What are the Actual Effects of Cash Holdings? Evidence from the Mutual Fund Industry

What are the Actual Effects of Cash Holdings?
Evidence from the Mutual Fund Industry

By

Haibei Zhao

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ACCEPTANCE

This dissertation was prepared under the direction of the Haibei Zhao Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business Administration in the J. Mack Robinson College of Business of Georgia State University.

Richard Phillips, Dean

DISSERTATION COMMITTEE
Vikas Agarwal
Lixin Huang
Ajay Subramanian
Vikram Nanda

ABSTRACT

I show that mutual fund cash holdings can adversely affect the market liquidity of their stocks. I study the events when a stock's mutual fund owners experience outflows. I find that the stocks held or sold by cash rich funds become more illiquid compared to the case with cash poor funds. Facing investor redemptions, cash poor funds are likely to engage in forced fire sale while cash rich funds are likely to engage in voluntary information sale. Other market participants are unwilling to provide liquidity to stocks held or sold by cash rich funds, since any selling on these stocks is more likely to be due to adverse selection. In contrast, any selling on stocks held or sold by cash poor funds is likely to be driven by funding liquidity needs followed by future price reversal.

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Abstract

I show that mutual fund cash holdings can adversely affect the market liquidity of their stocks. I study the events when a stock's mutual fund owners experience outflows. I find that the stocks held or sold by cash rich funds become more illiquid compared to the case with cash poor funds. Facing investor redemptions, cash poor funds are likely to engage in forced fire sale while cash rich funds are likely to engage in voluntary information sale. Other market participants are unwilling to provide liquidity to stocks held or sold by cash rich funds, since any selling on these stocks is more likely to be due to adverse selection. In contrast, any selling on stocks held or sold by cash poor funds is likely to be driven by funding liquidity needs followed by future price reversal.

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Keywords: liquidity buffers, cash holdings, fire sale, adverse selection.

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1. Introduction

The recent financial crisis brought significant attention to the issue of liquidity risk management. In September 2013, the Financial Stability Oversight Council under the U.S. Department of Treasury released a report that proposed to designate large asset management companies as systemically important financial institutions (SIFIs), and to impose similar liquidity requirements as those for large banks.[1] Recently, the Securities and Exchange Commission voted on September 22, 2015 to propose reforms for open-end mutual funds and exchange-traded funds, including the implementation of mandatory liquidity management programs and fund liquidity requirements such as a three-day liquid asset minimum.[2] These proposals follow the conventional wisdom that liquidity buffers such as cash and cash equivalents can mitigate asset-liability mismatch, thus reduce fire sales, contagions of risk, and run-like behaviors.[3]

While more cash holdings can mitigate the concern about asset fire sales, they raise the concern of information sales. Facing investor redemptions, a cash poor mutual fund is forced to sell some good stocks due to funding liquidity needs. The other traders are willing to provide liquidity to any potential flow-induced trades and buy the stock at a fire sale price. On the other hand, a cash rich mutual fund is not forced to sell after outflows, so it is more likely to sell voluntarily based on adverse information. Facing the informational risk of trading with informed managers, the other market participants are reluctant to be the counterparty of the cash rich funds

1 "Asset Management and Financial Stability", by the Office of Financial Research, September 2013. The liquidity requirements for SIFIs are included in Section. 115(b)(C) and Section 165(b)(1)(ii) of the Dodd Frank Act.
2 SEC Release No. 33-9922. "Three-day liquid asset minimum" means the percentage of the fund's assets invested in three-day liquid assets. Three-day liquid asset means cash and any asset that "could be converted into cash within three business days at a price that does not materially affect the value of that asset immediately prior to sale".
3 I use cash holdings and cash equivalents as the main measure of liquidity buffers and use these terms interchangeably. In the robustness I extend the definition of liquidity buffers by including the very liquid stocks (Huang, 2014) and find the results are robust.

and provide liquidity. Theory suggests that information asymmetry between informed investors and other market participants is a primary determinant of liquidity during normal time (Kyle, 1985; Glosten and Milgrom, 1985). Thus, cash holdings may have a negative impact on stock liquidity due to adverse selection.

I first document that facing investor outflows, the selling from cash rich funds is more likely to be information based. I find that the downward price pressure on stocks sold by cash poor funds is temporary, and stock prices reverse with positive abnormal returns after the selling pressure disappears. On the other hand, the price impact on stocks sold by cash rich funds is permanent, and these stocks have zero or negative future abnormal returns. These finding suggests that the stock sales from cash poor fund are induced by outflows and temporary funding liquidity needs, while those from cash rich fund is discretionary and contains information.

Since cash holdings change the intention of selling, they should also change the other market participants' intention to purchase and provide liquidity. When the stocks held or sold by cash poor funds experience liquidity issues, the other market participants should rationally *anticipate* that the price pressure will likely disappear in the future and would like to buy and profit from price reversals. I find that the subsequent abnormal performance of stocks sold by cash poor funds is around 5% during the next quarter, creating a strong incentive for liquidity provision. Such liquidity providers can be market makers (Hendershott and Seasholes, 2007), hedge funds (James, 2014; Jylha, Rinne and Suominen, 2015), algorithmic traders or quantitative investors (Hendershott, Jones, and Menkveld, 2011), and individuals (Kaniel, Saar and Titman, 2008). On the other hand, any potential selling by cash rich funds is likely to be driven by adverse information. The other traders would be less "sympathetic" about any liquidity issue for stocks held by cash rich funds, since they know the issue is likely due to adverse selection rather

than outflows or funding liquidity needs. These two scenarios correspond well with the traditional literature on the intention of trades. If the potential trades are based on information, stocks become more illiquid (Kyle, 1985; Glosten and Milgrom, 1985); whereas if the potential trades are due to immediacy, the future return reversal creates incentive for liquidity provision (Grossman and Miller, 1988).

The liquidity provision from other traders can be either ex-ante or ex-post, i.e. before or after the selling actions of mutual funds are revealed from the change in their portfolio holdings. After the selling actions of mutual funds are revealed, the other traders should be able to differentiate liquidity sale from information sale based on the fund owners' cash holdings. Before the selling actions are revealed, there is greater information risk of trading stocks held mostly by cash rich funds. These arguments suggest that the stocks either held or sold by cash rich mutual funds should become more illiquid in the future.

I investigate the events when a stock's mutual fund owners experience outflows. I find that the stocks held or sold by cash rich mutual funds indeed become more illiquid compared to the case with cash poor funds.[4] In other words, the funds with little "inside liquidity" such as cash holdings can rely on the "outside liquidity" provision from the marketplace through asset sales. On the other hand, the funds with much inside liquidity actually create more liquidity issues in the marketplace, since the other traders are unwilling to buy and provide liquidity to their asset holdings. In this case, the adverse selection in the market undermines its role in liquidity provision (Malherbe, 2014).

[4] My main tests are based on the stocks whose fund owners on average experience investor outflows. This condition is necessary because with inflows, both cash rich and cash poor funds receive cash from investors. Both would sell based on information so there is no role for cash holdings. See p.496 of Coval and Stafford (2007) for the results on discretionary sale by mutual fund managers. I discuss the case of investor inflows further in Section 4.8.

My findings are consistent with recent theoretical works that suggest cash holdings can have unintended consequences for the illiquid assets on the balance sheet (Bolton, Santos and Scheinkman, 2011; Malherbe, 2014). In these models, it is more efficient to rely on outside liquidity from the market, while the inside liquidity can lead to efficiency loss or market freeze. When informed investors hold more cash, there are fewer good assets for sale on the market because informed investors do not have to sell facing funding liquidity shocks. The other market participants are reluctant to buy and provide liquidity, since they rationally anticipates that the informed investors will not sell unless the assets are lemons. The cash holdings shift the composition between fire sale and information sale, increases the informational risk of trading, and creates a "*liquidity overhang*" problem.

I perform several tests to identify the channel through which cash holdings affect the stock liquidity. I find stronger liquidity overhang problem among stocks subject to greater information asymmetry, i.e. illiquid stocks, small stocks, and stocks with less analyst coverage. Next, previous studies (e.g. Bhojraj, Cho, and Yehuda, 2012; Dyakov, Jiang and Verbeek, 2014) show that mutual funds lose some informational advantage post the Regulation Fair Disclosure (Reg FD), because the corporate insiders are not allowed to selectively disclose material private information to mutual fund managers. I use Reg FD as an exogenous change to the information environment and find weaker effects. Finally, I find no evidence of liquidity overhang for index fund cash holdings, since index funds do not trade actively based on private information.

Having established the baseline results, I next address the endogeneity of cash holdings. First, the level of cash holding is not random but likely to be chosen by the fund managers, suggesting that the baseline results are subject to the omitted variable problem. Fund managers may also face constrains from their investment styles and portfolio liquidity, and cannot use all

the reported cash. I model the determinants of cash on the fund level using variables that can potentially affect the choice of cash, such as fund investment styles, past returns, portfolio liquidity, past flows, rear end load fees, and past flow volatility. My results are robust after controlling for these factors that explain the choice of cash holdings.

Second, fund managers may have the ability to "time" liquidity shocks and hoard cash ex-ante, similar to the precautionary motives of hoarding cash in corporations to hedge future adverse shocks and financial distress (e.g. Opler, Pinkowitz, Stulz, and Williamson, 1999; Bates, Kahle and Stulz, 2009; Acharya, Sergei, and Strebulaev, 2012). Such liquidity timing hypothesis suggests that the baseline results may be due to reverse causality. I address the timing hypothesis in the following ways. First, if mutual fund managers on average have liquidity timing ability, we should expect to see a stronger effect during the crisis period when there is a greater benefit from timing (e.g. Cao et al., 2013; Kacperczyk, Van Nieuwerburgh, and Veldkamp, 2014). On the contrary, I find that during the crisis the fund owners' cash has a positive relation with future stock liquidity. Although inconsistent with liquidity timing, it is consistent with the liquidity overhang hypothesis because the other traders such as hedge funds also suffer from illiquidity during the crisis (Ben-David, Franzoni and Moussawi, 2012; Aragon and Strahan, 2012; Jylha, Rinne and Suominen, 2015) or limits to arbitrage (Shleifer and Vishny, 1997; Gromb and Vayanos, 2002).[5]

Second, the timing hypothesis does not explain the performance results, i.e. why stocks sold by cash rich funds have worse abnormal performance in the future. Third, it is unclear why fund managers have less liquidity timing ability after Reg FD. In contrast, the weaker effects after Reg FD is consistent with the liquidity overhang hypothesis due to the lower informational

[5] This result also confirms the conventional wisdom about the benefits of holding liquidity buffers during the crisis periods, while my main results show the information cost of holding liquidity buffers during normal times when selling is more likely to be driven by private information. The main results are robust excluding the crisis periods.

risk of trading. Finally, I use the fund's unexpected investor flows as an instrument by decomposing past flows into expected and unexpected components. The expected flows are predicted by the fund's past performance, and the unexpected flows are likely to be driven by idiosyncratic redemptions. Since the managers are unaware of the magnitude of the unexpected flow by construction, it should not affect the managers' portfolio allocation choice. Further, since the flows are in the form of cash, they do not have a direct impact on stock liquidity except through the cash holdings, i.e. buy stocks with cash or sell stocks when cash is scarce. I show that the past unexpected flow is strongly related to the beginning of the current quarter's cash holdings, and the results are robust to the instrumental variable test.

