Stock Market Liquidity:

Financially Constrained Firms and Share Repurchase

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Abstract

Stock liquidity lowers the cost of share ownership to outside investors and decreases firms' cost of capital. This study substantiates that shares of financially constrained firms are significantly less liquid than shares of similar but financially unconstrained firms. Acting as buyers of last resort for their own shares, share repurchases by financially constrained firms enhance stock liquidity, which alleviates the cost of external financing and underinvestment. Increased stock liquidity improves information efficiency, inducing higher added value from incremental capital investments. Further, higher stock liquidity lowers stock volatility and allows financially constrained firms to issue equity.

1. Introduction

There is extensive literature focused on stock liquidity (see Vayanos and Wang, 2012, for a survey). This literature notes two different costs associated with stock illiquidity: adverse selection costs arising from information asymmetry and transactions costs associated with holding inventory. Investors require additional compensation for holding less liquid stocks, either in terms of greater stock returns or risks (Note 1). Increased stock liquidity that reduces the adverse selection and transaction costs to shareholders reduces the firm's cost of capital (Note 2). If managers wish to maximize firm value, they should pursue financial policies that improve the liquidity of their stock (Note 3). During market downturns, firms can, for instance, utilize share repurchase programs to help increase depth on the sell-side of the market to improve liquidity (Note 4). The presence of the firm as a buyer gives confidence to other market participants and reduces the number of sellers in the market. Repurchase firms can be thought of as buyers of last resort – supporting their market-makers and adding downside liquidity. In this paper, I investigate whether firms attempt to enhance their stock liquidity via share repurchase programs, and the implications of this activity on other firm behaviors. This is done in the context of firms that face costly external financing and have illiquid stocks and hence, would be expected to value stock liquidity more than other firms.

Specifically, I draw upon the existing literature on financial frictions to identify a set of firms that have a higher cost of capital and less stock liquidity: financially constrained firms. Financial constraint arises due to frictions in the supply of capital, the chief source of which being information asymmetries between investors and the firm (Tirole, 2006). Supply frictions increase costs of raising external capital, and, in the limit, the firm is shut out of the capital markets (Note 5). Since market liquidity captures information asymmetry among market participants, such firms are more likely to have less liquid stocks (Ascioglu, Hedge & McDermott, 2008). As a result, researchers hypothesize that these constraints may have substantial effects on a variety of decisions, including firms' investment and capital structure choices (Note 6). Studies find financially constrained firms plan to cut more investment, technology, marketing, and employment relative to financially unconstrained firms during crises. Financial constraints also restrict firms from pursuing attractive projects, or force them to cancel valuable investments.

I hypothesize that financially constrained firms, facing costly external financing and potential underinvestment, take steps to improve their stock liquidity in order to reduce information asymmetry, and to alleviate costs of financial constraint. The less liquid a firm's stock is ex-ante, the more valuable the enhanced liquidity is ex-post. Liquidity enhancements for such firms are also likely to have greater value than for other firms. As a corollary, if these firms raise external financing, it is more likely to be equity financing due to a lower cost of equity. They overcome the

underinvestment problem with additional financing. Furthermore, since improved liquidity increases price efficiency, the market will place higher value on their incremental investments. Concurrently, reduced liquidity costs could also result in reduced risk for these firms.

My research design has three parts. First, I confirm the relationship between financial constraint and illiquidity documented in the literature, and explore the impact of share repurchase on the constraint status. Second, I investigate the relationship between share repurchase and stock liquidity in a sample of financially constrained firms, controlling for the endogeneity between the two. Finally, I study the impact of additional liquidity on other policies in such firms.   Specifically, I examine the impact of additional liquidity on equity and debt issuance, and investment, and consequently, value added from incremental investments, and firm risk.

My sample consists of 183 financially constrained firms from the CRSP and Compustat data between 1992 and 2006. Firms selected in the sample must have all data available throughout the sample period in order to alleviate the confounding effects of different factors. I classify firms as financially constrained by Hadlock and Pierce's (2010) index (hereafter, HP index) (Note 7). My variable of chief interest in measuring liquidity is Amihud's (2002) illiquidity measure. The higher the value, the less liquid the stock. I measure repurchase intensity as repurchase amount divided by the total dollar trading volume over the fiscal year. Intuitively, this variable measures repurchase dollars per trading dollar volume. The higher the value, the greater the intensity of the repurchase.

My findings are consistent with my hypotheses. I shows how financially constrained firms with illiquid stocks utilize share repurchases to improve their liquidity, helping them issue additional equity, increase investments, increase value added from market perception, and reduce idiosyncratic risk.

My paper makes several contributions to the corporate finance literature. First, I provide conclusive evidence that firms influence and improve their stock liquidity. Although it has been argued that firms can and should improve their stock liquidity (Amihud & Mendelson, 2012), evidence on this has so far been sparse. As a result, stock liquidity is often regarded as exogenously determined. My results show that firms do care about their stock liquidity and take steps to improve it, especially when achieving and maintaining higher stock liquidity is crucial for them. In this respect, my findings are closely related to those reported by Dass, Nanda and Xiao (2013) which conclude that managers actively influence the liquidity of their companies' shares through reducing information asymmetry by frequent earnings guidance, stock splits, seasoned equity offerings, etc. My findings are also consistent with those of Balakrishnan, Billings, Kelly and Ljungqvist (2014), who show that managers provide more earnings guidance after the loss of public information producers (analysts) following brokerage-firm closures.

Second, my results materially contribute to the literature on repurchases and liquidity by proving that share repurchases improve liquidity, thereby providing a possible explanation why previous research appears inconclusive. I show that the liquidity enhancement effect of share repurchases is most pronounced for financially constrained firms, i.e., firms that value liquidity most. By not separating financially constrained firms from unconstrained firms, previous studies appear to have missed the effect of stock repurchases on liquidity. My results are consistent with Hillert, Maug and Obernberger (2016), who find that firms supply liquidity to the market when they repurchase a large number of shares, particularly in illiquid markets. However, they do not study the impact of improved liquidity on firm behavior, but instead focus on the market microstructure features of share repurchase. My results are inconsistent with Brockman, Howe and Mortal (2008), who find that market liquidity drives the repurchase decision. I find that a lack of stock liquidity drives the repurchase decision.

Third, my study identifies benefits of improving liquidity through its effect on corporate decisions. My paper builds on literature linking stock liquidity and external financing (Lipson & Mortal, 2009; Butler, Grullon & Weston., 2005), stock liquidity and investment (Becker-Blease & Paul, 2006; Li, 2011; Vo, 2013), stock liquidity and price efficiency (Chordia, Roll & Subrahmanyam, 2005; Chordia, Roll & Subrahmanyam, 2008), and stock liquidity and firm risk (Pastor & Stambaugh, 2003; Acharya & Pedersen, 2005; Chan, Hameed & Kang, 2013) by showing that these benefits are especially valuable to financially constrained firms.

Finally, my study complements the literature on payout decisions in financially constrained firms. Chen and Wang (2012) find that share repurchases by constrained firms lead to reduced cash and cash flow, increased leverage, and decreased investment. These firms also experience significantly weaker abnormal returns and operating performance post-repurchase. Why do financially constrained firms engage in share repurchases when repurchases do not enhance shareholder wealth? The authors propose managerial overconfidence as a possible reason. Managers of these firms tend to overestimate their firms' future investments and returns. I add to this discussion by providing another explanation, i.e., that managers of financially constrained firms repurchase shares to improve share liquidity.   To my knowledge, my paper is the first to link liquidity to share repurchase among financially constrained firms.

