Stock Liquidity and Corporate Cash Holdings: Feedback and the Cash as Ammunition Hypothesis[1]

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Abstract

Stock Liquidity and Corporate Cash Holdings: Feedback and the Cash as Ammunition Hypothesis

We advance the feedback/cash as ammunition hypothesis, namely that firms hold cash to address feedback from stock prices to cash flows and growth opportunities. Firms with more liquid stocks are expected to hold more cash, the opposite of the prediction from a standard information asymmetry perspective on stock liquidity. The effect should be amplified by growth opportunities. These and other predictions are supported in the data. We use the introduction of tick-size decimalization as a natural experiment where liquidity is exogenously shocked. The evidence also suggests that cash holdings and stock liquidity are mutually reinforcing. As predicted by theory, stock liquidity is affected by factors relating to information asymmetry, inventory risks, and transaction costs.

Keywords: Corporate cash holdings, Stock liquidity, Feedback

JEL: G12, G32

1 Introduction

US corporations hold substantial fractions of their assets as cash. Our own calculations show that in 2010, the average cash ratio for industrials was 21.2%.[1] Firms with more volatile cash flows and smaller size hold relatively more cash (Opler, Pinkowitz, Stulz and Williamson, 1999). As emphasized especially by Bates, Kahle and Stulz (2009), if we think of smaller firms as being characterized by larger information asymmetries between insiders and investors, this is consistent with the theoretical perspective of Myers and Majluf (1984) that firms have an incentive to hold cash for precautionary reasons, in particular, to hedge against the event that the arrival of, or optimal time to execute, positive NPV projects coincide with an excessive cost of external capital. We think of Myers and Majluf's perspective as the classical precautionary motive for a corporation to hold cash, and empirical support is provided by numerous other studies (e.g., 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). In this paper, we advance a complementary idea; namely that firms also hold cash to address feedback from stock prices to cash flows and growth opportunities. We argue that this perspective can be empirically separated from the classical precautionary motive, by looking at the relation between stock liquidity and cash holdings, and find support for the feedback idea in the data.

We start by outlining the feedback argument. As articulated by Subrahmanyam and Titman (2001), a firm's stock price can affect stakeholders' perceptions of the firm and its products and thereby stakeholders' firm-relevant actions. In turn, this affects cash flows and the value of growth opportunities (see also Hirshleifer, Subrahmanyam, and Titman, 2006). For example, as a firm's stock price falls, demand for its products may fall and it may also become increasingly difficult to attract or retain talent. Subrahmanyam and Titman show that this may lead to vicious circles (or cascades) of falling stock prices and reduced stakeholder involvement in the firm, for example reduced product demand. This expands on Titman's (1984) hypothesis that firms in or near to financial distress experience a reduction in demand for their products, which has received recent empirical support by Hortacsu, Matvos, Syverson, and Venkataraman (2013). Fang, Noe, and Tice (2009) also find evidence consistent with feedback. This idea is also present in the popular press. For example, Subrahmanyam and Titman cite a Wall Street Journal article by McGough

[1] Calculated from Compustat, excluding financials and utilities. For cash ratios over time, see Bates, Kahle, and Stulz (2009).

(2000) that argues that "the stock price can become a competitive weapon." More recently, an article on Slate.com entitled "Why does a company care if its stocks [*sic*] loses value?" by Palmer (2011) points out that falling stock prices can "undermine employee retention."[2] This is echoed in an article on CNBC.com in 2013 that reports that[3]

> Apple just can't seem to make anyone happy these days. Investors continue to shy away from the stock, which dipped below $400 on Monday ... But investors aren't the only ones running away from Apple. The company is beginning to have an employee retention problem that could pose a serious threat if it's not resolved soon, said Trip Chowdry, an analyst at Global Equities. "The stock price cannot be turned around if Apple can't attract people," Chowdry told CNBC.

Our incremental idea is that feedback loops between stock prices and stakeholder actions create an incentive for firms to hold cash to fight value-reducing feedback (or stimulate value-enhancing feedback). We refer to this as the cash as ammunition hypothesis.

We examine the feedback/cash as ammunition hypothesis by focusing on the impact on corporate cash holdings of three stock, or firm, characteristics; namely stock liquidity, short term institutional ownership (institutional turnover), and product market competition. We discuss these in turn, starting with stock liquidity which is our main variable.

To see the fundamental link between stock liquidity and the feedback/cash as ammunition hypothesis consider, for example, the case that a firm is experiencing downward pressure on its stock price and that without action by the firm, the stock price will slide enough to trigger value-reducing feedback. The most direct way to mitigate this situation is to reduce the downward pressure in the stock market by repurchasing shares. This relates to Peyer and Vermaelen (2009)'s conclusion that "... open market repurchases are a response to a market overreaction to bad news..." Grullon and Michaely (2002) report that the vast majority of US firms have share repurchase programs in place. As an example, Apple announced almost a doubling of its share repurchase program to USD 100 billion in the spring of 2013 after its stock price had fallen substantially over several months. The link between stock liquidity and cash holdings arises because, ceteris paribus, it takes more cash to support a liquid stock through repurchases than an

[2] www.slate.com/articles/news_and_politics/explainer/2011/08/watch_out_for_falling_stock_prices.html.
[3] "Apple needs to treat employees 'like gods': Analyst," CNBC.com, 25 June 2013, www.cnbc.com/id/100839163.

illiquid one, since the impact on returns for a given volume is smaller for more liquid stocks. In other words, dealing with feedback requires more cash the more liquid is the company's stock.[4]

Firms can also address feedback through means other than stock buybacks, for example through advertising and promotions such as cash rebates or by increasing dividends, actions that are less directly linked to stock liquidity. In the example above, Apple also announced a 15% dividend increase. In equilibrium, we would expect the marginal net benefit to dealing with feedback to be equated across different approaches. Thus, with respect to feedback and stock liquidity, we would expect that firms with more liquid stocks hold more cash.

This prediction can also be derived through a slightly modified logic that does not rely on the possibility of feedback. To see this, note first that firms have an incentive to buy back undervalued shares, as Peyer and Vermaelen argue they do, even if there is no risk of value reducing feedback. This is because repurchasing undervalued stock benefits long-term shareholders, including management. The potential to benefit from this is arguably larger for firms with more liquid stocks as these can buy back more of their undervalued stock without pushing the price back up to its fair value. Indeed, Brockman, Howe, and Mortal (2008) document that share repurchases are used relatively more heavily by firms with more liquid stock. Such firms therefore have an incentive to hold relatively more cash in order to take advantage of undervalued stock, even in the absence of feedback.

The feedback argument, however, has an additional, central implication. As shown by Subrahmanyam and Titman (2001), the impact of feedback is increasing in the potential for growth. Thus, the feedback/cash as ammunition hypothesis predicts not only that stock liquidity has a positive impact on cash holdings, but also that this impact is larger for firms with larger growth opportunities.

Because it can be viewed as a gauge of information asymmetry, stock liquidity also relates to the classical precautionary motive for holding cash. The market microstructure literature shows that the liquidity of a firm's stock is inversely related to the degree of information asymmetries among market participants (Bagehot, 1971; Glosten and Milgrom, 1985; and Kyle, 1985). Thus, using the logic in Grossman and Stiglitz (1980), we would expect a relatively high degree of in-

[4]Liquid stocks are, by definition, relatively cheap to trade. This may make them more susceptible to herding, for example from informational cascades (Bikhchandani, Hirshleifer, and Welch, 1992; Welch, 1992) or trading frenzies (Goldstein, Ozdenoren, and Yuan, 2013). In turn, this might increase the probability of feedback and enhance the incentive for firms with more liquid stock to hold more cash.

formation asymmetry to be associated with relatively large costs of information acquisition. In turn, this suggests that stock illiquidity is associated with a relatively large degree of information asymmetry between insiders and investors as well, implying a potentially large adverse selection problem with respect to outside financing (Myers and Majluf, 1984). In other words, firms with less liquid stocks are potentially more "financially constrained"; they face potentially larger excessive costs of external financing and would therefore be expected to hold more cash. This effect would be expected to be especially pronounced for firms with large growth opportunities. These predictions are the opposite of the implications of the cash as ammunition hypothesis outlined above. However, the argument here centers around information asymmetry rather than liquidity, as such. In our analysis, we try to isolate pure, or non-informational, liquidity effects by including standard measures of price-informativeness such as firm size and price-nonsynchronicity (Roll, 1988; Durnev, Morck, and Yeung, 2004) as controls and for the most part orthogonalizing our liquidity measures to size.

We expect that a firm's susceptibility to feedback is also related to the churn rate of its investors, as this may affect, for example, the likelihood of herding and large order imbalances. In particular, we expect firms with institutional investors that tend to rebalance portfolios more frequently to be more susceptible to feedback and therefore hold more cash. As a measure of short term investors, we use the institutional turnover measure of Gaspar, Massa, and Matos (2005), which is standard in the literature. The prediction is that a higher institutional turnover is associated with larger cash holdings, and the more so the larger are the firm's growth opportunities.

Feedback should also be more relevant for firms that face more intense product market competition, since increased competition is tantamount to more consumer choice and thus makes it easier for consumers to shift to alternative products. Employees may have more choice as well. To quote further from the CNBC.com article cited above "...there is a growing number of Apple employees who see the declining stock price as a sign to jump ship. The Apple workers are instead taking jobs at Google, LinkedIn, Facebook, and even Hewlett-Packard." Under the feedback/cash as ammunition hypothesis, we expect to see firms in more competitive industries holding more cash, and that this effect is magnified for firms with larger growth opportunities. Because the severity of feedback would be expected to be stronger for firms that face more competition, we also expect the impact of liquidity on cash holdings to be increasing in the degree of competition. The main competition measure we use in our analysis is Hoberg, Phillips, and Prabhala's (2014) product market fluidity. With respect to cash holdings and competition, our paper complements their's by also studying the interaction between liquidity and competition.

Our empirical analysis is divided into three parts. First, we run panel regressions of US industrial firms' cash ratios on lagged measures of stock liquidity, institutional turnover, fluidity, 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 also use industry and year fixed effects throughout and carry out robustness checks using firm fixed effects to address a potential omitted variables problem. 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). These regressions are run over several different time periods, determined by the availability of the variables. Regardless of which time period, stock liquidity measure, or set of control variables we use, we find that firms' cash ratios are increasing in stock liquidity, institutional turnover, and fluidity. Furthermore, growth opportunities, as measured by R&D expenditures or market to book ratios, amplify these effects. Thus, the evidence from the regression analysis is supportive of the cash as ammunition hypothesis.

Second, to address the possibility of reverse causality or a simultaneity bias in the panel regressions, we use a difference in difference methodology to test the effects on cash holding from an exogenous shock to liquidity. In particular, 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 a natural experiment where liquidity is exogenously shocked. As in Fang et al., we construct a test using the insight that decimalization improves liquidity especially for more actively traded stocks (Bessembinder, 2003; Furfine, 2003). Stocks are classified based on their trading activity ex ante, i.e., the year prior to decimalization. Robustness is examined through the use of placebo years, industry fixed effects, and controls for financial constraints. The latter two controls are motivated by 2001 also experiencing the dot-com crash and a recession. Our findings are consistent with the feedback/cash as ammunition hypothesis that firms hold more cash as the liquidity of their stocks increase.

Third, for an alternative approach to dealing with the possibility of simultaneity with respect to cash holdings and stock liquidity, we estimate a simultaneous equation system focusing on these two variables using two stage least squares (2SLS). While there are well known issues with this approach (see e.g. Roberts and Whited, 2012), the findings are once again supportive of the feedback/cash as ammunition hypothesis. We also find evidence consistent with the extant finding of Gopalan, Kadan, and Pevzner (2012) that larger cash holdings improve stock liquidity. In short, our results support the proposition that cash holdings and stock liquidity are jointly determined, with each variable having a positive impact on the other.

Our results from the simultaneous equation estimation also contribute to the literature on stock liquidity. The results are consistent with the theoretical ideas that stock liquidity is affected by information asymmetry, as discussed above, inventory risks (e.g., Garman, 1976; Ho and Stoll, 1981), and transaction costs (Amihud and Mendelson, 1986). This helps clarify why there is no contradiction between our findings on the relation between stock liquidity and cash holdings and the classical precautionary motive for holding cash. We also find a positive relation between stock liquidity and share repurchases.

The rest of the paper is organized as follows: Section 2 describes the data and the variables. Section 3 contains the panel regressions. Section 4 contains the difference in difference analysis around the start of tick-size decimalization. Section 5 contains the simultaneous equation estimation, and Section 6 concludes. An appendix contains detailed descriptions of all variables, including the datasources from which they are culled.

2 Data, variables, and descriptive statistics

Most of the variables we use are collected from the CRSP/Compustat merged database (CCM), 1963-2010 inclusive. 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 US$ 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. Stock liquidity measures are used with a lag of one year, making the effective maximum sample period 1964-2010, over which we have 92,169 firm-year observations. Non-CCM 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 brackets].

2.1 Liquidity measures

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*,[5] originally defined as

$$\mathit{ILLIQ\_}\text{Amihud}_{i,t} = \frac{1}{N_i}\sum_{d=1}^{N_i}\frac{|r_{i,t,d}|}{\mathit{DVol}_{i,t,d}},$$

where $r_{i,t,d}$ is stock i's rate of return on day d in year t, $\mathit{DVol}_{i,t,d}$ is the corresponding dollar volume (in USD millions), and N_i 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 values, and bound it away from zero, leaving us with the following final measure:[6]

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

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 1963-2010 period.

The high frequency liquidity measure is the relative effective bid-ask spread (Chordia, Roll,

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

[6] The cap of 71.9 is chosen to winsorize *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. See also footnote 23.

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 2010, 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 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.

2.2 Additional variables and datasources

To examine the feedback/cash as ammunition hypothesis, we also use institutional turnover (Gaspar, Massa, and Matos, 2005) and Hoberg, Phillips, and Prabhala's (2014) product market fluidity measure, which is a firm-level measure. Data on institutional investors' stock holdings are from Thomson Reuters (13f), which is available from 1980. Fluidity is downloaded from the Hoberg-Phillips data library (http://alex2.umd.edu/industrydata/) and is available over the period 1997-2008.

For our control variables, we follow the seminal reference in the cash holding literature of Opler, Pinkowitz, and Stulz (1999) and 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 also include Net equity issuance and 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 1-5. 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. 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.

As a control for price-informativeness, we also include Price-nonsynchronicity, defined, as in Durnev, Morck, and Yeung (2004), as $\ln[(1-R^2_{i,t})/R^2_{i,t}]$, where $R^2_{i,t}$ is estimated for each stock i for each year from the regression $r_{i,j,w} = \alpha_i + \beta_{i,m} r_{m,w} + \beta_{i,j} r_{j,w} + \varepsilon_{i,w}$. $r_{i,j,w}$ is the weekly stock return of firm i in industry j and week w, $r_{m,w}$ is the weekly value-weighted market return, and $r_{j,w}$ is the weekly value-weighted industry return, where industries are classified by three-digit SIC codes. As discussed by Roll (1988) and Durnev, Morck and Yeung (2004), price-nonsynchronicity can be viewed as a measure of the quantity of private information flowing into stock prices. Fresard (2012) provides evidence that price-nonsynchronicity has an impact on cash savings (changes in cash holdings).

Other control variables are: (i) Analyst coverage, calculated from IBES with availability from 1976, which is found by Chang (2012) to impact on 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. (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, implying that feedback should be more of an issue for these firms. (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.