My paper is related to several strands of literature. First, my analysis is consistent with the theoretical works by Bolton, Santos and Scheinkman (2011), Malherbe (2014), and related discussions in Holmstrom and Tirole (2011) and Tirole (2011). I show that inside liquidity such as cash holdings adversely affects outside or market liquidity through asset sales and information revelation. Second, my work is related to the fire sale studies which usually impose a strong condition on investor outflows to ensure the sale is not due to information.[6] However, the periods of extreme investor outflows are usually economy wide fly-to-liquidity episodes when all the market participants demand liquidity and face the limits to arbitrage. In contrast, I impose a milder condition and allow for the liquidity provision from other market participants during normal times, when the concern for fire sale is weaker and information sale is stronger. Finally, my study is related to the previous work on the situations when fire sale is mixed with information sale. Alexander, Cici, and Gibson (2007) document when mutual fund managers trade in the opposite direction to their flows (i.e. buy given outflows or sell given inflows), these

[6] Coval and Stafford (2007) require outflows to be below the 10th percentile. Edmans, Goldstein and Jiang (2012) require the fund outflows to be less than –5%.

trades contain information. Huang, Ringgenberg and Zhang (2016) show that part of the price pressure from fire sale is due to funds selling low quality stocks. Neither of them focuses on the role of cash holdings.

My findings have important policy implications. Although liquidity buffers protect illiquid assets from costly fire sale during the financial crisis, the overall effect of liquidity buffers on stock liquidity is negative. Imposing mandatory liquidity requirements during normal times can increase the informational risk of trading and liquidity cost. Since stocks are widely held and traded, all owners and traders bear the negative externality of liquidity overhang. The regulators should consider such adverse selection cost of liquidity requirements and efficiency loss for asset management companies and the market participants.

2. Hypothesis

My first hypothesis is related to the stock returns after the portfolio holding and selling from mutual funds are disclosed. Facing investor redemptions, the funds with little cash are forced to sell some good assets due to flow-induced trades. The downward price pressure on the stock is likely to be temporary, and stock prices should come back to the efficiency level after the selling pressure disappears. On the other hand, the funds with lots of liquidity buffers are likely to sell voluntarily when the managers have private information, and the price impact on the stock is more likely to be permanent. It is clear that these arguments are valid only when the funds experience outflows. With investor inflows, both cash rich and cash poor funds obtain liquidity from investors. Since they both engage in discretionary sales based on private information, there is no role for the cash holdings. Taken together, these arguments lead to the following hypothesis:

H1: Price impact on stocks sold by cash rich mutual funds are more likely to be permanent with subsequent return reversal, while the price impact on stocks sold by cash poor funds are more likely to be temporary with no subsequent return reversal.

Empirically, I follow the literature and focus on the *stock level* analysis by aggregating the fund level information on the individual stocks (e.g. Coval and Stafford, 2007; Edmans, Goldstein and Jiang, 2012; Lou, 2012; Shive and Yun, 2013). The aggregation measures both the net flow and net trades on the stock by mutual fund owners. Regarding the flows, since funds hold a portfolio of stocks, the selling pressure from a given fund may not be strong enough to generate material effect on the stock price. In addition, for a given stock some fund owners may experience outflows and demand liquidity, while others may experience inflows and supply liquidity to the stock. By aggregating the flows on the individual stocks we measure the net effect of fund flows more precisely. Regarding the trades, by aggregating the trades on the individual stocks it helps reduce the noise in the trades such as portfolio rebalancing. For example, Wermers, Yao and Zhao (2012) identify good stocks by aggregating the holdings of superior fund managers. Cohen, Coval, and Pastor (2005) identify skill relying on the similarity between a fund's holdings and the holdings of top managers. I include the detailed variable constructions in the data section.

My second hypothesis is related to the informational risk of trading with cash rich funds, and the implication on the stock liquidity. If cash holding separate the intention to sell, it should also affect the intention to buy and provide liquidity. The other market participants know in advance that the stocks sold by cash poor funds will have positive abnormal return in the future. The other traders would like to provide liquidity to these stocks, anticipating the compensation for liquidity provision from future return reversals.

Previous literature documents ample evidence of liquidity provision from various parties anticipating future return reversals, although they do not related to the role of cash holdings. Grossman and Miller (1988) show theoretically that market makers accommodate immediate liquidity needs and make a profit, where more negative autocorrelation of returns lead to better market liquidity. Hendershott and Seasholes (2007) show that the specialists provide liquidity and are compensated with return reversals. Jylha, Rinne and Suominen (2015) show that hedge funds supply liquidity and benefit from reversals during normal times. Kaniel, Saar and Titman (2008) show that individuals exploit short-term return reversals and provide liquidity to institutions. Hendershott, Jones, and Menkveld (2011) show that algorithm traders improve liquidity. Negal (2012) studies the profitability of return reversals under different market conditions.

On the other hand, if the cash rich funds are indeed more likely to sell bad stocks, the other market participants should anticipate the future risk of trading with these funds before their selling actions are disclosed. Since other traders are unwilling to be the counter party of informed managers, they can infer the informational risk from funds' portfolio holdings, and are less likely to provide liquidity to the stocks held by cash rich funds. In sum, inside liquidity negatively affects outside liquidity. Stocks held by cash rich funds should become more illiquid after the other market participants observe the funds' cash and stock holdings from their disclosure data.

Taken together, these arguments lead to the following hypothesis:

H2 (Liquidity overhang): Ceteris paribus, when the fund owners experience outflows the stocks held or sold by cash rich funds become more illiquid.

My liquidity overhang hypothesis is related to the recent theoretical literature on the effect of liquidity buffers when fire sale is mixed with information sale. Malherbe (2014) builds

a model of self-fulfilling liquidity dry-ups. When the firm's insider tries to sell the illiquid assets, it could be driven by funding liquidity shock and/or adverse private information. If the firm has lots of cash, any asset sale is likely due to bad information instead of funding liquidity. Therefore, market participants will bid down the asset price to the minimum value (Akerlof, 1970). In his liquidity hoarding equilibrium, no good asset is for sale and the market breaks down, which justifies the ex-ante hoarding of internal cash.[7] On the other hand, in the non-hoarding equilibrium the firm with no cash sells some good assets to the market in exchange for liquidity, and other traders are willing to provide liquidity given there is little adverse selection problem. Malherbe (2014) shows that imposing mandatory liquidity requirements strictly reduce welfare in his model due to the loss of investment efficiency.

Related, Bolton, Santos and Scheinkman (2011) model the choice between cash holdings or "inside liquidity", and asset sales or "outside liquidity" from the market. In their less efficient liquidity hoarding equilibrium, the originators of projects hold cash since it is difficult to go to the capital market later in the crisis, when potential buyers with patient capital (hedge funds and pension funds) suspect the asset sales are due to adverse information. On the contrary, in their more efficient delayed trading equilibrium the originators of projects hold less inside liquidity, generate more projects and later rely on outside liquidity from buyers with patient capital.

My third hypothesis relates to the factors that affect the liquidity overhang problem. The liquidity overhang is based on the condition that fire sale is mixed with information asymmetry about asset values. Therefore, I expect to see a stronger effect of cash on stock liquidity when there is more information asymmetry about the underlying stock.

[7] In Malherbe (2014), this future adverse liquidity conditions in the market causes the firm to hoard cash ex-ante, so the equilibrium is self-fulfilling and the causality between cash and asset liquidity goes both ways.

H3: When there is more (less) information asymmetry about the underlying stocks, the liquidity overhang problem is more (less) severe.

I use size, illiquidity, analyst coverage, and R-squared as proxies for information asymmetry. In addition, I use the passage of Reg FD as a shock that reduces information asymmetry between fund managers and the other market participants. Finally, I investigate the implications of cash holdings for index funds since by definition they do not trade based on information.

I next discuss the advantages of using mutual funds as a setting to test the hypothesis. First, information trades and fire sales are both of first order considerations for mutual funds. On the information side, numerous studies show that fund managers possess skill, especially from their holdings and trades. Chen, Jegadeesh and Wermers (2000) show that mutual fund trades contain information about future stock performance. Cremers and Petajisto (2007) and Kacperczyk, Sialm, and Zheng (2008) find skilled managers using active shares and return gap measures from holding and trading data. On the fire sale side, Edelen (1999) argue that open-end mutual funds provide liquidity to investors at a cost due to the mismatch between assets and redemptions. Funds invest in illiquid stocks while redemption payments in general must be made within seven days based on the 1940 Act.

Second, most mutual funds have self-imposed constraints on short sales and borrowings, and among those without the restrictions, very few funds choose to do so. For example, consistent with Almazan et al. (2004) I find that only around 3% of the funds from 1994 to 2013 report the use short sale in their filings to the SEC. Third, fund cash and the underlying stock investments are observable on a quarterly basis. Stocks have readily available market prices and well established liquidity measures. Finally, both the ownership and the cash holdings of mutual

funds should have material impact on stock prices. The average mutual fund ownership on stock is over 10%, and numerous studies show that mutual funds affect stock prices.[8] The average mutual fund cash holding alone is sufficient to satisfy investor redemptions in most cases, e.g. when outflows are above the 20th to 25th percentile of flows (Coval and Stafford, 2007; Shive and Yun, 2013).

3. Data and Variable Constructions

3.1 Fund level data

My empirical analysis is based on the Center for Research in Security Prices (CRSP) and Morningstar database from January 1994 to December 2013.[9] I construct a sample of mutual funds by taking domestic equity funds from CRSP (CRSP style code='E' and 'D') and US equity funds from Morningstar (Morningstar US category ='US Equity' or 'Sector Equity'). For CRSP mutual funds, I merge the return and assets under management (AUM) data with fund characteristics such as cash holdings and load fees using CRSP fund number. For Morningstar mutual funds, I obtain the share class level return and AUM data as well as fund characteristics and aggregate them to the fund level.

In order to merge the mutual fund data with the information on stock holdings, for each CRSP fund I obtain the fund holding data from the Thomson Reuters S12 database and merge them with CRSP mutual fund files using the MFLINK table. For Morningstar, I obtain a sample of mutual fund holding data from Morningstar Corporation and merge them with the fund characteristics data using FUNDID. I then manually merge the information from CRSP and Morningstar to form a union database of fund holdings and characteristics.

[8] See Coval and Stafford (2007); Jotikasthika, Lundblad, and Ramadorai (2012); Lou (2012); Edmans, Goldstein and Jiang (2012); Anton and Polk (2014); and Agarwal et al. (2015).
[9] As discussed in Yan (2006), the cash holdings data are not available prior to the 1990s in the CRSP database. In addition, our holdings data from Morningstar start from January 1994.

Both CRSP and Morningstar report the cash positions of the fund. For each quarter beginning, I obtain the cash holding positions (*mfcash*) of the funds as a percentage of the AUM which may include cash and cash equivalents (such as Treasury bills and money market investments). For robustness, following Huang (2014) I construct a measure of liquidity buffers (*mfbuffer*) to include both cash and very liquid stocks. At each quarter end, I sort all the stocks in CRSP by the Amihud (2002) liquidity measure, constructed from the previous month's return and volume data. I then pick the top 1% most liquid stocks. I add the dollar value of these stocks to the mutual fund cash holdings to obtain the total dollar value of the liquidity buffers. The fund level liquidity buffer *mfbuffer* is the total dollar value of the liquidity buffers as a percentage of the fund's AUM. One may concern that although these top 1% stocks are very liquid, they are still exposed to the market risk and hence not real cash equivalents. I repeat the analysis using a more stringent rule, i.e. a stock has to be very liquid (top 1% liquidity by Amihud) and has very low volatility (bottom 1% by return volatility) to be included and the results are robust.

I compute the mutual fund flows *mfvwflow* from the return and AUM data, i.e.

$$Flow_{i,t} = \frac{AUM_{i,t} - AUM_{i,t-1}(1 + R_{i,t})}{AUM_{i,t-1}} \quad (1)$$

where *t* is the time index and *i* denotes the fund's share class. The fund level flow is a weighted average of share class level flows, weighted by the assets of each share class. I calculate the flow volatility for each individual mutual fund by taking the standard deviation of fund flows over the previous 12 months to obtain *mfflowvol*.