The rest of the paper proceeds as follows. Section 2 reviews the literature on share repurchase and stock liquidity. Section 3 develops my empirical predictions. Section 4 describes my data collection procedure and details the construction of my main variables. Section 5 investigates the relation between repurchase intensity and financial constraint status. Section 6 examines the relation between repurchase intensity and liquidity. Section 7 examines the effect of liquidity on firms' behaviors. Section 8 concludes.

2. Literature Review

The existing literature argues that share repurchase programs can both improve and deteriorate stock liquidity. On the one hand, open market repurchase programs should be detrimental to market dynamics because the firm's presence in the market increases the fraction of "informed" traders, which in turn gives rise to an adverse selection cost in the form of reduced stock liquidity. On the other hand, share repurchases may actually improve stock liquidity by increasing depth on the sell-side of the market. Here, firms repurchase shares as a form of disbursing cash to shareholders, acting as a market maker in their own stocks supplying additional liquidity. The first study that examines the market liquidity impact of open market share repurchases is Barclay and Smith (1988). By examining relative bid-ask spreads before and after repurchase announcements for companies listed on the NYSE, they find that stock liquidity decreases following announcements, consistent with the information asymmetry hypothesis. Franz, Rao and Tripathy (1995) study repurchase announcements by NASDAQ-listed firms and find that stock liquidity increases with the repurchase announcements, due to a reduction in the informed trading costs. Brockman and Chung (2001) examine firms listed on the Stock Exchange of Hong Kong and conclude that stock liquidity deteriorates on repurchase days because market participants detect the presence of informed trading and partially or completely withdraw from the market. Brockman et al. (2008) study the impact of liquidity on repurchase decisions and show that a stock's liquidity is a determinant of the company's payout policy. All else equal, higher market liquidity encourages the use of repurchases over dividends. Repurchases have recently become the payout decision of choice, in part, because of rising stock market liquidity. De Cesari, Espenlaub, Khurshed and Simkovic (2012) analyze the impact of liquidity and ownership structure on the repurchase decision. They find a positive relation between buyback profits and firm liquidity. Ben-Rephael, Oded, and Wohl (2014) study recently disclosed, realized open market repurchases and find ambiguous results and conclude from indirect evidence that repurchasing firms consume liquidity rather than provide it. More recently, Hillert et al. (2016), using a new comprehensive data set of realized share repurchases in the US, show that repurchases unequivocally improve liquidity and suggest that endogenous controls have confounded results in earlier studies. Busch and Obernberger (2017) find that share repurchases make prices more efficient and reduce idiosyncratic risk, and that the effects are more pronounced during market downturn.

3. Testable Hypotheses

Drawing upon arguments made in the literature, I hypothesize that firms take actions that influence their stock liquidity. To test this, I focus on a set of firms that are expected to most value stock liquidity. Specifically, I argue that financially constrained firms face costly external financing and have illiquid stocks due to high levels of information asymmetry. Since share repurchases provide liquidity for less liquid stocks, firms that repurchase more shares are less likely to remain constrained. This leads me to my first testable hypothesis, stated in alternate form:

Hypothesis 1 (H1): *Ex-ante financial constrained firms that have greater share repurchase intensity are more likely to become unconstrained ex-post.*

I build on the notion that firms can influence the level of their stock liquidity. Given their higher cost of capital and underinvestment resulting from financial constraint, these firms will engage in share repurchases to improve their stock liquidity, and only do so when their stock liquidity is below some threshold. Specifically, my second testable hypothesis is:

Hypothesis 2 (H2): *Lagged illiquidity increases the probability that financially constrained firms will engage in share repurchase, and consequently, their stock liquidity will improve.*

Due to the strong preference of financially constrained firms for liquidity, I expect that the improvement in liquidity is more valuable for these firms and will be reflected in better corporate decisions and market perceptions. Therefore, my next four testable hypotheses are:

Hypothesis 3 (H3): *Improved liquidity increases the probability that firms will issue equity and the amount of equity issuance; but such impact is weaker, or nonexistent, for debt issuance.*

Hypothesis 4 (H4): *Improved liquidity is associated with increased firm investment.*

Hypothesis 5 (H5): *Improved liquidity is associated with greater value added per dollar of incremental investments.*

Hypothesis 6 (H6): *Improved liquidity reduces idiosyncratic risk and increases systematic risk.*

4. Data and Methodology

4.1 Sample Design

My sample starts with U.S. publicly traded firms between 1992 and 2006. According to Grullon and Michaely (2000), since the mid-1980s, more and more firms have decided to initiate share repurchase programs as a way to distribute cash flows to their shareholders. I start the sample in 1992 and end in 2006 to capture the popularity of share repurchases and, at the same time, to avoid any contaminating effects of the savings and loans crisis that started in 1989 and the credit crisis that began in 2007, both of which adversely affect market liquidity. In order to be included in my sample, firms must be in both the Center for Research in Security Prices (CRSP) and Compustat databases. I exclude financials and utilities because they do not report on share repurchases and have essentially unique types of assets and capital structure, leverage, and regulatory supervision. I also require firms to have positive assets and market capitalization.

I collect daily stock returns, prices, and trading volumes from CRSP to calculate Amihud's (2002) illiquidity measure, cumulative stock returns, and total risk. I include all ordinary common stocks (share code 10 and 11) traded on NYSE, AMEX and NASDAQ (exchange code 1, 2 and 3). Primes, closed-end funds, REITs, American Depository Receipts (ADRs), and foreign companies are excluded. I obtain firm financial characteristics from Compustat.

I require sample firms to have data available for the entire period, 1992 through 2006. Because the focus of the study is on financially constrained firms, i.e., firms that are already more likely to leave the sample, limiting my study to those that remain allows me to observe the effect of share repurchases via liquidity enhancement on their constraint status without the confounding effects of other factors. My final sample includes 1,082 firms that satisfy all criteria. I further exclude firms that are classified as financially sufficient to avoid contamination of financially unconstrained and constrained groups. My final sample consists of 786 firms, 603 of which are unconstrained and 183 constrained in 1992. In analyses involving financial constrained firms, I only use these 183 firms.

4.2 Measuring Stock Market Liquidity

Although there are numerous studies on liquidity, the stock liquidity concept itself is still evolving because it comprises several dimensions, including trading costs, turnover, bid-ask spread, and price impact. To capture stock liquidity, current finance literature generally examines liquidity in terms of the ability of investors to trade large quantities of stock quickly at low cost with little price impact (Liu, 2006; Chordia, Huh & Subrahmanyam, 2009). I use Amihud's (2002) illiquidity measure because it is widely used to measure liquidity at both the aggregate and the firm level, as in Acharya and Pedersen (2005), Kamara, Lou, and Sadka (2008), and Goyenko, Holden, and Trzcinka (2009). This measure is easy to compute, and is highly correlated with other liquidity measures, such as bid-ask spread, trading volume, and price impact measures. It is defined as the average ratio of the daily absolute return to the dollar of trading volume on that day. This ratio gives the absolute (percentage) price change per dollar of daily trading volume, or the daily price impact of the order flow.