The sample is winsorized as follows. R&D, Capital and Acquisition expenditures, and Industry sigma are winsorized on both sides at 1%. Equity beta is winsorized on both sides at 0.5%. Net working capital and Cash flow are winsorized from the bottom at 1% and MTB is winsorized from the top at 1%.[7]

2.3 Descriptive statistics

Table 1 displays descriptive statistics of all variables mentioned above (except the IPO dummies). Panel A provides statistics for the main variables, namely, Cash ratio, *ILLIQ*, Log_resprd, Inst_turn, and Fluidity. These are provided over different time periods, reflecting their availability over the different sub periods over which we run regressions in Section 3 and reflecting that the last four variables are used with a lag of one year. The average cash ratio ranges from 0.14 (1964-2010) to 0.19 (1998-2009). Over the same periods, average lagged *ILLIQ* is 13.30 and 15.66, respectively. For all five main variables, standard deviations have the same order of magnitude as the respective means. Summary statistics for the other variables are in Panel B.

Insert Table 1 here.

2.4 Correlations and orthogonalization

Table 2 provides the correlation matrix of all variables listed in Table 1 over the maximum overlapping availability time periods. The variables with the largest positive correlations with the cash ratio are R&D (0.48), Fluidity (0.39), Industry sigma (0.38), and MTB (0.37), which is consistent with the notions that firms hold cash to invest and for precautionary reasons.

Insert Table 2 here.

Firm size is a key determinant of cash holdings (Opler, Pinkowitz, Stulz, and Williamson, 1999; Bates, Kahle and Stulz, 2009), but is highly correlated with some of the other variables, leading to

[7] As a robustness check, we have also run all regressions and tests in this paper with the cash ratio being winsorized at 1% from the top. The results are qualitatively the same as the results we are reporting here, where the cash ratio is not winsorized.

a potential multicollinearity problem in our regressions. Its correlations with *ILLIQ*, Log_resprd, Price-nonsynchronicity, Analyst coverage, and Non-blocks are −0.57, −0.81, −0.57, 0.69, and 0.74, respectively. To address this, for each year t, we orthogonalize these variables with respect to size by running OLS as follows for each firm i and year t:

$$X_{i,t} = \gamma_0 + \gamma_1 \text{Firm size}_{i,t} + \eta_{i,t} \tag{2}$$

where X is one of the mentioned variables. In the analysis in subsequent sections, we typically replace the original variable, X, by the residual η from (2). But as a robustness check, we also run some regressions with the original liquidity measures. We denote the size-orthogonalized variable X by X_res; e.g., *ILLIQ* becomes *ILLIQ_res* and Log_resprd becomes Log_resprd_res.[8] The correlations of *ILLIQ* and Log_resprd with their respective size-orthogonalized versions are 0.77 and 0.65, respectively (over their respective full sample periods), showing that removing size from the liquidity measures leaves the liquidity measures more or less intact.

The correlations between the cash ratio and *ILLIQ* and Log_resprd are 0.00 and 0.02, respectively, showing that unconditionally, the relation between cash holdings and stock liquidity is weak. Yet, the correlations between *ILLIQ_res* and Log_resprd_res and the cash ratio are −0.22 and −0.24, respectively. Since higher values for both *ILLIQ* and Log_resprd reflect increased illiquidity, this means that controlling for size, more liquid stocks hold more cash. This is a first look at evidence in favor of the feedback/cash as ammunition hypothesis. In subsequent sections, we examine this more carefully.

The positive correlation between size-orthogonalized liquidity and the cash ratio is also noteworthy because firm size is positively correlated with liquidity but negatively with the cash ratio (−0.25). This points to measures of liquidity capturing economic factors that are not only unrelated to size, but different in substance.

3 Panel regressions

In this section, we run three sets of panel regressions to examine the predictions of the feedback/cash as ammunition hypothesis. Our baseline specifications regress the cash ratio on mea-

[8] The standard deviations of *ILLIQ_res* over the time periods in Table 3 are: 1963-2009, 17.92; 1970-2009, 18.40; 1980-2009, 19.62; 1997-2008, 19.84. The standard deviation of Log_resprd_res over the 1997-2008 time period is 0.66.

sures of stock liquidity, institutional turnover, product market fluidity, and the control variables discussed in the previous section and listed in the Appendix. We then run a second set of regressions that test the predictions of the cash as ammunition hypothesis that the effects of liquidity, institutional turnover, and competition are amplified by growth opportunities. These are captured by MTB and R&D expenditures. Finally, we examine whether the effects of stock liquidity are also amplified by increased levels of product market competition.

3.1 Baseline regressions

We use the following basic specification over firm-years (i, t)

$$\text{Cash ratio}_{i,t} = \beta_0 + \beta_1 \text{Liquidity}_{i,t-1} + \beta_2 \text{Inst\_turn}_{i,t-1} + \beta_3 \text{Fluidity}_{i,t-1} + \mathbf{\Gamma}' \mathbf{Z}_{i,t} + \varepsilon_{i,t}, \quad (3)$$

where Liquidity is either *ILLIQ*, *ILLIQ_res*, Log_resprd, or Log_resprd_res. **Z** is a vector of control variables and **Γ** the corresponding vector of regression coefficients. We run variations of (3) over four time periods, namely, 1964-2010 (the full sample period), 1971-2010 (net equity and debt issuance and acquisition expenditures are available from 1971), 1981-2010 (analyst coverage and institutional holding data are available from 1976 and 1980, respectively), and 1998-2009 (Log_resprd is available from 1994 and Fluidity from 1997 to 2008).[9] Industry and year fixed effects are used for all time periods, with firm and year fixed effects used over the 1998-2009 time period as a robustness check. Standard errors are clustered at the firm level.

Insert Table 3 here.

We start by discussing the baseline regressions with industry and year fixed effects. These are reported in Table 3, columns 1-10. In all specifications and time periods, the coefficient on the liquidity variable, whether it is orthogonalized to size or not, is negative and statistically significantly 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. This is consistent with the feedback/cash as ammunition hypothesis. For each of the four liquidity measures, the regression coefficients are

[9] Though available, the IPO dummies, IPON, are not used for the 1964-2010 time period. This is just to illustrate that these variables that we have adopted from Bates, Kahle, and Stulz (2009) and whose significance are relatively weak, as seen in Table 3, do not affect the general results. We do not include IPO1 in any specifications in this table because liquidity measures, which require stock data, are used with a lag of one year. This can create the situation that lagged liquidity measures are not available for some firms that have IPO1 = 1.

of similar magnitude across specifications. For *ILLIQ_res*, for example, the coefficient ranges from -0.050×10^{-2} (1998-2009 period) to -0.091×10^{-2} (1964-2010 period). In terms of economic magnitudes, over the 1964-2010 period, a one standard deviation decrease in *ILLIQ_res* increases the cash ratio by 1.63%. The significance of this can be seen in light of the fact that the average cash holding across firm-years over this period is 14% of assets. Thus, the 1.63% increase represents an increase of approximately 11.7% of an average firm's cash holdings. The corresponding numbers for Log_resprd_res, which is used over the 1998-2009 period (see column 10 in Table 3), are similar, namely 1.51% and 8.0%.

The results on Inst_turn and Fluidity are also consistent with the feedback/cash as ammunition hypothesis. The coefficient on Inst_turn is positive and statistically significant at the 5% level or better in all specifications where it is included. This is consistent with the notion that having more short term institutional investors makes the firm more susceptible to feedback and therefore induces it to hold more cash. Increased product market competition, as measured by Fluidity, is also associated with elevated cash ratios; the regression coefficients are positive and statistically significant at the 1% level. This is also as expected from the cash as ammunition hypothesis.

Our finding on Fluidity is consistent with those of Hoberg, Phillips, and Prabhala (2014). We have also run our regressions with the Herfindahl-Hirschman Index measured according to the text-based industry classifications in Hoberg and Phillips (2013), with very similar results. While there are a number of reasons for why firms in more competitive industries hold more cash, our point is that it is also consistent with the feedback/cash as ammunition hypothesis. But the strongest evidence consistent with this hypothesis in Table 3 is the impact on cash holdings of liquidity. We study competition in more detail in subsequent sections, where our analysis is more differentiated from that of the extant literature, since we look more carefully at the interaction of competition, on the one hand, and growth opportunities and liquidity, on the other.

If we think of stock liquidity as reflecting information asymmetries among market participants, it is difficult to reconcile the negative coefficients on the liquidity variables with the classical precautionary motive for holding cash. It points to liquidity capturing other economic factors besides private information, especially since the coefficients on the control variables are consistent with those in the extant literature, as summarized in Table 4. For example, as in Opler et al. and Bates et al. we find that larger firms, those with more volatile cash flows, and larger growth opportunities, as measured by either MTB or R&D, have higher cash ratios. Furthermore, the coefficient on Price-nonsynch_res is statistically significantly negative, which is also consistent with the classical precautionary motive, under the standard interpretation of Price-nonsynch_res measuring idiosyncratic information flow. As a robustness check, we have run the regressions in Table 3 without Price-nonsynch_res and find that our results are qualitatively unaffected (details available upon request). To summarize, whereas the coefficients on the control variables support the classical precautionary motive for holding cash, the results on liquidity, institutional turnover, and product market competition support the view that firms also hold cash to deal with feedback.

Insert Table 4 here.

With respect to the other control variables employed in this paper, the coefficient on Firm age is negative, whereas those on Analyst coverage, Blocks, and Non-blocks_res are positive. All are highly statistically significant. These results are also in line with what we would expect under the feedback/cash as ammunition hypothesis, as discussed in Section 2 (Firm age, Non-blocks_res), or that improved governance reduces the cost of holding cash (Blocks, Analyst coverage). The coefficient on Equity beta is also positive, consistent with the classical precautionary motive.

An important concern in empirical corporate finance is that of endogeneity as a result of omitted variables (Roberts and Whited, 2012). In the regressions in Table 3, columns 1–10, we use both year and industry fixed effects, which can be viewed as at least to some extent addressing a potential omitted variables problem. We also use a large and varied set of control variables across specifications. As seen in Table 4, for those variables that overlap, our findings coincide with those established in the literature (e.g. Opler, Pinkowitz, Stulz, and Williamson, 1999; and Bates, Kahle, and Stulz, 2009). As an additional check, we have also run the regressions in Table 3 with firm and year, instead of industry and year, fixed effects over the 1998-2009 time period with *ILLIQ_res* and Log_resprd_res as the liquidity variables. A drawback of this approach is that it may reduce power, especially if there is significant persistence in variables within firms, because it essentially removes the effect of variation between firms. However, it offers a potentially stronger defense against the omitted variables problem.

The results are in Table 3, columns 11 and 12. For the main variables, our findings are as follows: For both liquidity variables and Inst_turn, we still find statistical significance at the 1% level. The coefficients have the same sign as before. The results are weaker for Fluidity, the coefficient is no longer statistically significant.[10] This may be a result of a lack of power due to a lack of variation in Fluidity within firms over the relatively short time period for which this variable is available. Apart from the result on Fluidity, our baseline findings in Table 3 with industry and year fixed effects are thus quite robust. In Section 4, we deal more directly with endogeneity by studying the effects of exogenous liquidity shocks on cash holdings using a difference in difference methodology around the natural experiment of tick-size decimalization.

3.2 Amplification of feedback effects by growth opportunities

As emphasized by Subrahmanyam and Titman (2001), the effects of feedback are amplified by growth opportunities. Under the feedback/cash as ammunition hypothesis, we would therefore expect to see an augmentation of the impact on cash ratios of liquidity, institutional turnover, and competition for firms with more valuable growth opportunities. In this subsection we examine these predictions by modifying (3) as follows

$$\begin{aligned} \text{Cash ratio}_{i,t} \;=\; & \beta_0 + \beta_1 \text{Liquidity}_{i,t-1} + \beta_2 \text{Liquidity}_{i,t-1} \times \text{HighGrowth}_{i,t-1} \\ & + \beta_3 \text{Inst\_turn}_{i,t-1} + \beta_4 \text{Inst\_turn}_{i,t-1} \times \text{HighGrowth}_{i,t-1} \\ & + \beta_5 \text{Fluidity}_{i,t-1} + \beta_6 \text{Fluidity}_{i,t-1} \times \text{HighGrowth}_{i,t-1} \\ & + \beta_7 \text{HighGrowth}_{i,t-1} + \mathbf{\Gamma}' \mathbf{Z}_{i,t} + \varepsilon_{i,t}, \end{aligned} \tag{4}$$

where $\text{HighGrowth}_{i,t-1}$ is an indicator variable that is 1 if firm i in year $t-1$ is among the upper 50% of firms by growth opportunities, measured alternatively by MTB or R&D, and 0 otherwise.

We run (4) over two time periods, 1981-2010 and 1998-2009, to allow us to include Inst_turn and Fluidity, respectively; and two different liquidity measures, *ILLIQ_res* and Log_resprd_res (1998-2009). Since we use two different measures of HighGrowth, this means we run six variations of (4) in total. The regressions are estimated with industry and year fixed effects and standard errors are clustered at the firm level.

Insert Table 5 here.

Table 5 reports the results. Our focus is on the coefficients of the interaction terms. Across all specifications, the coefficient on Liquidity × HighGrowth is negative and those on Inst_turn ×

[10] If we did not cluster the standard errors, the coefficient on Fluidity, which is positive, would be measured as statistically significant at the 5% level. Note also in the firm and year fixed effects regressions in Table 3 (columns 11 and 12) that the sign of R&D reverses, which just reflects that R&D is an expenditure.

HighGrowth and Fluidity × HighGrowth are positive. All coefficients are statistically significant at the 5% level of better, except Inst_turn × HighMTB in the 1998-2010 regression which is significant at the 10% level. Furthermore, across all specifications, the sign on the coefficients of our liquidity measures is negative (as in our baseline regressions); that on Fluidity is positive (as in our baseline regressions); and that on Inst_turn is not statistically significant different from zero (unlike our baseline regression where it is positive). This shows that the effects of stock liquidity and competition on cash holdings are amplified by growth opportunities and that the effect of institutional turnover is especially important for high growth firms. These findings provide further support for the feedback/cash as ammunition hypothesis.

3.3 Competition and liquidity

As discussed in the Introduction, we expect feedback to especially be a concern for firms that are exposed to more intense competition. Ceteris paribus, this is expected to increase such firms' cash holdings. Hoberg, Phillips, and Prabhala (2014) also emphasize that competitive threats induce firms to hold more cash and Morellec, Nikolov, and Zucchi (2013) argue that this relates to financing constraints. In this subsection, we complement the analysis in these papers by studying the effect on cash holdings of liquidity for firms that face high versus low competition. Under the view that our liquidity measures capture the significance of feedback, we expect high competition to amplify the impact of liquidity on cash holdings. To test this, we run

$$\text{Cash ratio}_{i,t} = \beta_0 + \beta_1 \text{Liquidity}_{i,t-1} + \beta_2 \text{Liquidity}_{i,t-1} \times \text{HighComp}_{i,t-1} + \mathbf{\Gamma}'\mathbf{Z}_{i,t} + \varepsilon_{i,t}, \quad (5)$$

where $\text{HighComp}_{i,t-1}$ is an indicator variable that is 1 if firm i in year $t-1$ is among the upper 50% of firms by competition. We measure competition as before using Fluidity and, as a robustness, also use the Herfindahl-Hirschman Index (HHI) measured according to the text-based industry classifications in Hoberg and Phillips (2013). Both measures are firm level measures. For Liquidity, we use *ILLIQ_res* and Log_resprd_res. The regressions are estimated with industry and year fixed effects and standard errors are clustered at the firm level.