3.2 Stock level data

Our main variable of interest is the collective cash holdings of mutual funds on each stock (*cash*). For each quarter beginning and each stock, I calculate a weighted sum of cash

holdings by mutual funds (*mfcash*) that own the stock, weighted by the percentage of shares outstanding that the funds hold:

$$cash_{j,t} = \sum_{i=1}^{M} mfcash_{i,j,t} * ownership_{i,j,t} \quad (2)$$

where $mfcash_{i,j,t}$ is the cash holdings of mutual fund *i* that holds stock *j* at quarter *t*, $ownership_{i,j,t}$ is the ownership of mutual fund *i* on stock *j* at quarter *t* as a percentage of the stock's total shares outstanding. $cash_{j,t}$ therefore measures the cash holdings of a representative mutual fund that owns the stock. With more fund level cash, the selling is more likely to be information based rather than liquidity based. With more fund ownership, the fund is more likely to trade on the stock given the same amount of cash.

One may conjecture that the beginning of quarter cash plus fund flows during the quarter is another measure of liquidity buffer, which measures the fund's cash holding net of fund flows. This measure would be problematic since it is equal to the end of the quarter cash (plus the cash from fund trading during the quarter) instead of the beginning of the quarter. In addition, it does not differentiate between the effect of flows and cash holdings. Instead, I use the following alternative measures for *cash*: *buffer* which includes highly liquidity stocks, *ivcash* which is the predicted value from a first stage regression of *cash*, and *ecash* which is the fund level excess cash aggregated at the stock level. Similar to *cash*, I use fund ownership to weight *mfbuffer* and calculate the representative mutual fund's liquidity buffers (*buffer*) at the stock level. The difference between *cash* and *buffer* is that the liquidity buffer variable includes cash and cash equivalents as well as the highly liquid stocks. The construction of *ivcash* and *ecash* are discussed in detail in the empirical results.

The stock level flow measure *vwflow* is equal to the fund level flows (*mfvwflow*) weighed by fund ownership. Since I use fund ownership as weights to aggregate fund level flows, *vwflow* is essentially the same with Edmans, Goldstein and Jiang (2012). The only difference is that I scale the numerator by the total number of shares outstanding instead of the total trading volume on the stock, in order to ensure that it is not the denominator that drives the result. As explained in the introduction and hypothesis, my main tests are based on the sample of stocks with negative *vwflow* during the current quarter, i.e. when the representative fund owner experiences outflows. Unlike portfolio disclosure data, the fund flows are observable to market participants at a much higher frequency. For example, Morningstar has daily (estimated) flows as well as returns and AUM data for most funds.

The stock level change of mutual fund holding from previous quarter (*change*) is the collective change in mutual fund ownership in terms of the total number of shares held by all mutual funds on a given stock. The stock level *sell* is a signed variable that is equal to *change* when *change* is negative, and zero otherwise.

I obtain the stock level data from CRSP and construct two measures of stock (il)liquidity. The first one is the Amihud measure (Amihud, 2002) defined as the monthly average of daily price pressure:

$$Amihud = \frac{1}{\mathrm{N}} \sum_{1}^{\mathrm{N}} \frac{|Ret_{j,t}|}{P_{j,t} * Vol_{j,t}} \tag{3}$$

where *t* is the time index for days, N is the number of days in that month, $Ret_{\mathrm{j,t}}$ is the daily return of stock *j*, $P_{j,\mathrm{t}}$ is the closing price and $Vol_{j,t}$ is the daily volume. The Amihud measure captures how the stock prices move for a given level of trading volume. Our second measure of stock (il)liquidity is the relative spread, averaged over the month:

$$Rspread = \frac{1}{\mathrm{N}} \sum_{1}^{\mathrm{N}} \frac{Ask_{j,t} - Bid_{j,t}}{0.5(Ask_{j,t} + Bid_{j,t})}. \quad (4)$$

which captures the transaction cost for round-trip trades.

Since the liquidity measures are skewed, I scale these measures by using the logarithm of the Amihud measures and the relative spread measure in all specifications. I calculate the corresponding change in liquidity measures for the Amihud measure and the relative spread and denote them as *chgami* and *chgspd*, respectively. Finally, our control variables include the end of previous quarter size and book-to-market ratio, the previous quarter's liquidity measures (*loglagami* and *loglagspd*), and the number of analysts covering the firm during the quarter (*numana*) from I/B/E/S. Finally, *size* is the logarithm of market capitalization of the stock and *btm* is the book to market ratio. Table 1 reports the summary statistics of the data that I use for the empirical analysis.

4. Results

4.1 Cash Holdings and Stock Performance

I first check the price impact on stocks sold by cash rich versus cash poor mutual funds. If mutual funds sell based on information, the pressure is permanent and there should be *no* drift in abnormal returns following the trades. On the other hand, if the sale is driven by funding liquidity, we should see *positive* abnormal returns as a compensation for liquidity provision.[10]

The sequence of events is as follows. At the beginning of each quarter, we observe the cash holdings of mutual funds from the previous quarter end. During the quarter, funds receive new information on the stocks and satisfy investor redemptions by making the trading decisions. We then observe the collective selling actions by the funds on a given stock during the quarter

[10] See p.491 of Coval and Stafford (2007).

from the change in portfolio holdings at quarter end from previous quarter end. Next, I compute the future cumulative abnormal returns of the stocks. The event windows are from quarter end to 30, 45 and 60 days after quarter end date, and the estimation period for the Fama and French (1993) model is 250 days before quarter beginning. I do not study longer event windows after quarter end for the abnormal performance, since after the next quarter end the information environment will change after the new disclosures from mutual funds.[11]

I form 5x5 portfolios of future stock abnormal returns sorted on collective mutual funds sale (*sell*) during the quarter and then on the representative owner's cash (*cash*) measured at the quarter beginning. The sorting results using the cumulative abnormal return in different windows after quarter end are reported in Table 2. We see that facing investor outflows, the stocks sold by cash poor funds face temporary price pressure and the future stock returns are indeed positive. On the other hand, the stocks sold by cash rich funds on average have zero or slightly negative future performance, suggesting that these sales are not induced by flows but rather based on information. The abnormal return spreads between the top and bottom groups are economically and statistically significant, range from 4.2% to 10.0% during different event windows.

The portfolios of stocks sold by cash rich funds on average do not have much negative abnormal performance in the future, consistent with the discretionary sale result in Coval and Stafford (2007). The cash rich funds in our sample are likely to have completed their planned trades during the quarter based on private information, and their end of the quarter disclosures do not have much additional predictive power about the future price changes. However, their intra-quarter trades are based on information and the other market participants should consider the risk

[11] Mutual funds may not disclose portfolio holdings immediately after quarter end, since the regulatory deadline for disclosure is 60 days after quarter end. I discuss alternative assumptions about the disclosure dates in the robustness section.

of trading with cash rich funds during the quarter. We discuss the implications of such informational risk on stock liquidity during the current quarter in the next section.[12]

Daniel and Titman (1997) show that stock characteristics explain the cross-sectional variation of stock returns. To ensure that our results capture the difference between fire sale and information sale instead of being driven by stock characteristics, I perform multivariate regression analysis by controlling for the stock characteristics such as size and book to market ratio. I further control for year fixed effects and cluster the standard errors at the stock level, and report the results in Table 3. The interaction term between *cash* and *sell* is positive, suggesting that the difference of future abnormal performance between stocks sold by cash rich compared with cash poor funds is statistically significant. In addition, the coefficients on size and book to market ratio all have the expected signs, and are consistent with the findings in the previous literature. Finally, the coefficient on *sell* is negative, suggesting that when *cash* is zero all sales are liquidity sales, and larger sales create more liquidity pressure with greater future recovery.

It is possible that larger trades are more likely to be driven by information (Easley and O'Hara, 1987) while smaller trades can be driven by other reasons such as portfolio rebalancing. I construct an indicator variable *sellbig* that is equal to one if the selling intensity is above the 75th percentile in the cross-section, and zero otherwise. The results in the last three specifications suggest that larger sales by cash rich funds tend to be more informative. Conditional on a large sale, a one standard deviation change in our cash measure leads to –2.920*0.543% = –1.59% decrease in stock abnormal returns in the 45 day window, *ceteris paribus*. The magnitude is economically significant during this short event window, especially given that we "double" adjust for both the factor exposures and the stock characteristics. Finally, to ensure that the

[12] In untabulated results, I find that when fund owners on average have outflows, the stocks sold by cash rich and cash poor funds both have negative abnormal return during the current quarter.

results are not driven by the crisis period I report the results excluding the financial crisis in the Appendix Table A1. Overall, the magnitudes of the coefficients are slightly lower while still statistically and economically significant. In untabulated tests, I add the daily momentum factor in the calculation of the abnormal returns and the results are robust.[13]

These performance results support our first hypothesis. Previous studies find the level of cash holdings does not have material impact in equity fire sale during periods of extreme investor outflows (Coval and Stafford, 2007). In contrast, I only restrict the representative fund's outflow to be negative, and find that the level of cash holdings does contain information about the future change in stock prices. Given that the average cash holding by mutual funds in our sample is sufficient to satisfy investor redemptions at the 25th percentile of fund outflows, one should expect the cash holding to play an important role in terms of hedging investor redemptions, and change the intention of stock sales. By conditioning on extreme investor outflows the previous literature only identifies the fire sale, while my analysis also includes the information sale. I show that cash holdings change the motivation of asset sales following investor outflows.

4.2 Effects of Cash Holdings on Stock Liquidity

I next investigate the effect of informational risk of trading on stock liquidity. We see from the previous section that the stocks sold by cash poor funds have positive abnormal return in the future. Therefore, before the selling actions are revealed there is an incentive to provide liquidity to these stocks from possible future return reversal. On the other hand, there is no benefit of buying the stocks held by cash poor funds. If anything, there is a higher risk of trading

[13] Note that I do not include stock fixed effects in the performance regressions, since it is difficult to argue that certain stocks always have positive or negative abnormal performance. Including fixed effects would only introduce more noise to the estimations. In Appendix Table A2, I find that the performance results still hold even after including stock fixed effects, although the results are weaker. I control for stock fixed effects in the subsequent liquidity regressions since it is reasonable to assume that certain stocks are (il)liquid.

with informed traders and no positive abnormal return in the future as a compensation for liquidity provision.

In Table 4, I model the determinants of stock liquidity during the current quarter. The liquidity measures in the dependent variables are the Amihud (2002) measure and the relative spread. Our main variable of interest is the beginning of quarter cash holdings of the representative fund owner (*cash*). I also include the interaction terms between *cash* and the liquidity measures to see if the effect is stronger for stocks with more information asymmetry. It is well know that the liquidity measures are highly persistent. I control for the past level of stock liquidity from previous quarter since the past level can affect both the current level and the change in stock liquidity (Agarwal et al., 2015). Finally, I include the usual controls for the size and book to market ratio, and the fixed effects to account for any time-invariant characteristics that may explain stock liquidity such as the firm fixed effects.[14]

Consistent with the second hypothesis, we find that there is a statistically positive relation between the owners' collective cash holdings at quarter beginning and the subsequent change in (Panel A) and level of (Panel B) stock illiquidity during the quarter. The effect of cash holdings is economically significant. For example, we see from Panel A that one standard deviation increase in cash implies 12% to 15% increase in the standard deviation of the change in stock illiquidity among different specifications.