In this study, Amihud's (2002) illiquidity measure is calculated as follows

$$ILL_{i,t} = \frac{1}{D_{i,t}} \sum_{s=1}^{D_{i,t}} \frac{|R_{i,s}|}{P_{i,s} \times Vol_{i,s}} \tag{1}$$

where $D_{i,t}$ is the number of valid observation days for stock i during fiscal year t, $|R_{i,s}|$ is the absolute return on day s for stock i. $P_{i,s}$ and $Vol_{i,s}$ are respectively the daily price and trading volume of stock i on day s. I multiply the above estimate by 10^6 for practical purposes. This measure is called an illiquidity measure because a high value indicates low liquidity.

Following Amihud (2002) I exclude firms with less than 200 trading days during the year t. I also require firms to have trading volume and market capitalization in year t to calculate the Amihud's (2002) illiquidity measure. Because the impact of repurchases on liquidity may vary depending on the exchange that the stock is traded, I adjust Amihud's (2002) illiquidity measure by subtracting exchange illiquidity from the raw value of Amihud's (2002) illiquidity during the period.

4.3 Measuring Financial Constraint

To study the role of financial constraint on firm behavior, researchers are often in need of a measure of the severity of constraint. The literature suggests many possibilities, but is divided on which measure best captures financial constraint. As a result, empirical studies tend to employ a range of measures for robustness. The KZ index, as suggested by Kaplan and Zingales (1997), Lamont, Polk, and Saa-Requejo (2001), Chen, Goldstein, and Jiang (2007), and Hennessy, Levy, and Whited (2007), is often considered the most popular measure of financial constraint. Other popular measures are the cash-cash flow sensitivity of Almeida, Campello, and Weisbach (2004), the WW index of Whited and Wu (2006), and the HP index of Hadlock and Pierce (2010).

Ascioglu et al. (2008) argue that when a classification scheme for identifying constrained firms is based upon a measure correlated with net worth or internal funds, the characters of those firms, such as investment-cash flow sensitivity, are not consistent for firms with financial constraint. By collecting detailed qualitative information from financial filings to categorize financial constraint for a random sample of firms from 1995 to 2004, Hadlock and Pierce (2010) cast serious doubt on the validity of the KZ index, while offering mixed evidence on the validity of other common measures of constraint (Note 8). Concerned with the endogenous nature of common predictors such as leverage and cash flow to constraint status, they recommend researchers rely solely on firm size and age, two relatively exogenous firm characteristics, to identify constrained firms. Therefore, in this paper, I use the HP index to classify financially constrained firms. The HP index is calculated as

$$HP = (-0.737 \times Size) + (0.043 \times Size^2) - (0.040 \times Age) \qquad (2)$$

where *Size* equals the log of inflation-adjusted book assets, and *Age* is the number of years the firm is listed with a non-missing stock price on Compustat. In calculating this index, *Size* is capped at (the log of) \$4.5 billion, and *Age* is winsorized at 37 years. A firm with a high HP index is considered more financially constrained.

I construct the HP index for each firm in Compustat in 1992, and then again in 2006. To reduce the effects of a few extreme values, I winsorize components of the HP index at the 1st and 99th percentiles. For those two years of data, I sort all the firms in Compustat into terciles of 40th and 60th percentiles (40-20-40) according to the value of their HP indexes. Firms with the lowest HP index values are placed in tercile one, and firms with the highest values in tercile three. I then assign my sample firms to these groups based on their HP terciles in 1992 and 2006. I consider firms in the highest HP tercile to be financially constrained, firms in the middle HP tercile to be financially sufficient and firms in the lowest HP tercile to be financially unconstrained.

Table 1. Firm distribution

		Panel A: Full Sample			
		1992			
		Unconstrained	Sufficient	Constrained	Total
	Unconstrained	603	196	99	898
2006	Sufficient	0	24	68	92
	Constrained	0	8	84	92
	Total	603	228	251	1082

		Panel B: Unconstrained vs. Constrained Sample		
		1992		
		Unconstrained	Constrained	Total
2006	Unconstrained	603	99	702
	Constrained	0	84	84
	Total	603	183	786

Table 1, Panel A reports the frequency of firms for three groups: financially unconstrained, financially sufficient, and financially constrained, at the beginning of the sample period 1992, and at the end in 2006. Of my original sample of 1,082 firms, in 1992 55.7% are unconstrained, 21.1% are sufficient, and 23.2% are constrained. Their financial constraint status in 2006 evolves such that all unconstrained firms in 1992 remain unconstrained by 2006, while 86.0% of sufficient firms in 1992 improve to become unconstrained by 2006, while 39.4% of constrained firms in 1992

become unconstrained by 2006, and only 33.6% stay constrained. To some extent, sufficient firms behave more like financially unconstrained firms, potentially diluting the effect of the two extremes. I therefore exclude financially sufficient firms in my subsequent analyses, and report frequencies of only unconstrained vs. constrained firms in Panel B. Of the 786 firms, all unconstrained firms in 1992 stay unconstrained in 2006, while 54.1% of constrained firms in 1992 move up to being unconstrained in 2006, and the remainder stay the same. The fact that there is no movement from the 1992 unconstrained group suggests that share repurchases during the period do little to their status, further motivating my focus on financially constrained firms.

4.4 Measuring Share Repurchase

Measurement of the actual value of shares repurchased is not straightforward. The most accurate measure would be actual shares repurchased multiplied by the average price of repurchased shares as reported in the firm's financial statements. Unfortunately, detailed disclosure of repurchase activity has only been a requirement since 2004. Early studies rely on *The Wall Street Journal* announcements of share repurchases, while more recent studies identify repurchases from SDC and estimate the number of shares repurchased using either CRSP or Compustat data. Stephens and Weisbach (1998) discuss various estimates of actual repurchases using CRSP and Compustat data, and subsequent researchers have attempted to improve the accuracy of these estimates. Jagannathan, Stephens, and Weisbach (2000) examine whether monthly decreases in shares outstanding from CRSP or purchases of common and preferred stock reported in Compustat more accurately reflect actual repurchases. They find that the CRSP measure understates actual repurchases, while the Compustat measure overstates them, but their final sample contains only 35 firms with both CRSP and Compustat data available and includes a number of outliers. Grullon and Michaely (2002) and Kahle (2002) adjust Compustat purchases of common and preferred stock by removing changes in the value of preferred stock to better measure purchases of common stock. More recently, Massa, Rehman, and Vermaelen (2007) ignore preferred stock adjustments because preferred stock activity is an insignificant portion of firms' share repurchase activity. Fama and French (2001) adjust the Stephens and Weisbach (1998) measure of changes in the dollar value of treasury stock to account for firms that retire treasury shares. In a hand collected sample of firms, Banyi, Dyl and Kahle (2008) horse race various measures of share repurchases against share repurchases reported in firms' financial statements: they find annual and quarterly Compustat purchases of common stock, after adjusting for preferred stock repurchases, are good measures of actual repurchases in the sense that the proportion of extremely inaccurate data points is low.

