity in the placebo pre-event year is not related to subsequent changes in stock liquidity. The idea of the placebo test is that the test statistic is estimated conditional on there being no real treatment. If, in contrast, there is real treatment with impact on the outcome variable over the placebo period, the distribution of the test statistic would shift, and the probability of a type I error would be larger than assumed under the placebo null-hypothesis. In other words, a liquidity shock in the placebo period would contaminate the placebo treatment with real treatment and, thereby, impair the placebo test's ability to speak to the validity, or plausibility, of the exclusion restriction. We can think of it this way: if we accept the validity of the exclusion restriction only if the placebo test results in insignificance at conventional levels, then the presence of real treatment in the placebo event year will lead us to reject the plausibility of the exclusion restriction too often if real treatment has a real effect on the outcome variable. Under these circumstances, the more powerful the test, the worse the problem would be.

We are not aware of events in the two placebo periods that would make this an issue. Thus, if active trading does not affect cash holdings by itself or through other channels, we should see the two placebo Abadie and Imbens (2011) bias-corrected matching estimators being insignificant from zero. This is exactly what we find. The point estimates are close to zero, 0.009 (left) and 0.005 (right), and p-values are 0.197 (left) and 0.534 (right). This supports that the exclusion restriction is satisfied and, therefore, that we can draw the inference from the result in Panel A that improved stock liquidity has a positive effect on cash holdings.

3.3. Regression approach

We run DiD regressions on the same set of treated and matched control firms employed in the previous subsection. Because the regression approach allows us to control for firm characteristics that are not considered in the pure matching approach, the analysis in this subsection may be viewed as a robustness check on the analysis in the previous subsection. We use a standard specification, namely

$$\text{Cash ratio}_{i,t} = \beta_0 + \beta_1 \cdot \text{Treat}_i \times \text{Post}_t + \beta_2 \cdot \text{Post}_t + \beta_3 \cdot \text{Treat}_i + \mathbf{\Gamma}'\mathbf{Z}_{i,\tau(t)} + \varepsilon_{i,t}, \quad (5)$$

where i and t are firm and year indicators, respectively; Post_t is an indicator variable that is one for the decimalization and subsequent years, and zero otherwise; $\mathbf{Z}$ is a set of control variables and $\mathbf{\Gamma}$ is a vector of coefficients. Setting the decimalization year 2001 as $t = 0$, $\tau(t)$ is defined as

$$\tau(t) \equiv \begin{cases} t & \text{if } t < 0 \\ -1 & \text{otherwise.} \end{cases} \quad (6)$$

In other words, to address potential endogeneity concerns, controls are set at their pre-event values (year 2000) for the decimalization and subsequent years. Contemporaneous values for the control variables are used for years before decimalization. We run specifications with firm and year as well as Industry×Year fixed effects. The regressions are run with OLS over a baseline event window of $[-2, +2]$. Standard errors are clustered at the firm level.

The difference-in-differences estimator, β_1, captures the effect of decimalization on the treated firms, controlling for firm-specific characteristics. We expect β_1 to be positive as this would imply that the treatment effect on the treated firms is positive, as we found under the matching-estimator approach.

Insert Table 6 here.

The results are in Table 6. In total, we run six versions of Eq. (5). The first is without control variables, the second is with a partial set of controls, namely the full set less the matching variables, and the remaining four specifications employ all control variables discussed in Section 2.3 and used in the panel regressions in Table 3 over the 1998-2015 period.[11] Firm and year fixed effects are included in all specifications except that in Column 4, which employs firm and industry×year fixed effects. As robustness checks, the specification in Column 5 drops the event year and that in Column 6 uses a $[-3, +3]$ event window.

The DiD estimator is positive and statistically significant at least at the 5% level in all specifications. This supports the matching-estimator finding that improved stock liquidity leads to larger cash holdings. The positive coefficient on the Post_t indicator variable is consistent with the positive trend in cash holdings documented by Bates, Kahle, and Stulz (2009).

As regards point estimates, the DiD estimator is virtually identical across the four specifications that use the baseline event window of $[-2, +2]$ (with the event year included). It is 0.016 (Columns 1 and 3) or 0.015 (Columns 2 and 4), which represents approximately 10% of treated firms' average pre-shock (year 2000) cash ratios. That the estimated treatment effect is indifferent to whether or not controls are used and to the specific fixed effects that are employed can be viewed as validating the choice of matching variables and

[11] The full set of control variables is comprised of: Firm size, Leverage, MTB, Capex, R&D, Acquisition, Cash flow, Industry sigma, Firm age, Net working capital, Dividend dummy, Net equity issuance, Net debt issuance, Institutional turnover, Fluidity, Equity beta, Analyst coverage_res, Blocks, Non-blocks_res, and IPO2 to IPO5.

procedure in the previous subsection.

Robustness checks in Column 5 (event year dropped) and Column 6 (extended event window) shore up and strengthen the results from the first four columns. The DiD estimator is now 0.019 and 0.020, respectively, both statistically significant at the 1% level. In short, the regression DiD approach supports the view that enhanced stock liquidity has positive impact on cash holdings.

As before, to assess the validity of the exclusion restriction, we run placebo tests over placebo event windows that do not overlap with the actual decimalization event window. Placebo windows are also $[-2, +2]$. Thus, on the left, the placebo event year is 1996. On the right, the corresponding placebo event year is 2006. This means that the event window includes the financial crisis years of 2007 and 2008. Since the crisis arguably represents a large liquidity shock, this could compromise the placebo test on the right. Therefore, we run an additional placebo test with 2012 as the placebo year, which takes the event window away from the worst of the financial crisis period.

Insert Table 7 here.

The results are in Table 7. We run the same specifications as in Table 6, but do not consider the $[-3, +3]$ event window as this would overlap with the event window for the main test. Across all three placebo events and all specifications, the placebo DiD estimator is statistically insignificant from zero. For the placebo events 1996 and 2012, point estimates are also close to zero, never exceeding 0.007 in absolute value terms. For the placebo event 2006, where we may have some contamination from the crisis, point estimates are also small except for in Column 5, where it reaches 0.012, but still statistically insignificant. The placebo findings support that the exclusion restriction is satisfied and, therefore, the inference from Table 6 that stock liquidity affects cash holdings positively.

In the Internet Appendix (Table A4) we address concerns that our results may relate to the recession of 2001. The main issue is that recessions may differentially affect firms' abilities to finance operations or new investments because they face different degrees of financial constraints. This could be an omitted variable. While both the matching approach in Section 3.2 and the regression with industry-year fixed effects in this subsection should take care of this, we have also run the specification in Column 3 of Table 6 with several financial-constraint measures.[12] The results in Table A4 show that our findings are unaffected.

4. Mechanism behind the effect of stock liquidity on cash holdings

In this section, we examine the idea that the mechanism behind the effect of stock liquidity on cash holdings involves share buybacks. The main test is a difference-in-differences analysis centered on the SEC's adoption of Rule 10b-18 as a safe harbor for stock buybacks (Grullon and Michaely, 2002). This exogenous shock to repurchase activity is also used for identification by Hong, Wang, and Yu (2008).

4.1. Stock repurchases: SEC adoption of Rule 10b-18

In 1982, the SEC adopted Rule 10b-18, which is a guideline for firms with respect to share buybacks on the open market.[13] The rule provides a safe harbor for firms against charges of stock manipulation after share repurchases. Compliance requires firms to purchase all shares on the open market from a single broker or dealer on any single day, to purchase at a price not higher than the highest independent bid or the last sale price, to purchase no more than 25% of the average daily volume over the preceding four calendar weeks, and not to purchase during opening or the last thirty minutes before the closing of the market. Grullon and Michaely (2002) find that share repurchase activity increased significantly after the adoption of Rule 10b-18.

In this subsection, we carry out a DiD analysis based on the adoption of Rule 10b-18 to test whether firms with more liquid stock increase cash holdings relatively more when

[12]The financial-constraint measures are the following widely used dummy variables: (i) Small, which equals one if book assets are below the median in a year and zero otherwise, (ii) SAI, which equals one if a firm's size-and-age index (Hadlock and Pierce, 2010) is above the median in a year and zero otherwise, (iii) WWI, which equals one if a firm's Whited and Wu (2006) index is above the median in a year and zero otherwise, (iv) Bond rating, which equals one if a firm has a bond rating and zero otherwise (Whited, 1992; Denis and Sibilkov, 2010), and (v) Paper rating, which equals one if a firm has a commercial paper rating and zero otherwise (Almeida, Campello, and Weisbach, 2004). Ratings are from Compustat.

[13]Securities Exchange Act Release No. 19244 (November 17, 1982) and 47 Fed. Reg. 53333 (November 26, 1982).

constraints to share buybacks are eased. We would expect this to be the case if firms hold cash to repurchase shares, either to profit from undervaluations or to stabilize their stock prices, since firms with more liquid stock have lower trading costs and price impact. As in Section 3, for robustness, we employ both matching and regression techniques.

4.1.1. Matching approach

The analysis parallels that in Section 3.2. Treated firms are defined as those with the most liquid stocks in the closest pre-event year. Specifically, we define Treat_i, as being one for firms in the bottom tercile of ILLIQ_res in 1981 and zero otherwise (high-frequency data are not available at this time).

The outcome variable is the change in the Cash ratio from the end of 1981 to the end of 1983. The matched control group is picked based on the same matching variables and procedure as in Section 3. We continue to use the Abadie and Imbens (2011) bias-corrected matching estimator for the treatment effect on the treated group and Abadie and Imbens (2006) robust standard errors. Placebo tests are carried out on the first non-overlapping three-year windows on the left and the right.

Insert Tables 8 and 9 and Fig. 2 here.

Table 8 furnishes summary statistics on the matching variables for the treated and matched control firms in the pre-shock year, 1981. As seen, the marginal distributions of the individual variables in the two groups are similar.

To examine the parallel-trends condition, Fig. 2 graphs the mean Cash ratio for treated and control groups over the 1980 to 1983 period. The firms with more liquid stock hold more cash, but the two lines are visibly parallel until the event year.[14] Thus, the parallel-trends condition is satisfied.

With respect to the effect of Rule 10b-18 on cash holdings, Fig. 2 also indicates that treated firms increase cash holdings relatively more strongly after implementation of the rule. The formal test of the treatment effect is in Panel A, Table 9. The Abadie and Imbens (2011) bias-corrected matching estimator is positive and statistically significant

[14] A means test on the change in cash ratio for the treated and matched control groups from 1980 to 1981 has a t-statistic of -0.56 and a p-value of 0.57.

at the 5% level. The point estimate is 0.019, or 1.9 pps, which represents 17.4% of the treated firms' mean Cash ratio in 1981.[15]

Since Rule 10b-18 relates specifically to share repurchases, it is difficult to see a non-buyback explanation for our finding. However, as in Section 3.2, we also run placebo tests to assess the validity of the exclusion restriction. As seen in Panels B and C of Table 9, the placebo matching estimators have point estimates that are close to zero and not statistically significant at conventional levels.

Thus, the conclusion from the matching analysis around the adoption of Rule 10b-18 is that firms with relatively more liquid stock increase cash holdings relatively more when restraints on repurchases are relaxed. This supports the empirical relevance of the repurchase motive for holding cash and, in particular, that elevated stock liquidity strengthens this motive because of a larger potential gain from stock buybacks.

4.1.2. Regression approach

The DiD regressions are run on the same set of treated and matched control firms used in Section 4.1.1. The general specification is given by Eq. (5), and the baseline event window is $[-2, +2]$. Following the same structure as in Section 3.3, we estimate six versions of this. The first is without controls. The second adds the non-matching covariates as controls. The third and fourth use the full set of control variables, which now refers to all those discussed in Section 2.3 that are available over the event window.[16] The fifth drops the event year and the sixth expands the event window to $[-3, +3]$. All specifications are run with firm and year fixed effects, except the fourth, which has firm and industry×year fixed effects. Standard errors are clustered at the firm level.