In addition, recall from Table 2 and Table 3 that after the selling action of the mutual funds are revealed, the stocks sold by cash poor funds have a temporary price impact. Therefore, the liquidity provision (or the lack of) can be ex-post or after the selling actions of the mutual

[14] Since I include stock fixed effects, the cash variable already captures the innovation of cash holdings in excess of the average cash holdings in the history of that stock. For robustness, I use first difference fixed effect specification where the cash variable is the difference between current cash holdings and previous quarter's cash holdings. Our results are robust and are reported in Appendix Table A3.

funds are revealed from the change in portfolio holdings. To separate these two effects, in specifications (3) and (4) I include the funds' previous quarter's collective selling intensity on the stock (*sell*) and the interaction term between previous quarter beginning cash and sell (*cashxsell*). We find that the information revelation from previous quarter's sale has some impact on the stock liquidity during the current quarter. When stocks are sold by cash rich mutual funds, market participants learn from this additional piece of information. Since the price impact on these stocks is more likely to be permanent, there is less incentive to trade on the stocks. Moreover, our main results on liquidity overhang during the current quarter are unchanged.

Motivated by the theoretical work (Kyle, 1985; Glosten and Milgrom, 1985), previous literature usually uses the liquidity measures as proxies for the level of information asymmetry. We see that the interaction terms between cash holdings and the illiquidity measures are positive. This supports our third hypothesis, suggesting that the liquidity overhang problem is more severe among stocks with stronger information asymmetry. In the next section, I use alternative measures for information asymmetry on the stock level and check the robustness of the results.

Mutual funds may use both cash and very liquidity stocks to satisfy investor redemptions. I use an alternative definition of liquidity buffers which include both cash and very liquid stocks, and repeat our analysis. Following Huang (2014), the very liquid stocks include the top 1% most liquid stocks sorted by the Amihud (2002) measure in each quarter. I report the results in the Appendix Table A4 and find that our inference is unchanged. These results are not direct extensions of my main results, because the correlation between cash holdings and the amount of liquid stock holdings is negative on the fund level, rather than positive. Finally, we see that the results using the change in and the level of liquidity are very similar, and I focus on the change in stock liquidity for the subsequent analysis.

4.3 Alternative Information Asymmetry Measures

In the previous section, I use the liquidity measures as proxies for information asymmetry. We find supporting evidence that stocks that are more subject to information asymmetry have more liquidity overhang problems. To further test our third hypothesis, I use additional variables as proxies for information asymmetry, such as stock size, the number of analysts following the stock, and the regression R-squared from three factor models.[15] These results are reported in Table 5. We find that the interaction terms between cash holdings and these information asymmetry measures are significant. Specifically, smaller stocks, stocks with less analyst coverage, and stocks with lower R-squared are more subject to the liquidity overhang problem. These results are consistent with our previous findings and lend further support to our third hypothesis. The coefficients on the interaction between *sell* and *cash* become insignificant in some specifications, suggesting that the effect of previous selling by cash rich funds is explained by the other factors such as analyst coverage.

4.4 Endogeneity of Cash Holdings

Since funds with illiquid stocks may hold more cash to protect their underlying stock investments, there is a potential concern about the reverse causality of our test. In other words, managers may be able to time the change in stock liquidity, hoard cash ex-ante and use cash to protect the underlying stock investments from costly fire sales. However, note that our previous tests are conditional on investor outflows, and we focus on the change in liquidity from previous quarter. If funds use liquidity buffers to protect the underlying assets, the stocks held by cash rich funds should become more liquid facing outflows, rather than the reverse. In this section, I conduct three sets of tests to further investigate the alternative story of liquidity timing: the

[15] A higher R-squared measures a higher degree of firm specific information in stock prices (Roll, 1988). Chan and Hameed (2006) show that greater analyst coverage increases stock R-squared.

results during the recent financial crisis, the test using instrument variables, and the tests using excess cash holdings.

4.4.1 Results during Financial Crisis

If mutual fund managers possess liquidity timing ability on the stock level, it is reasonable to conjecture that such ability is stronger during the crisis period when there is greater benefit from timing. Cao et al. (2013) show stronger liquidity timing skills for hedge fund managers during the crisis, while Kacperczyk, Van Nieuwerburgh, and Veldkamp (2014) find stronger market timing ability for mutual fund managers during recessions. In Table 6, I restrict the sample period to the recent financial crisis from the fourth quarter of 2007 to the first quarter of 2009. We see that if anything, the results show zero or negative aforementioned timing ability from mutual fund managers. The coefficients on cash and the interaction terms between cash and stock liquidity are negative, suggesting that the timing hypothesis does not explain our results.

This result supports the conventional wisdom about the benefits of holding liquidity buffers during the crisis periods. Facing investor redemptions, the cash buffer can protect the illiquid stocks from costly fire sale during the financial crisis. In the flight to liquidity episode there is little liquidity supply in the market. Ben-David, Franzoni and Moussawi (2012), Aragon and Strahan (2012) and Jylha, Rinne and Suominen (2015) show that hedge funds demand liquidity during the crisis period although they provide liquidity during normal times (Jylha, Rinne and Suominen, 2015). If sophisticated investors such as hedge funds also suffer from illiquidity during financial crisis, there is no provision for liquidity for the fire sale stocks. In sum, the results from the crisis period are consistent with the mechanisms in the liquidity overhang hypothesis, but do not support the strategic liquidity timing.

4.4.2 Results Using Instrumental Variable

To further explore the robustness of our result, I calculate the stock level unexpected flows from investors from previous quarter as an instrument for the beginning of quarter *cash*. I then model the determinants of *cash* on the stock level in the first stage regression and test its effect on stock liquidity in the second stage.

The stock level unexpected flow *unexp_flow* is calculated in a similar way to the stock level flow measure *vwflow*. I first obtain the fund level unexpected flow and then aggregate them on the stock level using fund ownership on the stock as weights. This aggregation procedure is similar to Edmans, Goldstein and Jiang (2012), although I scale the dollar flows by the total number of shares outstanding instead of the total trading volume such that our measure is not driven by the change in the denominator. The fund level unexpected flows are the regression residuals by regressing past quarter's flows on the previous two quarters' flows and returns. In order for the flows to be unexpected, I use the information known to the manager up to date to estimate the flow (Shive and Yun, 2013). The out-of-sample prediction model to estimate the flows for fund *k* from the previous two quarters' (*t*-1 and *t*-2) returns and flows is as follows:

$$E_{t-1}(flow_{k,t}) = \sum_{\tau=1}^{2} \alpha_{k,t} * flow_{k,t-\tau} + \sum_{\tau=1}^{2} \beta_{k,t} * Ret_{k,t-\tau} \quad (5)$$

The fund level unexpected flow is the residual from the above regression, which is measured in the quarter before the current cash holdings. If the flows are unexpected, it should not affect the managers' portfolio allocation choice. In addition, the investor flows are in the form of cash flows. The flows do not affect stock liquidity except through the cash holdings, when the managers buy stocks with cash or sell stocks when cash is scarce. After I obtain the fund level unexpected flow I aggregate them on the stock level to compute *unexp_flow* using fund ownership as weights.

I report the regression results of the two-stage least squares in Table 7, Panels A and B. We see from Panel A that the past unexpected flow is strongly related to the beginning of the current quarter's cash holdings. Since our second stage variables include the interaction terms with cash, I use the predicted values for cash from the first stage regression (*ivcash*) and interact them with the corresponding variables in the second stage. The results from Panel B suggest that our main results are robust to the instrumental variable tests.

4.4.3 Results Using Excess Cash

The results in Panel B of Table 7 aggregate all the information on the stock level first and then modeling the determinants of cash. Alternatively, one can model the determinants on the fund level first and then aggregate the residual cash on the stock level. However, under this specification the unexpected flow is not an instrument since our second stage is on stock level, instead of fund. The benefit of this specification is that we can control for the choice of cash on the fund level using fund characteristics. I model the cash holdings on the fund level by controlling for a set of variables that are related to manager's choice of cash. Specifically, the coefficient estimates for the model are:

$$cash_{i,t} = 0.758cash_{i,t-1} + 0.003portliq_{i,t} + 0.008ret_{i,[t-1,t]} + 0.946mfflowvol_{i,[t-4,t]} + 0.503mfvwflow_{i,[t-1,t]} - 0.038rear_{i,t} + style\ FE + Year\ FE \quad (6)$$

where $cash_{i,t}$ is the cash level at the current quarter beginning, $cash_{i,t-1}$ is the cash level from previous quarter beginning, $portliq_{i,t}$ is the portfolio liquidity measured by Amihud (2002), $ret_{i,[t-1,t]}$ is the previous quarter's fund return, $mfflowvol_{i,[t-4,t]}$ is the fund flow volatility during the past 12 months, $mfvwflow_{i,[t-1,t]}$ is the fund flow from past quarter, and $rear_{i,t}$ is an indicator variable that is equal to one if the fund charges rear end load fees. The fund level

excess cash is the regression residual from the model. I then aggregate funds' excess cash on the stock level using fund ownership as weights to compute the stock level excess cash (*ecash*).

The economic motivation for using excess cash is the fund managers may not be able to use all the cash holdings for investor redemptions. The explanatory variables in equation (6) capture the restrictions that the fund managers face to maintain a certain level of cash holdings. Therefore, the excess cash is a proxy for the discretionary cash holding by the fund manager. I repeat the determinants of stock liquidity in Panel C using *ecash* and find that our results are robust to this alternative specification.

4.5 Evidence from Index Funds

The subsample of index funds provides an interesting setting to further illustrate our idea. The purpose to set up an index fund is to track the index portfolio, rather than delivering abnormal return to investors. Therefore, we should not see the liquidity overhang problem for these index fund owners because there is no information sale. I report the results on index funds in Table 8 by separating the collective mutual fund holdings on the stock into two parts, one by index funds (*indcash*) and the other one by active funds (*cash*), respectively. For the convenience of reporting I normalize the cash holdings variable for index funds by multiplying it by 100 since the magnitude of the variable is small.[16] There are several findings from the index funds analysis. First, the coefficient on index fund cash holdings is negative, which is the opposite of our finding for active mutual funds. Since there is no concern for information asymmetry, the fire sale or liquidity hedging effect dominates for the index funds. With more cash holdings, there is less price pressure on the underlying investments facing investor redemptions. Second, the

[16] The small magnitude of *indcash* on the stock level is due to the fact that we have much fewer index funds in our sample compared with active funds, not because index funds hold much less cash than active funds. The cash holding by index funds is likely due to tracking errors. Empirically, the fund level cash holdings between active and index funds are comparable in magnitude.

interactions between index fund cash holdings and illiquidity measures are negative. This evidence suggests that the hedging effect of liquidity buffers is stronger among illiquid stocks. Collectively, the results in this section show that when we close the adverse selection channel there is no concern for informational trading, and the stocks do not suffer from the liquidity overhang problem.

4.6 Evidence from Regulation Fair Disclosure

There is much evidence on the effect of Regulation Fair Disclosure (Reg FD) as an exogenous change to the information environment in the market. In the setting of mutual fund industry, Bhojraj, Cho, and Yehuda (2012) and Dyakov, Jiang and Verbeek (2014) show that mutual fund managers lose some informational advantage since post Reg FD the corporate insiders cannot selectively disclose material information to these managers. If the economic intuition of liquidity overhang is correct, then facing a reducing of private information there is less risk of trading with cash rich mutual funds. I construct an indicator variable that is equal to one after the passage of Reg FD (zero from 1994Q1 to 2000Q3, and one from 2001Q1 to 2013Q4), and interact the indicator variable with the cash holdings (*cash*). I do not include the indicator variable itself since it is correlated with the year fixed effects. I present the results with such interaction terms in Table 9. The coefficients on the interaction term are negative among different specifications, suggesting that the effect of liquidity overhang is indeed weaker after the passage of Reg FD.