In this study, I follow Grinstein and Michaely (2005) and Massa et al. (2007) to calculate repurchase activity. I use data item PRSTKC from Compustat database as a measure of repurchase amount. Although by definition this item includes preferred as well as common stock, preferred stock repurchase activity is a minute fraction of overall repurchases. Furthermore, in some instances this item is reported as zero but there is a significant reduction in the redemption value of preferred stocks (item PSTKRV), suggesting a negative repurchase amount if I adjust for preferred stock repurchases. Therefore, item PRSTKC best estimates common stock repurchase amount. My main variable measuring intensity of repurchase activity ($RI_{i,t}$) is defined as the amount of share repurchased reported during the fiscal year (item PRSTKC) divided by the total dollar trading volume over the same period (data from CRSP).

$$RI_{i,t} = \frac{PRSTKC_{i,t}}{\sum_{s=1}^{Di,t} P_{i,s} \times Vol_{i,s}} \tag{3}$$

where $D_{i,t}$ is the number of valid observation days for stock i during fiscal year t, $PRSTKC_{i,t}$ is the repurchase amount reported by firm i during fiscal year t. $P_{i,t}$ and $Vol_{i,t}$ are respectively the daily price and trading volume of stock i on day s. I multiply the above estimate by 1000 for practical purposes. This measure is a repurchase intensity measure because a high value indicates greater repurchase dollars per thousand dollar trading volume. Hillert et al. (2016) construct similar measures of repurchase intensity, but use number of shares outstanding as the denominator.

4.5 Control Variables and Descriptive Statistics

To examine the effect of share repurchase on liquidity and subsequent firm behavior, I follow the current literature on financial constraint to control for a set of firm and industry characteristics that may affect their behavior. Specifically, I use the component variables of the KZ index, including cash flow, cash, dividend, leverage, and Tobin's Q. *Cash flow* is defined as cash flow over lagged book assets, *cash* as cash balances over lagged book assets, *dividend* as cash dividends over lagged book assets, *leverage* as the sum of long-term debt and current debt over

lagged book assets, and *Tobin's Q* as the ratio of the market-to-book value of the firm's assets. I also use the component variables of the WW index for robustness check, including cash flow, dividend dummy, long-term debt, sales growth, and industry sales growth. The dividend dummy variable equals one if the firm pays cash dividends and zero otherwise, long-term debt is defined as long-term debt over lagged book assets, sales growth as the firm's sales growth, and industry sales growth as the firm's three-digit industry sales growth. I also include stock volatility and stock returns in selected analyses. *Stock volatility* is defined as the annualized standard deviation of daily stock returns, and *stock returns* as the cumulative of daily stock returns over the fiscal year. All of the results hold whether I use KZ variables or WW variables; therefore, I only report the results using KZ variables for some tables. The results with WW variables are available upon request. All the variables are defined in detail in the Appendix.

Table 2. Financial constraint and firm characteristics

Panel A: Firm characteristics in 1992 per financial constraint status

	Unconstrained	Sufficient	Constrained	Unconstrained vs. Constrained
Market capitalization	4,466.37	283.97	94.71	**4,371.66*****
Total assets	3,381.30	146.18	31.26	**3,350.04*****
Income	159.66	5.79	-0.50	**160.16*****
Cash flows	0.11	0.11	0.02	**0.09*****
Dividend	0.02	0.01	0.00	**0.02*****
Cash	0.11	0.20	0.33	**-0.22*****
Leverage	0.24	0.22	0.14	**0.09*****
Tobin's Q	2.16	2.20	3.56	**-1.40*****
Investment	0.10	0.13	0.17	**-0.07*****
N	603	228	251	

Panel B: Firm characteristics in 2006 per financial constraint status

	Unconstrained	Sufficient	Constrained	Unconstrained vs. Constrained
Market capitalization	5,319.27	133.14	39.63	**5,279.64*****
Total assets	5,844.74	79.53	21.13	**5,823.61*****
Income	292.28	-3.98	-1.92	**294.20*****
Cash flows	0.11	-0.01	-0.05	**0.16*****
Dividend	0.01	0.01	0.02	0.00
Cash	0.16	0.30	0.32	**-0.16*****
Leverage	0.20	0.13	0.14	**0.06*****
Tobin's Q	1.80	1.97	2.40	**-0.60****
Investment	0.09	0.13	0.16	**-0.07*****
N	898	92	92	

Table 2 provides summary statistics for firm characteristics for three groups of firms based on their constraint status: financially unconstrained, financially sufficient, and financially constrained firms, as of 1992, and as of 2006. There are significant differences among the three groups. Unconstrained firms are significantly bigger, have more income, more cash flow, less cash, higher leverage, smaller Tobin's Q, and less investment. This is consistent with Hadlock and Pierce (2010), who suggest constrained firms choose to hold more cash and keep leverage low for precautionary reasons. In addition, the fact that constrained firms have higher Tobin's Q, a proxy for growth opportunities, and higher investment, emphasizes the wedge between internal needs and external cost of funds at constrained firms.

5. The Impact of Share Repurchase on Financial Constraint

Hennessy and Whited (2007) suggest that the financial constraint status of firms has a substantial effect on a variety of firm decisions, including investment and capital structure choices. Similarly, given their constraints, such firms choose different payout methods with varying intensity. By restricting firms with available data throughout 15 years,

from 1992 to 2006, I am able to observe a firm's status coming into the period (in 1992), its payout behaviors during the period, and its status coming out of the period (in 2006). While unconstrained firms coming in and going out of the period experience no change in status, more than half of ex-ante constrained firms come out unconstrained. By controlling for other factors that can also affect constraint status, I study the effect of share repurchases on firm financial constraint status and subsequent firm behaviors as hypothesized in Hypothesis 1.

5.1 Univariate Analysis

I start my analysis by looking at three groups of firms based on their constraint status in 1992 and their cumulative payout activity between 1992 and 2006 reported in Table 3.

Table 3. Financial constraint and corporate payouts

Panel A: Unconstrained firms in 1992

	N	Mean	Standard Deviation	25th percentile	Median	75th percentile
HP-Index 1992	603	-3.85	0.42	-4.23	-3.89	-3.45
Illiquidity 1992	603	-3.76	5.42	-9.71	-1.03	-1.02
HP-Index 2006	603	-4.37	0.29	-4.63	-4.49	-4.12
Illiquidity 2006	603	-0.13	1.08	-0.02	-0.02	-0.02
Cumulative dividend amount	603	1,254.13	2,589.87	41.40	204.19	920.48
Cumulative dividend ratio	603	1.65%	2.37%	0.64%	1.42%	2.05%
Cumulative repurchase amount	603	1,182.05	2,057.23	31.44	237.54	1,331.31
Cumulative repurchase intensity	603	21.13	30.81	4.32	12.20	25.03

Panel B: Sufficient firms in 1992

HP-Index 1992	228	-2.87	0.14	-3.00	-2.86	-2.76
Illiquidity 1992	228	-4.10	11.53	-10.58	-8.82	-0.96
HP-Index 2006	228	-3.66	0.30	-3.86	-3.70	-3.49
Illiquidity 2006	228	-0.17	2.20	-1.01	-0.89	-0.02
Cumulative dividend amount	228	51.77	168.00	0.00	3.17	34.06
Cumulative dividend ratio	228	1.43%	3.16%	0.00%	0.44%	1.46%
Cumulative repurchase amount	228	191.24	601.63	2.58	17.54	87.94
Cumulative repurchase intensity	228	16.60	31.98	1.05	5.90	15.27

Panel C: Constrained firms in 1992

HP-Index 1992	251	-2.10	0.45	-2.48	-2.21	-1.82
Illiquidity 1992	251	-1.96	15.66	-10.54	-8.74	-1.01
HP-Index 2006	251	-3.18	0.49	-3.56	-3.24	-2.88
Illiquidity 2006	251	0.35	3.27	-1.01	-0.94	-0.02
Cumulative dividend amount	251	7.77	26.24	0.00	0.00	4.34
Cumulative dividend ratio	251	0.80%	2.11%	0.00%	0.00%	0.70%
Cumulative repurchase amount	251	37.36	146.01	0.00	1.61	13.85
Cumulative repurchase intensity	251	8.51	19.57	0.00	1.13	8.05

By classification, unconstrained firms have the lowest HP index, and constrained firms the highest. As a whole, each group's HP index decreases from 1992 to 2006, reflecting improved financial status. This is not surprising, given that the HP index loads primarily on size and age. As firms grow, they become less constrained. In term of illiquidity, values are negative because they are adjusted by subtracting exchange illiquidity from raw Amihud's (2002) illiquidity during the same period. The more negative the value, the more liquid the stock relative to the liquidity of its exchange. In general, unconstrained firms are more liquid than constrained firms. This is consistent with Cleary, Povel, and Raith (2007), who suggest information asymmetry between firms and uninformed investors is a primary root cause of financial constraint.