Insert Table 10 here.

The results are reported in Table 10. The DiD estimator (the coefficient on Treat×Post)

[15]In the Internet Appendix (Table A5), we carry out a robustness check using a broader set of matching variables, which includes covariates such as Firm size. The point estimate for the treatment effect is unaffected and remains statistically significant at the 5% level.

[16] The full set of control variables is now: Firm size, Leverage, MTB, Capex, R&D, Acquisition, Cash flow, Industry sigma, Firm age, Net working capital, Dividend dummy, Net equity issuance, Net debt issuance, and IPO2 to IPO5.

is seen to be positive and statistically significant at conventional levels in all specifications. This is consistent with the result from the matching-estimator approach above that when repurchase rules are relaxed, firms with more liquid stocks subsequently experience abnormally large increases in cash holdings.

In the first four specifications, which all use the baseline $[-2, +2]$ event window, but different sets of controls and fixed effects, the DiD estimator is in a fairly tight range from 0.012 (Column 4) to 0.016 (Column 2). A treatment effect in the middle of this range of 0.014, or 1.4 pps, represents approximately 15% of treated firms' mean Cash ratio in the closest pre-shock year, 1981. The estimate of the treatment effect on the treated firms increases to 2.1 pps over the expanded $[-3, +3]$ event window (Column 6), which represents approximately 23% of pre-shock average cash holdings. Thus, the treatment effect is also economically significant.

Insert Table 11 here.

As in Section 3.3, we run placebo tests over non-overlapping five-year windows to the left and to the right. For each placebo event, we run the first five specifications discussed above, the version with the $[-3, +3]$ window being dropped. Results are in Table 11. As seen, none of the estimated placebo DiD estimators is statistically significantly different from zero. This supports that the exclusion restriction is satisfied.

In summary, the regression DiD analysis yields the same overall result as the matching analysis, namely that firms with more liquid stock have abnormally large increases in cash holdings after the adoption of Rule 10b-18. The results are quantitatively similar under the two approaches and economically meaningful. Since Rule 10b-18 eased constraints on stock buybacks, these findings support the empirical relevance of the repurchase motive for holding cash.

4.2. Repurchases, stock liquidity, and market-to-book

This subsection studies the relation between stock liquidity and repurchase activity further. The logic of the repurchase motive for holding cash suggests that this relation should be positive and enhanced for undervalued firms. Our specific analysis is motivated by the findings of Ikenberry, Lakonishok, and Vermaelen (1995) that announcements of open-market repurchase programs are followed by positive long-run abnormal returns. Excess returns are especially large for value firms (low MTB). Peyer and Vermaelen (2009) show that these patterns have persisted over time. Consistent with the implication that firms with low MTB can profit more from buying back undervalued stock, Dittmar (2000) finds that repurchase activity is negatively correlated with MTB. Thus, we expect to see stock liquidity being especially highly correlated with repurchase activity when MTB is low.

To investigate this, we divide the full sample of firm-years into high and low MTB based on yearly medians. We then estimate the following specification, as a tobit, on the high- and low-MTB subsamples:

$$\text{Rep}_{i,t} = \beta_0 + \beta_1 \text{Liquidity}_{i,t-1} + \boldsymbol{\Gamma}' \boldsymbol{Z}_{i,t-1} + \varepsilon_{i,t}, \tag{7}$$

where Rep is the ratio of repurchase amount over lagged market capitalization (repurchase ratio), and Liquidity is ILLIQ_res or Log_resprd_res. We use a tobit approach because share repurchases are bounded below by zero (and in a given year, there are many firms with zero repurchases). The coefficients of interest are the β_1's in the high- versus low-MTB subsamples.

The vector of control variables, $\boldsymbol{Z}$, is comprised of Firm size, MTB, Market-adjusted stock returns, Free cash flows, Return on equity (ROE), Industry-adjusted leverage, Non-operating profit, and Dividend (cash dividend). These variables largely follow Dittmar (2000) and capture different motives of stock buybacks, for example, market timing, excess capital distribution, and optimal leverage. Industry and year fixed effects are also included. Standard errors are clustered at the firm level.

Insert Table 12 here.

The tobit coefficients are in Table 12, Panel A.[17] In both subsamples, the coefficient on either liquidity measure is negative and statistically significant at conventional levels. Moreover, it is significantly larger (in absolute value) in the low-MTB subsample. The p-values of the coefficient equality test are 0.00 and 0.01 under ILLIQ_res and Log_resprd_res,

[17]See Table A6 in the Internet Appendix for coefficients on the controls.

respectively. In short, the relation between stock liquidity and repurchase activity is stronger for firms with low MTB. This supports the idea that firms with more liquid stock can profit relatively more from undervaluation through buybacks.

The tobit coefficients in Panel A combine the change in the probability of repurchasing shares and the change in the repurchase ratio conditional on repurchasing per unit change in stock liquidity (McDonald and Moffitt, 1980). Panel B decomposes the tobit coefficients into these two marginal effects. We report averages, keeping the values of the controls fixed at observed values. For ILLIQ_res as the liquidity measure, we find that the relation between stock liquidity and the repurchase ratio conditional on repurchases (the probability of repurchasing) is three and a half (two) times larger in the low-MTB subsample as compared with the high-MTB subsample. For Log_resprd_res, the estimated marginal effects are similar in the two subsamples. Overall, our findings support the hypothesis that stock liquidity has a bigger effect on the buyback activity of firms that potentially can gain more from repurchasing undervalued stock. In turn, this is consistent with the idea that the repurchase motive for holding cash is stronger for firms with more liquid stock.

5. Credit market access

The basic idea in this paper is that firms have an incentive to hold cash to repurchase shares if and when they are undervalued or under pressure. However, in principle, firms could also finance stock buybacks by issuing fresh debt or tapping credit lines. In this section, we address these two alternatives in turn.

5.1. New debt

The viability of financing repurchases of undervalued equity with fresh debt clearly depends on the extent to which a firm may be debt constrained. Thus, if issuing new debt is a relevant alternative, we would expect to see more debt-constrained firms responding more strongly, with respect to cash holdings, to improved stock liquidity. To investigate this, we expand on the regression approach in Section 3.3 around the introduction of tick-size decimalization and estimate the following triple-difference specification:

$$\begin{aligned} \text{Cash ratio}_{i,t} \;&=\; \beta_0 + \beta_1 \cdot \text{Treat}_i \times \text{Post}_t + \beta_2 \cdot \text{Post}_t + \beta_3 \cdot \text{Treat}_i + \lambda_1 \cdot \text{DC}_i \\ &\quad + \lambda_2 \cdot \text{DC}_i \times \text{Post}_t + \lambda_3 \cdot \text{DC}_i \times \text{Treat}_i \times \text{Post}_t + \mathbf{\Gamma}'\mathbf{Z}_{i,\tau(t)} + \varepsilon_{i,t}, \end{aligned} \tag{8}$$

where DC_i is an indicator variable for firms that are relatively highly debt constrained, the λ's are regression coefficients, and the rest of the notation is as for Eq. (5). We use the same sample of treated and matched control firms as in Section 3. Hence, we use decimalization to identify treated firms (in terms of receiving a relatively high improvement to stock liquidity), but expand the regression specification to include terms to test whether relatively debt-constrained firms react stronger to treatment. The coefficient of interest, the triple-difference estimator, is λ_3.

For robustness, we use four measures of debt constraints. The first two are Bond rating and Commercial paper rating (Whited, 1992; Almeida, Campello, and Weisbach, 2004; Faulkender and Wang, 2006; Denis and Sibilkov, 2010). For these measures, DC_i is 1 for firms without a rating in year $t = -1$ (year 2000) and zero otherwise. Ratings are from Compustat. The third is High leverage and the fourth is the Hoberg-Maksimovic (2015) text-based measure of debt constraints (Debt-focus delay). For these, DC_i is 1 for firms above the median in year $t = -1$ (year 2000) and zero otherwise.

The regression, Eq. (8), is estimated with OLS and the full set of control variables (see footnote 11) over a $[-2, +2]$ event window, as for the estimation of Eq. (5). Firm and year fixed effects are included and standard errors are clustered at the firm level. Results are in Table 13.

Insert Table 13 here.

In all four specifications, the basic DiD estimator (Treat×Post) is positive and statistically significant at conventional levels. So the qualitative results from Section 3 are robust to estimation in a triple-difference framework.

However, the main object of interest now, the triple-difference estimator (the coefficient on $\text{DC}_i \times \text{Treat}_i \times \text{Post}_t$), is statistically insignificant from zero at conventional levels for all debt-constraint measures. (The smallest p-value is 0.279, for the Hoberg and Maksimovic, 2015, measure.) Hence, there is no evidence that firms that are more debt constrained react more strongly, with respect to the cash ratio, to stock-liquidity improvements. In turn, this suggests that fresh debt is not a substitute for cash on hand when it comes to repurchasing undervalued stock.

The reason behind this result could be that debt tends to be undervalued when equity is, implying an excessive cost of debt (relative to the full-information cost). In this case, financing buybacks of undervalued stock using cash would be a better option. Theoretically, we cannot say that undervalued equity generically implies undervalued debt. From basic applications of the Merton (1974) model, or its binomial counterpart, we know that if information asymmetries between firms and markets are predominantly about first moments (the value of assets), misvaluation of debt moves in tandem with that of equity. On the other hand, if it is about volatility, debt is undervalued (overvalued) when equity is overvalued (undervalued). However, given the empirical negative average correlation between same-firm stock returns and bond yields (Kwan, 1996) and CDS spreads (Liu, Pu, and Zhao, 2015), it seems plausible that, in practice, equity and debt tend to comove with respect to misvaluations. Thus, a strategy of issuing fresh debt to buy undervalued stock in the future may be less attractive than financing such repurchases with cash on hand.

To take a closer look at the empirical importance of debt financing for repurchases, we check two simple cash-financing feasibility conditions. The first condition is:

$$\text{Cash}_{i,t-1} + \text{EBITDA}_{i,t} - \text{Interest}_{i,t} - \text{Tax}_{i,t} \geq \text{Payout}_{i,t}, \tag{9}$$

where Cash is cash holdings, Payout is total payout to equity (repurchases plus dividends), i and t are firm and year indicators, respectively, and the other terms are self explanatory. This condition checks whether cash at the beginning of the year is sufficient to cover total equity payouts over the year, given after-tax earnings.

The second condition is:

$$\text{Cash}_{i,t-1} + \text{EBITDA}_{i,t} - \text{Interest}_{i,t} - \text{Tax}_{i,t} - \max[\text{NI}_{i,t}, 0] \geq \text{Payout}_{i,t}, \tag{10}$$

where NI is net investments, that is,

$$\text{NI}_{i,t} = \text{Capex}_{i,t} + \Delta\text{WC}_{i,t} - A_t - (\text{EI}_{i,t} + \text{DI}_{i,t}), \tag{11}$$

where Capex is capital expenditures, ΔWC is change in working capital, A is asset sales, EI is gross equity issues, and DI is net debt issues. This condition tightens Eq. (9) by asking whether cash on hand from last year is sufficient to cover not only total payouts to equity but also net investments (if positive), again given after-tax earnings.

In our screened sample, for firm-years from 1983 to 2015 with repurchases,[18] the first condition is violated 6.28% of the time and the second condition 19.63%. Hence, new debt issues are rarely pivotal with respect to financing repurchases. This may be a contributing factor to our finding that highly debt-constrained firms do not increase cash holdings relatively more than other firms when stock liquidity improves.

Since these figures imply that cash at the beginning of the year plus after-tax earnings are, for the vast majority of firm-years, sufficient to cover repurchases, they also imply that credit lines are not vital with respect to financing repurchases. However, next, we look more closely into credit lines.