4.7 Alternative Assumption on Fund Filing Dates

The tests so far assume that the information on mutual fund cash and stock holdings is available to the market participants after quarter end. The market may obtain such information from fund disclosure documents to investors, fund voluntary disclosure to the SEC, and fund

disclosure to the commercial database. However, mutual funds have the discretion to withhold disclosure report to SEC until 60 days after the quarter end. In this section, I re-compute the change in stock liquidity measures under the assumption that the information on stock holdings and cash positions are available after the regulatory filing deadline. All the liquidity measures are therefore measured during the [t+60, t+90] window where t is the quarter end date. I report the results in Table 10. Overall, our results are robust to the alternative assumption on mutual fund disclosure dates.

4.8 Investor Inflows

Our main tests are conditional on collective investor outflows on the stock. In this section, I investigate how the previous results change when there are collective investor inflows on a given stock. One may conjecture that with investor inflows, it is possible that the selling contains even more adverse information about the underlying assets because the funds have more cash. Related, when funds with little cash buy the stocks, their orders are likely to be more informative since they have to sell other stocks at a cost. I argue that the predictions for investor inflow are unclear due to the following reasons. First, after getting investor inflows all sales are discretionary. Both cash rich and cash poor funds obtain liquidity from investors, and there is no role for cash holdings. On the other hand, facing investor outflows the fund is forced to liquidate the underlying assets or use the liquidity buffers. Second, funds have the discretion to buy any stock on the market. If the stocks become illiquid, the fund doesn't need to buy when it's costly. On the other hand, with investor outflows the fund has to sell the stocks that are already in its portfolio, unless the mutual fund borrows or shorts the stocks which are relatively rare. In sum, the main difference is with investor outflows, the fund without enough liquidity buffers is forced to sell, while with investor inflows, all buy and sell decisions are discretionary. Koch, Ruenzi

and Starks (2016) analyze the effect of flows on the commonality of stock liquidity, and find little effect when fund owners experience investor inflows yet strong effect for outflows.

In Table 11 I repeat our main tests conditional on investor inflows. I do not find a relation between mutual fund cash holdings and stock liquidity. This result confirms that when all trades are discretionary there is little role for cash holdings, since trades are primarily discretionary and driven by information (Coval and Stafford, 2007).

4.9 Additional Robustness

In the last section, I include additional robustness checks and report the results in the Appendix Table A5. First, instead of using the entire sample period I focus on the normal times excluding the recent financial crisis from 2007Q4 to 2009Q1. Since we see from Table 6 that during the crisis the coefficients are the opposite to those in the main tests, we should expect that the results using only normal times to be robust, since including the crisis period can only bias against our findings. In Panel A and Panel B of Table A5, we see that the results on cash holdings and the interaction terms are positive, whether we use the change of liquidity as independent variable in Panel A or the level in Panel B.

Second, our stock level cash measure is a weighted average of fund cash, weighted by fund ownership. One may concern that it is fund ownership that affects stock liquidity, instead of fund cash holdings. I include total mutual fund ownership on the stock as an additional control variable and repeat the analysis in Panel C and D, using the change and level of stock liquidity as dependent variables, respectively. The coefficient on fund ownership is negative, which suggests that funds tend to own more liquid stocks facing investor outflows. An alternative explanation is when funds owners have outflows, if they do not reduce ownership on certain stocks then these

stocks face less price pressure and are relatively more liquid. I do not differentiate between these two explanations since it is not the main focus of this paper.

In addition, I include the fund owners' flows (*vwflow*) as an addition control variable in Panel C and D. If the funds experience fire sale and engage in flow induced trades, then the coefficients on fund owner's flow should be negative. We observe that the coefficients on *vwflow* are either positive or insignificant. The reason is we only condition the sample on negative outflows, so the fire sale is mixed with information sale. Holding cash constant, more outflows can lead to more fire sale which causes the drop in stock liquidity, but fewer outflows can lead to more information sale which can also cause the drop in stock liquidity. The fact that the coefficient on *vwflow* is positive suggests that a significant portion of stock trades is due to information. This finding is also consistent with our main result on *cash* which has a negative impact on stock liquidity. In general, the positive coefficients on *cash* and *vwflow* indicate that more inside liquidity negatively affect the outside market liquidity on stocks. More importantly, the results on cash and the interaction terms are robust to the inclusion of these control variables.

Third, in the main results we focus on the events when the stock owners on average experience outflows during the quarter. The reason is nowadays the market participants should be able to observe concurrent fund flows from data providers such as Morningstar on monthly or even daily frequency. Arguably, it is possible that the information on concurrent fund flows is not available to some market participants. Therefore, in Panel E and F I repeat the analysis by conditioning the sample on expected negative flows from mutual fund owners, instead of the actual or realized negative flows. The expected flows are estimated using equation (5) which is free of look-ahead bias. The results from the change and level of liquidity in Panel E and F suggest that the results are not sensitive to the conditioning criterion.

5. Conclusion

I show that liquidity buffers such as cash holdings can change the informed trader's intention to sell assets, and hence the other market participants' intention to buy and provide liquidity. These results are in stark contrast with previous literature on the effect of liquidity buffers. The bank run literature argues that liquidity buffers can reduce run-like behaviors (Diamond and Dybvig, 1983). Liu and Mello (2011) analyze a model of fund runs and show that hedge funds need to hold more cash than the first-best level to pre-empt runs. Chen, Goldstein and Jiang (2010) find flows are more sensitive to performance when mutual funds hold more illiquid assets, since investors are more concerned about strategic redemptions from others. Moreover, the fire sale literature argues that fire sale caused by funding liquidity shocks can be costly for financial institutions (Shleifer and Vishny, 1992, 1997; Brunnermeier and Pedersen, 2009). Liquidity buffers should help reduce the extent of asset fire sale. However, funds also trade based on private information. Although liquidity buffers can reduce the probability of selling, I show that they can increase the transaction cost of asset sales when the informed trader goes to the capital market for external liquidity provision.

I find supporting evidence for the liquidity overhang hypothesis: inside liquidity adversely affects outside liquidity. I find stronger effect of liquidity overhang for small stocks, illiquid stocks, and stocks with less analyst coverage, and weaker effect after the passage of Reg FD. I use instrumental variables and control for the determinants of cash holdings and find robust results. The results using index funds and investor inflows lend further support to my hypothesis. My results have implications on the liquidity requirements asset management companies and capital structure choices in corporations when they finance through asset sales.

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Table 1: Summary Statistics

This table reports the summary statistics of the variables. Panel A reports the mutual fund variables. *mfcash* is the cash holdings reported by mutual funds as a percentage of fund's AUM. *mfbuffer* is the liquidity buffers held by the fund as a percentage of fund's AUM, including cash and the top 1% liquid stocks ranked by the Amihud (2002) measure during the quarter. *mfflow* is the average flows on the fund level, weighted by the assets in each share class. *mfflowvol* is the volatility of monthly fund flows during the past 12 months. *aum* is the logarithm of asset under management in millions. P25 and P75 denote the summary statistics at the 25th and 75th percentile, respectively. The summary statistics are based on 200,367 fund-quarter observations from January 1994 to December 2013. Panel B reports the stock level variables on the quarterly frequency: *cash*, *buffer*, and *vwflow* are the mutual fund cash holdings, liquidity buffers, and flows aggregated on the stock level, weighted by the percentage ownership of stock held by each fund. *numana* is the number of analysts following the stock during the quarter, *ownership* is the collective mutual fund ownership on the stock, *size* is the logarithm of the stock size, *btm* is the book to market ratio, *chgami* and *chgspd* are the changes of logarithm Amihud and logarithm relative spread measures, and *logami* and *logspd* are the logarithm Amihud and logarithm relative spread measures. The summary statistics are based on 425,733 stock-quarter observations from January 1994 to December 2013.

Panel A: Mutual Fund Variables

Variables	**P25**	**Mean**	**Median**	**STD**	**P75**
mfcash	0.62%	3.48%	2.22%	4.28%	4.62%
mfbuffer	0.91%	8.33%	2.95%	13.34%	7.67%
mfflow	–0.039	0.028	0.013	0.140	0.088
mfflowvol	0.028	0.061	0.051	0.050	0.079
aum	54.8	774.1	199.2	1587.0	695.1

Panel B: Stock Variables

Variables	**P25**	**Mean**	**Median**	**STD**	**P75**
cash	0.014%	0.405%	0.167%	0.543%	0.603%
buffer	0.036%	0.621%	0.308%	0.852%	0.871%
vwflow	–0.24%	3.71%	3.41%	8.39%	7.78%
chgami	–0.501	–0.029	–0.006	0.958	0.478
chgspd	0.76	1.08	0.97	0.76	1.23
logami	–19.83	–17.41	–17.55	3.20	–15.08
logspd	–6.17	–4.92	–4.67	1.56	–3.71
rsq	0.184	0.362	0.328	0.216	0.519
numana	1.000	2.734	2.000	2.296	3.000
ownership	0.011	0.115	0.054	0.408	0.174
size	11.35	12.72	12.63	1.94	13.98
btm	0.30	0.66	0.53	0.56	0.84

Table 2 Stock Abnormal Returns Sorted on Sell and Cash

This table reports the sorting results of stock abnormal returns based on the Fama and French (1993) 3-factor model. The event windows are from current quarter end to 30, 45 and 60 days after quarter end in Panels A, B and C, respectively. In each Panel, the stocks whose fund owners experience outflows during the quarter are sorted into 5x5 portfolios based on collective mutual funds sale (*sell*) and then on stock level cash measure (*cash*). *sell* is measured during the current quarter, and *cash* is measured at the beginning of current quarter.

Panel A

	1 (Sell Low)	2	3	4	5 (Sell High)
1 (Cash Poor)	0.070	0.083	0.053	0.041	0.052
2	0.057	0.041	0.033	0.019	0.021
3	0.051	0.017	–0.001	0.005	0.014
4	0.025	0.031	0.011	–0.019	0.006
5 (Cash Rich)	0.026	0.014	0.006	–0.008	0.008
Diff (1–5)	0.045	0.069	0.047	0.049	0.044
t–stat	3.02	5.08	3.61	3.61	3.69

Panel B

	1 (Sell Low)	2	3	4	5 (Sell High)
1 (Cash Poor)	0.067	0.085	0.049	0.028	0.050
2	0.055	0.024	0.027	0.017	0.026
3	0.035	–0.001	–0.015	–0.014	0.008
4	0.013	0.014	–0.011	–0.036	0.007
5 (Cash Rich)	0.016	0.007	–0.014	–0.018	0.008
Diff (1–5)	0.051	0.078	0.063	0.046	0.042
t–stat	2.93	4.55	3.70	2.83	2.92

Panel C

	1 (Sell Low)	2	3	4	5 (Sell High)
1 (Cash Poor)	0.090	0.124	0.081	0.059	0.093
2	0.087	0.049	0.042	0.029	0.041
3	0.045	0.023	–0.015	–0.006	0.027
4	0.021	0.036	0.001	–0.020	0.011
5 (Cash Rich)	0.035	0.024	–0.004	–0.010	0.022
Diff (1–5)	0.055	0.100	0.084	0.069	0.072
t–stat	2.74	4.96	4.29	3.60	2.92

Table 3 Predicting Future Abnormal Stock Returns

This table reports the regression results on the future abnormal returns. *car_1*, *car_2* and *car_3* are the stock's abnormal returns using the Fama and French (1993) 3-factor model 30, 45 and 60 days after quarter end, respectively. *sellbig* is an indicator variable that is equal to one if the selling intensity is above the 75th percentile, and zero otherwise. *cashxsell* and *cashxsellbig* denote the interaction terms between *cash* and the corresponding variables. The other variables are defined in previous tables. The regressions control for the year fixed effects and the standard errors are clustered at the stock level.