Insert Table 6 here.

The result, which are in Table 6, are supportive of the feedback/cash as ammunition hypothesis. First, as before, the coefficients on the liquidity measures are negative and statistically significant at least at the 5% level in all specifications. Second, the coefficient on the interaction term, Liquidity× HighComp, is also negative and statistically significant (at least 5%). In other words, increased competition amplifies the effect of liquidity, as we would expect from the feedback argument.

In this subsection, we have asked whether the effect of liquidity is affected by the level of competition. We could equally ask whether the effect of competition is affected by liquidity. In work that is not tabulated, we have looked at this by first creating an indicator variable that is 1 for the 50% most liquid stocks (in a given year) and rerun (5) with this variable in place of HighComp and either of the competition measures in place of the liquidity measures. The signs on the interaction terms are, not surprisingly, the same as in Table 6. In other words, the effect of competition on cash holdings are amplified by liquidity. Under the view that liquidity measures information asymmetries and financial constraints, this is not what one would expect if the effect of competition on cash holdings is mostly about firms hoarding cash to deal with potential competitive threats because of financial constraints, which is the thesis of Morellec, Nikolov, and Zucchi (2013). Our results can be reconciled, however, under the view that there are dimensions to liquidity that are not related to information asymmetries and financial constraints, as our other results suggest.

4 Difference in difference tests

While our results in the previous section consistently support the feedback/cash as ammunition hypothesis, across a variety of model specifications and subsamples of the data, it is also possible that causality flows the other way. That is, the cash ratio influences stock liquidity, institutional turnover, and product market competition. Certainly, theoretical arguments for such reverse causality can be made in all three cases. Such reverse causality can obscure both economic and statistical inference. If the variables are jointly determined, our regressions are subject to a simultaneity bias which is difficult to sign and may lead to estimated coefficients that have the opposite sign of the true coefficient.

In this section, we re-examine the impact of liquidity on cash holdings using a difference in difference methodology around the introduction of tick-size decimalization on the three major US exchanges in 2001. We focus on liquidity in part because it is our main explanatory variable and in part because the introduction of tick-size decimalization provides us with a suitable event to study the effect of an exogenous shock to liquidity.[11]

About the event: 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.[12] This event has been used previously in the literature to study the effect of liquidity in other contexts (Chordia, Roll, and Subrahmanyam,2008; Fang, Noe, and Tice, 2009). As in Fang et al., we use the findings of Furfine (2003) and Bessembinder (2003) that more actively traded and larger market capitalization stocks improved their liquidity more than less actively traded and smaller stocks as a result of decimalization, in line with the predictions of Harris (1999). The implication under the feedback/cash as ammunition hypothesis is that we would therefore expect to see firms with more actively traded and larger stocks increase their cash holdings more than less actively traded and smaller stocks in the period after the introduction of decimalization.

Using TAQ, we measure how actively a stock is traded in the year prior to decimalization (2000) by the total number of trades (Num_trades). Based on this, we divide the test sample into the 50% most active and the 50% least active stocks. We then look at the change in cash holding for these two groups from the year before decimalization (end of 2000) to the year after (end of 2002). This two-year window around the introduction of decimalization follows Fang, Noe, and Tice (2009) and provides time for the change in liquidity to affect a firm's cash holdings.

We use the following baseline specification:

$$\Delta \text{Cash ratio}_i = \beta_0 + \beta_1 \text{Active}_i + \mathbf{\Gamma}'(\Delta \mathbf{Z}_i) + \varepsilon_i, \tag{6}$$

where Active_i is an indicator variable that equals 1 for the 50% most active stocks and 0 for the least active stocks (in the year 2000), $\mathbf{Z}_i$ represents the control variables, $\mathbf{\Gamma}$ is the corresponding vector of regression coefficients, and Δ is a difference operator that takes the difference between the values in 2002 and 2000 of the variable to which it is applied. The control variables include all those in Table 3 as well as IPO1.[13] The regression (6) is run using OLS with and without industry fixed

[11]The empirical impact of competition on cash holdings is studied in more detail elsewhere (e.g by Hoberg, Phillips, and Prabhala, 2014). With respect to institutional turnover, we do not have a good natural experiment for this variable and, in any case, the results on institutional turnover are not as strong as those on liquidity.

[12]Pilot programs were carried out before trading on all listed stocks were decimalized. For example, at the NYSE, decimalization was introduced for 159 securities between August and December in 2000. At the NASDAQ, decimalization was introduced for 211 securities in March 2001.

[13]Unlike the regressions in Table 3, no lagged variable is used in the current test, allowing us to include IPO1

effects. Reported t-values are calculated using White's (1980) correction for heteroscedasticity. The difference in difference estimator is β_1. Under the feedback/cash as ammunition hypothesis, this should be positive.

Insert Table 7 here.

The regression results are in Table 7. The first two columns report coefficients for (6) without industry dummies. The last two columns report the results when including industry dummies. Using industry fixed effects in (6) allows for the possibility that there were industry specific shifts in cash holdings in 2001. This can therefore also be seen as a control for the dot-com crash of 2001, which can have led dot-com stocks to have experienced changes in cash holdings that year. We have also run (6) without dot-com stocks, with the results being qualitatively the same.[14] Under either specification, the coefficient on Active is a statistically significant (1%) 0.018, or 1.8%. This is 9.5% of the average firm's cash holdings. In other words, more active stocks, whose liquidity improved the most as a result of decimalization, experienced a larger increase in cash holdings after decimalization than less active stocks. This is consistent with the feedback/cash as ammunition hypothesis and the magnitude of the effect is in line with the results in Section 3.

We carry out several robustness checks on the baseline results. First, we employ a placebo test where we re-run (6) for each year in a ten year window around 2001, i.e. from 1996 to 2006. In this exercise, the placebo, or test, year takes the place of 2001. So for the test year t, we run (6) with Active defined using trading activity in year $t-1$ and changes in the cash ratio and other variables are measured from end of year $t-1$ to end of $t+1$.

Second, we address concerns that our results may relate to the recession of 2001. The main concern here is that issues relating to financial constraints could contaminate our baseline results. So, for example, if capital markets tighten during a recession, this may affect firms differently, depending on the extent to which they are financially constrained. So financial constraint could be an omitted variable in the baseline specification. To address this, we modify (6) as follows

$$\Delta\text{Cash ratio}_i = \beta_0 + \beta_1\text{Active}_i + \beta_2\text{Dummy\_FC}_i + \mathbf{\Gamma}'(\Delta\mathbf{Z}_i) + \varepsilon_i, \tag{7}$$

where Dummy_FC_i is an indicator variable for financially constrained firms, as measured in the year

among the regressors. See footnote 9.

[14]Dot-com stocks are defined as in Ljungqvist and Wilhelm (2003). Details of the results when excluding these stocks are available from the authors upon request.

prior to decimalization (2000). The variable is 1 if firm i is deemed to be financially constrained (or relatively highly constrained) and zero otherwise. We consider four measures of financial constraints for firm i in year t.[15]

1. FC_Div: 1 if firm i does not pay a dividend, zero otherwise. Numerous studies in the literature, including the seminal contribution of Fazzari, Hubbard, and Petersen (1988), identify relatively large dividend payers as being less financially constrained. Whited and Wu's (2006) financial constraint index includes a dummy for positive dividends that loads negatively. The Kaplan and Zingales (1997) index constructed by Lamont, Polk, and Saa-Requejo (2001) also classifies firms as being more financially constrained the smaller is their dividend payment (relative to total assets).

2. FC_Junk: 1 if firm i does not have a rating (as reported in Compustat) or is rated below investment grade (below BBB-) according to Standard & Poor's (from Compustat), zero otherwise. Whited (1992) uses the absence of a bond rating as a proxy for asymmetric information (and thus financial constraints) and Whited and Wu (2006) find that more financially constrained firms are less likely to have ratings. In addition, Farre-Mensa and Ljungqvist (2014) argue that firms with below investment grade ratings are plausibly financially constrained.

3. FC_CP: 1 if firm i (a) has outstanding debt but does not have, and has not had in previous years, a commercial paper rating, or (b) has a commercial paper rating of D or SD, zero otherwise. This measure is first used by Calomiris, Himmelberg, and Wachtel (1995) and is also adopted by Almeida, Campello, and Weisbach (2004).

4. FC_Small: 1 if firm i is among the 50% smallest firms by assets, zero otherwise. Whited and Wu (2006), among others, find that smaller firms are more financially constrained.

Note that using the size indicator variable, FC_Small, alongside Active in (7), is problematic because of the high correlation between size and liquidity and also because Bessembinder (2003) finds that larger stocks increased liquidity more than small stocks as a result of decimalization.[16]

[15] We have chosen to use financial constraint measures based on individual variables rather than quantitative indices, because the standard indices used in the literature are found by Farre-Mensa and Ljungqvist (2014) to work less well outside of the time periods over which they are constructed.

[16] The correlation between log(Num_trades) and firm size in our sample is 0.65.

Thus, the coefficient on FC_Small may pick up a liquidity as well as a financial constraint effect. To deal with these two issues, we replace Active by Active_res when we use FC_Small, where Active_res is defined in the same manner as Active, but based on the size-orthogonalized log(Num_trades) rather than Num_trades itself. In addition, to take liquidity out of size, we also run a specification where we base the size indicator variable on firm size orthogonalized to log(Num_trades), which we refer to as FC_Small_res.

The financial constraint control is combined with the placebo test by running (7) for all years, 1996-2006. The results are in Table 8. Panel A (B) is run without (with) industry fixed effects. In each panel, there are six specifications, one without the financial constraint control, one for each of the financial constraint dummies, and one with Active_res and FC_Small_res. For each specification, we report the coefficients on Active or Active_res and the financial constraint control, as applicable.

Insert Table 8 here.

We first discuss the results in the first seven columns (i.e. when not using the size based financial constraint measures). There are three main points to note. First, with one exception, Active is positive and statistically significant at the 1% level in all specifications for the decimalization year 2001, whether or not industry fixed effects are included. The exception is the case that Dummy_FC is FC_Junk, in which case the p-value is 0.0106. The coefficient ranges from 0.018 to 0.021 without industry fixed effects and from 0.015 to 0.020 with industry fixed effects. Thus, the results in Table 7 are robust to including a control for financial constraints. Second, across specifications, Active is not significantly different from zero at conventional levels for any of the placebo years, except for 2003 when the financial constraint measure is FC_Junk or FC_CP. In this case, the coefficient on Active is negative. This supports the view that our results for 2001 are driven by decimalization. Third, the financial constraint dummies are, for the most part, insignificant. For 2001, the exception is the coefficient on FC_Div in the specification without industry dummies. When including industry dummies, none of the financial constraint variables are significant in 2001. These results support the view that the positive difference in difference estimator we document for 2001 is not driven by the recession touching firms differently depending on their level of financial constraint. It supports that our findings are driven by decimalization and a relatively large improvement in liquidity for the most actively traded stocks.

Next, we discuss the results when using a size-based financial constraint measure and the size-orthogonalized active stocks measure, as reported in the last four columns of Table 8. With respect to Active_res, the results echo those discussed above for Active. For 2001, when industry fixed effects are not included, the results are essentially the same as before. In the specification with FC_Small the coefficient on Active_res is 0.014 and with FC_Small_res it is 0.017, with these coefficients being statistically significant at the 5 and 1% levels, respectively. For other years, we see no significance, whether or not industry fixed effects are included.

When including industry dummies, the coefficient on Active_res is not significant for 2001 when the financial constraint measure is FC_Small. But the coefficient on FC_Small is negative and statistically significant at the 1% level. This could be a result of firm size capturing financial constraints, or it could reflect a relatively large improvement in liquidity for large firms, as found by Bessembinder (2003). To investigate this further, we look at the results when using Active_res and FC_Small_res. For this specification, Table 8 (last two columns) reports that Active_res is positive and statistically significant for 2001 (only) whether or not industry dummies are included, whereas the coefficient on FC_Small_res is not significant in either case. This suggests that the effect seen on FC_Small for 2001 is due to liquidity rather than recession related financial constraint effects. These findings represent fairly strong evidence that liquidity has a positive impact on cash holdings. To conclude, the results from the natural experiment of tick size decimalization support the feedback/cash as ammunition hypothesis with respect to its predictions on stock liquidity and cash holdings.

5 Cash and stock liquidity: Simultaneous equation estimation

In this section, we continue to focus on the relation between cash holdings and stock liquidity. In particular, we estimate a simultaneous equation system with the Cash ratio and Stock liquidity as left-hand-side variables. The analysis in this section thus complements the analysis in the previous section by providing an alternative approach to addressing a potential simultaneity bias with respect to the estimated effect of stock liquidity on cash holdings. The simultaneous equation approach also allows us to comment on the possibility of joint causality between stock liquidity and cash holdings. In addition, the results in this section give insight into our size-orthogonalized liquidity variables and thereby contribute to the literature on stock liquidity.

The estimated simultaneous equation system is described by

$$\text{Cash ratio}_{i,t} = \alpha_0 + \alpha_1 \text{Liquidity}_{i,t} + \sum_{k=2}^{K} \alpha_k Z_{k,i,t-1} + \varepsilon_{i,t} \tag{8}$$

$$\text{Liquidity}_{i,t} = \beta_0 + \beta_1 \text{Cash ratio}_{i,t} + \sum_{l=2}^{L} \beta_l X_{l,i,t-1} + \eta_{i,t} \tag{9}$$

where Liquidity is *ILLIQ_res* or Log_resprd_res, i refers to firms, t refers to years, and k and l refer to control variables (instruments). We denote the set of $K-1$ control variables in the Cash equation, (8), by $\boldsymbol{Z}$ and the set of $L-1$ control variables in the Liquidity equation, (9), by $\boldsymbol{X}$. For each liquidity measure, the system is run using two-stage least squares, 2SLS, with, firm and year fixed effects.[17] Standard errors are clustered at the firm level.

The set of control variables (instruments), $\boldsymbol{Z}$, in the Cash ratio equation is the same as in our baseline regressions in Table 3, with one modification. In particular, we break out Net equity issuance into Gross equity issuance and Repurchases.[18] We do this because the composition of Net equity issuance may be relevant for stock liquidity (see below). To allow for the inclusion of all other controls used in Table 3, we use the 1998–2009 sample period.

Identification requires that there is at least one instrument in each of the sets $\boldsymbol{Z}$ and $\boldsymbol{X}$ that is not in the other. Thus, we form $\boldsymbol{X}$ by taking those variables from $\boldsymbol{Z}$ that, based on the extant empirical and theoretical literatures on stock liquidity, are most plausibly related to stock liquidity and add three new variables (described below). We recognize that the set of instruments we have chosen is not necessarily complete. Firm fixed effects are included to address this potential issue.

The variables included in $\boldsymbol{X}$ are motivated in large part by the theoretical ideas that stock

[17]In the first stage, the Cash ratio and the liquidity variable, *ILLIQ_res* or Log_resprd_res, are regressed on all controls, or instruments, $\boldsymbol{Z}$ and $\boldsymbol{X}$. The second step runs regressions (8) and (9), where the fitted values of the Cash ratio, $\widehat{\text{Cash ratio}}$, and the liquidity variable, $\widehat{\text{Liquidity}}$, are used instead of the corresponding original variables on the right-hand-side. The fixed effects are used in both stages. We have also run the system using industry and year fixed effects. However, for this specification, the Sargan-Hansen test of the overidentifying restrictions reject the null hypothesis that the instruments are exogenous, which confounds inference.