5.2. Credit lines

Tapping credit lines to buy back undervalued stock may be more attractive than issuing fresh debt since the funding terms have been negotiated in advance. Thus, positive comovement in the misvaluations of debt and equity may be viewed as less of a concern. However, firms may wish to refresh drawn lines, which will be on terms reflecting current conditions. Thus, drawing on credit lines to buy undervalued stock may suffer from a similar drawback to that of issuing fresh debt (misvaluation comovement with equity). In addition, as discussed in the Introduction, the opportunity to buy back undervalued stock may arise in states-of-the-world where there is an increased risk of credit-line covenant-violations, with terms being reset in firms' disfavor (Peyer and Vermaelen, 2009; Sufi, 2009). For these reasons, credit lines may be a relatively poor substitute for cash as regards buying back

[18] We take years from 1983, since repurchases grew in importance after the introduction of Rule 10b-18 in 1982.

stock that is undervalued or under pressure.

To examine this, we estimate the triple-difference specification Eq. (8) with the indicator variable DC_i replaced by an indicator variable, NL_i, which is one if firm i does not have a credit line in the year 2000 and zero otherwise. We use the same sample of treated firms and matched controls as in Section 3 and run specifications with different sets of controls and fixed effect, as in Section 3.3. The baseline estimation window is $[-2, +2]$, but we also run specifications without the event year and over an extended window of $[-3, +3]$. Standard errors are clustered at the firm level.

Credit-line data are from Sufi (2009), who provides a yearly credit-line indicator variable for Compustat firms.[19] In addition, we have manually collected credit-line information from 10-K filings on forty firms in our sample of treated and matched control firms that are missing in Sufi's sample for the year 2000. If credit lines are a substitute for cash with respect to repurchasing undervalued shares, we would expect to see a stronger treatment effect for firms without credit lines.

Insert Table 14 here.

The results in Table 14 parallel those in the previous subsection. In particular, the triple-difference estimator (the coefficient on $\mathrm{NL}_i \times \mathrm{Treat}_i \times \mathrm{Post}_t$) is statistically insignificant from zero at conventional levels in all specifications. There may be several reasons as to why a firm's cash-holding response to increased stock liquidity does not depend on whether or not it has access to a credit line. First, as shown above, fresh debt, including credit-line drawdowns, does not play a pivotal role with respect to financing stock repurchases. Cash on hand is typically sufficient. Second, the extant evidence suggests that misvaluations of debt and equity comove. This is relevant also for credit lines to the extent that firms seek to replace drawn lines. Third, unlike cash, credit lines are not fully committed financing, but may be renegotiated when covenants are violated (Sufi, 2009). Furthermore, as discussed above, covenant violations may occur exactly when profitable buyback opportunities arise, which would increase the cost of financing these with credit lines.

[19] The data are available on Amir Sufi's webpage, https://amirsufi.net/chronology.html.

6. Concluding remarks

The main point in this paper is that enhanced stock liquidity has a positive effect on corporate cash holdings. This is surprising because liquidity is typically thought of as reducing financial constraints. So if firms hold cash for precautionary reasons related to real investments, firms with more liquid stock, ceteris paribus, should hold less cash. Yet, empirically, they hold more cash.

The positive relation between stock liquidity and the cash ratio is robust in the data. We first see it in the correlations between size-orthogonalized stock-liquidity measures and the cash ratio. This carries over to panel regressions over different time periods and using large sets of control variables. Endogeneity concerns are addressed using matching and regression DiD approaches based on the introduction of tick-size decimalization in 2001. The result holds up and survives a wide range of robustness checks. In short, firms increase cash holdings when stock liquidity improves, ceteris paribus.

The second key point of the paper is an explanation for this finding. In particular, we propose that firms hold cash not only to invest in real assets but also for financial reasons, namely to buy back stock. They may do this to profit from undervalued equity or to stabilize their stock prices. That stock liquidity is positively related to cash holdings may be interpreted as implying that for stock liquidity, the repurchase motive for holding cash dominates the real investments motive. This resonates with Warusawitharana and Whited's (2016) conclusion that misvaluation affects financial policy more than investments. That is, stock liquidity matters more to firms with respect to taking advantage of, or dealing with, misvaluations than with respect to funding real investments.

As a third dimension to this paper, we have examined the plausibility of the repurchase motive for holding cash as an explanation for the finding that stock liquidity and cash holdings are positively related. Our approach uses the SEC's adoption of Rule 10b-18 in 1982, which eased regulatory constraints on stock repurchases, to construct a difference-in-differences test for the relative increase in cash holdings for firms with more liquid versus less liquid stock. Consistent with the logic of the repurchase motive for holding cash, we find that firms with more liquid stock increase their cash holdings significantly more.

We have also explored the repurchase motive further by examining the relation between stock liquidity and repurchase activity. In particular, we use panel regressions to document that there is a positive relation between stock liquidity and repurchase activity and that this is stronger for firms with stock that may be said to be relatively more undervalued. This supports the repurchase motive for holding cash.

Fourth, we also contribute to the literature on cash versus credit markets by running triple-difference tests that examine the impact of debt constraints and credit lines on firms' reactions, as regards cash holdings, to enhanced stock liquidity. The evidence shows that access to credit markets does not have a significant effect. This suggests, in particular, that cash and lines of credit are not close substitutes when it comes to buying back undervalued stock. While most theoretical insights regarding credit lines are from static models, a fuller understanding of our finding may require a dynamic setup where the benefits of tapping credit lines are traded off against costs of replacement. The double coincidence of financial covenant violations and profitable buyback opportunities after poor earnings releases, as suggested by the findings of Sufi (2009) and Peyer and Vermaelen (2009), may be another contributing factor to our finding. Investigating this further would be an interesting avenue for future research.

Overall, our paper contributes to the cash holding literature by documenting that stock liquidity has a positive influence on corporate cash holdings. As an explanation, we suggest that firms with more liquid stock are better able to take advantage of undervaluations or need more cash to reverse slides in stock prices, ceteris paribus. As far as we know, this is the first paper to emphasize the repurchase motive for holding cash. In future work, it may be interesting to disentangle the relative importance of motives for cash holdings that relate to real versus financial investments. This could potentially help shed light on variations in corporate cash holdings over time.

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Appendix: Definitions of variables

The names of variables in Compustat are shown in parentheses.

Variable	Data source	Description
Acquisition	Compustat	The ratio of acquisition expenditures (AQC) relative to total (book) assets (AT).
Analyst coverage	IBES	Take average of the number of estimates across months within a fiscal year. Then take logarithm of one plus the average. If a stock is not covered in IBES, set Analyst coverage to zero.
Blocks	Thomson Reuters (13f)	Total proportion of shares outstanding held by institutional investors with more than 5% of shares outstanding each.
Cash flow	Compustat	[EBITDA (OIBDP) − interest (XINT) − taxes (TXT) − common dividends (DVC)]/total assets (AT).
Capex	Compustat	The ratio of capital expenditures (CAPX) to the total assets (AT).
Cash ratio	Compustat	The ratio of cash and short-term investment (CHE) to total assets (AT).
Dividend	Compustat	The ratio of cash dividends to net income.
Dividend dummy	Compustat	Dummy equaling one if a firm paid common dividends (DVC) in that year and zero otherwise.
Equity beta	CRSP	Annual Scholes-Williams (1977) equity beta.
Fluidity	Hoberg and Phillips data library	Product market fluidity constructed by Hoberg, Phillips, Prabhala (2014) as a measure of competition in product market.

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Variable	Data source	Description
Firm age	CRSP	Calculate the number of months since a stock first appears in CRSP. Then take the logarithm of one plus the number of months.
Firm size	Compustat	Logarithm of total assets, where the total assets are deflated to 1962 dollars.
Free cash flow	Compustat	Operating income before depreciation minus interest expenses, preferred dividend, common dividend, and income taxes, plus deferred taxes, then divided by total assets.
H-M DFD	Hoberg and Maksimovic data library	Dummy equaling one if the Debt-Focus Delay score proposed by Hoberg and Maksimovic (2015) is above the median in a year and zero otherwise.
High leverage	Compustat	Dummy equaling one if a firm's leverage is above the median in a year and zero otherwise.
Industry sigma	Compustat	The industry (2-digit SIC codes) mean of firm-level Cash flow standard deviations over 10 years (at least 3 firm-year observations required). Follows the definition in Bates, Kahle, and Stulz (2009).
ILLIQ	CRSP	Adjusted version of Amihud's (2002) original illiquidity measure. See Eq. (2).

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Variable	Data source	Description
Inst_turn	Thomson Reuters (13f)	First, calculate institutional churn ratio following Yan and Zhang (2009): $\text{Churn ratio}_{k,t} = \frac{\min(\text{Churn\_buy}_{k,t}, \text{Churn\_sell}_{k,t})}{\sum_{i=1}^{N_k}(S_{k,i,t}P_{i,t} + S_{k,i,t-1}P_{i,t-1})/2}$, where N_k is the total number of stocks in the portfolio of institution k, $S_{k,i,t}$ is the number of shares of stock i held by institution k in quarter t, $P_{i,t}$ is the price of stock i in quarter t, $\text{Churn\_buy}_{k,t} = \sum_{i=1,\ S_{k,i,t}>S_{k,i,t-1}}^{N_k} \lvert S_{k,i,t}P_{i,t} - S_{k,i,t-1}P_{i,t-1} - S_{k,i,t-1}\Delta P_{i,t}\rvert$, $\text{Churn\_sell}_{k,t} = \sum_{i=1,\ S_{k,i,t}\leq S_{k,i,t-1}}^{N_k} \lvert S_{k,i,t}P_{i,t} - S_{k,i,t-1}P_{i,t-1} - S_{k,i,t-1}\Delta P_{i,t}\rvert$, $\Delta P_{i,t}$ is the change in price, $P_{i,t} - P_{i,t-1}$. Second, following Gaspar, Massa, and Matos (2005), Inst. turnover is calculated as $\sum_{k\in\mathcal{S}} w_{i,k,t}\left(\frac{1}{4}\sum_{r=1}^{4}\text{Churn Ratio}_{k,t-r+1}\right)$, where $\mathcal{S}$ is the set of institutional shareholders of stock i, and $w_{i,k,t}$ is the weight of investor k in the total percentage held by institutional investors in year-quarter t. Then an annual Inst_turn is calculated as the average across a year.

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Variable	Data source	Description
IPO2-IPO5	CRSP	Dummy variables equaling one if the difference between the year of the fiscal year-end and the year of the first occurrence in CRSP is two to five, respectively, and zero otherwise.
Leverage	Compustat	Total debt divided by total assets (AT), where total debt is long-term debt (DLTT) plus debt in current liabilities (DLC).
Leverage_IA	Compustat	Market leverage minus the median market leverage in the same industry (2-digit SIC). The market leverage is the total debt divided by market value of total assets, where total debt is long-term debt (DLTT) plus debt in current liabilities (DLC), and market value of total assets is the book value of assets (AT) minus the book value of common shareholders' equity (CEQ) plus the multiplication of common shares outstanding (CSHO) and stock price at fiscal year-end (PRCC_F).
Log_resprd	TAQ	Logarithm of relative effective bid-ask spread. Relative effective bid-ask spread is the difference between the execution price and the mid-point of the prevailing bid-ask quote divided by the mid-point of the prevailing bid-ask quote.
Market-adjusted return	CRSP	Annual cumulative stock return minus the annual cumulative CRSP value-weighted market return.
MTB	Compustat	[Total assets (AT) − book value of equity (CEQ) + market value of equity (PRCC_F× CSHO)]/total assets (AT).
Net debt issuance	Compustat	[Annual total debt issuance (DLTIS) − debt retirement (DLTR)]/total assets (AT).