In terms of liquidity trend, market liquidity improves from 1992 to 2006, regardless of firm group. This is consistent with Kamara et al. (2008), who observe that the substantial increase in institutional investing and index trading in the past 50 years plays a key role in increasing trading volume and liquidity in U.S. equity markets. The liquidity of financially sufficient firms more closely resembles that of unconstrained firms than constrained firms, consistent with the notion that financially sufficient firms behave more like unconstrained firms. This also motivates me to remove financially sufficient firms from my final sample of constrained firms.

Consistent with the free-cash-flow hypothesis of corporate payouts, first proposed by Jensen (1986), financially unconstrained firms pay out much more than the other two groups, either in the form of dividends or share repurchases. These firms are more likely to have fewer growth opportunities. Sufficient and constrained firms pay out much less, and utilize more share repurchases than dividends. This is in line with Jagannathan et al. (2000) and Guay and Harford (2000), who suggest that share repurchases are used to distribute cash flows unlikely to reoccur.

5.2 Cross-sectional Regression Analyses

Before focusing on constrained firms, I investigate the characteristics of financial constraint as these firms enter my sample in 1992. I limit my sample to 786 firms that are either unconstrained or constrained. I run probit regressions to assess whether the probability of being unconstrained is correlated with different characteristics of firms. The primary test variable here is firm illiquidity. I use the components of the KZ index as additional explanatory variables in Column 1, and rerun the regression using the WW index components as a robustness test in Column 2. I do not use log(Total Assets) as one of the WW index components because of multicolinearity, given that the HP index is also calculated based on total assets. The results are shown in Table 4. Intercepts are not reported.

Table 4. Predicting Firms' "Financial Constrained" Status in 1992

		Prob(Unconstrained in 1992) (1)	Prob(Unconstrained in 1992) (2)
Illiquidity 1992	(−)	**-0.035*** **	**-0.02*** **
		(0.01)	**(0.01)**
Cash flows 1992		**2.4*** **	**1.428*** **
		(0.61)	**(0.48)**
Cash 1992		**-1.49*** **	
		(0.36)	
Dividend 1992		**43.648*** **	
		(5.82)	
Leverage 1992		**1.758*** **	
		(0.42)	
Tobin's Q 1992		**-0.222*** **	
		(0.04)	
Dividend Dummy 1992			**1.704*** **
			(0.13)
Long-term Debt 1992			**2.628*** **
			(0.42)
Sales Growth 1992			**-0.566*** **
			(0.17)
Industry Sales Growth 1992			-0.895
			(0.88)
Number of firms		786	786
Prob > chi-square		<.0001	<.0001
Pseudo R^2		0.511	0.529

All coefficients are statistically significantly different from zero, implying the HP classification is a good measure of financial constraint. Consistent with prior literature, unconstrained firms are more liquid, have more cash flow, pay more dividends, and have fewer growth opportunities. Hadlock and Pierce (2010) argue that constrained firms hold more cash and keep financial slack for precautionary purposes. I also find that unconstrained firms have less cash and more leverage. Consistent with Ascioglu et al. (2008), the more liquid a firm's stock, the more likely it is unconstrained. High illiquidity implies high information asymmetry between the firm and the market, increasing costs of external financing. This relationship is statistically and economically significant. Holding all control variables constant at their mean levels, a one standard deviation above mean level of illiquidity decreases the probability of a firm being unconstrained, from 84.76% to 75.86%, an almost 9% decrease in likelihood.

Of 786 firms that enter my sample period in 1992, all 603 unconstrained firms come out as still unconstrained in 2006, and there is no significant cross-sectional change in financial constraint among unconstrained firms. However, of 183 constrained firms in 1992, 99 become unconstrained by 2006, and only 84 remain constrained.

Does repurchase intensity play a role in improving the financial status of more than half of the constrained firms? I test for Hypothesis 1 by running probit regressions on the group of constrained firms in 1992 only, modelling the probability of being unconstrained in 2006. The test variables are cumulative repurchase intensity and cumulative dividend ratio. Cumulative repurchase intensity is the repurchase intensity over 15 years, from 1992 to 2006, calculated as the sum of repurchase amount over 15 years divided by the total dollar trading volume over the same period. Cumulative dividend ratio is calculated as the sum of dividends paid throughout 15 years divided by the sum of total assets in the years that dividends are paid. This variable is used to test for the dividend substitution hypothesis (Grullon & Michaely, 2002). The control variables are either all the KZ's components (Column 1) or all the WW's components in 2006 (Column 2). Again, I do not use log(Total Assets) for WW variables. The results are shown in Table 5. Intercepts are not reported.

Table 5. Predicting Firms' "Financial Constrained" Status in 2006

Given firms are constrained in 1992		Prob(Unconstrained in 2006) (1)	Prob(Unconstrained in 2006) (2)
Cumulative repurchase intensity	(+)	0.019**	0.018*
		(0.01)	(0.01)
Cumulative dividend ratio	(−)	-0.482***	-0.535***
		(0.16)	(0.17)
Illiquidity 2006	(−)	-1.078***	-0.994***
		(0.25)	(0.23)
Cash flows 2006		1.98***	2.174***
		(0.61)	(0.52)
Cash 2006		0.137	
		(0.38)	
Leverage 2006		2.308***	
		(0.86)	
Tobin's Q 2006		-0.076	
		(0.08)	
Long-term Debt 2006			2.122***
			(0.77)
Sales Growth 2006			0.965**
			(0.45)
Industry Sales Growth 2006			1.112
			(1.21)
Number of firms		183	183
Prob > chi-square		<.0001	<.0001
Pseudo R^2		0.562	0.596

Similar to Table 4, unconstrained firms are more liquid, and have more cash flows and more leverage. The coefficient on *Cash* is not significant. According to Kaplan and Zingales (1997), constrained firms have less internal

funding, e.g. cash, whereas Hadlock and Pierce (2010) argue that constrained firms hold more cash as a precaution. In both of my columns, the coefficients on cumulative repurchase intensity are positive and significant. The higher the repurchase intensity, the more likely an ex-ante constrained firm becomes unconstrained ex-post. Repurchase intensity helps reduce financial constraint. Keeping all other control variables at their mean values, a one standard deviation above the mean value of repurchase intensity increases the probability of constrained firms in 1992 being unconstrained by 2006 from 7.21% to 10.1%, a significant increase of 2.89% in likelihood. In contrast to the impact of repurchase intensity, the coefficients of cumulative dividend ratio are negative and statistically significant. The more dividends firms pay, the more likely they are constrained. This is inconsistent with the dividend substitution hypothesis of share repurchase, which implies that the effect of share repurchase and dividends are analogous. However, it is consistent with Brav, Graham, Harvey, and Michaely (2005), where CFOs acknowledge rigidity of dividends; regardless of the financial status of the firms, firms have to keep paying dividends, or risk sending unfavorable signals to the market; with higher cost of capital, this deteriorates the financial status of the firm, making it more constrained.