[18]Both Gross equity issuance and Repurchases are normalized by total assets (see the Appendix for precise definitions), as our other variables are. In the literature, repurchases are sometimes normalized by lagged market capitalization (e.g., Dittmar, 2000; Billett and Xue, 2007), but Hovakimian, Opler, Titman (2001) normalize repurchases by the book value of total assets as we do. As a robustness check we have also run the system (8) and (9) with repurchases normalized by lagged market capitalization. The results are qualitatively the same when using Log_resprd_res as the liquidity variable, but somewhat weaker when using *ILLIQ_res*.

liquidity is decreasing in the levels of (i) private/asymmetric information among investors (Bagehot, 1971; Copeland and Galai, 1983; Glosten and Milgrom, 1985; Kyle, 1985), (ii) inventory risks (Garman, 1976; Ho and Stoll, 1981) which may be related to the cost of immediacy (Grossman and Miller, 1988), and (iii) transaction costs (Amihud and Mendelson, 1986). Our choice of control variables in (9) are as follows:

Information variables. Price-nonsynch_res: Price-nonsynchronicity (Roll, 1988) is widely used in the literature as a price-informativeness variable. While a common interpretation is that higher levels of price-nonsynchronicity reflects more informative prices (e.g., Durnev, Morck, and Yeung, 2004; Fresard, 2012), other researchers argue that it reflects higher levels of asymmetric information (e.g., Dasgupta, Gan, and Gao, 2010; Chan and Chan, 2014). Consistent with the latter perspective, there is empirical evidence that price-nonsynchronicity is negatively associated with stock liquidity (Chan, Hameed, and Kang, 2012). Analyst coverage_res: Investment analysts disseminate stock relevant information to the public (e.g., Brown and Rozeff, 1978; Brennan, Jegadeesh, and Swaminathan, 1993; Womack, 1996; Kelly and Ljungqvist, 2012) and Brennan and Subrahmanyam (1995) provide evidence that a greater analyst following improves stock liquidity. Firm age: Longer financial and product market track records would be expected to be associated with decreased levels of information asymmetry (Megginson and Weiss, 1991; Petersen and Rajan, 1994: Krishnaswami, Spindt, and Subramaniam, 1999; Chemmanur and Fulghieri, 1999). Gross equity issuance: Myers and Majluf (1984) and many others show that the decision to issue equity may signal managers' private information. The empirical evidence supports this idea (Smith, 1986; Asquith and Mullins 1986; Masulis and Korwar, 1986; Barclay and Litzenberger, 1988; Corwin, 2003) and so we would expect higher levels of equity issuance to be associated with lower levels of information asymmetry in the market and, in turn, more liquid stock. Repurchases: There is evidence that firms with more liquid stocks carry out more stock repurchases (Brockman, Howe, and Mortal, 2008). This may relate to adverse selection effects (Barclay and Smith, 1988), but, more generally, is a logical consequence of lower price impact, as discussed in the Introduction. Note finally that firm size, which is often viewed as being negatively related to information asymmetries, is not included in $\boldsymbol{X}$, since we use size-orthogonalized liquidity variables.

Inventory risk variables. Inst_turn: Stocks with higher institutional turnover would be expected to offer cheaper immediacy (in the sense of Grossman and Miller, 1988), thereby reducing inventory risks. In general, in line with the perspective of Grullon, Kanatas, and Weston (2004) and Barber and Odean (2008), we would expect stocks that attract more investor attention to offer cheaper immediacy, for example because they attract more uninformed buyers, and thus be relatively more liquid. We include five variables to capture this idea, namely (i) Advertising:[19] Grullon, Kanatas, Weston (2004) advance, and find supporting evidence for, the idea that advertising grabs investors' attention and thereby increases liquidity. (ii) Equity beta: Frazzini and Pedersen (2014) argue that investors with borrowing constraints are attracted to high beta stocks (thus explaining the relatively low beta-adjusted returns of such stocks as found by Black, Jensen, and Scholes, 1972). There is empirical evidence that equity betas and stock liquidity are positively related (Chan, Hameed, and Kang, 2012);[20] (iii-v) MTB, Cash flow, Stock annual return: It seems plausible that High market-to-book stocks ("glamour stocks") and firms with high earnings power and stock returns (Barber and Odean, 2008) attract relatively more investor attention. Industry sigma: Stocks in industries with more variable cash flows may see more disagreement about value across investors (Miller, 1977), contributing to more balanced order flows and thus reduced inventory risks. Fluidity: Inventory risks may be higher for stocks in highly competitive industries because of the increased risk of negative feedback and sharp downward movements. Leverage: Increased leverage may amplify feedback effects, thus increasing inventory risks. On the other hand, along the lines of Frazzini and Pedersen's argument, investors with borrowing constraints may be attracted to firms with highly levered equity.

Transaction cost variables. Log(Stock price)_res: Larger stock prices may be associated with relatively low commission fees (Falkenstein, 1996; Chordia, Huh, Subrahmanyam, 2007).

In addition to the above variables, we also include variables that capture different dimensions of institutional ownership, Block and Non-blocks_res. Institutional ownership is linked to liquidity in both the empirical and theoretical literatures. In particular, there is evidence that institutional ownership overall improves liquidity (Rubin, 2007), but that institutional block ownership lowers liquidity (Heflin and Shaw, 2000; Rubin, 2007; Brockman, Chung, and Yan, 2009). There is some disagreement as to whether the latter effect is due to private information on the part of the block owner (the first two papers) or a reduction in float (the third paper). In contrast, Khanna and

[19]The variable Advertising is defined as $\log(1 + \text{advertising expenditures})$, where we set advertising expenditures to be 0 if the value is missing in Compustat, as it is in more than 60% of cases. This high incidence of missing values precludes us from dropping firm-years with missing advertising expenditures. Not including Advertising does not affect our results in any notable way. Advertising expenditures is measured in millions.

[20]However, these authors argue that the positive relation between beta and liquidity is the result of reduced levels of asymmetric information.

Mathews (2012) argue theoretically that blockholders may help increase liquidity through stock price stabilization.

In total, we exclude 11 of the controls in the Cash equation, (8), from the Liquidity equation, (9), namely Net working capital, Acquisition, Capex, R&D, Firm size, Dividend dummy, Net debt issuance, and IPO2-IPO5. The three variables that only appear in the Liquidity equation are Log(stock price)_res, Stock annual return, and Advertising.[21]

Validity of the instruments, $\boldsymbol{Z}$ and $\boldsymbol{X}$, requires that they meet the relevance and exogeneity (exclusion) conditions. To examine exogeneity, we carry out a Sargan-Hansen test of the overidentifying restrictions, where the null hypothesis is that the excluded instruments are exogenous. For this test, we report the Hansen (1982) J-statistic. With respect to the relevance condition, we report on the results of tests for underidentification (Kleibergen-Paap, 2006, rk LM statistic) and weak identification (Kleibergen-Paap, rk Wald F statistic), with the null hypotheses being underidentification and weak identification, respectively.[22]

Insert Table 9 here.

Table 9, Panel B, contain the instrument validity tests for both the Cash equation and the Liquidity equation. The two leftmost (rightmost) columns report on the specification with *ILLIQ_res* (Log_resprd_res) as the liquidity variable. With respect to the underidentification and weak identification tests, for both equations and either liquidity measure, the test statistics strongly support the (alternative) hypothesis that the relevance condition is satisfied. With respect to the test of the overidentifying restrictions, we cannot reject the null hypothesis of instrument exogeneity. The the lowest p-value in the two Cash (Liquidity) specifications is 0.61 (0.58). Thus, for both equations, the excluded instruments comfortably pass the test for exogeneity, as the instruments also do for relevance.

[21] The means and standard deviations of the new variables introduced in this section over the 1998-2009 sample period are as follows [mean, standard deviation, units]: Advertising [0.73, 1.47, log(million dollars)]; Log(Stock price_res) [0.00, 0.78, log(dollars)]; Stock annual return [0.14, 0.93, decimals]; Repurchases [0.02, 0.05, decimals]; Gross equity issuance [0.06, 0.16, decimals]. Note that all these variables are lagged one year in the estimation so that the effective sample period for which statistics are reported here is 1997-2008. Repurchases and Gross equity issuance are normalized by total assets.

[22] Since standard errors are clustered at the firm level, the Anderson (1951) canonical correlations test and the Cragg-Donald (1993) Wald statistic are no longer valid (Baum, Schaffer, and Stillman, 2007). Therefore, as recommended by Baum et al, we report the Kleibergen-Paap rk LM statistic in the underidentification test and, for the weak identification test, use the Kleibergen-Paap, rk Wald F statistic and apply the rule of thumb of Staiger and Stock (1997) and the Stock and Yogo (2005) critical values initially tabulated for the Cragg-Donald (1993) statistic.

The regression coefficients of the Cash and Liquidity equations are in Panel A, Table 9. The coefficient on the liquidity variable in the Cash equation is negative and statistically significant at the 1% level, regardless of whether we use *ILLIQ_res* or Log_resprd_res. This is consistent with the findings in the previous sections and supports the feedback/cash as ammunition hypothesis. The table also reports that when the liquidity variable is Log_resprd_res, the coefficient on the Cash ratio in the Liquidity equation is negative and statistically significant. This is consistent with the view put forth by Gopalan, Kadan, and Pevzner (2012) that increased levels of cash increase stock liquidity. However, when *ILLIQ_res* is used as the liquidity variable, the coefficient on the Cash ratio is not statistically different from zero. Thus, our results are weakly supportive of two-way causality, with the results being stronger for the idea that stock liquidity affects cash holdings than for the other way around.[23] Thus, the results of the simultaneous equation analysis supports the hypothesis advanced in this paper that increased stock liquidity strengthens the incentive for firms to hold cash.

While caution needs to be exercised with respect to interpreting the coefficients on the control variables, it is nevertheless interesting to take a look at them, perhaps especially those in the Liquidity equation. However, starting with the Cash equation, we see that the regression coefficients on the control variables are for the most part in line with the findings in Table 3. With respect to the decomposition of Net equity issuance, we note that, not surprisingly, the coefficients on Gross equity issuance and Repurchases are positive and negative, respectively, with both being statistically significant at the 1% level in either specification. Some coefficients that are statistically significant in Table 3 are no longer significant in Table 9, for example, those on MTB, R&D, and Equity beta. This may reflect that these variables may not have sufficient variation vis-à-vis the Cash ratio over the relatively short sample period studied here to "survive" firm fixed effects at both stages of the 2SLS procedure as well as being used as instruments for liquidity.

Looking at the liquidity equation allows us to comment on the factors that relate to liquidity. The results are largely consistent with the extant literature and the view that stock liquidity relates to several factors. Consistent with the notion that reduced levels of information asymmetry are associated with increased stock liquidity, the coefficients on Analyst coverage, Firm age, and Gross equity issuance are negative (indicating higher liquidity) and statistically significant at the

[23] We have examined the robustness of our results by using different versions of *ILLIQ* . In particular, we have tried Amihud's original (raw) measure in square root form as well as winsorized it at 90^{th} and 99^{th} percentiles, with and without bounding it away from 0 as in (1). The results are qualitatively unaffected.

1% level in at least one of the two specifications. Price-nonsynchronicity is insignificant when using *ILLIQ_res* as the liquidity variable, but positive and statistically significant (1%) when using Log_resprd_res. This is in line with Chan, Hameed, and Kang (2012) and is suggestive of there being an asymmetric information dimension to price-nonsynchronicity.

The findings are also supportive of inventory risks and investor attention affecting liquidity. The coefficient on institutional turnover is negative and statistically significant (1%) in both specifications. Among our "investor attention variables", the coefficients on Stock annual return, MTB, and Cash flow are all negative and statistically significant (1%) in both specifications, with those on Advertising and Equity beta being negative and statistically significant (10% and 1%, respectively) when the liquidity variable is *ILLIQ_res*.

The coefficient on Log(stock price)_res is negative and significant (1%) in both specifications, which is consistent with the view that stocks with lower transaction costs (those with higher stock prices) are more liquid. There is also weak evidence for the idea that product market competition reduces stock liquidity; the coefficient on Fluidity is positive and statistically significant (1%) when liquidity is Log_resprd_res. This may relate to the feedback idea that more intense product market competition increases the likelihood of sharp stock price downturns. Leverage is also seen to be strongly inversely related with liquidity.

Finally, Repurchases is an especially interesting variable with respect to the feedback/cash as ammunition hypothesis since, as argued in the Introduction, the most obvious way to address feedback is through stock repurchases. Consistent with this notion and with the empirical findings of Brockman, Howe, and Mortal (2008), we find evidence that share repurchases are positively related to stock liquidity; the coefficients are negative and statistically significant (1%) in both specifications.[24]

These results suggest that stock liquidity is related to a variety of factors. The theoretical ideas of information asymmetry, inventory risks, and transaction costs all appear to be relevant. This helps shed light on our main finding that an increase in stock liquidity leads to an increase in cash holdings. At first glance, our finding appears to be inconsistent with the classical precautionary motive for holding cash (Myers and Majluf, 1984), given that stock liquidity is decreasing in information asymmetries. However, our finding is based on size-orthogonalized liquidity measures.

[24]This is difficult to reconcile with the alternative explanation of our main finding that it is driven by firms with illiquid stocks making larger payouts to compensate investors for the relative illiquidity of their stock, and, as a consequence, end up holding less cash (Zucchi, 2014).

Under the common view that information asymmetries are smaller for larger firms, this strips out a potentially large portion of the "information asymmetry factor" of stock liquidity. The other two factors, inventory risk and transaction costs, may therefore dominate. Since these are not directly related to information asymmetry, there is no contradiction between our finding on the relation between cash holdings and stock liquidity and the classical precautionary motive for holding cash. Instead, this finding is consistent with the feedback/cash as ammunition hypothesis and that size-orthogonalized *ILLIQ* and Log_resprd reflect to a significant degree non-informational liquidity factors.

6 Concluding remarks

We have provided evidence that supports the idea that there is a channel from the stock market to corporate financial policy. In particular, controlling for firm size and other standard variables in the cash holding literature, we have found that corporations with more liquid stocks have higher cash ratios. The impact is amplified for firms with larger growth opportunities. We argue that this is consistent with firms holding cash to address feedback from stock markets to, for example, product markets, along the lines of the theory of Subrahmanyam and Titman (2001). This is especially so because they show that the impact of feedback is larger for firms with more growth opportunities. The cash as ammunition hypothesis is further supported by similar findings on institutional turnover and product market competition.

To address issues regarding reverse causality and simultaneity with respect to stock liquidity and corporate cash holdings, we have carried out a difference in difference test on the impact of tick-size decimalization in 2001 on more active versus less active stocks. Previous work has shown that decimalization improved the liquidity of more active stocks relatively more than less active stocks. We control for industry effects as well as the possibility that inferences regarding the impact of liquidity are contaminated by the recession of 2001. Robustness checks are also carried out by repeating the tests for ten placebo years, five years either side of 2001. The results support the view that an increase in liquidity leads to an increase in cash holdings. As a complement to this analysis, we also run a simultaneous equation system on cash holdings and liquidity. The results provide evidence that cash holdings and stock liquidity are jointly determined, with both variables having a positive impact on the other. These findings are consistent with the feedback/cash as ammunition hypothesis.