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Variable	Data source	Description
Net equity issuance	Compustat	[Equity sales (SSTK)− equity purchases (PRSTKC)]/total assets (AT).
Net working capital	Compustat	[Net working capital (WCAP) − cash and short-term investment (CHE)]/total assets (AT)
Non-blocks	Thomson Reuters (13f)	Total proportion of shares outstanding held by institutional investors with less than 5% of shares outstanding each.
No-bond-rating	Compustat	Dummy equaling one if a firm does not have an S&P bond rating and zero otherwise.
No-paper-rating	Compustat	Dummy equaling one if a firm does not have an S&P commercial paper rating and zero otherwise.
NL	Sufi (2009) and 10K filings	Dummy equaling one if a firm does not have a line of credit in the year before the decimalization and zero otherwise.
Non-operating profit	Compustat	The ratio of nonoperating income (NOPI) to total assets (AT).
R&D	Compustat	The ratio of research and development expense (XRD) to total assets (AT). If XRD is missing then set R&D to zero.
Rep	Compustat	The ratio of dollar volume of repurchase to the market capitalization at the previous year-end. The repurchase is adjusted by the decrease in preferred stock.
ROE	Compustat	The ratio of net income (NI) to the book value of equity (SEQ).

Table 1

Descriptive statistics

This table displays summary statistics for the variables. *Panel A* is for the main variables. *Panel B* is for control variables. The column *Period* indicates the relevant sample period. The column *Unit* indicates the units of the corresponding variables (a blank in this column indicates that the variable is a digit, e.g. a ratio or a dummy). Observations are yearly. N denotes the number of firm-year observations. Variables (except dummies) are winsorized at the 1^{st} and 99^{th} percentiles. Definitions of the variables and the underlying data sources are provided in the Appendix.

Name	Period	Unit	Mean	Median	Std. Dev.	Std. Err.	Min.	Max.	N
Panel A: Main Variables									
Cash ratio	'64-'15		0.14	0.07	0.17	0.0005	0.00	0.79	98,323
	'71-'15		0.14	0.07	0.17	0.0006	0.00	0.79	92,371
	'81-'15		0.15	0.08	0.18	0.0006	0.00	0.79	78,432
	'98-'15		0.18	0.10	0.20	0.0010	0.00	0.79	39,512
ILLIQ	'64-'15	1/Million$	12.50	1.01	22.75	0.0726	0.25	71.90	98,323
	'71-'15	1/Million$	13.24	1.16	23.27	0.0766	0.25	71.90	92,371
	'81-'15	1/Million$	14.63	1.27	24.42	0.0872	0.25	71.90	78,432
	'98-'15	1/Million$	12.83	0.67	23.53	0.1184	0.25	71.90	39,512
Log_resprd	'98-'15		-5.68	-5.75	1.35	0.0068	-8.17	-2.85	39,160
Panel B: Control Variables									
Firm size	'64-'15	log(Million$)	3.67	3.58	1.94	0.0062	-0.40	8.49	98,323
Leverage	'64-'15		0.23	0.21	0.19	0.0006	0.00	0.78	98,323
MTB	'64-'15		1.63	1.29	1.04	0.0033	0.57	6.36	98,323
Firm age	'64-'15	log(month)	4.79	4.94	0.98	0.0031	2.08	6.47	98,323
Net working capital	'64-'15		0.14	0.14	0.19	0.0006	-0.34	0.58	98,078
Dividend dummy	'64-'15		0.43	0	0.50	0.0016	0	1	98,323
R&D	'64-'15		0.03	0.00	0.07	0.0002	0.00	0.36	98,323
Capex	'64-'15		0.06	0.05	0.06	0.0002	0.00	0.30	98,311
Cash flow	'64-'15		0.04	0.07	0.13	0.0004	-0.62	0.25	97,477
Industry sigma	'64-'15		0.07	0.06	0.05	0.0002	0.01	0.33	98,323
Equity beta	'64-'15		0.89	0.86	0.60	0.0019	-0.38	2.50	97,391
IPO2	'64-'15		0.06	0	0.23	0.0007	0	1	98,323
IPO3	'64-'15		0.05	0	0.22	0.0007	0	1	98,323
IPO4	'64-'15		0.05	0	0.22	0.0007	0	1	98,323
IPO5	'64-'15		0.05	0	0.21	0.0007	0	1	98,323
Net equity issuance	'71-'15		0.01	0.00	0.09	0.0003	-0.19	0.52	91,531
Net debt issuance	'71-'15		0.01	0.00	0.08	0.0003	-0.27	0.29	91,958
Acquisition	'71-'15		0.02	0.00	0.04	0.0001	0.00	0.24	91,981

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Name	Period	Unit	Mean	Median	Std. Dev.	Std. Err.	Min.	Max.	N
Analyst coverage	’81-’15		1.26	1.19	1.04	0.0037	0.00	3.40	77,080
Blocks	’81-’15		0.13	0.09	0.13	0.0005	0.00	0.53	75,892
Non-blocks	’81-’15		0.26	0.21	0.21	0.0008	0.00	0.76	75,892
Inst_turn	’81-’15		0.09	0.09	0.04	0.0001	0.02	0.22	76,374
Fluidity	’98-’15		6.51	6.06	3.03	0.0157	1.50	15.61	37,236

Table 2
Correlations

Pairwise correlations between selected variables. The sample period is from 1964 to 2015 for most variables, except Net equity issuance, Net debt issuance, and Acquisition (1971-2015); Inst_turn (1980-2015); Analyst coverage, Blocks, and Non-blocks (1981-2015); Log_resprd (1993-2015); and Fluidity (1997-2015). Correlations with these variables are calculated over their respective sample periods. Variables are winsorized at the 1^{st} and 99^{th} percentiles. Definitions of the variables and the underlying data sources are provided in the Appendix.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
(1) Cash ratio	1																					
(2) *ILLIQ*	0.01	1																				
(3) Log_resprd	0.01	0.65	1																			
(4) Firm size	-0.22	-0.57	-0.83	1																		
(5) Leverage	-0.43	0.01	-0.02	0.18	1																	
(6) MTB	0.35	-0.09	-0.21	-0.07	-0.21	1																
(7) Firm age	-0.12	-0.12	-0.29	0.37	-0.02	-0.13	1															
(8) Net working capital	-0.27	0.00	0.15	-0.12	-0.15	-0.18	0.05	1														
(9) Dividend dummy	-0.20	-0.31	-0.37	0.43	-0.05	-0.09	0.33	0.16	1													
(10) R&D	0.49	0.04	0.10	-0.23	-0.25	0.31	-0.10	-0.12	-0.25	1												
(11) Capex	-0.19	-0.10	-0.02	0.08	0.10	0.03	-0.10	-0.19	0.07	-0.14	1											
(12) Cash flow	-0.28	-0.16	-0.29	0.32	-0.04	-0.06	0.13	0.19	0.21	-0.43	0.17	1										
(13) Industry sigma	0.33	0.08	-0.11	-0.08	-0.13	0.25	0.01	-0.24	-0.27	0.37	-0.12	-0.18	1									
(14) Equity beta	0.05	-0.34	-0.42	0.28	0.03	0.11	0.02	-0.03	0.03	0.07	0.07	0.05	0.01	1								
(15) Net equity issuance	0.17	0.09	0.22	-0.24	-0.05	0.20	-0.27	-0.07	-0.18	0.23	0.04	-0.37	0.10	0.04	1							
(16) Net debt issuance	-0.04	-0.08	-0.08	0.08	0.17	0.00	0.01	0.02	0.06	-0.02	0.19	-0.03	0.00	0.03	-0.15	1						
(17) Acquisition	-0.08	-0.09	-0.15	0.13	0.07	0.03	0.00	-0.06	0.00	-0.03	-0.09	0.08	0.08	0.02	0.00	0.27	1					
(18) Analyst coverage	0.01	-0.52	-0.74	0.72	-0.03	0.18	0.22	-0.13	0.28	0.01	0.09	0.24	0.13	0.34	-0.15	0.08	0.12	1				
(19) Blocks	0.03	-0.25	-0.31	0.28	0.00	-0.03	0.09	-0.06	0.01	-0.01	-0.08	0.10	0.10	0.11	-0.11	0.00	0.08	0.22	1			
(20) Non-blocks	-0.01	-0.52	-0.86	0.75	-0.04	0.16	0.29	-0.13	0.28	-0.07	0.00	0.29	0.11	0.36	-0.19	0.06	0.17	0.72	0.34	1		
(21) Fluidity	0.27	-0.11	-0.04	0.00	-0.01	0.15	-0.24	-0.28	-0.24	0.30	0.09	-0.19	0.20	0.12	0.17	0.03	0.00	0.10	-0.01	0.03	1	
(22) Inst_turn	0.14	-0.14	-0.05	0.02	-0.04	0.12	-0.24	-0.09	-0.16	0.09	0.05	0.01	0.06	0.18	0.15	0.01	0.06	0.11	0.07	0.15	0.17	1

Table 3

Panel regressions of Cash ratio on liquidity measures and controls over different time periods

This table presents the results from panel regressions with the general specification Cash $\text{ratio}_{i,t} = \beta_0 + \beta_1 \text{Liquidity}_{i,t-1} + \mathbf{\Gamma}'\mathbf{Z}_{i,t} + \varepsilon_{i,t}$, where Liquidity is *ILLIQ*_res, *ILLIQ*, Log_resprd_res, or Log_resprd, $\boldsymbol{Z}$ is a vector of control variables, and $\mathbf{\Gamma}$ is a vector of coefficients. The sample period varies with the availability of Liquidity and control variables, as indicated in the top row. Industry (Fama-French 48 sectors) fixed effects and year fixed effects are included in Columns 1 to 10. Firm fixed effects and year fixed effects are included in Columns 11 and 12. The full sets of control variables over the respective subperiods are used, and coefficients are in Table A1 in the Internet Appendix. Variables (except dummies) are winsorized at the 1^{st} and 99^{th} percentiles. t-statistics are based on firm-clustered standard errors and displayed in parentheses. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c***, respectively. A * indicates that coefficients are multiplied by 100.

	1964-2015		1971-2015		1981-2015		1998-2015					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ILLIQ_res^*_{t-1}	$-0.087^{\boldsymbol{a}}$		$-0.085^{\boldsymbol{a}}$		$-0.064^{\boldsymbol{a}}$		$-0.064^{\boldsymbol{a}}$				$-0.043^{\boldsymbol{a}}$	
	(-15.33)		(-15.07)		(-10.53)		(-6.95)				(-5.13)	
$ILLIQ^*_{t-1}$		$-0.077^{\boldsymbol{a}}$		$-0.079^{\boldsymbol{a}}$		$-0.059^{\boldsymbol{a}}$		$-0.055^{\boldsymbol{a}}$				
		(-15.96)		(-16.29)		(-11.03)		(-6.88)				
$\text{Log\_resprd\_res}_{t-1}$									$-0.024^{\boldsymbol{a}}$			$-0.011^{\boldsymbol{a}}$
									(-9.00)			(-5.45)
Log_resprd_{t-1}										$-0.018^{\boldsymbol{a}}$		
										(-8.19)		
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Firm fixed effects	No	No	No	No	No	No	No	No	No	No	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	74,032	91,166	68,868	84,315	55,241	68,562	25,091	31,007	25,090	31,058	25,141	25,140
Adjusted R^2	0.476	0.489	0.492	0.502	0.501	0.513	0.552	0.564	0.552	0.563	0.211	0.210

Table 4

Descriptive statistics of matching variables in treated and matched control firms: Decimalization

This table displays summary statistics for the matching variables used to select matched control firms for the tick-size decimalization event. Panel A (B) is for treated (matched control) firms. Definitions of the variables and the underlying data sources are provided in the Appendix.