	(1) *car_1*	(2) *car_2*	(3) *car_ 3*	(4) *car_ 1*	(5) *car_ 2*	(6) *car_ 3*
cashxsell	0.403***	0.509***	0.697***	0.183**	0.206**	0.354***
	(5.82)	(6.14)	(7.64)	(2.43)	(2.26)	(3.41)
sell	–0.015***	–0.021***	–0.025***	–0.012***	–0.017***	–0.020***
	(–18.95)	(–22.13)	(–24.02)	(–14.44)	(–16.84)	(–18.20)
cashxsellbig				–2.118***	–2.920***	–3.360***
				(–4.58)	(–5.23)	(–5.28)
sellbig				0.063***	0.092***	0.103***
				(11.26)	(13.17)	(13.32)
cash	1.312***	1.916***	2.192***	1.309***	1.824***	2.126***
	(5.42)	(6.70)	(6.53)	(4.27)	(5.08)	(5.23)
vwflow	0.086***	0.095**	0.157***	0.092***	0.104***	0.167***
	(2.93)	(2.57)	(3.76)	(3.12)	(2.81)	(3.99)
size	–0.052***	–0.067***	–0.077***	–0.057***	–0.073***	–0.084***
	(–39.46)	(–41.12)	(–43.23)	(–40.27)	(–42.45)	(–44.58)
btm	–0.002	–0.009***	–0.008**	–0.003	–0.011***	–0.010***
	(–0.81)	(–2.74)	(–2.32)	(–1.27)	(–3.28)	(–2.87)
Constant	0.597***	0.766***	0.890***	0.646***	0.839***	0.972***
	(35.30)	(36.68)	(38.57)	(36.44)	(38.33)	(40.25)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	62,316	62,316	62,316	62,316	62,316	62,316
Adj. R^2 (%)	0.072	0.066	0.07	0.076	0.071	0.075

Table 4: Determinants of Stock Liquidity

This table reports the regression results on the change and the level of stock liquidity using the Amihud (2002) measure (specifications 1 and 3) and the relative spread (specifications 2 and 4). *cash* is the average cash holdings by mutual funds that own the stock, weighted by mutual fund ownership. *cashxami*, *cashxspd*, and *cashxsell* are the interaction variables between cash holdings and the Amihud measure, relative spread measure, and collective mutual fund sales from previous quarter, respectively. Panel A presents the change in stock liquidity from previous quarter. Panel B reports the level of stock liquidity during the current quarter. The other variables are defined in previous tables. The regressions control for the year and stock fixed effects and the standard errors are clustered at the stock level.

Panel A

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
cash	26.547***	20.128***	31.459***	22.448***
	(4.13)	(5.14)	(4.57)	(5.49)
cashxami	1.503***		1.842***	
	(4.31)		(4.81)	
cashxspd		2.438**		3.035***
		(2.54)		(2.91)
cashxsell			–0.927***	–0.928**
			(–3.58)	(–2.56)
sell			0.008***	0.002
			(2.58)	(0.30)
ownership	–0.501***	–0.964***	–0.493***	–0.989***
	(–5.33)	(–3.62)	(–5.54)	(–3.60)
vwflow	–0.030	0.567***	–0.032	0.585***
	(–0.31)	(6.69)	(–0.32)	(6.98)
loglagami	–0.551***		–0.553***	
	(–103.33)		(–102.82)	
loglagspd		–0.558***		–0.562***
		(–39.97)		(–39.92)
size	–0.878***	–0.382***	–0.878***	–0.383***
	(–86.73)	(–39.94)	(–87.13)	(–39.50)
btm	0.064***	0.044***	0.064***	0.044***
	(6.91)	(4.98)	(6.98)	(4.96)
Constant	2.037***	3.627***	2.009***	3.624***
	(21.78)	(40.06)	(21.36)	(40.43)
Stock and Year FE	Yes	Yes	Yes	Yes
Observations	62,365	62,060	62,365	62,060
R–squared	0.451	0.236	0.451	0.236

Panel B

	(1) *logami*	(2) *logspd*	(3) *logami*	(4) *logspd*
cash	26.547***	9.177***	31.459***	10.070***
	(4.13)	(4.15)	(4.57)	(4.42)
cashxami	1.503***		1.842***	
	(4.31)		(4.81)	
cashxspd		1.087**		1.336**
		(2.01)		(2.27)
cashxsell			–0.927***	–0.418**
			(–3.58)	(–2.02)
sell			0.008***	0.002
			(2.58)	(0.74)
ownership	–0.501***	–0.630***	–0.493***	–0.636***
	(–5.33)	(–3.74)	(–5.54)	(–3.70)
vwflow	–0.030	0.494***	–0.032	0.498***
	(–0.31)	(10.20)	(–0.32)	(10.41)
size	–0.878***	–0.290***	–0.878***	–0.291***
	(–86.73)	(–55.58)	(–87.13)	(–56.21)
btm	0.064***	0.032***	0.064***	0.032***
	(6.91)	(6.66)	(6.98)	(6.73)
loglagami	0.449***		0.447***	
	(84.10)		(83.21)	
loglagspd		0.585***		0.584***
		(103.52)		(103.66)
Constant	2.037***	2.006***	2.009***	2.003***
	(21.78)	(36.33)	(21.36)	(37.13)
Stock and Year FE	Yes	Yes	Yes	Yes
Observations	62,365	62,060	62,365	62,060
R–squared	0.800	0.866	0.800	0.866

Table 5: Effect of Information Asymmetry

This table reports the regression results the change of stock liquidity using the Amihud (2002) measure and the relative spread. *numana* is the number of analysts coverage on the stock during the quarter. *rsq* is the R-squared of the stock from three-factor models using the stock's past 12 month returns. *cashxsize*, *cashxana* and *cashxrsq* are the interaction variables between cash holdings and stock size, number of analysts and R-squared, respectively. The other variables are defined in previous tables. The regressions include year and stock fixed effects and the standard errors are clustered at the stock level. The control variables are suppressed to conserve space.

Panel A

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
cash	24.779***	46.687***	29.007***	60.359***
	(3.72)	(4.57)	(4.01)	(4.84)
cashxsize	–2.507***	–4.101***	–2.918***	–5.349***
	(–5.02)	(–5.02)	(–5.21)	(–5.22)
cashxsell			–0.877***	–1.698***
			(–3.36)	(–4.54)
sell			0.011***	0.013**
			(3.62)	(2.11)
size	–0.875***	–0.370***	–0.872***	–0.365***
	(–84.59)	(–37.55)	(–83.41)	(–36.27)
Controls	Yes	Yes	Yes	Yes
Stock and Year FE	Yes	Yes	Yes	Yes

Panel B

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
cash	7.640***	8.196***	8.086***	8.732***
	(5.94)	(4.69)	(6.14)	(5.11)
cashxana	–0.557***	–0.635***	–0.555***	–0.718***
	(–5.59)	(–2.65)	(–5.08)	(–2.62)
numana	0.016***	0.019***	0.016***	0.019***
	(14.42)	(8.67)	(13.74)	(8.18)
cashxsell			0.351	0.110
			(1.52)	(0.30)
sell			–0.007***	–0.010
			(–3.10)	(–1.64)
Controls	Yes	Yes	Yes	Yes
Stock and Year FE	Yes	Yes	Yes	Yes

Panel C

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
cash	17.324***	12.206***	18.129***	12.537***
	(10.21)	(5.74)	(10.46)	(5.77)
cashxrsq	–27.716***	–17.448***	–26.606***	–17.022***
	(–9.37)	(–4.43)	(–8.95)	(–4.38)
rsq	0.068*	0.170***	0.061*	0.167***
	(1.94)	(5.33)	(1.71)	(5.22)
cashxsell			0.877***	0.407
			(4.03)	(1.28)
sell			–0.008***	–0.006
			(–3.55)	(–0.85)
Controls	Yes	Yes	Yes	Yes
Stock and Year FE	Yes	Yes	Yes	Yes

Table 6: Determinants of Stock Liquidity during Crisis Period

This table reports the regression results on the change of stock liquidity during the recent crisis period using the Amihud (2002) measure and the relative spread. The regressions use the sample period during the recent financial crisis from 2007Q4 to 2009Q1. The variables are defined in previous tables. The regressions control for the year and stock fixed effects and the standard errors are clustered at the stock level.

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
cash	–11.501	–48.849***	–5.961	–50.015***
	(–0.84)	(–3.59)	(–0.42)	(–3.68)
cashxami	–0.873		–0.454	
	(–1.26)		(–0.61)	
cashxspd		–9.711***		–10.199***
		(–3.91)		(–4.03)
cashxsell			–1.100***	0.790
			(–2.96)	(0.90)
sell			0.035***	–0.040
			(7.82)	(–1.36)
vwflow	–0.516*	0.769	–0.454	0.713
	(–1.76)	(1.64)	(–1.55)	(1.53)
ownership	–0.913***	–1.546***	–0.755***	–1.757***
	(–6.37)	(–5.83)	(–5.22)	(–4.96)
size	–1.073***	–0.778***	–1.077***	–0.777***
	(–51.76)	(–26.79)	(–52.35)	(–26.88)
btm	0.001	–0.006	0.001	–0.007
	(0.07)	(–0.30)	(0.08)	(–0.35)
loglagami	–0.757***		–0.762***	
	(–64.63)		(–64.11)	
loglagspd		–1.134***		–1.131***
		(–27.95)		(–28.93)
Constant	–0.075	4.618***	–0.100	4.592***
	(–0.23)	(12.99)	(–0.31)	(12.72)
Stock and Year FE	Yes	Yes	Yes	Yes
Observations	15,309	15,315	15,309	15,315
R–squared	0.567	0.300	0.569	0.301

Table 7: Instrumental Variable and Excess Cash

This table reports the results using instrumental variable and excess cash holdings. Panels A and B show the 2-stage least squares results on the change of stock liquidity. Panel A shows the first stage regression of cash holdings (*cash*) on unexpected flows (*unexp_flow*) as instrument and controls from the second stage. The regressions include year fixed effects and the standard errors are clustered at the stock level. Panel B shows the second stage results where *ivcash*, *ivcashxami*, *ivcashxspd*, and *ivcashxsell* are the predicted values of cash and the corresponding interaction terms. The regressions include year and stock fixed effects and the standard errors are clustered at the stock level. Panel C shows the results of using the stock level excess cash (*ecash*), which is the regression residual from the determinants of cash holdings on the fund level aggregated at the stock. The regressions include year and stock fixed effects and the standard errors are clustered at the stock level.