Our paper also contributes to the literature on stock liquidity. Market microstructure theory relates stock liquidity to information asymmetries among market participants; the larger these are, the less liquid is the stock. Theory also relates stock liquidity to inventory risks and transaction costs, and we find that variables meant to capture these factors are related to stock liquidity in a way that is consistent with the theory. This helps explain our finding that when controlling for firm size (which is commonly viewed as capturing information asymmetries), stock liquidity has a positive impact on corporate cash holdings, rather than the negative impact one might expect to see under the classical precautionary motive for holding cash. Our analysis shows that caution must be exercised with respect to interpreting stock liquidity measures in empirical research. When firm size is controlled, stock liquidity may well be stripped of a large portion of its information asymmetry component, possibly affecting the interpretation of the results with respect to the stock liquidity measure.

The idea put forth and tested in this paper builds on the theory of Subrahmanyam and Titman (2001) of feedback between stock prices and cash flows. Our findings suggest that further theoretical work in this area would be valuable in order to better understand the role stock liquidity plays with respect to feedback. While we have emphasized that it takes more cash to support a stock the more liquid it is, there may also be an information link between feedback and liquidity. Stakeholders do not necessarily understand the underlying reasons behind stock price changes, since these may relate to changes in expectations regarding costs, revenue, or risk. Nevertheless, stakeholders may change their involvement with the firm when stock prices move because they put some positive probability on that the underlying reason would affect them. For example, consumers may view a sliding stock price as an indication that the firm's products are becoming less attractive in the marketplace, which in turn reduces demand for the firm's products. Employees might leave simply because the stock price slides. Because information gets impounded more quickly and efficiently into more liquid stocks, such firms may be more susceptible to feedback and may therefore have an added incentive to hold more cash. Developing this idea further might help us get more precise predictions with respect to the cash as ammunition hypothesis as well as understanding the role and importance of stock liquidity on corporate financial policies better.

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Appendix: Descriptions of variables

The names of variables in Compustat are shown in parentheses. Variables with * are only used in Section 5.

Variable	Data source	Description
Acquisition	Compustat	The ratio of acquisition expenditures (AQC) relative to total (book) assets (AT).
Advertising*	Compustat	The logarithm of one plus the advertising expense (XAD). If XAD is missing, set XAD to zero.
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 dummy	Compustat	A dummy equal to one if a firm paid common dividends (DVC) in that year; zero otherwise.
Equity beta	CRSP	Annual Scholes-Williams (1977) equity beta.
FC_CP	Compustat	Dummy variable for financial constraint, which equals 1 for firm i in year t if either (i) it has outstanding debt but has never had a commercial paper rating (SPSTICRM) in year s, $s \leq t$, or (ii) it has a commercial paper rating of D or SD.

Continued on next page

Appendix – continued from previous page

Variable	Data source	Description
FC_Div	Compustat	Dummy variable for financial constraint, which equals 1 for firm i in year t if it does not pay dividends in year t.
FC_Junk	Compustat	Dummy variable for financial constraint, which equals 1 for firm i in year t if it has either no bond rating (SPLTICRM) or a rating below investment grade.
FC_Small	Compustat	Dummy variable for financial constraint, which equals 1 for firm i in year t if Firm size is below the median in year t.
Fluidity	Hoberg-Phillips Data Library http://alex2.umd.edu /industrydata/	Product market fluidity defined in Hoberg, Phillips, Prabhala (2014) as a measure of competition in product market: Each year collect J_t key words of product descriptions in 10-Ks of all firms. Let $W_{i,t}$ be the indicator vector of the J_t words for firm i in year t. Denote the normalized $W_{i,t}$ by $N_{i,t} = \frac{W_{i,t}}{\|W_{i,t}\|}$. Then capture the changes in the overall use of a given word in year t by an aggregate vector $D_{t-1,t}$ as $\|\sum_i (W_{i,t} - W_{i,t-1})\|$. The product market fluidity of firm i is defined as the dot product between $N_{i,t}$ and normalized $D_{t-1,t}$.
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 (AT), where the total assets are deflated to 1962 dollars.
Gross equity issuance*	Compustat	Equity sales (SSTK)/total assets (AT).

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Variable	Data source	Description
HHI	Hoberg-Phillips Data Library http://alex2.umd.edu /industrydata/	Herfindahl-Hirschman Index based on the text-based industry classifications (TNIC) in Hoberg and Phillips (2013): Each year collect J_t words of product descriptions in 10-Ks of all firms. Let $W_{i,t}$ be the indicator vector of the J_t key words for firm i in year t. Denote the normalized $W_{i,t}$ by $N_{i,t} = \frac{W_{i,t}}{\|\|W_{i,t}\|\|}$. Then define the product cosine similarity between firm i and firm j as the dot product of $N_{i,t}$ and $N_{j,t}$. Industry network for firm i includes all firms with a product cosine similarity not less than 21.32%. Based on this industry classification, the HHI is calculated as the sum of the squares of market share in the industry.
HighComp_Fluid		Dummy variable which equals 1 if Fluidity in a year is above the median in that year, and 0 otherwise.
HighComp_HHI		Dummy variable which equals 1 if HHI in a year is below the median in that year, and 0 otherwise.
HighMTB	Compustat	Dummy variable which equals 1 if MTB is above the median in a year, and 0 otherwise.
HighRD	Compustat	Dummy variable which equals 1 if R&D is above the median in a year, and 0 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	Compustat	Adjusted version of Amihud's (2002) original illiquidity measure. See equation (1) in the text.

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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
IPO1-IPO5	CRSP	Dummy variables equal to one if the difference between the year of the fiscal year end and the year of the first occurrence in CRSP is 1 to 5 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).
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.
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).
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.

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Variable	Data source	Description
Price-nonsynchronicity	CRSP	Defined as in Durnev et al. (2004). Firm specific stock return variation of firm i in year t. Specifically, it is $\ln[(1 - R^2_{i,t})/R^2_{i,t}]$, where $R^2_{i,t}$ is estimated each year for the regression $r_{i,j,w} = \alpha_i + \beta_{i,m} r_{m,w} + \beta_{i,j} r_{j,w} + \varepsilon_{i,w}$. $r_{i,j,w}$ is the weekly stock return of firm i in industry j week w, $r_{m,w}$ is the weekly market return, $r_{j,w}$ is the weekly industry (3-digit SIC code) return. Market and industry returns are value-weighted averages.
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.
Repurchases*	Compustat	Share repurchase defined as equity purchases (PRSTKC)/total assets (AT).
log(Stock price)*	CRSP	Logarithm of stock price. Adjusted to 1962 dollars by the CPI.
Stock annual return*	CRSP	Annualized stock return based on monthly CRSP stock file within a fiscal year.

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. Definitions of the variables and the underlying data source are provided in the Appendix.

Name	Period	Unit	Mean	Median	Std. Dev.	Std. Err.	Min.	Max.	N
Panel A: Main Variables									
Cash ratio	’64-’10		0.14	0.07	0.18	0.0006	0.00	0.99	92,169
	’71-’10		0.15	0.07	0.19	0.0006	0.00	0.99	86,002
	’81-’10		0.16	0.08	0.20	0.0007	0.00	0.99	71,900
	’98-’09		0.19	0.10	0.22	0.0013	0.00	0.99	27,637
ILLIQ	’63-’09	1/Million$	13.30	1.28	23.37	0.0776	0.25	71.90	90,754
	’70-’09	1/Million$	14.02	1.51	23.83	0.0813	0.25	71.90	85,826
	’80-’09	1/Million$	15.78	1.81	25.14	0.0940	0.25	71.90	71,498
	’97-’08	1/Million$	15.66	1.26	25.69	0.1513	0.25	71.90	28,802
Log_resprd	’97-’08		-5.33	-5.21	1.29	0.0076	-9.14	-2.04	28,797
Fluidity	’97-’08		6.63	6.09	3.28	0.0196	0.33	23.43	27,866
Inst_turn	’80-’09		0.09	0.09	0.04	0.0002	0.00	0.58	69,063
	’97-’08		0.10	0.09	0.04	0.0002	0.00	0.58	28,590
Panel B: Control Variables									
Price-nonsynchronicity	’64-’10		1.66	1.63	1.81	0.0061	-12.07	16.35	88,136
Firm size	’64-’10	log(Million$)	3.49	3.39	1.94	0.0064	-2.14	10.73	92,169
Leverage	’64-’10		0.23	0.21	0.19	0.0006	0.00	1.00	92,169
MTB	’64-’10		1.69	1.29	1.26	0.0042	0.17	29.70	92,169
Firm age	’64-’10	log(month)	4.66	4.84	1.03	0.0034	1.61	6.60	92,169
Net working capital	’64-’10		0.15	0.14	0.19	0.0006	-0.67	0.92	92,169
Dividend dummy	’64-’10		0.42	0.00	0.49	0.0016	0.00	1.00	92,169
R&D	’64-’10		0.03	0.00	0.07	0.0002	0.00	0.85	92,169
Capex	’64-’10		0.07	0.05	0.06	0.0002	0.00	0.51	92,169
Cash flow	’64-’10		0.04	0.07	0.15	0.0005	-1.51	1.63	92,169
Industry sigma	’64-’10		0.07	0.06	0.04	0.0001	0.01	0.19	92,169
Equity beta	’64-’10		0.88	0.84	0.62	0.0021	-2.00	3.49	90,918
IPO1	’64-’10		0.06	0.00	0.24	0.0008	0	1	92,169
IPO2	’64-’10		0.06	0.00	0.24	0.0008	0	1	92,169
IPO3	’64-’10		0.06	0.00	0.23	0.0008	0	1	92,169

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Name	Period	Unit	Mean	Median	Std. Dev.	Std. Err.	Min.	Max.	N
IPO4	’64-’10		0.05	0.00	0.22	0.0007	0	1	92,169
IPO5	’64-’10		0.05	0.00	0.22	0.0007	0	1	92,169
Net equity issuance	’71-’10		0.04	0.00	0.16	0.0005	-2.11	2.95	86,002
Net debt issuance	’71-’10		0.01	0.00	0.11	0.0004	-5.27	1.22	86,002
Acquisition	’71-’10		0.02	0.00	0.05	0.0002	0.00	0.44	86,002
Analyst coverage	’81-’10		1.11	1.03	1.02	0.0038	0.00	3.89	71,900
Blocks	’81-’10		0.11	0.07	0.12	0.0005	0.00	0.90	69,249
Non-blocks	’81-’10		0.24	0.17	0.21	0.0008	0.00	0.99	69,249

Table 2
Correlations
Pair-wise correlations between selected variables. The sample period is from 1964 to 2010 for most variables, except Net equity issuance, Net debt issuance, and Acquisition (1971-2010); Inst_turn (1980-2010); Analyst coverage, Blocks, and Non-blocks (1981-2010), Log_resprd (1993-2010) and Fluidity (1997-2008). Correlations with these variables are calculated over their respective sample periods.

	Cash ratio	*ILLIQ*	Log_ resprd	Inst. _turn	Fluid.	Prc- nschr.	Firm size	Lever -age	MTB	Firm age	Net wcap	Net equity	Net debt	Div. dum.	R&D	Capex	Acq	Cash flow	Ind. sigma	Equity beta	Anlst cov.	Blocks	Non- blocks
Cash ratio	1																						
ILLIQ	0.00	1																					
Log_resprd	0.02	0.69	1																				
Inst_turn	0.16	-0.18	-0.10	1																			
Fluidity	0.39	-0.14	-0.07	0.20	1																		
Price-nonsynchronicity	0.08	0.39	0.59	-0.06	0.01	1																	
Firm size	-0.25	-0.57	-0.81	0.03	-0.02	-0.57	1																
Leverage	-0.42	0.05	0.01	-0.06	-0.04	-0.01	0.17	1															
MTB	0.37	-0.12	-0.15	0.15	0.23	-0.02	-0.14	-0.22	1														
Firm age	-0.21	-0.12	-0.29	-0.25	-0.32	-0.22	0.39	0.01	-0.20	1													
Net working capital	-0.26	-0.06	0.11	-0.08	-0.33	0.02	-0.07	-0.16	-0.16	0.08	1												
Net equity issuance	0.34	0.02	0.17	0.18	0.23	0.10	-0.24	-0.12	0.32	-0.36	-0.11	1											
Net debt issuance	-0.02	-0.07	-0.05	0.03	0.05	-0.04	0.06	0.17	0.00	-0.01	0.02	-0.11	1										
Dividend dummy	-0.22	-0.34	-0.36	-0.15	-0.29	-0.31	0.46	-0.05	-0.13	0.36	0.17	-0.19	0.04	1									
R&D	0.48	0.06	0.09	0.08	0.38	0.12	-0.22	-0.24	0.31	-0.12	-0.12	0.24	-0.01	-0.24	1								
Capex	-0.15	-0.10	-0.02	0.05	0.07	-0.08	0.07	0.09	0.04	-0.10	-0.21	0.04	0.17	0.06	-0.11	1							
Acquisition	-0.08	-0.08	-0.12	0.07	0.00	-0.04	0.10	0.09	0.01	-0.04	-0.06	0.02	0.23	-0.02	-0.04	-0.08	1						
Cash flow	-0.30	-0.24	-0.28	-0.01	-0.27	-0.19	0.33	-0.02	-0.14	0.17	0.22	-0.40	-0.03	0.21	-0.44	0.13	0.06	1					
Industry sigma	0.38	0.16	-0.02	0.09	0.36	0.16	-0.21	-0.18	0.27	-0.08	-0.23	0.14	-0.02	-0.36	0.42	-0.14	0.08	-0.20	1				
Equity beta	0.06	-0.36	-0.40	0.18	0.17	-0.38	0.26	0.01	0.10	0.00	0.00	0.05	0.04	0.03	0.06	0.06	0.01	0.06	-0.07	1			
Analyst coverage	-0.02	-0.52	-0.69	0.11	0.14	-0.49	0.69	-0.05	0.10	0.21	-0.07	-0.13	0.05	0.29	0.00	0.10	0.09	0.24	0.02	0.31	1		
Blocks	-0.01	-0.21	-0.30	0.08	-0.03	-0.12	0.27	0.01	-0.08	0.11	-0.03	-0.12	-0.01	0.03	-0.03	-0.07	0.06	0.11	0.04	0.07	0.20	1	
Non-blocks	-0.03	-0.52	-0.85	0.16	0.02	-0.52	0.74	-0.06	0.09	0.29	-0.09	-0.16	0.04	0.29	-0.06	0.00	0.13	0.27	0.05	0.33	0.70	0.33	1

Table 3

Baseline 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 $\text{ratio}_{i,t} = \beta_0 + \beta_1 \text{Liquidity}_{i,t-1} + \beta_2 \text{Inst\_turn}_{i,t-1} + \beta_3 \text{Fluidity}_{i,t-1} + \mathbf{\Gamma}' \mathbf{Z}_{i,t} + \varepsilon_{i,t}$, where Liquidity is *ILLIQ*_res, *ILLIQ*, Log_resprd_res, or Log_resprd, $\mathbf{Z}$ is a vector of control variables, and $\mathbf{\Gamma}$ is a vector of coefficients. The sample period varies with the availability of Liquidity, Inst_turn, Fluidity, and control variables, as indicated in the top row. Industry (Fama-French, 48 sectors) and year fixed effects are included in Columns (1) to (10). Firm and year fixed effects are included in Columns (11) and (12). t-statistics are based on firm-clustered standard errors. Statistical significance at the 1%, 5% and 10% level is indicated by $\boldsymbol{a}$, $\boldsymbol{b}$, and $\boldsymbol{c}$ respectively. A * indicates that the coefficient is multiplied by 100.