Variables	Mean	Median	Std. Dev.	Std. Err.	Min.	Max.	N
Panel A: Treated firms							
Cash flow	0.08	0.10	0.12	0.01	-0.89	0.35	346
Change in net working capital	0.00	0.00	0.07	0.00	-0.47	0.39	346
Capex	0.07	0.05	0.05	0.00	0.00	0.29	346
Acquisition	0.03	0.00	0.05	0.00	0.00	0.29	346
Net equity issuance	0.01	0.00	0.12	0.01	-0.42	0.97	346
Net debt issuance	0.01	0.00	0.07	0.00	-0.34	0.32	346
Panel B: Matched controls							
Cash flow	0.08	0.09	0.10	0.01	-0.60	0.35	346
Change in net working capital	0.00	0.00	0.06	0.00	-0.46	0.26	346
Capex	0.06	0.05	0.05	0.00	0.00	0.36	346
Acquisition	0.02	0.00	0.03	0.00	0.00	0.19	346
Net equity issuance	0.01	0.00	0.08	0.00	-0.16	0.72	346
Net debt issuance	0.00	0.00	0.05	0.00	-0.14	0.15	346

Table 5
Matching estimator for the DiD test using the introduction of tick-size decimalization in 2001

This table reports on the Abadie and Imbens (2011) bias-corrected matching estimator for the DiD analysis based on tick-size decimalization. Panel A is for the analysis based on the actual event in 2001. Panel B (C) is for the placebo test on the left (right) side of the actual event. We estimate the average treatment effect on treated firms by comparing changes (with the bias correction) in Cash ratio (ΔCash, the year after minus the year before the event) of treated and control firms. Firms whose stocks are in the top tercile by number of trades in the year before the event are classified as treated. Matched controls are picked from nontreated firms within the same industry (Fama-French twelve) with replacement using a nearest-neighbor approach and the Mahalanobis metric. The matching variables are: Cash flows, change in Net working capital, Capex, Acquisition, Net equity issuance, and Net debt issuance in the year before the event. Abadie and Imbens (2006) robust standard errors are used. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c***, respectively.

ΔCash	Coef.	Std. err.	z	$P > \|z\|$	[95% Conf.	Interval]
Panel A: Matching estimator (2000 vs. 2002)						
Treatment	0.024[a]	0.009	2.60	0.009	0.006	0.042
Panel B: Placebo test left to the actual event (1997 vs 1999)						
Treatment	0.009	0.007	1.29	0.197	-0.005	0.024
Panel C: Placebo test right to the actual event (2003 vs. 2005)						
Treatment	0.005	0.009	0.62	0.534	-0.012	0.022

Table 6

DiD regressions using the introduction of tick-size decimalization in 2001

This table reports the results from the following regression: Cash ratio$_{i,t}$ $= \beta_0 + \beta_1 \cdot \text{Treat}_i \times \text{Post}_t + \beta_2 \cdot \text{Post}_t + \mathbf{\Gamma}'\mathbf{Z}_{i,\tau(t)} + \varepsilon_{i,t}$, where i refers to firm i, t refers to year t, the dummy variable Treat equals 1 (0) for treated (control) firms using the same matched sample as in Table 5, the dummy variable Post equals 1 if a year is in or after the event year and 0 otherwise, $\mathbf{Z}_{i,\tau(t)}$ is a vector of control variables, $\tau(t)$ equals t in years before the event and -1 (the year before the event) in years in or after the event, and $\mathbf{\Gamma}$ is a vector of coefficients. Control variables in Columns 3-6 consist of the full set of control variables (listed in footnote 11). Controls in Column 2 consist of the same variables less those used in the matching process. The coefficient β_1 is the DiD estimator. The main event window is $[-2, +2]$. Firm fixed effects are included in all columns. Industry×Year fixed effects are included in Column 4. Year fixed effects are included in all columns except Column 4. Column 5 shows the robustness test in which the event year is dropped. Column 6 shows the robustness test in which an alternative window [-3,+3] is applied. t-statistics are based on firm-clustered standard errors and displayed in parentheses. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c***, respectively.

	(1) Cash	(2) Cash	(3) Cash	(4) Cash	(5) Cash	(6) Cash
Treat×Post	0.016***b***	0.015***b***	0.016***b***	0.015***b***	0.019***b***	0.020***a***
	(2.35)	(2.28)	(2.38)	(2.12)	(2.42)	(2.70)
Post	0.025***a***	0.034***a***	0.031***a***		0.029***a***	0.019***c***
	(3.88)	(4.17)	(3.80)		(3.35)	(1.95)
Controls	No	Partial	All	All	All	All
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	No	Yes	Yes
Industry×Year fixed effects	No	No	No	Yes	No	No
Observations	2,650	2,531	2,531	2,493	2,043	3,345
Adjusted R^2	0.061	0.070	0.103	0.887	0.120	0.123

Table 7

Placebo tests for the DiD regression analysis based on decimalization

This table reports the placebo tests for the DiD regressions based on the decimalization. The setting parallels that in Table 6 (except that Fluidity is not in the set of controls as it is missing for the first placebo event). Panel A (B, C) shows the results for the placebo event year 1996 (2006, 2012). The event window is $[-2, +2]$. Column 5 shows the robustness test in which the event year is dropped. t-statistics are based on firm-clustered standard errors and displayed in parentheses. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c***, respectively.

	(1) Cash	(2) Cash	(3) Cash	(4) Cash	(5) Cash
Panel A: placebo year 1996					
Treat×Post	-0.004	-0.005	-0.006	-0.005	-0.007
	(-0.70)	(-0.90)	(-1.13)	(-0.87)	(-1.11)
Post	-0.005	0.001	-0.006		-0.004
	(-0.92)	(0.17)	(-0.97)		(-0.68)
Controls	No	Partial	All	All	All
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	No	Yes
Industry×Year fixed effects	No	No	No	Yes	No
Observations	3,685	3,667	3,667	3,651	2,951
Adjusted R^2	0.001	0.022	0.135	0.852	0.144

Continued on next page

Table 7 – continued from previous page

Panel B: placebo year 2006					
Treat×Post	-0.001	0.004	0.007	0.004	0.012
	(-0.10)	(0.55)	(1.04)	(0.61)	(1.57)
Post	-0.025[a]	-0.021[a]	-0.018[b]		-0.021[b]
	(-3.74)	(-2.73)	(-2.35)		(-2.56)
Controls	No	Partial	All	All	All
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	No	Yes
Industry×Year fixed effects	No	No	No	Yes	No
Observations	2,950	2,792	2,792	2,762	2,248
Adjusted R^2	0.023	0.049	0.209	0.889	0.190
Panel C: placebo year 2012					
Treat×Post	-0.000	0.003	0.004	0.001	0.003
	(-0.07)	(0.43)	(0.62)	(0.11)	(0.45)
Post	-0.019[a]	-0.010	-0.006		-0.005
	(-3.44)	(-1.34)	(-0.87)		(-0.64)
Controls	No	Partial	All	All	All
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	No	Yes
Industry×Year fixed effects	No	No	No	Yes	No
Observations	3,084	2,896	2,896	2,802	2,317
Adjusted R^2	0.014	0.028	0.112	0.874	0.123

Table 8

Descriptive statistics of matching variables in treated and matched control firms: Rule 10b-18

This table displays summary statistics for the matching variables used to select matched control firms for the Rule 10b-18 event. Panel A (B) is for treated (matched control) firms. Definitions of the variables and the underlying data sources are provided in the Appendix.

Variables	Mean	Median	Std. Dev.	Std. Err.	Min.	Max.	N
Panel A: Treated firms							
Cash flow	0.06	0.07	0.06	0.00	-0.29	0.23	232
Change in net working capital	-0.01	-0.01	0.07	0.00	-0.21	0.23	232
Capex	0.08	0.05	0.07	0.00	0.01	0.40	232
Acquisition	0.01	0.00	0.02	0.00	0.00	0.17	232
Net equity issuance	0.01	0.00	0.04	0.00	-0.21	0.22	232
Net debt issuance	0.01	0.00	0.08	0.01	-0.27	0.32	232
Panel B: Matched controls							
Cash flow	0.06	0.07	0.04	0.00	-0.13	0.26	232
Change in net working capital	-0.01	-0.01	0.05	0.00	-0.17	0.19	232
Capex	0.08	0.06	0.06	0.00	0.01	0.41	232
Acquisition	0.00	0.00	0.01	0.00	0.00	0.09	232
Net equity issuance	0.01	0.00	0.02	0.00	-0.05	0.13	232
Net debt issuance	0.01	0.00	0.05	0.00	-0.22	0.25	232

Table 9

Matching estimator for the DiD tests using the adoption of SEC Rule 10b-18 in 1982

This table reports on the Abadie and Imbens (2011) bias-corrected matching estimator for the DiD analysis based on the adoption of SEC Rule 10b-18. Panel A is for the analysis based on the actual event in 1982. Panel B (C) is for the placebo test on the left (right) side of the actual event. We estimate the average treatment effect on treated firms by comparing changes (with the bias correction) in Cash ratio (ΔCash, the year after minus the year before the event) of treated and control firms. Firms with ILLIQ_res in the top tercile the year before the event are classified as treated. Matched controls are picked from nontreated firms within the same industry (Fama-French twelve) with replacement using a nearest-neighbor approach and the Mahalanobis metric. The matching variables are: Cash flows, change in Net working capital, Capex, Acquisition, Net equity issuance, and Net debt issuance in the year before the event. Abadie and Imbens (2006) robust standard errors are used. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c***, respectively.

ΔCash	Coef.	Std. err.	z	$P > \|z\|$	[95% Conf.	Interval]
Panel A: Matching estimator (1981 vs. 1983)						
Treatment	0.019$^{\boldsymbol{b}}$	0.009	2.10	0.036	0.001	0.037
Panel B: Placebo test left to the actual event (1978 vs. 1980)						
Treatment	0.001	0.007	0.14	0.886	-0.013	0.015
Panel C: Placebo test right to the actual event (1984 vs. 1986)						
Treatment	-0.007	0.009	-0.71	0.479	-0.025	0.012

Table 10

DiD regressions using the adoption of SEC Rule 10b-18 in 1982

This table reports the results from the following regression: Cash $\text{ratio}_{i,t} = \beta_0 + \beta_1 \cdot \text{Treat}_i \times \text{Post}_t + \beta_2 \cdot \text{Post}_t + \mathbf{\Gamma}'\mathbf{Z}_{i,\tau(t)} + \varepsilon_{i,t}$, where i refers to firm i, t refers to year t, the dummy variable Treat equals 1 (0) for treated (control) firms using the same matched sample as in Table 5, the dummy variable Post equals 1 if a year is in or after the event year and 0 otherwise, $\mathbf{Z}_{i,\tau(t)}$ is a vector of control variables, $\tau(t)$ equals t in years before the event and -1 (the year before the event) in years in or after the event, and $\mathbf{\Gamma}$ is a vector of coefficients. Control variables in Columns 3-6 consist of the full set of available control variables (listed in footnote 16). Controls in Column 2 consist of the same variables less those used in the matching process. The coefficient β_1 is the DiD estimator. The main event window is $[-2, +2]$. Firm fixed effects are included in all columns. Industry×Year fixed effects are included in Column 4. Year fixed effects are included in all columns except Column 4. Column 5 shows the robustness test in which the event year is dropped. Column 6 shows the robustness test in which an alternative window [-3,+3] is applied. t-statistics are based on firm-clustered standard errors and displayed in parentheses. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c***, respectively.

	(1) Cash	(2) Cash	(3) Cash	(4) Cash	(5) Cash	(6) Cash
Treat×Post	0.014^{b}	0.016^{b}	0.013^{b}	0.012^{c}	0.016^{b}	0.021^{a}
	(2.05)	(2.27)	(2.05)	(1.84)	(2.09)	(3.18)
Post	0.015^{a}	0.014	-0.009		-0.015	-0.019
	(2.81)	(0.95)	(-0.69)		(-1.05)	(-1.43)
Controls	No	Partial	All	All	All	All
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	No	Yes	Yes
Industry×Year fixed effects	No	No	No	Yes	No	No
Observations	1,854	1,854	1,854	1,837	1,467	2,479
Adjusted R^2	0.064	0.070	0.238	0.767	0.265	0.267

Table 11

Placebo tests for DiD regressions based on the adoption of SEC Rule 10b-18

This table reports the placebo tests for the DiD regressions based on the adoption of SEC Rule 10b-18. The setting parallels that in Table 10. Panel A (B) shows the results for the placebo event year 1977 (1987). The event window is $[-2, +2]$. Column 5 shows the robustness test in which the event year is dropped. t-statistics are based on firm-clustered standard errors and displayed in parentheses. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c***, respectively.