Panel A

	(1) *cash*	(2) *cash*	(3) *cash*	(4) *cash*
unexp_flow	0.004***	0.004***	0.005***	0.004***
	(7.08)	(7.12)	(7.55)	(7.39)
sell			0.000***	0.000***
			(21.33)	(15.59)
size	–0.000***	–0.000***	–0.000***	–0.000***
	(–14.61)	(–14.14)	(–6.18)	(–4.54)
btm	0.000***	0.000***	0.000***	0.000***
	(7.81)	(8.33)	(10.25)	(10.06)
loglagami	–0.001***		–0.001***	
	(–41.55)		(–40.56)	
loglagspd		–0.002***		–0.002***
		(–57.68)		(–54.95)
Constant	–0.008***	–0.004***	–0.010***	–0.006***
	(–31.17)	(–17.23)	(–37.16)	(–22.15)
Year FE	Yes	Yes	Yes	Yes
Observations	53,264	53,173	53,264	53,173
Adj. R^2 (%)	0.347	0.365	0.352	0.368

Panel B

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
ivcash	78.284***	26.162***	78.827***	25.470***
	(7.03)	(3.73)	(7.01)	(3.53)
ivcashxami	4.362***		4.363***	
	(7.20)		(7.21)	
ivcashxspd		6.635***		6.621***
		(4.85)		(4.86)
ivcashxsell			–2.933***	–2.543***
			(–5.93)	(–2.92)
sell	0.025***	0.013	0.025***	0.013
	(5.37)	(1.37)	(5.38)	(1.34)
vwflow	–0.100	0.634***	–0.145	0.688***
	(–0.96)	(6.52)	(–0.90)	(5.28)
ownership	–0.410***	–0.664***	–0.410***	–0.665***
	(–6.14)	(–4.37)	(–6.13)	(–4.36)
size	–0.852***	–0.399***	–0.852***	–0.399***
	(–80.92)	(–37.39)	(–80.91)	(–37.28)
btm	0.062***	0.045***	0.062***	0.045***
	(6.59)	(4.74)	(6.58)	(4.75)
loglagami	–0.546***		–0.546***	
	(–89.01)		(–89.01)	
loglagspd		–0.601***		–0.601***
		(–37.65)		(–37.48)
Constant	1.489***	3.634***	1.488***	3.636***
	(13.69)	(37.25)	(13.68)	(37.22)
Stock and Year FE	Yes	Yes	Yes	Yes
Observations	53,488	53,247	53,488	53,247
R–squared	0.454	0.234	0.454	0.234

Panel C

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
ecash	22.652	49.712***	28.127*	29.153***
	(1.52)	(4.54)	(1.67)	(2.86)
ecashxami	1.366*		1.703*	
	(1.70)		(1.80)	
ecashxspd		9.283***		3.817**
		(4.50)		(2.00)
ecashxsell			–0.061	7.801***
			(–0.06)	(4.58)
sell			0.011***	0.011**
			(5.42)	(2.30)
ownership	–0.337***	–0.479***	–0.334***	–0.490***
	(–5.32)	(–5.29)	(–5.02)	(–5.23)
vwflow	0.137	0.730***	0.131	0.754***
	(1.01)	(7.90)	(0.97)	(8.12)
size	–0.893***	–0.397***	–0.891***	–0.396***
	(–139.47)	(–45.57)	(–139.09)	(–45.05)
btm	0.049***	0.029***	0.051***	0.031***
	(7.01)	(3.25)	(7.23)	(3.43)
loglagami	–0.542***		–0.543***	
	(–169.43)		(–169.55)	
loglagspd		–0.488***		–0.492***
		(–46.88)		(–47.32)
Constant	2.000***	4.010***	1.970***	3.989***
	(32.72)	(49.22)	(32.12)	(48.59)
Stock FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	64,818	64,451	64,818	64,451
Adj. R^2 (%)	0.448	0.169	0.448	0.170

Table 8: Index Mutual Funds

This table reports the regression results on the change of stock liquidity using the Amihud (2002) measure and the relative spread. *indcash* is the average cash holdings by index funds that own the stock, weighted by fund ownership. *indcashxami* and *indcashxspd* are the interaction terms between *indcash* and the Amihud measure and the relative spread, respectively. The other variables are defined in previous tables. The regressions include year and stock fixed effects and the standard errors are clustered at the stock level.

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
indcash	–15.816***	–7.990***	–20.753***	–9.272***
	(–6.26)	(–6.03)	(–8.07)	(–6.91)
indcashxami	–0.528***		–0.806***	
	(–4.17)		(–6.29)	
indcashxspd		–0.667***		–0.899***
		(–3.06)		(–4.15)
cash			39.566***	11.781***
			(6.79)	(4.60)
cashxami			2.116***	
			(6.62)	
cashxspd				1.259**
				(1.99)
vwflow	–0.198***	0.232***	–0.203***	0.233***
	(–3.27)	(5.98)	(–3.34)	(5.99)
ownership	–0.452***	–0.645***	–0.481***	–0.799***
	(–6.10)	(–5.21)	(–5.03)	(–3.51)
size	–1.011***	–0.380***	–1.010***	–0.381***
	(–89.12)	(–50.54)	(–89.19)	(–49.64)
btm	0.063***	0.043***	0.063***	0.043***
	(6.58)	(6.11)	(6.56)	(6.06)
loglagami	–0.620***		–0.624***	
	(–113.14)		(–112.20)	
loglagspd		–0.547***		–0.551***
		(–61.24)		(–61.49)
Constant	2.540***	3.568***	2.473***	3.567***
	(25.06)	(48.76)	(24.42)	(48.26)
Stock and Year FE	Yes	Yes	Yes	Yes
Observations	81,035	80,730	81,035	80,730
R–squared	0.465	0.262	0.465	0.262

Table 9: Effects of Regulation Fair Disclosure

This table reports the regression results on the effects of Regulation Fair Disclosure. *cashxrfd*, is the interaction term between cash and an indicator variable that is set equal to zero if the date is between 1994Q1 and 2000Q3, and equal to one if the date is between 2001Q1 and 2013Q4. The other variables are defined in previous tables. The regressions include stock and year fixed effects and the standard errors are clustered at the stock level.

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
cash	35.773***	32.831***	43.687***	38.853***
	(5.11)	(8.08)	(5.74)	(9.05)
cashxrfd	–4.792	–12.672***	–5.159*	–12.794***
	(–1.57)	(–3.96)	(–1.72)	(–4.10)
cashxami	1.539***		2.098***	
	(3.92)		(4.78)	
cashxspd		0.590		2.497*
		(0.50)		(1.92)
cashxsell			–1.711***	–3.417***
			(–5.21)	(–6.35)
sell			0.018***	0.027***
			(4.44)	(2.95)
vwflow	–2.140***	–1.241***	–2.150***	–1.241***
	(–36.17)	(–15.11)	(–37.08)	(–16.22)
ownership	–0.949***	–1.819***	–0.900***	–1.800***
	(–6.43)	(–4.39)	(–6.43)	(–4.34)
size	–0.932***	–0.295***	–0.931***	–0.298***
	(–87.52)	(–35.39)	(–88.23)	(–35.12)
btm	0.097***	0.134***	0.098***	0.134***
	(10.40)	(13.52)	(10.60)	(13.95)
rfd	–0.026*	–0.165***	–0.019	–0.163***
	(–1.66)	(–13.31)	(–1.26)	(–13.24)
loglagami	–0.564***		–0.566***	
	(–105.59)		(–105.99)	
loglagspd		–0.386***		–0.401***
		(–24.36)		(–27.68)
Constant	2.051***	3.101***	1.998***	3.077***
	(20.93)	(32.21)	(20.80)	(33.42)
Stock FE	Yes	Yes	Yes	Yes
Observations	62,365	62,060	62,365	62,060
R–squared	0.390	0.105	0.391	0.107

Table 10: Alternative Assumption on Disclosure Dates

This table reports the regression results on the change of stock liquidity using the Amihud (2002) measure and the relative spread. The changes are calculated using the change in current quarter's stock liquidity 60 days after quarter end from the previous quarter's measure. Panel A shows the results using OLS and Panel B shows the results with instrumental variable. The variables are defined in previous tables. The regressions include stock and year fixed effects and the standard errors are clustered at the stock level.

Panel A

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
cash	21.311***	19.066***	22.383***	16.609***
	(4.35)	(8.53)	(4.26)	(7.35)
cashxami	1.502***		1.511***	
	(5.88)		(5.36)	
cashxspd		3.507***		3.648***
		(9.34)		(9.25)
cashxsell			–0.260	–0.260
			(–1.34)	(–1.20)
sell			0.006**	0.002
			(2.35)	(0.74)
Controls and FE	Yes	Yes	Yes	Yes

Panel B

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
ivcash	22.867***	9.118***	19.521***	42.721***
	(3.34)	(2.88)	(2.78)	(6.01)
ivcashxami	1.337***		1.907***	
	(3.83)		(2.63)	
ivcashxspd		1.654***		1.998**
		(3.16)		(2.53)
ivcashxsell			–0.000***	–0.000***
			(–7.27)	(–4.86)
sell			0.000***	0.000***
			(9.74)	(3.61)
Controls and FE	Yes	Yes	Yes	Yes

Table 11: Investor Inflows

This table reports the regression results on the change of stock liquidity using the Amihud (2002) measure and the relative spread conditional on aggregate investor inflows. The variables are defined in previous tables. The regressions include stock and year fixed effects and the standard errors are clustered at the stock level.

	(1)	(2)	(3)	(4)
	chgami	*chgspd*	*chgami*	*chgspd*
cash	–3.442	2.878	2.134	–0.852
	(–0.74)	(1.32)	(0.43)	(–0.37)
cashxami	0.200		0.543**	
	(0.85)		(2.11)	
cashxspd		1.311***		0.315
		(3.60)		(0.79)
cashxsell			0.078	0.283*
			(0.40)	(1.78)
sell			–0.009***	0.008***
			(–3.08)	(3.68)
loglagami	–0.552***		–0.553***	
	(–126.38)		(–126.34)	
loglagspd		–0.406***		–0.402***
		(–46.44)		(–45.76)
size	–0.860***	–0.262***	–0.863***	–0.260***
	(–94.28)	(–42.25)	(–97.97)	(–41.83)
btm	0.075***	0.038***	0.073***	0.040***
	(10.14)	(7.08)	(9.96)	(7.42)
Stock FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	198,978	197,514	198,978	197,514
Adj. R^2 (%)	0.407	0.185	0.407	0.186

Appendix

Table A1: Stock Abnormal Returns Excluding Crisis Period

This table reports the sorting results of stock abnormal returns based on the Fama and French (1993) 3-factor model. The event window is from current quarter end to 45 days after quarter end in Panels A, and 30, 45 and 60 days in Panel B. Panel A presents the sorting results as in Table 2 and Panel B presents the regression results as in Table 3.

Panel A

	1 (Sell low)	2	3	4	5 (Sell high)
1 (Cash poor)	0.044	0.047	0.022	0.034	0.021
2	0.035	0.015	0.021	0.002	–0.004
3	0.003	–0.003	–0.004	0.004	0.003
4	–0.005	0.018	0.005	–0.009	–0.003
5 (Cash rich)	0.017	0.010	–0.001	0.001	0.001
Diff (1–5)	0.027	0.036	0.023	0.033	0.020
t–stat	2.50	3.35	2.42	3.28	2.64

Panel B

	(1) *car_1*	(2) *car_2*	(3) *car_ 3*	(4) *car_ 1*	(5) *car_ 2*	(6) *car_ 3*
cashxsell	0.383***	0.582***	0.710***	0.242***	0.275***	0.382***
	(4.66)	(6.17)	(6.90)	(2.76)	(2.68)	(3.42)
sell	–0.014***	–0.020***	–0.023***	–0.012***	–0.015***	–0.018***
	(–16.30)	(–18.86)	(–19.81)	(–13.15)	(–14.38)	(–15.29)
cashxsellbig				–1.380***	–3.059***	–3.317***
				(–2.71)	(–5.01)	(–4.93)
sellbig				0.057***	0.091***	0.100***
				(9.67)	(12.50)	(12.39)
cash	2.114***	2.794***	3.284***	1.815***	2.671***	3.128***
	(7.63)	(8.61)	(9.06)	(5.31)	(6.71)	(7.00)
vwflow	–0.022	–0.040	–0.030	–0.019	–0.038	–0.027
	(–0.73)	(–1.05)	(–0.70)	(–0.61)	(–0.99)	(–0.64)
size	–0.043***	–0.057***	–0.064***	–0.047***	–0.063***	–0.070***
	(–30.38)	(–32.34)	(–33.84)	(–30.98)	(–33.61)	(–34.97)
btm	0.002	–0.002	–0.006	0.001	–0.004	–0.008*
	(0.69)	(–0.61)	(–1.44)	(0.28)	(–1.10)	(–1.93)
Constant	0.486***	0.646***	0.730***	0.530***	0.712***	0.804***
	(26.86)	(28.56)	(30.00)	(27.75)	(30.05)	(31.40)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	47,069	47,069	47,069	47,069	47,069	47,069
Adj. R^2 (%)	0.067	0.065	0.058	0.070	0.070	0.062

Table A2: Predicting Future Abnormal Stock Returns

This table reports the regression results on the future abnormal returns. *car_1*, *car_2* and *car_3* are the stock's abnormal returns using the Fama and French (1993) 3-factor model 30, 45 and 60 days after quarter end, respectively. *sellbig* is an indicator variable that is equal to one if the selling intensity is above the 75th percentile, and zero otherwise. *cashxsell* and *cashxsellbig* denote the interaction terms between *cash* and the corresponding variables. The other variables are defined in previous tables. The regressions control for the year and stock fixed effects and the standard errors are clustered at the stock level.