In sum, the results here are consistent with Hypothesis 1, showing the positive impact of share repurchase on alleviating firms' constraint status.

6. The Impact of Share Repurchase on Market Liquidity

Section 5 shows the impact of repurchase intensity on the financial status of a firm, in particular for ex-ante constrained firms. The higher repurchase intensity a firm has, the more likely it becomes unconstrained ex-post. Share repurchases therefore reduce financial constraint, but how? I argue that share repurchases enhance market liquidity, which lowers information asymmetry between the firms and uninformed investors, as stated in Hypothesis 2. By buying back shares, firms increase depth on the sell-side of the market. This effect should be more pronounced for financially constrained firms, of which illiquid stocks benefit more from added market depth. Here, firms can be thought of as buyers of last resort – supporting their market makers and adding downside liquidity in a high information asymmetry environment. Further, the presence of a large buyer in a falling market gives confidence to market participants. Grullon and Ikenberry (2000) find evidence that the stock returns of firms that actively repurchase their shares are less sensitive to market-wide movements in declining or bearish markets. In this section, I test Hypothesis 2 for my sample of ex-ante financially constrained firms from 1992 to 2006. I require all firms to have liquidity data available throughout the whole period, limiting my sample to 163 constrained firms in 1992, for a total of 2,445 firm-year observations.

There are two issues to be considered in this analysis. First, share repurchases imply a decision made by managers. Heckman (1979) proposes a two-stage estimation procedure using the inverse Mill's ratio to take account of selection bias. Second, there is possible endogeneity between share repurchases and market liquidity. Brockman et al. (2008) observe that market liquidity plays a significant role in repurchase initiations, as well as recurring payout decisions, while Barclay and Smith (1988) examine liquidity changes following the repurchase decision. To address these two issues, I utilize Heckman-corrected two-stage-least-square (2SLS) regressions. In the first step, I model the probability of doing share repurchases in a given year with a probit model. Firms that engage in share repurchases are those that have positive repurchase intensity in a given year. Then I calculate the inverse Mill's ratio from this probit estimation and use it in the 2SLS estimation as an exogenous variable.

Table 6 reports the results of this approach. Intercepts are not reported. Column 1 reports the results of the probit regression. Column 2 reports the first stage of the 2SLS, and column 3 reports the second stage. The endogenous variables are repurchase intensity and change in illiquidity each year. *Change in illiquidity* is calculated as the illiquidity of the current year minus the illiquidity of the previous year. The more liquid a stock is, the more negative the change in illiquidity becomes. The instrument variables for repurchase intensity are lagged illiquidity and lagged firm characteristics. Firm characteristics are KZ components. The model is:

$$\Pr(Re\,purchase\,Intensity_{i,t} > 0) = f(Illiquidity_{i,t-1}, Firm\,characteristics_{i,t-1}) \tag{4}$$

$$Re\,purchase\,Intensity_{i,t} = g(Illiquidity_{i,t-1}, Firm\,characteristics_{i,t-1}, \\ InverseMill's\,ratio, Firm\,characteristics_{i,t}) \tag{5}$$

$$\Delta Illiquidit\,y_{i,t} = h(\text{Re}\,purchase\,Intensity_{i,t},$$
$$InverseMill's\,ratio, Firm\,characteristics_{i,t})\quad(6)$$

Table 6. Illiquidity and Repurchase Intensity

		Probit	2SLS	
		Prob(Repurchase$_{i,t}$)	*Repurchase Intensity$_{i,t}$*	*ΔIlliquidity$_{i,t}$*
		(1)	(2)	(3)
Repurchase Intensity$_{i,t}$	(−)			**-0.556****
				(-2.07)
Illiquidity$_{i,t-1}$	(+)	**0.007****	**1.161****	
		(2.12)	**(1.97)**	
Inverse Mill's ratio			14.890	**-10.820*****
			(1.02)	**(-3.07)**
Cash Flows$_{i,t-1}$		**1.164*****	29.070	
		(5.24)	(1.64)	
Cash$_{i,t-1}$		-0.152	**-5.483****	
		(-1.32)	**(-2.04)**	
Dividend$_{i,t-1}$		-0.0333	-10.800	
		(-0.03)	(-0.23)	
Leverage$_{i,t-1}$		**-0.773*****	**-31.970****	
		(-3.61)	**(-1.96)**	
Tobin's Q$_{i,t-1}$		**-0.070*****	-1.568	
		(-4.41)	(-1.58)	
Stock Volatility$_{i,t-1}$		**-0.808*****	-30.200	
		(-6.00)	(-1.50)	
Cash Flows$_{i,t}$			-3.194	-3.097
			(-0.63)	(-0.98)
Cash$_{i,t}$			-2.047	-0.939
			(-0.98)	(-0.48)
Dividend$_{i,t}$			113.600	**71.401***
			(1.56)	**(1.73)**
Leverage$_{i,t}$			19.060	6.004
			(1.22)	(0.97)
Tobin's Q$_{i,t}$			**-0.881*****	-0.546
			(-2.59)	(-1.50)
Stock Volatility$_{i,t}$			**-12.340****	-0.578
			(-2.28)	(-0.14)
N		2,282	2,282	2,282

H0: Under-identification	Chi-square = **14.021****
H0: Valid instruments	Chi-square = 7.163
H0: Endogenous variables are exogenous	Chi-square = **11.147*****

In terms of the decision to repurchase shares, the coefficient on lagged illiquidity is statistically significant and positive. This implies that the more illiquid a stock, the more likely the firm is to repurchase shares. This validates my notion that stock illiquidity motivates firms to repurchase shares, in the expectation that doing so increases stock

liquidity, consistent with Hypothesis 2. This is inconsistent with Brockman et al. (2008), who suggest higher market liquidity encourages use of repurchases, but their analysis includes unconstrained and constrained firms. Prior literature suggests unconstrained and constrained firms behave differently, so combining both increases the chance that the effect of share repurchases on the liquidity of firms in one group could be masked. Firms with more cash flows, less leverage, less growth opportunities, and less risk, are more likely to repurchase shares. The statistically significant negative coefficient on Tobin's Q confirms the investment substitution hypothesis of share repurchase noted in Brav et al. (2005). Firms repurchase shares when they have exhausted good investment opportunities.

The 2SLS regressions disentangle the endogenous relationship between share repurchases and market liquidity. The specifications for Table 6 are robust to over-identification, valid instruments, and truly endogenous variable restrictions. The key variables here are lagged illiquidity in Column 2 and repurchase intensity in Column 3. Both coefficients are statistically significant and carry predicted signs. The more illiquidity the previous year, the higher the repurchase intensity the current year. Consequently, the higher repurchase intensity, the more negative the change in illiquidity, i.e., the more liquid the stock becomes. In other words, lagged illiquidity prompts firms to repurchase shares, and repurchase intensity enhances market liquidity, consistent with Hypothesis 2. This is also consistent with Hillert et al. (2016), who postulate that firms supply liquidity to the market when they repurchase a large number of shares, and this effect is most pronounced for illiquid markets. My analysis improves upon Hillert et al. (2016) in that I employ 2SLS to control for endogeneity, while they use lagged illiquidity in their OLS regressions and do not control for selection bias.