	1964-2010		1971-2010		1981-2010		1998-2009					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$ILLIQ\_res^{*}_{t-1}$	-0.091^{a}		-0.086^{a}		-0.063^{a}		-0.050^{a}				-0.023^{a}	
	(-17.39)		(-16.40)		(-10.47)		(-5.45)				(-2.78)	
$ILLIQ^{*}_{t-1}$		-0.079^{a}		-0.080^{a}		-0.058^{a}		-0.049^{a}				
		(-16.14)		(-16.25)		(-10.15)		(-5.39)				
$\text{Log\_resprd\_res}_{t-1}$									-0.023^{a}			-0.006^{a}
									(-8.77)			(-2.77)
Log_resprd_{t-1}										-0.017^{a}		
										(-6.57)		
Inst_turn_{t-1}					0.136^{a}	0.140^{a}	0.114^{b}	0.112^{b}	0.140^{a}	0.150^{a}	0.104^{a}	0.112^{a}
					(5.37)	(5.66)	(2.46)	(2.41)	(3.04)	(3.24)	(2.67)	(2.84)
Fluidity_{t-1}							0.009^{a}	0.009^{a}	0.009^{a}	0.009^{a}	0.001	0.001
							(11.47)	(11.46)	(11.66)	(11.66)	(1.27)	(1.34)
Price-nonsynch_res					-0.001^{a}	-0.001^{a}	-0.002^{b}	-0.002^{b}	-0.001	-0.001	-0.001^{b}	-0.001^{c}
					(-2.72)	(-2.64)	(-2.32)	(-2.31)	(-1.43)	(-1.64)	(-1.97)	(-1.95)
Firm size	-0.009^{a}	-0.013^{a}	-0.008^{a}	-0.012^{a}	-0.009^{a}	-0.013^{a}	-0.012^{a}	-0.016^{a}	-0.012^{a}	-0.020^{a}	-0.013^{a}	-0.012^{a}
	(-13.22)	(-17.85)	(-11.47)	(-16.38)	(-11.46)	(-14.08)	(-9.94)	(-11.11)	(-10.06)	(-11.88)	(-2.87)	(-2.83)
Leverage	-0.303^{a}	-0.309^{a}	-0.314^{a}	-0.319^{a}	-0.321^{a}	-0.32 6^{a}	-0.307^{a}	-0.307^{a}	-0.301^{a}	-0.306^{a}	-0.198^{a}	-0.199^{a}
	(-46.75)	(-48.94)	(-45.35)	(-47.20)	(-40.20)	(-41.70)	(-26.03)	(-26.10)	(-25.47)	(-25.80)	(-12.43)	(-12.34)
MTB	0.017^{a}	0.017^{a}	0.014^{a}	0.013^{a}	0.011^{a}	0.011^{a}	0.012^{a}	0.013^{a}	0.011^{a}	0.012^{a}	0.005^{a}	0.005^{a}
	(15.76)	(16.70)	(12.83)	(12.99)	(9.74)	(10.02)	(8.25)	(8.31)	(7.62)	(8.03)	(3.71)	(3.71)
Industry sigma	0.366^{a}	0.389^{a}	0.335^{a}	0.356^{a}	0.266^{a}	0.277^{a}	0.044	0.046	0.036	0.039	0.116	0.119
	(7.88)	(8.41)	(7.13)	(7.61)	(4.89)	(5.13)	(0.55)	(0.57)	(0.44)	(0.48)	(1.21)	(1.24)
Firm age					-0.011^{a}	-0.012^{a}	-0.005^{c}	-0.005^{c}	-0.006^{b}	-0.006^{b}	-0.020^{a}	-0.022^{a}
					(-6.41)	(-7.24)	(-1.82)	(-1.88)	(-2.17)	(-2.10)	(-3.74)	(-3.99)
Net Work. Cap.	-0.269^{a}	-0.266^{a}	-0.288^{a}	-0.287^{a}	-0.304^{a}	-0.304^{a}	-0.307^{a}	-0.307^{a}	-0.304^{a}	-0.305^{a}	-0.259^{a}	-0.259^{a}
	(-35.73)	(-36.04)	(-36.22)	(-36.65)	(-32.69)	(-33.58)	(-22.98)	(-22.97)	(-22.85)	(-22.79)	(-16.90)	(-16.85)
R&D	0.446^{a}	0.448^{a}	0.436^{a}	0.434^{a}	0.399^{a}	0.391^{a}	0.404^{a}	0.403^{a}	0.405^{a}	0.404^{a}	-0.156^{a}	-0.156^{a}
	(18.33)	(19.32)	(17.84)	(18.63)	(15.84)	(16.35)	(11.54)	(11.52)	(11.58)	(11.53)	(-3.05)	(-3.04)

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	1964-2010		1971-2010		1981-2010		1998-2009					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Capex	-0.395^a	-0.382^a	-0.510^a	-0.504^a	-0.576^a	-0.572^a	-0.661^a	-0.660^a	-0.664^a	-0.662^a	-0.400^a	-0.401^a
	(-26.27)	(-26.38)	(-29.29)	(-29.79)	(-29.29)	(-30.13)	(-20.35)	(-20.29)	(-20.44)	(-20.27)	(-13.90)	(-13.90)
Acquisition			-0.381^a	-0.378^a	-0.404^a	-0.404^a	-0.461^a	-0.458^a	-0.469^a	-0.456^a	-0.328^a	-0.329^a
			(-25.88)	(-26.36)	(-25.81)	(-26.48)	(-18.51)	(-18.27)	(-18.61)	(-18.04)	(-16.23)	(-16.17)
Div. dummy	-0.016^a	-0.017^a	-0.015^a	-0.016^a	-0.010^a	-0.011^a	-0.004	-0.004	-0.006	-0.005	0.010^c	0.010^c
	(-6.70)	(-7.22)	(-5.95)	(-6.51)	(-3.49)	(-3.80)	(-0.82)	(-0.84)	(-1.35)	(-1.16)	(1.96)	(1.88)
Cash flow	-0.058^a	-0.056^a	-0.001	0.007	-0.008	-0.002	-0.004	-0.001	-0.004	0.002	0.020	0.020
	(-6.65)	(-6.91)	(-0.06)	(0.81)	(-0.88)	(-0.25)	(-0.28)	(-0.08)	(-0.29)	(0.16)	(1.40)	(1.39)
Net equity issu.			0.128^a	0.138^a	0.121^a	0.129^a	0.094^a	0.098^a	0.100^a	0.107^a	0.152^a	0.154^a
			(14.02)	(16.05)	(12.45)	(14.12)	(6.26)	(6.46)	(6.65)	(6.97)	(10.63)	(10.63)
Net debt issu.			0.182^a	0.188^a	0.194^a	0.198^a	0.204^a	0.208^a	0.195^a	0.207^a	0.174^a	0.173^a
			(11.56)	(12.28)	(11.37)	(12.02)	(6.54)	(6.61)	(6.19)	(6.46)	(7.69)	(7.58)
Equity beta					0.010^a	0.010^a	0.013^a	0.014^a	0.015^a	0.015^a	0.002	0.003
					(6.33)	(6.60)	(5.13)	(5.15)	(5.67)	(5.74)	(1.11)	(1.27)
Analyst coverage_res					0.005^a	0.006^a	0.009^a	0.009^a	0.006^a	0.007^a	0.003	0.003
					(3.72)	(4.34)	(3.78)	(3.80)	(2.62)	(3.00)	(1.13)	(1.01)
Blocks					0.050^a	0.052^a	0.066^a	0.066^a	0.070^a	0.072^a	0.043^a	0.042^a
					(5.23)	(5.49)	(5.29)	(5.25)	(5.72)	(5.85)	(2.75)	(2.72)
Non-blocks_res					0.036^a	0.036^a	0.054^a	0.054^a	0.028^b	0.038^a	0.080^a	0.075^a
					(4.06)	(4.09)	(4.41)	(4.47)	(2.23)	(3.05)	(5.51)	(5.20)
IPO2			0.021^a	0.019^a	0.007^b	0.004	0.019^a	0.019^a	0.020^a	0.019^a	0.004	0.004
			(7.88)	(7.50)	(2.09)	(1.22)	(2.95)	(2.95)	(3.13)	(3.09)	(0.64)	(0.64)
IPO3			0.008^a	0.006^b	-0.005	-0.008^a	-0.004	-0.004	-0.003	-0.004	-0.001	-0.002
			(3.37)	(2.53)	(-1.55)	(-2.82)	(-0.66)	(-0.63)	(-0.61)	(-0.65)	(-0.25)	(-0.30)
IPO4			0.005^b	0.004	-0.004	-0.006^b	0.003	0.003	0.003	0.003	-0.001	-0.001
			(1.98)	(1.61)	(-1.46)	(-2.27)	(0.54)	(0.56)	(0.66)	(0.55)	(-0.18)	(-0.19)
IPO5			0.001	0.000	-0.008^a	-0.010^a	-0.005	-0.005	-0.004	-0.004	-0.005	-0.005
			(0.31)	(0.01)	(-2.96)	(-3.64)	(-1.00)	(-0.97)	(-0.89)	(-0.94)	(-1.16)	(-1.15)
Intercept	0.289^a	0.312^a	0.271^a	0.293^a	0.323^a	0.351^a	0.251^a	0.270^a	0.253^a	0.196^a	0.374^a	0.379^a
	(41.76)	(44.35)	(42.98)	(44.96)	(26.20)	(28.55)	(13.71)	(14.33)	(13.81)	(9.96)	(11.78)	(11.84)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Firm	No	No	No	No	No	No	No	No	No	No	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2_{adj}	0.478	0.480	0.497	0.500	0.511	0.516	0.560	0.559	0.561	0.560	0.844	0.844
N	80,993	84,243	75,974	78,570	57,352	59,473	22,059	22,059	22,038	22,038	22,059	22,038

Table 4

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 (5) of Table 3 [except Fluidity which is from column (8)]; 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.

*These papers study cash savings rather than cash holdings.

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	−	+	Bates, Kahle, and Stulz (2009)
Inst_turn	+	+	Brown, Chen and Shekhar (2011)
Fluidity	+	+	Hoberg, Phillips, and Prabhala (2014), Morellec, Nikolov, and Zucchi (2013)
Price-nonsynchronicity	−	mixed	Fresard (2012)*
Analyst coverage	+	+	Chang (2012)
Panel B: in this paper			
Stock liquidity	+		
Firm age	−		
Equity beta	+		
Blocks	+		
Non-blocks_res	+		

Table 5
Feedback and growth opportunity amplification effects: Cash ratio regressions with growth opportunity interaction terms

This table presents the results from panel regressions with the following specification

$$\begin{aligned}\text{Cash ratio}_{i,t} = &\ \beta_0 + \beta_1\text{Liquidity}_{i,t-1} + \beta_2\text{Liquidity}_{i,t-1} \times \text{HighGrowth}_{i,t-1}\\ &+ \beta_3\text{Inst\_turn}_{i,t-1} + \beta_4\text{Inst\_turn}_{i,t-1} \times \text{HighGrowth}_{i,t-1}\\ &+ \beta_5\text{Competition}_{i,t-1} + \beta_6\text{Competition}_{i,t-1} \times \text{HighGrowth}_{i,t-1}\\ &+ \beta_7\text{HighGrowth}_{i,t-1} + \mathbf{\Gamma}'\mathbf{Z}_{i,t} + \varepsilon_{i,t},\end{aligned}$$

where Liquidity refers to *ILLIQ*_res or Log_resprd_res. $\text{HighGrowth}_{i,t-1}$ is either $\text{HighRD}_{i,t-1}$ or $\text{HighMTB}_{i,t-1}$ which is equal to 1 if R&D, or alternatively MTB, for firm i is above the cross-sectional median in year $t-1$. $\mathbf{Z}$ is a vector of control variables and $\mathbf{\Gamma}$ is a vector of coefficients. The sample period in columns (1) and (2) is 1981 to 2010. The sample period in columns (3) to (6) is 1998 to 2009 (in order to include Fluidity). Industry (Fama-French, 48 sectors) and year fixed effects are included in all regressions. t-statistics 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 the coefficient is multiplied by 100.

	1981-2010		1998-2009			
	(1)	(2)	(3)	(4)	(5)	(6)
$ILLIQ\_res^*_{t-1}$	-0.034$^{\boldsymbol{a}}$	-0.043$^{\boldsymbol{a}}$	-0.031$^{\boldsymbol{a}}$	-0.032$^{\boldsymbol{a}}$		
	(-4.73)	(-6.56)	(-2.86)	(-3.15)		
$ILLIQ\_res_{t-1}\times\text{HighRD}^*_{t-1}$	-0.062$^{\boldsymbol{a}}$		-0.040$^{\boldsymbol{b}}$			
	(-5.65)		(-2.31)			
$ILLIQ\_res_{t-1}\times\text{HighMTB}^*_{t-1}$		-0.060$^{\boldsymbol{a}}$		-0.054$^{\boldsymbol{a}}$		
		(-5.97)		(-3.23)		
$\text{Log\_resprd\_res}_{t-1}$					-0.008$^{\boldsymbol{b}}$	-0.018$^{\boldsymbol{a}}$
					(-2.56)	(-5.50)
$\text{Log\_resprd\_res}_{t-1}\times\text{HighRD}_{t-1}$					-0.028$^{\boldsymbol{a}}$	
					(-5.76)	
$\text{Log\_resprd\_res}_{t-1}\times\text{HighMTB}_{t-1}$						-0.015$^{\boldsymbol{a}}$
						(-3.26)
Inst_turn_{t-1}	-0.046	-0.022	0.005	0.028	0.037	0.046
	(-1.59)	(-0.72)	(0.11)	(0.52)	(0.77)	(0.88)
$\text{Inst\_turn}_{t-1}\times\text{HighRD}_{t-1}$	0.421$^{\boldsymbol{a}}$		0.232$^{\boldsymbol{a}}$		0.215$^{\boldsymbol{b}}$	
	(8.42)		(2.74)		(2.55)	
$\text{Inst\_turn}_{t-1}\times\text{HighMTB}_{t-1}$		0.271$^{\boldsymbol{a}}$		0.126$^{\boldsymbol{c}}$		0.159$^{\boldsymbol{b}}$
		(6.44)		(1.71)		(2.16)
Fluidity_{t-1}			0.002$^{\boldsymbol{b}}$	0.007$^{\boldsymbol{a}}$	0.002$^{\boldsymbol{b}}$	0.007$^{\boldsymbol{a}}$
			(2.13)	(8.24)	(2.14)	(8.29)
$\text{Fluidity}_{t-1}\times\text{HighRD}_{t-1}$			0.014$^{\boldsymbol{a}}$		0.014$^{\boldsymbol{a}}$	
			(11.14)		(11.18)	
$\text{Fluidity}_{t-1}\times\text{HighMTB}_{t-1}$				0.003$^{\boldsymbol{a}}$		0.003$^{\boldsymbol{a}}$
				(2.92)		(2.98)
Price-nonsynch_res	-0.002$^{\boldsymbol{a}}$	-0.002$^{\boldsymbol{a}}$	-0.002$^{\boldsymbol{a}}$	-0.003$^{\boldsymbol{a}}$	-0.002$^{\boldsymbol{b}}$	-0.002$^{\boldsymbol{b}}$
	(-2.90)	(-3.81)	(-2.84)	(-3.10)	(-2.20)	(-2.16)
Firm size	-0.010$^{\boldsymbol{a}}$	-0.009$^{\boldsymbol{a}}$	-0.013$^{\boldsymbol{a}}$	-0.011$^{\boldsymbol{a}}$	-0.013$^{\boldsymbol{a}}$	-0.012$^{\boldsymbol{a}}$
	(-11.92)	(-10.99)	(-10.57)	(-9.00)	(-10.74)	(-9.68)
Leverage	-0.334$^{\boldsymbol{a}}$	-0.324$^{\boldsymbol{a}}$	-0.308$^{\boldsymbol{a}}$	-0.310$^{\boldsymbol{a}}$	-0.307$^{\boldsymbol{a}}$	-0.305$^{\boldsymbol{a}}$
	(-41.70)	(-40.55)	(-26.38)	(-26.15)	(-26.26)	(-25.58)
R&D		0.418$^{\boldsymbol{a}}$		0.418$^{\boldsymbol{a}}$		0.418$^{\boldsymbol{a}}$
		(16.64)		(11.97)		(11.99)