	(1) *car_1*	(2) *car_2*	(3) *car_3*	(4) *car_1*	(5) *car_2*	(6) *car_3*
cashxsell	0.140*	0.172*	0.269**	–0.015	–0.039	0.039
	(1.84)	(1.82)	(2.41)	(–0.19)	(–0.38)	(0.32)
sell	–0.006***	–0.010***	–0.011***	–0.004***	–0.006***	–0.007***
	(–5.83)	(–7.45)	(–7.20)	(–3.53)	(–4.80)	(–4.69)
cashxsellbig				–1.423***	–1.846***	–2.001***
				(–2.83)	(–2.99)	(–2.84)
sellbig				0.046***	0.068***	0.076***
				(7.53)	(8.85)	(8.86)
cash	2.037***	2.878***	3.303***	2.055***	2.772***	3.163***
	(6.64)	(7.66)	(7.30)	(5.50)	(6.13)	(5.97)
size	–0.119***	–0.161***	–0.199***	–0.122***	–0.165***	–0.204***
	(–44.68)	(–47.23)	(–50.57)	(–45.57)	(–48.48)	(–51.89)
btm	–0.023***	–0.037***	–0.044***	–0.024***	–0.039***	–0.046***
	(–6.46)	(–8.24)	(–8.95)	(–6.80)	(–8.67)	(–9.38)
Constant	1.397***	1.894***	2.352***	1.427***	1.941***	2.404***
	(42.24)	(44.49)	(47.74)	(43.13)	(45.68)	(48.98)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stock FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	62,316	62,316	62,316	62,316	62,316	62,316
R–squared	0.138	0.142	0.162	0.140	0.145	0.164

Table A3: Determinants of Stock Liquidity

This table reports the regression results on the change of stock liquidity using the Amihud (2002) measure (specifications 1 and 3) and the relative spread (specifications 2 and 4). *chgcash* is the change in cash holdings by mutual funds that own the stock. *chgcashxami* and *chgcashxspd* are the interaction variables between the cash holding changes and the Amihud measure and relative spread measure, respectively. The regressions control for the year fixed effects and the standard errors are clustered at the stock level.

	(1)	(2)	(3)	(4)
	chgami	*chgspd*	*chgami*	*chgspd*
chgcash	17.361***	2.804**	16.038***	2.355*
	(4.06)	(2.02)	(3.69)	(1.69)
chgcashxami	0.928***		0.839***	
	(3.99)		(3.54)	
chgcashxspd		0.618**		0.541**
		(2.27)		(1.98)
loglagami	–0.544***		–0.544***	
	(–102.80)		(–102.82)	
size	–0.883***	–0.303***	–0.882***	–0.302***
	(–64.83)	(–50.57)	(–64.36)	(–50.27)
btm	0.048***	0.025***	0.048***	0.027***
	(8.05)	(7.04)	(8.17)	(7.36)
loglagspd		–0.399***		–0.401***
		(–54.16)		(–54.61)
Constant	1.990***	2.194***	1.977***	2.179***
	(32.44)	(67.15)	(32.16)	(66.67)
Year FE	Yes	Yes	Yes	Yes
Observations	62,365	62,060	62,365	62,060
R–squared	0.443	0.274	0.443	0.275

Table A4: Alternative Definition of Liquidity Buffers

This table reports the regression results on the change and the level of stock liquidity using they Amihud (2002) measure (specifications 1 and 3) and the relative spread (specifications 2 and 4). Fund level liquidity buffers include mutual fund cash holdings and the holdings of the top 1% most liquid stocks in each quarter sorted by the Amihud (2002) measure. Stock level liquidity buffers (*buffer*) are the average fund level liquidity buffers weighted by mutual fund ownership. *bufferxami*, *bufferxspd* and *bufferxsell* are the interaction variables between liquidity buffers and the Amihud measure, the relative spread, and the collective mutual fund sale on stock, respectively. Panel A reports the change in stock liquidity from previous quarter and Panel B reports the level of stock liquidity. The regressions include stock and year fixed effects and the standard errors are clustered at the stock level.

Panel A

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
buffer	29.052***	20.800***	31.975***	17.651***
	(4.59)	(5.32)	(4.90)	(4.50)
bufferxami	2.014***		2.230***	
	(6.12)		(6.40)	
bufferxspd		4.201***		4.119***
		(5.83)		(5.48)
bufferxsell			–0.000***	–0.000
			(–5.04)	(–1.01)
sell			0.000***	0.000**
			(7.67)	(2.14)
loglagami	–0.551***		–0.553***	
	(–103.16)		(–102.90)	
loglagspd		–0.548***		–0.549***
		(–39.97)		(–40.25)
size	–0.886***	–0.394***	–0.884***	–0.393***
	(–87.67)	(–42.92)	(–87.46)	(–42.41)
btm	0.059***	0.037***	0.061***	0.038***
	(6.41)	(4.19)	(6.65)	(4.36)
Stock FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	62,127	61,823	62,127	61,823
Adj. R^2 (%)	0.454	0.233	0.455	0.232

Panel B

	(1) *logami*	(2) *logspd*	(3) *logami*	(4) *logspd*
buffer	29.052***	9.381***	31.975***	7.525***
	(4.59)	(4.31)	(4.90)	(3.43)
bufferxami	2.014***		2.230***	
	(6.12)		(6.40)	
bufferxspd		2.256***		2.158***
		(6.29)		(5.79)
bufferxsell			–0.000***	–0.000
			(–5.04)	(–0.72)
sell			0.000***	0.000***
			(7.67)	(2.98)
loglagami	0.449***		0.447***	
	(84.14)		(83.10)	
loglagspd		0.590***		0.590***
		(107.63)		(106.88)
size	–0.886***	–0.299***	–0.884***	–0.298***
	(–87.67)	(–60.93)	(–87.46)	(–60.68)
btm	0.059***	0.027***	0.061***	0.028***
	(6.41)	(5.71)	(6.65)	(5.95)
Stock FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	62,127	61,823	62,127	61,823
Adj. R^2 (%)	0.801	0.864	0.801	0.864

Table A5: Additional Robustness

This table reports the additional robustness results. Panel A and B use the normal times excluding the recent financial crisis. The dependent variables are the changes and levels of stock liquidity in Panel A and B, respectively. Panel C and D report the results conditional on negative predicted flows, instead of the negative realized flows. The dependent variables are the changes and levels of stock liquidity in Panel C and D, respectively.

Panel A

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
cash	17.818**	43.065***	26.527***	44.180***
	(2.13)	(11.03)	(2.93)	(10.79)
cashxami	1.341***		1.903***	
	(3.06)		(3.90)	
cashxspd		8.418***		8.842***
		(11.98)		(11.46)
cashxsell			–1.364***	–1.342***
			(–3.61)	(–3.02)
sell			0.005	0.023***
			(1.31)	(4.48)
loglagami	–0.578***		–0.580***	
	(–92.44)		(–92.23)	
loglagspd		–0.492***		–0.498***
		(–30.19)		(–30.02)
size	–0.917***	–0.324***	–0.917***	–0.322***
	(–75.63)	(–32.06)	(–76.19)	(–31.85)
btm	0.060***	0.053***	0.059***	0.056***
	(4.81)	(5.35)	(4.80)	(5.75)
Constant	2.053***	3.121***	2.026***	3.082***
	(19.35)	(37.49)	(19.03)	(37.09)
Fund and year FE	Yes	Yes	Yes	Yes
Observations	47,108	46,797	47,108	46,797
R–squared	0.453	0.263	0.453	0.264

Panel B

	(1) *logami*	(2) *logspd*	(3) *logami*	(4) *logspd*
cash	17.818**	28.294***	26.527***	29.396***
	(2.13)	(11.44)	(2.93)	(11.45)
cashxami	1.341***		1.903***	
	(3.06)		(3.90)	
cashxspd		5.664***		6.023***
		(13.84)		(13.54)
cashxsell			–1.364***	–0.954***
			(–3.61)	(–3.38)
sell			0.005	0.014***
			(1.31)	(4.46)
loglagami	0.422***		0.420***	
	(67.49)		(66.89)	
size	–0.917***	–0.250***	–0.917***	–0.249***
	(–75.63)	(–44.63)	(–76.19)	(–44.28)
btm	0.060***	0.043***	0.059***	0.045***
	(4.81)	(7.33)	(4.80)	(7.68)
loglagspd		0.633***		0.629***
		(99.35)		(96.87)
Constant	2.053***	1.653***	2.026***	1.630***
	(19.35)	(30.70)	(19.03)	(30.28)
Fund and Year FE	Yes	Yes	Yes	Yes
Observations	47,108	46,797	47,108	46,797
R–squared	0.788	0.892	0.788	0.892

Panel C

	(1) *chgami*	(2) *chgspd*	(3) *chgami*	(4) *chgspd*
cash	22.047***	19.370***	25.109***	19.290***
	(3.25)	(4.80)	(3.50)	(4.87)
cashxami	1.464***		1.720***	
	(4.14)		(4.47)	
cashxspd		4.530***		4.643***
		(5.92)		(6.13)
cashxsell			–1.231***	–0.777***
			(–6.00)	(–3.10)
sell			0.021***	0.020***
			(6.70)	(5.01)
loglagami	–0.555***		–0.557***	
	(–97.92)		(–97.66)	
loglagspd		–0.453***		–0.457***
		(–26.22)		(–25.95)
size	–0.907***	–0.312***	–0.904***	–0.309***
	(–82.43)	(–30.02)	(–82.25)	(–29.38)
btm	0.064***	0.033***	0.066***	0.035***
	(6.46)	(4.50)	(6.68)	(4.76)
Constant	2.049***	3.055***	1.996***	3.021***
	(20.81)	(35.26)	(20.07)	(34.62)
Fund and Year FE	Yes	Yes	Yes	Yes
Observations	61,621	61,224	61,621	61,224
R–squared	0.468	0.202	0.469	0.203

Panel D

	(1) *logami*	(2) *logspd*	(3) *logami*	(4) *logspd*
cash	22.047***	9.130***	25.109***	9.054***
	(3.25)	(4.44)	(3.50)	(4.39)
cashxami	1.464***		1.720***	
	(4.14)		(4.47)	
cashxspd		2.459***		2.499***
		(7.21)		(7.14)
cashxsell			–1.231***	–0.349**
			(–6.00)	(–2.49)
sell			0.021***	0.009***
			(6.70)	(3.91)
loglagami	0.445***		0.443***	
	(78.58)		(77.74)	
loglagspd		0.602***		0.600***
		(118.24)		(116.05)
size	–0.907***	–0.283***	–0.904***	–0.282***
	(–82.43)	(–59.60)	(–82.25)	(–59.11)
btm	0.064***	0.030***	0.066***	0.031***
	(6.46)	(6.46)	(6.68)	(6.66)
Constant	2.049***	1.863***	1.996***	1.846***
	(20.81)	(38.66)	(20.07)	(38.21)
Fund and Year FE	Yes	Yes	Yes	Yes
Observations	61,621	61,224	61,621	61,224
R–squared	0.790	0.862	0.790	0.862