7. The Impact of Market Liquidity on Corporate Decisions and Market Perception

So far, I have shown that financially constrained firms repurchase shares to enhance their stock liquidity. The more illiquid their stock the prior year, the higher the repurchase intensity the current year, and the more liquid their stock becomes. Why would constrained firms care about market liquidity? Fang, Noe and Tice (2009) investigate the relation between stock liquidity and firm performance and show that firms with liquid stocks have better performance, as measured by market-to-book ratio. This effect is greater for liquid stocks with high business uncertainty (high operating income volatility or high R&D intensity). They suggest stock liquidity improves firm performance through a feedback effect where liquidity stimulates the entry of informed investors who make prices more informative to stakeholders. Liquidity also improves firm performance by increasing the efficiency of performance-sensitive managerial compensation. Additionally, Gopalan, Kadan and Pevzner (2012) document a positive and economically large relation between stock liquidity and asset liquidity, and the relation is more positive for firms with fewer growth opportunities and financial constraints.

This implies stock liquidity enhancement from share repurchases affect asset liquidity and subsequent financial performance. I test for this argument by looking at the impact of improved liquidity on the characteristics of financially constrained firms, i.e. costly external financing (supply side) and underinvestment (demand side) (Note 9). Since improved liquidity also implies lower information asymmetry, I also look at market perception of the value added of incremental investments, and firm risk. The predictions for these tests are stated in Section 3, Hypothesis 3 through Hypothesis 6.

7.1 External Financing

While financial constraint limits a firm's ability to access external capital, improved stock liquidity reduces transaction costs, reducing the cost of capital. Butler et al. (2005) find that stock liquidity is an important determinant of the cost of raising external capital because both flotation costs and investment banking fees are lower when stock liquidity improves. I examine the effect of improved liquidity on a firm's equity and debt issuances in the period from 1992 to 2006 using Heckman's (1979) two-stage regression to control for selection bias. In the first stage, I model the probability that a firm issues equity or debt in a given year with a probit model. Firms that issue equity (debt) are those that have positive equity (debt) issuance. Then I calculate the inverse Mill's ratio from this probit estimation and use it in the OLS estimation as an additional explanatory variable. Specifically, I use the following specification:

$$\Pr(External\ Finance_{i,t} > 0) = f\,(\Delta Illiquidity_{i,t}, Firm\ characteristics_{i,t-1})$$

$$External\ Finance_{i,t} = g\,(\Delta Illiquidity_{i,t}, Inverse\ Mill's\ ratio, Firm\ characteristics_{i,t-1})$$

$$(7)$$

where *External Finance* is either equity issuance or debt issuance of firm *i* in year *t*. Equity issuance is defined as sales of common and preferred stocks over lagged book assets. Debt issuance is defined as the sum of long-term debt

issuance and the change in current debt over lagged book assets. Δ*Illiquidity* is the change in illiquidity, calculated as the illiquidity in the current year minus the illiquidity in the previous year. Firm characteristics are the KZ components.

Table 7 reports results of this analysis, predicted by Hypothesis 3. Panel A looks at equity issuance, while Panel B looks at debt issuance. The first column in each panel reports results of the first stage of the Heckman model. The second and third columns report the second stage: the second column uses reported change in illiquidity; and the third column uses predicted and residual change in illiquidity. All regressions control for industry fixed effects and cluster by year. Intercepts are not reported.

Table 7. Illiquidity and External Financing

Panel A – Equity Issuance – Given firms are constrained in 1992				
		Prob(Equity Issuance$_{i,t}$)	*Equity Issuance$_{i,t}$*	*Equity Issuance$_{i,t}$*
		(1)	(2)	(3)
ΔIlliquidity$_{i,t}$	(−)	**-0.009*****	**-0.002*****	
		(-2.75)	**(-3.05)**	
Predicted ΔIlliquidity$_{i,t}$	(−)			**-0.002*****
				(-3.11)
Residuals ΔIlliquidity$_{i,t}$	(−)			**-0.002*****
				(-3.04)
Inverse Mill's ratio			**0.172****	**0.172****
			(2.51)	**(2.55)**
Cash Flows$_{i,t-1}$		**-0.404***	**-0.378*****	**-0.378*****
		(-1.92)	**(-4.51)**	**(-4.52)**
Cash$_{i,t-1}$		**0.432*****	-0.028	-0.028
		(3.31)	(-1.30)	(-1.30)
Dividend$_{i,t-1}$		**-2.232***	**-0.453*****	**-0.453*****
		(-1.89)	**(-3.54)**	**(-3.52)**
Leverage$_{i,t-1}$		-0.274	-0.030	-0.030
		(-1.42)	(-0.53)	(-0.52)
Tobin's Q$_{i,t-1}$		**0.090*****	**0.052*****	**0.052*****
		(5.23)	**(6.62)**	**(6.65)**
Stock Volatility$_{i,t-1}$		**-0.680*****		
		(-7.30)		
N		2,282	2,282	2,282
Adjusted R-square			0.274	0.274
Industry Fixed Effects			YES	YES
Cluster by Year			YES	YES

Panel B – Debt Issuance – Given firms are constrained in 1992

		Prob(Debt Issuance$_{i,t}$)	*Debt Issuance$_{i,t}$*	*Debt Issuance$_{i,t}$*
		(7)	(8)	(9)
ΔIlliquidity$_{i,t}$	(−)	-0.002	-0.000	
		(-0.61)	(-1.46)	
Predicted ΔIlliquidity$_{i,t}$	(−)			**-0.001***
				(-1.81)
Residuals ΔIlliquidity$_{i,t}$	(−)			-0.0001
				(-1.30)
Inverse Mill's ratio			0.169	0.165
			(0.98)	(0.96)
Cash Flows$_{i,t-1}$		0.166	0.048	0.048
		(1.15)	(1.21)	(1.22)
Cash$_{i,t-1}$		**-0.561*****	-0.104	-0.102
		(-7.12)	(-1.52)	(-1.49)
Dividend$_{i,t-1}$		**-3.298****	-0.662	-0.649
		(-2.46)	(-1.52)	(-1.48)
Leverage$_{i,t-1}$		**2.020*****	**0.487****	**0.482****
		(12.46)	**(2.24)**	**(2.21)**
Tobin's Q$_{i,t-1}$		-0.012	0.000	0.000
		(-1.28)	(0.13)	(0.13)
Stock Volatility$_{i,t-1}$		-0.039		
		(-0.45)		
N		2,282	2,282	2,282
Adjusted R-square			0.096	0.096
Industry Fixed Effects			YES	YES
Cluster by Year			YES	YES

For Table 7 Panel A, in Column 1, the coefficient of change in illiquidity is negative and statistically significant. The more negative the change in illiquidity, i.e. the more liquidity improves, the more likely a firm is to issue equity. This is in support of Butler et al. (2005), since the cost of raising equity when liquidity improves is lower. Firms also are more likely to issue equity when they have less cash flow, more cash, and pay fewer dividends. These are the characteristics of constrained firms, the very ones that are in need of external capital. In addition, firms are more likely to issue equity when they have growth opportunities as measured by Tobin's Q, consistent with the notion that firms need more capital to fund their investments. The negative and significant coefficient on stock volatility is in support of Larrain and Varas (2013), who observe that among stocks with high return volatility, those that issue equity are more likely to have highly negative expected returns. This implies that firms are more likely to issue equity when their volatility is low. Column 2 and 3 confirm the probit model in Column 1. Firms issue more equity when their liquidity improves.