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Table 5 – continued from previous page

	1981-2010		1998-2009			
	(1)	(2)	(3)	(4)	(5)	(6)
HighRD$_{t-1}$	-0.013^{b}		-0.073^{a}		-0.071^{a}	
	(-2.33)		(-6.60)		(-6.51)	
MTB	0.013^{a}		0.013^{a}		0.012^{a}	
	(11.20)		(8.95)		(8.19)	
HighMTB$_{t-1}$		-0.015^{a}		-0.017^{c}		-0.024^{a}
		(-3.36)		(-1.90)		(-2.66)
Industry sigma	0.299^{a}	0.270^{a}	0.076	0.050	0.066	0.043
	(5.32)	(4.98)	(0.94)	(0.61)	(0.80)	(0.53)
Firm age	-0.012^{a}	-0.011^{a}	-0.005^{c}	-0.005^{c}	-0.006^{b}	-0.006^{b}
	(-6.88)	(-6.12)	(-1.88)	(-1.80)	(-2.22)	(-2.22)
Net work. cap.	-0.308^{a}	-0.312^{a}	-0.314^{a}	-0.316^{a}	-0.312^{a}	-0.313^{a}
	(-33.59)	(-34.13)	(-23.76)	(-24.04)	(-23.73)	(-23.85)
Capex	-0.559^{a}	-0.579^{a}	-0.609^{a}	-0.664^{a}	-0.607^{a}	-0.664^{a}
	(-28.29)	(-29.33)	(-18.82)	(-20.38)	(-18.77)	(-20.36)
Acquisition	-0.408^{a}	-0.418^{a}	-0.456^{a}	-0.480^{a}	-0.462^{a}	-0.484^{a}
	(-25.91)	(-26.52)	(-18.77)	(-19.07)	(-19.01)	(-18.98)
Div. dum.	-0.012^{a}	-0.009^{a}	-0.004	-0.001	-0.006	-0.004
	(-4.15)	(-2.89)	(-0.98)	(-0.33)	(-1.36)	(-0.79)
Cash flow	-0.068^{a}	-0.003	-0.061^{a}	0.003	-0.063^{a}	0.003
	(-7.15)	(-0.30)	(-4.54)	(0.23)	(-4.67)	(0.20)
Net equity issu.	0.116^{a}	0.137^{a}	0.085^{a}	0.110^{a}	0.091^{a}	0.117^{a}
	(12.10)	(14.26)	(5.71)	(7.40)	(6.11)	(7.81)
Net debt issu.	0.193^{a}	0.196^{a}	0.190^{a}	0.206^{a}	0.184^{a}	0.197^{a}
	(11.48)	(11.37)	(6.43)	(6.48)	(6.26)	(6.04)
Equity beta	0.011^{a}	0.010^{a}	0.012^{a}	0.014^{a}	0.014^{a}	0.016^{a}
	(7.23)	(6.80)	(4.63)	(5.24)	(5.22)	(5.89)
Analyst coverage_res	0.008^{a}	0.006^{a}	0.009^{a}	0.010^{a}	0.006^{a}	0.007^{a}
	(5.34)	(4.22)	(3.70)	(4.30)	(2.58)	(3.12)
Blocks	0.055^{a}	0.045^{a}	0.072^{a}	0.060^{a}	0.076^{a}	0.063^{a}
	(5.75)	(4.74)	(5.85)	(4.81)	(6.30)	(5.15)
Non-blocks_res	0.036^{a}	0.042^{a}	0.057^{a}	0.061^{a}	0.036^{a}	0.034^{a}
	(4.00)	(4.64)	(4.71)	(4.95)	(2.93)	(2.68)
IPO2	0.006^{c}	0.007^{b}	0.017^{a}	0.019^{a}	0.019^{a}	0.020^{a}
	(1.66)	(2.11)	(2.72)	(2.98)	(3.01)	(3.21)
IPO3	-0.005^{c}	-0.004	-0.002	-0.002	-0.002	-0.002
	(-1.72)	(-1.31)	(-0.43)	(-0.35)	(-0.29)	(-0.37)
IPO4	-0.004	-0.003	0.005	0.004	0.006	0.005
	(-1.54)	(-1.09)	(0.92)	(0.81)	(1.20)	(0.89)
IPO5	-0.008^{a}	-0.008^{a}	-0.003	-0.004	-0.002	-0.004
	(-2.89)	(-2.98)	(-0.65)	(-0.85)	(-0.45)	(-0.76)
Intercept	0.347^{a}	0.347^{a}	0.301^{a}	0.281^{a}	0.303^{a}	0.285^{a}
	(27.90)	(28.36)	(16.23)	(15.49)	(16.39)	(15.78)
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
R^2_{adj}	0.503	0.510	0.560	0.557	0.562	0.559
N	57,352	57,352	22,059	22,059	22,038	22,038

Table 6
Competition amplification effect: Panel regressions of Cash ratio with a liquidity and competition interaction term

This table presents the results from panel regressions with the following specification

$$\text{Cash ratio}_{i,t} = \beta_0 + \beta_1 \text{Liquidity}_{i,t-1} + \beta_2 \text{Liquidity}_{i,t-1} \times \text{HighComp}_{i,t-1} + \mathbf{\Gamma}'\mathbf{Z}_{i,t} + \varepsilon_{i,t},$$

where Liquidity is *ILLIQ*_res or Log_resprd_res, HighComp is an indicator variable for high competition measured by Fluidity or HHI: $\text{HighComp\_Fluid}_{i,t-1}$ ($\text{HighComp\_HHI}_{i,t-1}$) equals 1 if a firm i's Fluidity (HHI) measure is above (below) the cross-sectional median in year $t-1$, and 0 otherwise, $\mathbf{Z}$ is a vector of control variables, and $\mathbf{\Gamma}$ is a vector of coefficients. The sample period is 1998 to 2009. Industry (Fama-French, 48 sectors) and year fixed effects are included in all regressions. t-statistics 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 the coefficient is multiplied by 100.

	(1)	(2)	(3)	(4)
$ILLIQ\_res^{*}_{t-1}$	-0.024^{b}		-0.031^{a}	
	(-2.30)		(-2.84)	
$ILLIQ\_res_{t-1}\times\text{HighComp\_Fluid}^{*}_{t-1}$	-0.065^{a}			
	(-4.01)			
$ILLIQ\_res_{t-1}\times\text{HighComp\_HHI}^{*}_{t-1}$			-0.060^{a}	
			(-4.00)	
$\text{Log\_resprd\_res}_{t-1}$		-0.016^{a}		-0.019^{a}
		(-4.81)		(-5.37)
$\text{Log\_resprd\_res}_{t-1}\times\text{HighComp\_Fluid}_{t-1}$		-0.017^{a}		
		(-3.78)		
$\text{Log\_resprd\_res}_{t-1}\times\text{HighComp\_HHI}_{t-1}$				-0.011^{b}
				(-2.46)
$\text{HighComp\_Fluid}_{t-1}$	0.021^{a}	0.022^{a}		
	(5.57)	(5.76)		
$\text{HighComp\_HHI}_{t-1}$			0.039^{a}	0.039^{a}
			(10.62)	(10.77)
Inst_turn_{t-1}	0.127^{a}	0.160^{a}	0.129^{a}	0.161^{a}
	(2.70)	(3.38)	(2.76)	(3.45)
Price-nonsynch_res	-0.002^{b}	-0.001	-0.002^{b}	-0.001
	(-2.23)	(-1.45)	(-2.46)	(-1.59)
Firm size	-0.010^{a}	-0.010^{a}	-0.012^{a}	-0.012^{a}
	(-8.25)	(-8.54)	(-9.32)	(-9.76)
Leverage	-0.307^{a}	-0.301^{a}	-0.303^{a}	-0.297^{a}
	(-25.67)	(-25.05)	(-25.58)	(-25.04)
MTB	0.012^{a}	0.011^{a}	0.013^{a}	0.012^{a}
	(8.07)	(7.42)	(8.60)	(7.89)
Industry sigma	0.102	0.090	0.109	0.110
	(1.26)	(1.11)	(1.36)	(1.37)
Firm age	-0.008^{a}	-0.009^{a}	-0.009^{a}	-0.010^{a}
	(-3.08)	(-3.45)	(-3.55)	(-4.01)

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Table 6 – continued from previous page

	(1)	(2)	(3)	(4)
Net working capital	-0.315^{a}	-0.313^{a}	-0.313^{a}	-0.310^{a}
	(-23.20)	(-23.05)	(-23.10)	(-22.92)
R&D	0.442^{a}	0.444^{a}	0.405^{a}	0.409^{a}
	(12.52)	(12.60)	(11.66)	(11.76)
Capex	-0.655^{a}	-0.657^{a}	-0.659^{a}	-0.661^{a}
	(-19.74)	(-19.78)	(-19.95)	(-19.99)
Acquisition	-0.466^{a}	-0.472^{a}	-0.458^{a}	-0.465^{a}
	(-18.37)	(-18.31)	(-18.17)	(-18.26)
Dividend dummy	-0.008^{c}	-0.010^{b}	-0.010^{b}	-0.012^{a}
	(-1.94)	(-2.37)	(-2.19)	(-2.64)
Cash flow	-0.011	-0.011	-0.015	-0.015
	(-0.73)	(-0.79)	(-1.06)	(-1.07)
Net equity issuance	0.099^{a}	0.106^{a}	0.100^{a}	0.107^{a}
	(6.48)	(6.93)	(6.54)	(7.01)
Net debt issuance	0.207^{a}	0.197^{a}	0.204^{a}	0.196^{a}
	(6.50)	(6.05)	(6.39)	(6.09)
Equity beta	0.014^{a}	0.016^{a}	0.014^{a}	0.016^{a}
	(5.42)	(6.06)	(5.19)	(5.90)
Analyst coverage_res	0.010^{a}	0.008^{a}	0.009^{a}	0.006^{a}
	(4.32)	(3.24)	(3.79)	(2.65)
Blocks	0.067^{a}	0.070^{a}	0.060^{a}	0.066^{a}
	(5.24)	(5.58)	(4.84)	(5.36)
Non-blocks_res	0.051^{a}	0.025^{c}	0.047^{a}	0.023^{c}
	(4.18)	(1.93)	(3.80)	(1.77)
IPO2	0.018^{a}	0.020^{a}	0.018^{a}	0.019^{a}
	(2.90)	(3.13)	(2.80)	(3.02)
IPO3	-0.004	-0.004	-0.005	-0.005
	(-0.71)	(-0.69)	(-0.88)	(-0.82)
IPO4	0.003	0.004	0.002	0.003
	(0.61)	(0.76)	(0.44)	(0.62)
IPO5	-0.005	-0.004	-0.005	-0.004
	(-0.96)	(-0.87)	(-0.98)	(-0.91)
Intercept	0.295^{a}	0.298^{a}	0.297^{a}	0.300^{a}
	(16.28)	(16.43)	(16.77)	(16.88)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
R^2_{adj}	0.553	0.554	0.558	0.558
N	21,836	21,815	21,828	21,807

Table 7
Difference in difference test using the introduction of tick-size decimalization in 2001

This table reports the results from the following regression

$$\Delta\text{Cash ratio}_i = \beta_0 + \beta_1 \text{Active}_i + \mathbf{\Gamma}'(\Delta \mathbf{Z}_i) + \varepsilon_i,$$

where i refers to firm i, and Δ is a difference operator over the 2-year interval that runs for the year 2000 to the year 2002, i.e. the year before and the year after tick-size decimalization was introduced. The indicator variable Active equals 1 for the 50% most active stocks in 2000, as measured by the number of trades, and 0 otherwise. $\mathbf{Z}$ is a vector of control variables and $\mathbf{\Gamma}$ is a vector of coefficients. β_1 is the difference in difference estimator. Industry (Fama-French, 48 sectors) fixed effects are included in columns (3) and (4). t-statistics are based on White's (1980) heteroscedasticity robust standard errors. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c*** respectively.

	Coefficient (1)	t-value (2)	Coefficient (3)	t-value (4)
Intercept	0.005	0.82	0.019	1.02
Active	**0.018**$^{\boldsymbol{a}}$	**3.09**	**0.018**$^{\boldsymbol{a}}$	**2.86**
Δ Inst_turn	-0.075	-0.72	-0.079	-0.75
Δ Price-nonsynch_res	0.000	0.13	0.000	0.17
Δ Firm size	-0.016	-1.54	-0.011	-1.08
Δ Leverage	-0.255$^{\boldsymbol{a}}$	-7.10	-0.253$^{\boldsymbol{a}}$	-7.02
Δ MTB	0.002	0.58	0.004	1.15
Δ Industry sigma	-0.170	-0.68	-0.853$^{\boldsymbol{b}}$	-2.27
Δ Net working capital	-0.220$^{\boldsymbol{a}}$	-6.30	-0.205$^{\boldsymbol{a}}$	-6.05
Δ R&D	-0.220$^{\boldsymbol{c}}$	-1.77	-0.242$^{\boldsymbol{c}}$	-1.93
Δ Capex	-0.186$^{\boldsymbol{b}}$	-2.50	-0.184$^{\boldsymbol{b}}$	-2.56
Δ Acquisition	-0.233$^{\boldsymbol{a}}$	-4.88	-0.236$^{\boldsymbol{a}}$	-4.80
Δ Dividend dummy	-0.003	-0.33	-0.002	-0.25
Δ Cash flow	0.001	0.02	-0.005	-0.13
Δ Net equity issuance	0.149$^{\boldsymbol{a}}$	5.35	0.156$^{\boldsymbol{a}}$	5.48
Δ Net debt issuance	0.119$^{\boldsymbol{a}}$	2.63	0.117$^{\boldsymbol{a}}$	2.68
Δ Equity beta	-0.008	-1.19	-0.006	-0.91
Δ Analyst coverage_res	-0.004	-0.58	-0.004	-0.56
Δ Blocks	0.074$^{\boldsymbol{b}}$	2.21	0.070$^{\boldsymbol{b}}$	2.06
Δ Non-blocks_res	0.037	1.07	0.019	0.57
Δ IPO1	0.008	0.33	0.007	0.31
Δ IPO2	-0.013	-0.77	-0.004	-0.21
Δ IPO3	0.025	1.49	0.026	1.54
Δ IPO4	-0.005	-0.38	0.000	-0.03
Δ IPO5	0.006	0.49	0.008	0.60
Industry	No		Yes	
R^2_{adj}	0.185		0.183	
N	1,387		1,387	

Table 8

Difference in difference regressions: placebo tests and financial constraint controls

Versions of the following specification are run for all years, 1996 to 2006

$$\Delta\text{Cash ratio}_i = \beta_0 + \beta_1 \text{ACTIVEVAR}_i + \beta_2 \text{Dummy\_FC}_i + \mathbf{\Gamma}'(\Delta \mathbf{Z}_i) + \varepsilon_i,$$

where i refers to firm i, ACTIVEVAR is an indicator variable that is 1 for the 50% most active stocks (defined below), and 0 otherwise, Dummy_FC is an indicator variable that is 1 for the 50% most financially constrained firms (defined below), and 0 otherwise, Δ is the 2-year difference operator (as in Table 7), $\mathbf{Z}$ is a vector of control variables, and $\mathbf{\Gamma}$ is a vector of coefficients. ACTIVEVAR is either Active or Active_res. Active is defined as in Table 7. Active_res is defined analogously, by first running a cross-sectional regression of Active on Firm size for each year and then forming the indicator variable using the residuals. Dummy_FC is either FC_Div, FC_Junk, FC_CP, FC_Small, or FC_Small_res, where the four first of these are as defined in the Appendix. FC_Small_res is defined analogously to FC_Small by first running a cross-sectional regression of Firm size on log(number of trades) for each year, and then forming FC_Small_res using the residuals. The regressions in Column (1) are run without Dummy_FC, and the coefficients on Active are reported. The regressions in the remaining columns are run with Dummy_FC. Each pair of columns (e.g. 2a and 2b) report the coefficients on ACTIVEVAR and Dummy_FC as indicated. Panel A (B) reports the results without (with) industry (Fama-French, 48 sectors) fixed effects. t-statistics are based on White's (1980) heteroscedasticity robust standard errors. Coefficients on ACTIVEVAR for the year 2001 (the year of the introduction of tick-size decimalization) are in bold. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c*** respectively.