	(1) Cash	(2) Cash	(3) Cash	(4) Cash	(5) Cash
Panel A: event year 1977					
Treat×Post	0.004	0.005	0.007	0.006	0.007
	(0.88)	(1.13)	(1.51)	(1.36)	(1.51)
Post	-0.011$^{\boldsymbol{a}}$	-0.010	-0.013$^{\boldsymbol{b}}$		-0.013$^{\boldsymbol{b}}$
	(-2.71)	(-1.45)	(-2.05)		(-2.05)
Observations	2,473	2,470	2,470	2,464	2,470
Adjusted R^2	0.015	0.023	0.228	0.763	0.228
Panel B: event year 1987					
Treat×Post	-0.000	0.001	0.002	0.007	0.002
	(-0.06)	(0.16)	(0.23)	(0.92)	(0.23)
Post	-0.013$^{\boldsymbol{c}}$	0.002	-0.007		-0.007
	(-1.87)	(0.19)	(-0.77)		(-0.77)
Observations	2,526	2,515	2,515	2,487	2,515
Adjusted R^2	0.014	0.030	0.160	0.829	0.160
Controls	No	Partial	All	All	All
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	No	Yes
Industry×Year fixed effects	No	No	No	Yes	No

Table 12

Repurchases, stock liquidity, and market-to-book ratio

This table presents results from the following tobit model: $\text{Rep}_{i,t} = \beta_0 + \beta_1 \text{Liquidity}_{i,t-1} + \mathbf{\Gamma}'\mathbf{Z}_{i,t-1} + \varepsilon_{i,t}$, where Liquidity is ILLIQ_res, or Log_resprd_res, $\mathbf{Z}$ is a vector of control variables (see the text), and $\mathbf{\Gamma}$ is a vector of coefficients. Panel A reports the tobit coefficients and Panel B reports the average marginal effects of the stock illiquidity measures for the two components: i) the repurchase ratio conditional on repurchasing, and ii) the probability of repurchases. We calculate average marginal effects with observed values on the control variables. Industry (Fama-French, 48 sectors) fixed effects and year fixed effects are controlled. The sample period is from 1972 (1994) to 2015 for tests using ILLIQ_res (Log_resprd_res). The label Low (High) MTB is for the sub-sample with MTB below (above) median in a year. *p-value* is for the equality test of the stock illiquidity coefficients in the two sub-samples. t (z)-statistics in parentheses of Panel A (B) are based on firm-clustered standard errors (standard errors using the delta method). Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c***, respectively. A * indicates that coefficients are multiplied by 100.

Panel A: tobit regressions	Low MTB	High MTB	Low MTB	High MTB
	(1)	(2)	(3)	(4)
ILLIQ_res*	-0.027[a]	-0.008[c]		
	(-5.26)	(-1.89)		
Log_resprd_res			-0.014[a]	-0.010[a]
			(-8.42)	(-8.87)
Controls	Yes	Yes	Yes	Yes
p-value	*0.00*		*0.01*	
N	31,044	30,257	17,267	16,936

Panel B: Marginal effects		Conditional on rep.	Probability of rep.
Illiq_res*	Low MTB	-0.007[a]	-0.105[a]
		(-5.26)	(-5.28)
	High MTB	-0.002[c]	-0.049[c]
		(-1.89)	(-1.89)
Log_resprd_res	Low MTB	-0.004[a]	-0.072[a]
		(-8.50)	(-8.74)
	High MTB	-0.004[a]	-0.076[a]
		(-8.83)	(-8.90)

Table 13

Debt constraints and the effect of stock liquidity on cash holdings

This table reports the results from the following triple-difference specification: Cash $\text{ratio}_{i,t} = \beta_0 + \beta_1 \cdot \text{Treat}_i \times \text{Post}_t \times \text{DC}_{i,-1} + \beta_2 \cdot \text{Treat}_i \times \text{Post}_t + \mathbf{\Gamma}'\mathbf{Z}_{i,\tau(t)} + \varepsilon_{i,t}$, where i refers to firm i, t refers to year t, the dummy variable Treat equals 1 (0) for treated (control) firms using the same matched sample as in Table 5, the dummy variable Post equals 1 if a year is in or after the decimalization year and 0 otherwise, DC stands for debt-constraint measures with the value in the year before decimalization, including No-bond-rating (No-paper-rating) [dummy equaling 1 if a firm does not have a bond (commercial paper) rating and 0 otherwise, ratings from Compustat], High leverage (dummy equaling 1 if a firm's leverage is above the median in a year and 0 otherwise), and H-M DFD [dummy equaling 1 if the Debt-Focus Delay score (Hoberg and Maksimovic, 2015) is above the median in a year and 0 otherwise], $\mathbf{Z}_{i,\tau(t)}$ is a vector of control variables (listed in footnote 11), $\tau(t)$ equals t in years before decimalization and -1 (the year before decimalization) in years in or after decimalization, and $\mathbf{\Gamma}$ is a vector of coefficients. The event window is $[-2, +2]$. Firm fixed effects and year fixed effects are included. t-statistics are based on firm-clustered standard errors and displayed in parentheses. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c***, respectively.

	(1)	(2)	(3)	(4)
Dependent variable	Cash	Cash	Cash	Cash
Debt constraint (DC)	No-bond-rating	No-paper-rating	High leverage	H-M DFD
Treat×Post×DC	0.005	-0.001	-0.007	-0.016
	(0.32)	(-0.08)	(-0.53)	(-1.08)
Treat×Post	0.017^{b}	0.019^{b}	0.021^{c}	0.032^{a}
	(2.08)	(2.19)	(1.71)	(2.83)
Post×DC	0.005	0.003	0.002	0.029^{a}
	(0.47)	(0.37)	(0.15)	(2.66)
Post	0.028^{a}	0.025^{a}	0.027^{b}	0.003
	(2.78)	(2.82)	(2.38)	(0.29)
Controls	All	All	All	All
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	2,140	2,436	2,436	1,992
Adjusted R^2	0.122	0.103	0.107	0.118

Table 14

Bank lines of credit and the effect of stock liquidity on cash holdings

This table reports the results from the following triple-difference specification: Cash $\text{ratio}_{i,t} = \beta_0 + \beta_1 \cdot \text{Treat}_i \times \text{Post}_t \times \text{NL}_{i,-1} + \beta_2 \cdot \text{Treat}_i \times \text{Post}_t + \mathbf{\Gamma}'\mathbf{Z}_{i,\tau(t)} + \varepsilon_{i,t}$, where i refers to firm i, t refers to year t, the dummy variable Treat equals 1 (0) for treated (control) firms using the same matched sample as in Table 5, the dummy variable Post equals 1 if a year is in or after the decimalization year and 0 otherwise, NL is a dummy variable that equals 1 if a firm does not have a line of credit in the year prior to decimalization and 0 otherwise, $\mathbf{Z}_{i,\tau(t)}$ is a vector of control variables (listed in footnote 11), $\tau(t)$ equals t in years before decimalization and -1 (the year before decimalization) in years in or after decimalization, and $\mathbf{\Gamma}$ is a vector of coefficients. The event window is $[-2, +2]$. Firm fixed effects and year fixed effects are included. t-statistics are based on firm-clustered standard errors and displayed in parentheses. Statistical significance at the 1%, 5% and 10% level is indicated by $\boldsymbol{a}$, $\boldsymbol{b}$, and $\boldsymbol{c}$, respectively.

	(1) Cash	(2) Cash	(3) Cash	(4) Cash	(5) Cash	(6) Cash
Treat×Post×NL	0.030	0.031	0.029	0.004	0.029	0.017
	(1.01)	(1.10)	(1.00)	(0.15)	(0.90)	(0.57)
Treat×Post	$0.013^{\boldsymbol{c}}$	$0.012^{\boldsymbol{c}}$	$0.013^{\boldsymbol{c}}$	$0.013^{\boldsymbol{c}}$	$0.016^{\boldsymbol{b}}$	$0.018^{\boldsymbol{b}}$
	(1.94)	(1.76)	(1.89)	(1.89)	(2.01)	(2.43)
Post×NL	$-0.047^{\boldsymbol{b}}$	$-0.047^{\boldsymbol{b}}$	$-0.045^{\boldsymbol{b}}$	$-0.040^{\boldsymbol{c}}$	$-0.054^{\boldsymbol{b}}$	-0.034
	(-1.98)	(-2.12)	(-2.00)	(-1.80)	(-2.11)	(-1.52)
Post	$0.030^{\boldsymbol{a}}$	$0.038^{\boldsymbol{a}}$	$0.035^{\boldsymbol{a}}$		$0.033^{\boldsymbol{a}}$	$0.022^{\boldsymbol{b}}$
	(4.79)	(4.50)	(4.12)		(3.68)	(2.20)
Controls	No	Partial	All	All	All	All
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry x year fixed effects	No	No	No	yes	No	No
Year fixed effects	Yes	Yes	Yes	No	Yes	Yes
Observations	2,650	2,531	2,531	2,493	2,043	3,345
Adjusted R-squared	0.068	0.077	0.109	0.888	0.130	0.126

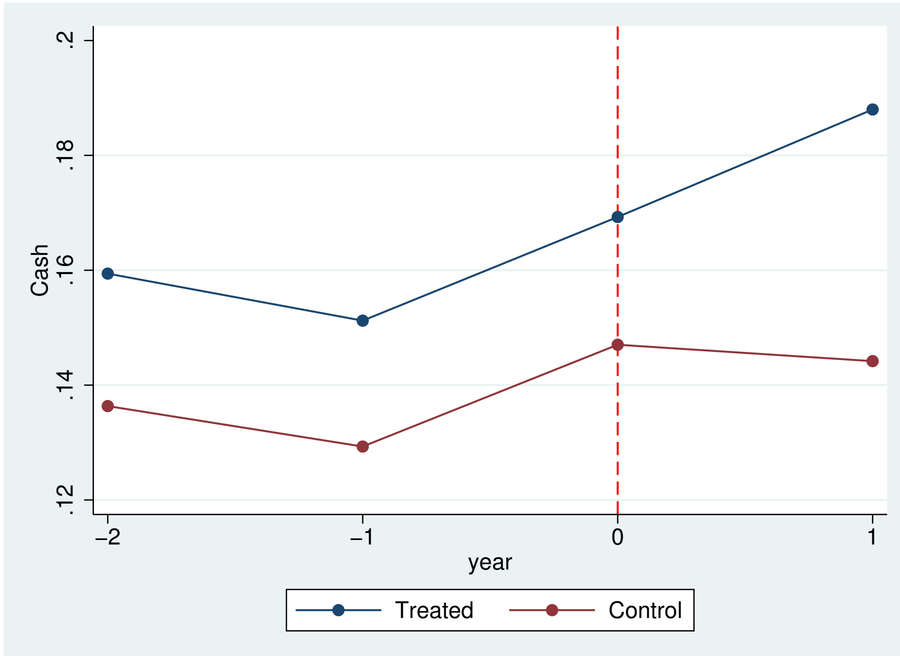

Fig. 1. Parallel trends, tick-size decimalization. Cash ratio trends for treated and matched control firms around the introduction of tick-size decimalization in 2001. Firms whose stocks are in the top tercile by number of trades in the year before the event are classified as treated. Matched controls are picked from nontreated firms within the same industry (Fama-French twelve) with replacement using a nearest-neighbor approach and the Mahalanobis metric. The matching variables are: Cash flows, change in Net working capital, Capex, Acquisition, Net equity issuance, and Net debt issuance in the year before the event. The y-axis plots the average Cash ratio of treated and control firms. The blue (red) line is for the treated (control) group. The x-axis shows the year relative to the event year (year 0 as indicated by the vertical red dashed line).