		Pairs of regression coefficients									
Year	Active (1)	Active (2a)	FC_Div (2b)	Active (3a)	FC_Junk (3b)	Active (4a)	FC_CP (4b)	Active_res (5a)	FC_Small (5b)	Active_res (6a)	FC_Small_res (6b)
Panel A: No industry fixed effect											
1996	0.003	0.003	-0.005	0.002	-0.007	0.000	-0.007	-0.006	-0.006	-0.002	-0.014^{a}
	(0.72)	(0.52)	(-1.04)	(0.37)	(-1.16)	(-0.01)	(-1.07)	(-1.25)	(-1.18)	(-0.36)	(-2.63)
1997	0.008	0.007	-0.003	0.009	0.003	0.005	0.010	-0.001	-0.012^{b}	0.005	-0.017^{a}
	(1.51)	(1.37)	(-0.66)	(1.49)	(0.49)	(0.93)	(1.38)	(-0.11)	(-2.26)	(0.87)	(-2.89)
1998	0.003	0.002	-0.006	0.000	-0.009	0.002	-0.005	-0.007	-0.010^{c}	-0.003	-0.013^{b}
	(0.49)	(0.35)	(-1.12)	(0.07)	(-1.47)	(0.33)	(-0.71)	(-1.27)	(-1.88)	(-0.51)	(-2.27)
1999	0.002	0.001	-0.007	-0.003	-0.017^{b}	0.006	-0.017^{b}	-0.006	-0.006	-0.006	-0.002
	(0.29)	(0.12)	(-1.32)	(-0.40)	(-2.45)	(0.87)	(-2.32)	(-1.12)	(-1.03)	(-1.01)	(-0.30)
2000	0.000	-0.001	-0.004	-0.002	-0.004	-0.006	-0.008	-0.006	-0.015^{b}	-0.005	-0.004
	(-0.06)	(-0.16)	(-0.69)	(-0.22)	(-0.65)	(-0.72)	(-1.16)	(-1.03)	(-2.43)	(-0.79)	(-0.70)
2001	**0.018^{a}**	**0.021^{a}**	0.013	**0.018^{b}**	-0.001	**0.021^{a}**	0.005	**0.014^{b}**	-0.021^{a}	**0.017^{a}**	-0.005
	(3.09)	**(3.33)**	(2.23)	**(2.56)**	(-0.20)	**(3.10)**	(0.73)	**(2.28)**	(-3.58)	**(2.86)**	(-0.76)
2002	0.007	0.007	-0.006	0.002	-0.019^{a}	-0.003	-0.021^{a}	-0.003	-0.014^{b}	0.004	-0.015^{a}
	(1.35)	(1.19)	(-1.15)	(0.31)	(-2.93)	(-0.41)	(-3.06)	(-0.60)	(-2.43)	(0.66)	(-2.61)
2003	-0.004	-0.006	-0.015^{a}	-0.012^{c}	-0.027^{a}	-0.012^{c}	-0.029^{a}	-0.005	-0.001	0.001	-0.013^{c}
	(-0.68)	(-0.92)	(-2.67)	(-1.74)	(-4.11)	(-1.79)	(-4.26)	(-0.80)	(-0.23)	(0.23)	(-1.87)
2004	-0.001	-0.002	-0.009	-0.004	-0.011^{c}	-0.009	-0.020^{a}	0.005	0.009	0.006	-0.002
	(-0.14)	(-0.31)	(-1.58)	(-0.56)	(-1.68)	(-1.34)	(-2.93)	(0.78)	(1.58)	(0.88)	(-0.38)
2005	0.008	0.008	0.001	0.008	0.001	0.001	0.001	-0.002	0.000	-0.001	-0.003
	(1.44)	(1.43)	(0.11)	(1.31)	(0.13)	(0.13)	(0.19)	(-0.39)	(-0.01)	(-0.14)	(-0.48)
2006	-0.003	-0.001	0.007	-0.003	0.000	0.006	0.018^{b}	-0.003	0.004	-0.005	0.006
	(-0.48)	(-0.18)	(1.26)	(-0.42)	(-0.03)	(0.89)	(2.52)	(-0.49)	(0.74)	(-0.86)	(0.95)

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Table 8 – continued from previous page

		Pairs of regression coefficients									
Year	Active	Active	FC_Div	Active	FC_Junk	Active	FC_CP	Active_res	FC_Small	Active_res	FC_Small_res
	(1)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)
Panel B: With industry fixed effect											
1996	0.002	0.002	-0.004	0.001	-0.004	-0.002	-0.006	-0.006	-0.004	-0.003	-0.011^{c}
	(0.47)	(0.32)	(-0.73)	(0.28)	(-0.69)	(-0.38)	(-0.92)	(-1.19)	(-0.63)	(-0.65)	(-1.85)
1997	0.007	0.006	-0.004	0.008	0.002	0.003	0.008	-0.002	-0.012^{b}	0.003	-0.018^{a}
	(1.33)	(1.14)	(-0.86)	(1.29)	(0.29)	(0.54)	(1.07)	(-0.31)	(-2.09)	(0.59)	(-3.00)
1998	0.002	0.002	-0.003	-0.001	-0.012^{c}	0.002	-0.004	-0.007	-0.009	-0.004	-0.012^{c}
	(0.39)	(0.31)	(-0.52)	(-0.15)	(-1.88)	(0.30)	(-0.63)	(-1.31)	(-1.50)	(-0.67)	(-1.88)
1999	0.004	0.003	-0.004	0.000	-0.015^{b}	0.008	-0.017^{b}	-0.003	-0.006	-0.002	-0.001
	(0.58)	(0.48)	(-0.59)	(-0.06)	(-2.10)	(1.22)	(-2.26)	(-0.56)	(-0.96)	(-0.41)	(-0.23)
2000	-0.002	-0.003	-0.005	-0.003	-0.005	-0.006	-0.007	-0.009	-0.018^{a}	-0.006	-0.005
	(-0.27)	(-0.40)	(-0.91)	(-0.41)	(-0.71)	(-0.81)	(-1.07)	(-1.41)	(-2.65)	(-1.02)	(-0.78)
2001	**0.018^{a}**	**0.019^{a}**	0.009	**0.015^{b}**	-0.008	**0.020^{a}**	-0.002	**0.007**	-0.025^{a}	**0.012^{c}**	-0.010
	(2.86)	**(2.99)**	(1.43)	**(2.13)**	(-1.14)	**(2.98)**	(-0.21)	**(1.09)**	(-4.00)	**(1.95)**	(-1.46)
2002	0.008	0.007	-0.005	0.003	-0.019^{a}	-0.001	-0.022^{a}	-0.006	-0.015^{b}	0.001	-0.016^{a}
	(1.49)	(1.33)	(-0.93)	(0.48)	(-2.72)	(-0.18)	(-3.04)	(-1.11)	(-2.57)	(0.09)	(-2.66)
2003	-0.006	-0.008	-0.015^{a}	-0.014^{b}	-0.027^{a}	-0.014^{b}	-0.031^{a}	-0.002	0.003	0.002	-0.010
	(-0.98)	(-1.28)	(-2.60)	(-2.03)	(-3.97)	(-2.15)	(-4.24)	(-0.32)	(0.43)	(0.25)	(-1.54)
2004	-0.003	-0.004	-0.012^{b}	-0.006	-0.015^{b}	-0.011	-0.021^{a}	0.002	0.011	0.003	-0.004
	(-0.41)	(-0.64)	(-2.05)	(-0.93)	(-2.18)	(-1.63)	(-2.96)	(0.33)	(1.88)	(0.45)	(-0.65)
2005	0.007	0.007	0.002	0.007	0.002	-0.002	0.000	-0.002	0.002	-0.002	-0.001
	(1.20)	(1.23)	(0.37)	(1.14)	(0.26)	(-0.31)	(0.02)	(-0.34)	(0.35)	(-0.26)	(-0.19)
2006	-0.004	-0.001	0.011^{c}	-0.003	0.003	0.005	0.019^{b}	-0.001	0.006	-0.004	0.008
	(-0.62)	(-0.22)	(1.83)	(-0.44)	(0.34)	(0.73)	(2.54)	(-0.22)	(1.01)	(-0.66)	(1.18)

Table 9

Simultaneous equation system

This table displays the results from running a system of two simultaneous equations:

$$\text{(i)} \qquad \text{Cash ratio}_{i,t} = \alpha_0 + \alpha_1 \text{Liquidity}_{i,t} + \sum_{k=2}^{K} \alpha_k Z_{k,i,t-1} + \varepsilon_{i,t},$$

$$\text{(ii)} \qquad \text{Liquidity}_{i,t} = \beta_0 + \beta_1 \text{Cash ratio}_{i,t} + \sum_{l=2}^{L} \beta_l X_{l,i,t-1} + \eta_{i,t},$$

where Liquidity is *ILLIQ_res* or Log_resprd_res, Z_k represents lagged controls in the Cash ratio equation, (i); and X_l represents lagged controls in the stock liquidity equation, (ii). The system is estimated using two-stage least squares (2SLS). In Stage 1, Cash ratio (Liquidity) is regressed on all controls, as listed below from both equations, yielding fitted values $\widehat{\text{Cash ratio}}$ ($\widehat{\text{Liquidity}}$). Excluded instruments are indicated by a dash, –. In Stage 2, $\widehat{\text{Cash ratio}}$ ($\widehat{\text{Liquidity}}$) is used in the Liquidity (Cash ratio) regression in place of Cash ratio (Liquidity). Firm and year fixed effects are used in all regressions. *t*-statistics are based on firm-clustered standard errors. *Panel A* reports the estimation results of the system. *Panel B* reports on validity tests of the instruments. The sample period is from 1998 to 2009, when lagged Fluidity is available. Statistical significance at the 1%, 5% and 10% level is indicated by ***a***, ***b***, and ***c*** respectively. A * indicates that the coefficient is multiplied by 100.

	Liquidity is *ILLIQ_res*				Liquidity is Log_resprd_res			
	Cash ratio		*ILLIQ_res*		Cash ratio		Log_resprd_res	
	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Estimation of the system								
Cash ratio			2.661	0.35			-0.774[a]	-3.67
*ILLIQ_res**	-0.146[a]	-3.75						
Log_resprd_res					-0.036[a]	-3.89		
Inst_turn	0.047	1.22	-21.538[a]	-3.57	0.062[c]	1.65	-0.425[a]	-3.20
Fluidity	0.001[b]	2.24	0.039	0.47	0.002[b]	2.52	0.009[a]	3.13
Price-nonsynch_res	0.001	1.25	-0.016	-0.17	0.001[c]	1.70	0.008[a]	2.92
Firm size	-0.015[a]	-4.26	–		-0.014[a]	-3.94	–	
Leverage	-0.095[a]	-7.53	3.879[a]	2.68	-0.091[a]	-7.23	0.179[a]	3.91
MTB	0.001	0.63	-0.384[a]	-2.59	0.000	0.09	-0.040[a]	-8.65
Industry sigma	-0.097	-1.11	5.358	0.47	-0.152[c]	-1.72	-1.339[a]	-3.55
Firm age	-0.009[b]	-2.40	0.419	0.85	-0.012[a]	-3.15	-0.060[a]	-4.03
Net working capital	-0.107[a]	-8.13	–		-0.101[a]	-7.90	–	
R&D	0.008	0.20	–		0.012	0.29	–	
Capex	-0.285[a]	-11.80	–		-0.274[a]	-11.55	–	
Acquisition	-0.188[a]	-12.87	–		-0.184[a]	-13.03	–	
Dividend dummy	-0.004	-0.87	–		-0.004	-0.87	–	
Cash flow	-0.010	-0.66	-7.684[a]	-4.99	-0.010	-0.68	-0.318[a]	-8.23
Gross equity issuance	0.049[a]	4.20	-4.878[a]	-3.76	0.054[a]	4.67	-0.023	-0.63
Repurchases	-0.074[a]	-3.05	-9.743[a]	-4.07	-0.076[a]	-3.15	-0.522[a]	-5.66
Net debt issuance	0.071[a]	6.20	–		0.069[a]	6.31	–	
Equity beta	0.001	0.43	-1.659[a]	-6.21	0.003	1.58	-0.003	-0.40
Analyst coverage_res	-0.004	-1.63	-1.661[a]	-5.08	-0.003	-1.23	-0.042[a]	-4.37
Blocks	0.026[c]	1.93	0.668	0.38	0.023[c]	1.71	-0.057	-1.03
Non-blocks_res	0.031[b]	2.42	7.133[a]	4.38	-0.009	-0.60	-0.851[a]	-15.26
IPO2	0.004	1.07	–		0.005	1.15	–	
IPO3	0.001	0.33	–		0.002	0.50	–	
IPO4	-0.002	-0.63	–		-0.004	-0.90	–	
IPO5	-0.001	-0.23	–		-0.002	-0.47	–	
Advertising	–		-0.355[c]	-1.84	–		0.014	1.60
Log(Stock price)_res	–		-4.337[a]	-10.69	–		-0.137[a]	-13.26
Stock annual return	–		-2.393[a]	-10.58	–		-0.104[a]	-13.80

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Table 9 – continued from previous page

	Liquidity is *ILLIQ_res*		Liquidity is Log_resprd_res	
	Cash ratio	*ILLIQ_res*	Cash ratio	Log_resprd_res
Panel B: Validity tests of instrumental variables				
Excluded instruments in Cash eq.	Log(Stock price)_res, Stock annual return, Advertising			
Excluded instruments in Liq. eq.	Net work. cap., Acquisition, CapX, R&D, Firm size, Dividend dummy, Net debt issuance, IPO2-IPO5			
Overidentification test				
Hansen J statistic	0.97	8.55	0.80	6.13
χ^2_2 p-value	0.61		0.67	
χ^2_{10} p-value		0.58		0.80
Underidentification test				
Kleibergen-Paap rk LM statistic	234.61	272.39	325.40	272.39
χ^2_3 p-value	0.00		0.00	
χ^2_{11} p-value		0.00		0.00
Weak identification test				
Kleibergen-Paap rk Wald F statistic	63.96	31.24	111.42	31.24
Staiger and Stock (1997) "Rule of thumb"	10	10	10	10
Stock-Yogo weak ID test critical values (0.15 maximal IV size) of a 5% Wald test	12.83	22.06	12.83	22.06