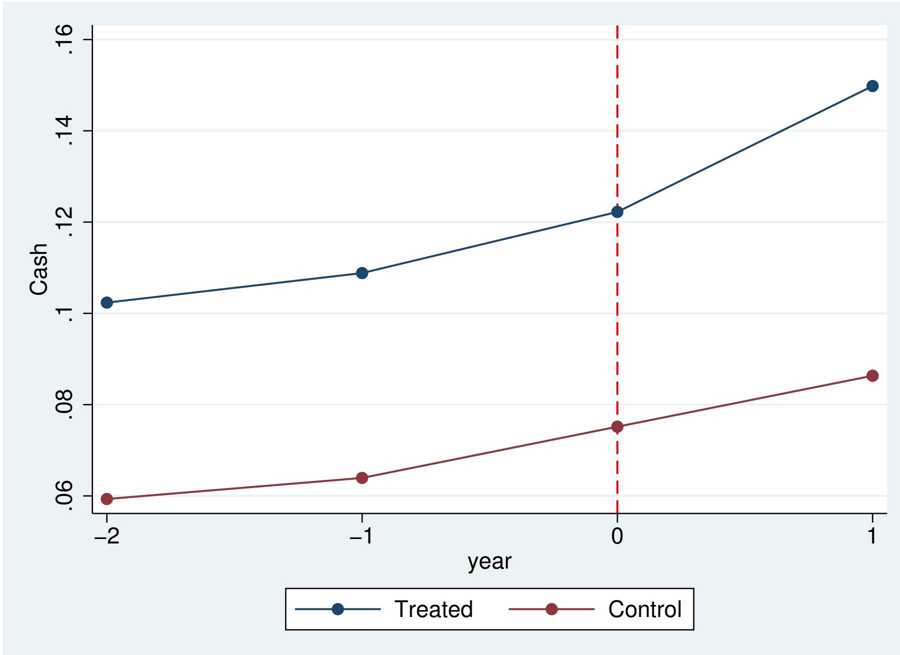

Fig. 2. Parallel trends, Rule 10b-18. Cash ratio trends for treated and matched control firms around the adoption of Rule 10b-18 in 1982. Firms with ILLIQ_res in the top tercile the year before the event are classified as treated. Matched controls are picked from nontreated firms within the same industry (Fama-French twelve) with replacement using a nearest-neighbor approach and the Mahalanobis metric. The matching variables are: Cash flows, change in Net working capital, Capex, Acquisition, Net equity issuance, and Net debt issuance in the year before the event. The y-axis plots the average Cash ratio of treated and control firms. The blue (red) line is for the treated (control) group. The x-axis shows the year relative to the event year (year 0 as indicated by the vertical red dashed line).

Internet Appendix

The effect of stock liquidity on cash holdings: The repurchase motive[1]

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Table A1

Panel regressions of Cash ratio on liquidity measures and controls over different time periods (with coefficients on control variables)

This table presents the results from panel regressions with the general specification Cash ratio$_{i,t} = \beta_0 + \beta_1$Liquidity$_{i,t-1} + \mathbf{\Gamma}'\mathbf{Z}_{i,t} + \varepsilon_{i,t}$, where Liquidity is *ILLIQ*_res, *ILLIQ*, Log_resprd_res, or Log_resprd, $\boldsymbol{Z}$ is a vector of control variables, and $\mathbf{\Gamma}$ is a vector of coefficients. The sample period varies with the availability of Liquidity and control variables, as indicated in the top row. Industry (Fama-French 48 sectors) fixed effects and year fixed effects are included in Columns 1 to 10. Firm fixed effects and year fixed effects are included in Columns 11 and 12. Variables (except dummies) are winsorized at the 1^{st} and 99^{th} percentiles. t-statistics are based on firm-clustered standard errors and displayed in parentheses. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c*** respectively. A * indicates that coefficients are multiplied by 100.

	1964-2015		1971-2015		1981-2015		1998-2015					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ILLIQ_res$^{*}_{t-1}$	-0.087^{a}		-0.085^{a}		-0.064^{a}		-0.064^{a}				-0.043^{a}	
	(-15.33)		(-15.07)		(-10.53)		(-6.95)				(-5.13)	
ILLIQ$^{*}_{t-1}$		-0.077^{a}		-0.079^{a}		-0.059^{a}		-0.055^{a}				
		(-15.96)		(-16.29)		(-11.03)		(-6.88)				
Log_resprd_res$_{t-1}$									-0.024^{a}			-0.011^{a}
									(-9.00)			(-5.45)
Log_resprd$_{t-1}$										-0.018^{a}		
										(-8.19)		
Firm size	-0.009^{a}	-0.013^{a}	-0.009^{a}	-0.013^{a}	-0.011^{a}	-0.013^{a}	-0.011^{a}	-0.015^{a}	-0.012^{a}	-0.020^{a}	-0.012^{a}	-0.012^{a}
	(-14.17)	(-18.58)	(-12.87)	(-17.45)	(-13.24)	(-15.81)	(-9.82)	(-11.72)	(-9.98)	(-13.13)	(-3.07)	(-3.10)
Leverage	-0.292^{a}	-0.300^{a}	-0.308^{a}	-0.317^{a}	-0.316^{a}	-0.323^{a}	-0.300^{a}	-0.305^{a}	-0.295^{a}	-0.302^{a}	-0.202^{a}	-0.200^{a}
	(-45.13)	(-50.81)	(-45.29)	(-50.66)	(-42.07)	(-47.09)	(-29.84)	(-32.99)	(-29.26)	(-32.56)	(-16.46)	(-16.31)
MTB	0.018^{a}	0.019^{a}	0.017^{a}	0.017^{a}	0.016^{a}	0.015^{a}	0.016^{a}	0.016^{a}	0.014^{a}	0.015^{a}	0.008^{a}	0.007^{a}
	(14.60)	(16.84)	(13.44)	(15.09)	(11.24)	(12.41)	(9.23)	(10.27)	(8.28)	(9.75)	(4.75)	(4.65)
Industry sigma	0.174^{a}	0.201^{a}	0.173^{a}	0.194^{a}	0.164^{a}	0.177^{a}	0.083^{a}	0.086^{a}	0.082^{a}	0.084^{a}	0.027	0.028
	(7.23)	(8.41)	(6.91)	(7.86)	(6.02)	(6.71)	(2.74)	(2.96)	(2.69)	(2.87)	(1.18)	(1.21)
Net Work. Cap.	-0.276^{a}	-0.269^{a}	-0.299^{a}	-0.290^{a}	-0.309^{a}	-0.300^{a}	-0.315^{a}	-0.305^{a}	-0.312^{a}	-0.302^{a}	-0.311^{a}	-0.310^{a}
	(-37.26)	(-38.79)	(-38.24)	(-39.76)	(-35.87)	(-37.29)	(-25.92)	(-26.75)	(-25.67)	(-26.52)	(-21.15)	(-21.00)
R&D	0.484^{a}	0.499^{a}	0.467^{a}	0.480^{a}	0.432^{a}	0.438^{a}	0.488^{a}	0.474^{a}	0.488^{a}	0.475^{a}	-0.246^{a}	-0.253^{a}
	(17.74)	(20.71)	(16.93)	(19.66)	(15.17)	(17.51)	(12.62)	(13.88)	(12.61)	(13.87)	(-4.35)	(-4.46)
Capex	-0.449^{a}	-0.417^{a}	-0.589^{a}	-0.550^{a}	-0.638^{a}	-0.600^{a}	-0.691^{a}	-0.648^{a}	-0.694^{a}	-0.649^{a}	-0.508^{a}	-0.511^{a}
	(-28.06)	(-28.84)	(-32.94)	(-33.90)	(-32.33)	(-33.81)	(-23.37)	(-23.91)	(-23.49)	(-24.01)	(-18.33)	(-18.49)
Div. dummy	-0.009^{a}	-0.013^{a}	-0.010^{a}	-0.014^{a}	-0.007^{b}	-0.009^{a}	-0.008^{b}	-0.007^{c}	-0.010^{b}	-0.009^{b}	0.005	0.005
	(-3.95)	(-5.88)	(-4.09)	(-5.89)	(-2.45)	(-3.25)	(-2.09)	(-1.92)	(-2.55)	(-2.36)	(1.40)	(1.22)
Cash flow	-0.057^{a}	-0.066^{a}	-0.012	-0.020^{b}	-0.024^{b}	-0.033^{a}	-0.033^{b}	-0.044^{a}	-0.033^{b}	-0.040^{a}	0.021	0.019
	(-5.82)	(-7.86)	(-1.21)	(-2.36)	(-2.27)	(-3.66)	(-2.15)	(-3.37)	(-2.19)	(-3.04)	(1.47)	(1.34)
Acquisition			-0.453^{a}	-0.439^{a}	-0.477^{a}	-0.464^{a}	-0.562^{a}	-0.547^{a}	-0.567^{a}	-0.542^{a}	-0.422^{a}	-0.424^{a}
			(-30.99)	(-32.69)	(-31.03)	(-32.92)	(-27.23)	(-28.57)	(-27.30)	(-28.45)	(-28.22)	(-28.26)

Continued on next page

Table A1 – continued from previous page

	1964-2015		1971-2015		1981-2015		1998-2015					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Net equity issu.			0.063^a	0.061^a	0.053^a	0.048^a	0.030	0.029^c	0.041^b	0.044^a	0.132^a	0.135^a
			(4.84)	(5.83)	(3.94)	(4.42)	(1.50)	(1.78)	(2.10)	(2.70)	(8.45)	(8.69)
Net debt issu.			0.261^a	0.245^a	0.275^a	0.254^a	0.309^a	0.284^a	0.297^a	0.282^a	0.244^a	0.241^a
			(29.03)	(29.50)	(27.79)	(27.84)	(20.66)	(20.19)	(19.99)	(20.07)	(19.59)	(19.41)
Firm age					-0.005^b	-0.009^a	-0.001	-0.006^a	-0.002	-0.007^a	-0.016^a	-0.018^a
					(-2.57)	(-6.09)	(-0.40)	(-2.67)	(-0.70)	(-2.99)	(-3.39)	(-3.89)
Equity beta					0.006^a	0.008^a	0.010^a	0.013^a	0.012^a	0.015^a	0.002	0.003
					(3.85)	(6.03)	(4.18)	(5.91)	(4.81)	(6.60)	(1.35)	(1.58)
Analyst coverage_res					0.004^a	0.006^a	0.006^a	0.009^a	0.003	0.007^a	0.002	0.001
					(2.71)	(4.17)	(2.61)	(4.24)	(1.34)	(3.10)	(0.77)	(0.54)
Blocks					0.037^a	0.045^a	0.050^a	0.057^a	0.055^a	0.065^a	0.034^a	0.030^b
					(4.11)	(5.27)	(4.29)	(5.26)	(4.79)	(6.05)	(2.84)	(2.50)
Non-blocks_res					0.033^a	0.031^a	0.057^a	0.056^a	0.030^b	0.035^a	0.076^a	0.066^a
					(3.72)	(3.65)	(4.78)	(5.01)	(2.44)	(3.09)	(6.72)	(5.79)
Inst_turn					0.193^a	0.190^a	0.222^a	0.201^a	0.280^a	0.264^a	0.139^a	0.164^a
					(6.63)	(7.24)	(4.47)	(4.43)	(5.60)	(5.79)	(3.43)	(4.08)
Fluidity							0.004^a	0.005^a	0.004^a	0.005^a	0.000	0.000
							(6.22)	(7.42)	(6.38)	(7.55)	(0.78)	(0.80)
IPO2			0.012^a	0.017^a	0.007^c	0.003	0.022^a	0.015^a	0.024^a	0.016^a	0.011^b	0.011^b
			(4.49)	(7.18)	(1.68)	(1.05)	(3.44)	(2.86)	(3.74)	(2.97)	(2.06)	(2.06)
IPO3			0.007^a	0.006^a	0.003	-0.005^c	0.011^b	0.000	0.012^b	-0.000	0.009^c	0.008^c
			(3.01)	(2.80)	(0.78)	(-1.92)	(2.06)	(0.06)	(2.18)	(-0.04)	(1.86)	(1.78)
IPO4			0.003	0.003	-0.001	-0.006^b	0.006	-0.001	0.006	-0.002	0.001	0.001
			(1.26)	(1.50)	(-0.35)	(-2.34)	(1.30)	(-0.18)	(1.29)	(-0.35)	(0.33)	(0.26)
IPO5			0.003	-0.000	0.000	-0.008^a	0.006	-0.002	0.006	-0.002	-0.001	-0.002
			(1.48)	(-0.03)	(0.10)	(-3.34)	(1.30)	(-0.46)	(1.34)	(-0.58)	(-0.44)	(-0.51)
Observations	74,032	91,166	68,868	84,315	55,241	68,562	25,091	31,007	25,090	31,058	25,141	25,140
Adjusted R^2	0.476	0.489	0.492	0.502	0.501	0.513	0.552	0.564	0.552	0.563	0.211	0.210

Table A2

The effect on cash holding of different variables: our paper vs. the literature

This table reports the signs of the regression coefficients in this paper as compared with the literature. The column labelled "Sign Us" lists the signs of coefficients in Column 9 of Table A1; the column labelled "Sign Lit." provides the signs in the relevant literature. NS stands for not significant at conventional levels (10% or better). The symbol + (−) indicates that the coefficient is positive (negative) and statistically significant at least at the 10% level.

Variable	Sign Us	Sign Lit.	Literature
Panel A: in the extant literature and this paper			
Firm size	−	−	Opler, Pinkowitz, Stulz, and Williamson (1999), Bates, Kahle, and Stulz (2009)
Leverage	−	−	Opler, Pinkowitz, Stulz, and Williamson (1999), Bates, Kahle, and Stulz (2009)
MTB	+	+	Opler, Pinkowitz, Stulz, and Williamson (1999), Bates, Kahle, and Stulz (2009)
Industry sigma	+	+	Opler, Pinkowitz, Stulz, and Williamson (1999), Bates, Kahle, and Stulz (2009), Han and Qiu (2007)
Net working capital	−	−	Opler, Pinkowitz, Stulz, and Williamson (1999), Bates, Kahle, and Stulz (2009)
R&D	+	+	Opler, Pinkowitz, Stulz, and Williamson (1999), Bates, Kahle, and Stulz (2009), Brown and Petersen (2011)
Capex	−	−	Opler, Pinkowitz, Stulz, and Williamson (1999), Bates, Kahle, and Stulz (2009)
Acquisition	−	−	Opler, Pinkowitz, Stulz, and Williamson (1999), Bates, Kahle, and Stulz (2009)
Dividend dummy	−	−	Opler, Pinkowitz, Stulz, and Williamson (1999), Bates, Kahle, and Stulz (2009)
Cash flow	NS	mixed	Opler, Pinkowitz, Stulz, and Williamson (1999), Bates, Kahle, and Stulz (2009), Riddick and Whited (2009)
Net equity issuance	+	+	Bates, Kahle, and Stulz (2009), McLean (2011)
Net debt issuance	+	+	Bates, Kahle, and Stulz (2009)
IPO2	+	+	Bates, Kahle, and Stulz (2009)
IPO3	NS	+	Bates, Kahle, and Stulz (2009)
IPO4	NS	+	Bates, Kahle, and Stulz (2009)
IPO5	NS	+	Bates, Kahle, and Stulz (2009)
Inst_turn	+	+	Brown, Chen and Shekhar (2011)
Fluidity	+	+	Hoberg, Phillips, and Prabhala (2014), Morellec, Nikolov, and Zucchi (2013)
Analyst coverage	+	+	Chang (2012)
Panel B: in this paper			
Stock liquidity	+		
Firm age	−		
Equity beta	+		
Blocks	+		
Non-blocks_res	+		

Table A3

Robustness tests using alternative matching variables: matching estimator for the DiD analysis based on tick-size decimalization in 2001

This table reports on the Abadie and Imbens (2011) bias-corrected matching estimator for the DiD analysis based on tick-size decimalization with an alternative set of matching variables. We estimate the average treatment effect on treated firms by comparing changes (with the bias correction) in Cash ratio (ΔCash, the year after minus the year before the event) of treated and control firms. Firms whose stocks are in the top tercile by number of trades in the year before the event are classified as treated. Matched controls are picked from nontreated firms within the same industry (Fama-French twelve) with replacement using a nearest-neighbor approach and the Mahalanobis metric. The matching variables are: Cash flows, change in Net working capital, Capex, Acquisition, Net equity issuance, Net debt issuance, Firm size, Leverage, Firm age, R&D, Inst_turn, Fluidity, Analyst coverage_res, Blocks, and Non-blocks_res in the year before the event. Abadie and Imbens (2006) robust standard errors are used. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c***, respectively.

ΔCash	Coef.	Std. err.	z	$P > \|z\|$	[95% Conf.	Interval]
Treatment	0.028[b]	0.011	2.54	0.011	0.006	0.049

Table A4
Decimalization DiD tests controlling for financial constraints

This table presents the DiD regressions for tick-size decimalization controlling for financial constraints. The specification is as follows: Cash ratio$_{it} = \beta_0 + \beta_1 \cdot \text{Treat}_i \times \text{Post}_t + \beta_2 \cdot \text{Post}_t + \mathbf{\Gamma}'\mathbf{Z}_{i,\tau(t)} + \varepsilon_{i,t}$, where i refers to firm i, t refers to year t, the dummy variable Treat equals 1 (0) for treated (control) firms using the matched sample as in the matching estimator, the dummy variable Post equals 1 if a year is in or after the event year and 0 otherwise, $\mathbf{Z}_{i,\tau(t)}$ is a vector of control variables (as in Table 6), $\tau(t)$ equals t in years before the event and -1 (the year before the event) in years in or after the event, $\mathbf{\Gamma}$ is a vector of coefficients. The coefficient β_1 is the DiD estimator. Financial constraint is measured by widely used dummy variables: i) Small, which equals one if book assets are below the median in a year and zero otherwise, ii) SAI, which equals one if a firm's size-and-age index (Hadlock and Pierce, 2010) is above the median in a year and zero otherwise, iii) WWI, which equals one if a firm's Whited and Wu index (Whited and Wu, 2006) is above the median in a year and zero otherwise, iv) Bond rating, which equals one if a firm does not have a rating and zero otherwise (Whited, 1992; Denis and Sibilkov, 2010), and v) Paper rating, which equals one if a firm does not have a commercial paper rating and zero otherwise (Almeida, Campello, and Weisbach, 2004). Ratings data is from Compustat. The event window is $[-2, +2]$. Firm and year fixed effects are included in all columns. t-statistics are based on firm-clustered standard errors and displayed in parentheses. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c***, respectively.

	(1) Cash	(2) Cash	(3) Cash	(4) Cash	(5) Cash
Treat×Post	0.016$^{\boldsymbol{b}}$	0.016$^{\boldsymbol{b}}$	0.016$^{\boldsymbol{b}}$	0.016$^{\boldsymbol{b}}$	0.015$^{\boldsymbol{b}}$
	(2.38)	(2.38)	(2.38)	(2.30)	(2.18)
Post	0.031$^{\boldsymbol{a}}$	0.031$^{\boldsymbol{a}}$	0.031$^{\boldsymbol{a}}$	0.034$^{\boldsymbol{a}}$	0.034$^{\boldsymbol{a}}$
	(3.81)	(3.83)	(3.73)	(4.15)	(4.22)
Fin. constr. dummy	Small	SAI	WWI	Bond rating	Paper rating
Controls	All	All	All	All	All
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	2,531	2,531	2,531	2,215	2,196
Adjusted R^2	0.102	0.102	0.102	0.122	0.122

Table A5

Robustness tests using alternative matching variables: matching estimator for the DiD analysis based on the adoption of SEC Rule 10b-18 in 1982

This table reports the matching estimator for the DiD analysis based on the the adoption of SEC Rule 10b-18. The matching estimator estimates the average treatment effect on treated firms by comparing changes in Cash ratio (ΔCash, the year after minus the year before the event) of treated and control firms. The treated (control) firms are those with ILLIQ_res below (above) the bottom tercile in the year before the event, i.e. with relatively lower (higher) trading costs. Nearest-neighbor matching pairs the closest match by the Mahalanobis distance metric. The matching with replacement is across Cash flows, change in Net working capital, Capex, Acquisition, Net equity issuance, Net debt issuance, Firm size, Leverage, Firm age, and R&D in the year before the decimalization and a matched pair is required to be in the same industry (Fama-French 12). Robust heteroskedastic errors are allowed and bias is adjusted using the matching variables. Statistical significance at the 5% level is indicated by ***b***.

ΔCash	Coef.	Std. err.	z	$P > \|z\|$	[95% Conf.	Interval]
Treatment	0.019$^{\boldsymbol{b}}$	0.010	1.97	0.048	0.000	0.038

Table A6

Repurchases, stock liquidity, and market-to-book ratio (showing coefficients of control variables)

This table presents results from the following tobit model: $\text{Rep}_{i,t} = \beta_0 + \beta_1 \text{Liquidity}_{i,t-1} + \mathbf{\Gamma}'\mathbf{Z}_{i,t-1} + \varepsilon_{i,t}$, where Liquidity is ILLIQ_res, or Log_resprd_res, $\mathbf{Z}$ is a vector of control variables, and $\mathbf{\Gamma}$ is a vector of coefficients. The lower bound of Rep is zero. Industry (Fama-French, 48 sectors) fixed effects and year fixed effects are controlled. The sample period is from 1972 (1994) to 2015 for tests using ILLIQ_res (Log_resprd_res). The label Low (High) MTB is for the sub-sample with MTB below (above) median in a year. *p-value* is for the equality test of the stock illiquidity coefficients in the two sub-samples. t (z)-statistics in parentheses are based on firm-clustered standard errors. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c***, respectively. A * indicates that coefficients are multiplied by 100.

Tobit regressions	Low MTB	High MTB	Low MTB	High MTB
	(1)	(2)	(3)	(4)
ILLIQ_res*	-0.027^{a}	-0.008^{c}		
	(-5.26)	(-1.89)		
Log_resprd_res			-0.014^{a}	-0.010^{a}
			(-8.42)	(-8.87)
MTB	-0.010^{b}	-0.004^{a}	-0.007^{c}	-0.005^{a}
	(-2.18)	(-8.30)	(-1.76)	(-9.08)
Free cash flow	0.148^{a}	0.114^{a}	0.100^{a}	0.103^{a}
	(11.96)	(15.84)	(8.82)	(13.26)
ROE	0.009^{a}	0.004^{a}	0.005^{b}	0.004^{a}
	(4.02)	(3.69)	(2.50)	(3.25)
Firm size	0.007^{a}	0.007^{a}	0.008^{a}	0.008^{a}
	(12.70)	(18.48)	(14.38)	(21.32)
Leverage, industry adjusted	-0.070^{a}	-0.021^{a}	-0.051^{a}	-0.041^{a}
	(-11.69)	(-3.99)	(-8.50)	(-6.51)
Non-operating profit	0.429^{a}	0.391^{a}	0.299^{a}	0.347^{a}
	(7.94)	(9.89)	(5.13)	(7.60)
Stock return, market adjusted	0.005^{a}	-0.006^{a}	0.003^{c}	-0.005^{a}
	(3.16)	(-7.63)	(1.92)	(-5.47)
Dividend	-0.000	0.003^{b}	0.001	0.001
	(-0.02)	(2.46)	(0.93)	(0.86)
p-value	*0.00*		*0.01*	
N	31,044	30,257	17,267	16,936

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