In Table 7 Panel B, none of the coefficients on change in illiquidity are significant for debt issuance, implying no relationship between change in illiquidity and debt issuance. There are two caveats to this. First, these are constrained firms only, which tend to be small and less likely to issue public debt. Brown and Petersen (2009)

observe that in the last few decades, there has been a sharp increase in the use of public equity financing by young firms, suggesting that stock issues may have become a closer substitute for internal financing. Vo (2014) documents that small firms tend to raise more external equity than debt. Second, improved liquidity is more likely to be beneficial for the equity market than the debt market. Lipson and Mortal (2009) examine the relation between market liquidity and capital structure and find that firms with more liquid equity have lower leverage and prefer equity financing when raising capital. Similarly, Bharath, Pasquariello, and Wu (2009) show that firms that use a higher percentage of financing through debt, have lower liquidity in the stock market. Firms with higher leverage raise more debt, implying that these are underleveraged firms, consistent with the notion that constrained firms have lower leverage to keep financial slack for precautionary purposes (Hadlock & Pierce, 2010).

In sum, the results shown in this section are consistent with Hypothesis 3.

7.2 Internal Investment

With improved liquidity, constrained firms are able to issue more equity, presumably to fund investment. As a result, their investments should increase with the improved liquidity. Using a panel of Latin American firms, Munoz (2013) finds evidence that higher trading volume, a proxy for stock liquidity, is associated with higher firm investment. This relationship is greater for firms with tighter financial constraints and better investment opportunities. Vo (2014) shows that stock liquidity is significantly correlated with R&D activity.

I test for this argument with the following specification:

$$Investments_{i,t} = f(\Delta Illiquidity_{i,t}, Illiquidity_{i,t-1}, Firm\,characteristics_{i,t}) \qquad (8)$$

where *Investments* is defined as the sum of the firm's capital expenditure and R&D expense over lagged book assets. $\Delta Illiquidity$ is the change in illiquidity, calculated as the illiquidity in the current year minus the illiquidity in the previous year. *Firm characteristics* are the KZ components. Table 8 reports the estimates of this panel regression. All regressions are controlled for industry fixed effects and clustered by year. Intercepts are not reported.

Table 8. Illiquidity and Investments

		$Investment_{i,t}$	$Investment_{i,t}$
		(1)	(2)
$\Delta Illiquidity_{i,t}$	(−)	-0.002***	
		(-4.88)	
Predicted $\Delta Illiquidity_{i,t}$	(−)		-0.001***
			(-5.35)
Residuals $\Delta Illiquidity_{i,t}$	(−)		-0.002***
			(-4.90)
$Illiquidity_{i,t-1}$		-0.002***	-0.001***
		(-4.60)	(-4.66)
Cash Flows$_{i,t}$		-0.194***	-0.194***
		(-8.09)	(-8.11)
Cash$_{i,ti,r}$		0.144***	0.144***
		(5.39)	(5.39)
Dividend$_{i,t}$		-0.189	-0.190
		(-1.68)	(-1.70)
Leverage$_{i,t}$		0.043**	0.042**
		(2.65)	(2.64)
Tobin's Q$_{i,t}$		0.010***	0.010***
		(11.33)	(11.18)
N		2,282	2,282
Adjusted R-square		0.405	0.405
Industry Fixed Effects		YES	YES
Cluster by Year		YES	YES

In Table 8, the coefficients on change in illiquidity are negative and statistically significant. The more negative the change in illiquidity, i.e., the more liquidity improves, the more investments a firm makes. This result is robust to a reported change in illiquidity and predicted and residual changes in illiquidity. Lagged illiquidity is included as a control. Its coefficient sign is negative and significant, implying that firms reduce investment if their stock was illiquid the previous year. However, improved liquidity, potentially from stock repurchases, is associated with greater investment, consistent with Hypothesis 4.   Signs on control variable coefficients are consistent with the literature. Firms will invest more if they have more cash, less cash flows, more leverage, and more growth opportunities.

7.3 Value added from Market Perception

Ascioglu et al. (2008) suggest that market liquidity captures information asymmetry between informed and uninformed investors. As market liquidity improves, price become more informative to firm managers and other stakeholders, implying that markets now value firm investment more than when their stocks were less liquid. I test for this by constructing a variable called value added (per dollar of incremental investments).

$$Value\ Added_{i,t} = \frac{MVAssets_{i,t} - MVAssets_{i,t-1} - NetEquityIssuance_{i,t} - NetDebtIssuance_{i,t}}{Capex_{i,t} + R\&D_{i,t}} \quad (9)$$

This variable measures the increase in market value of assets, adjusting for net equity issuance and debt issuance, per dollar of investments. The intuition is that, as a firm chooses to invest in different projects, the market observes this and reflects its perception of the value of such investments through stock price. When information asymmetry falls, the market is more informed and more likely to place higher value on those investments, increasing the market value of assets. Therefore, changes to the market value of assets due to investments will tend to be greater for firms with reduced information asymmetry. In other words, this is the value added from market perception associated with better transparency. The change in the market value of assets needs to be adjusted for net external finance (after share repurchase and/or debt repayment) because the market value of assets can also be increased by additional external finance. Since improved liquidity reduces information asymmetry, I anticipate an increase in the value added variable, stated in Hypothesis 5. I test this prediction using the following specification:

$$Value\ Added_{i,t} = f(\Delta Illiquidity_{i,t}, Firm\ characteristics_{i,t}) \quad (10)$$

Table 9 reports estimates of this panel regression, controlling for industry fixed effects and clustering by year. Intercepts are not reported. The sample period is from 1992 to 2006, for a sample of 163 constrained firms in 1992. The control variables are the KZ components. The first column uses calculated change in illiquidity, and the second uses predicted and residual changes in illiquidity.

Table 9. Illiquidity and Value Added

		$Value\ Added_{i,t}$	$Value\ Added_{i,t}$
		(1)	(2)
$\Delta Illiquidity_{i,t}$	(−)	**-0.671****	
		(-2.44)	
Predicted $\Delta Illiquidity_{i,t}$	(−)		**-0.584****
			(-2.19)
Residuals $\Delta Illiquidity_{i,t}$	(−)		**-0.682****
			(-2.51)
Cash Flows$_{i,t}$		**39.25*****	**39.21*****
		(7.80)	**(7.83)**
Cash$_{i,ti,r}$		**23.00****	**23.12****
		(2.27)	**(2.28)**
Dividend$_{i,t}$		**-92.21****	**-92.83****
		(-2.90)	**(-2.98)**
Leverage$_{i,t}$		-7.380	-7.459
		(-0.60)	(-0.60)
Tobin's Q$_{i,t}$		**2.461*****	**2.471*****
		(4.04)	**(4.11)**
N		2,282	2,282
Adjusted R-square		0.027	0.027
Industry Fixed Effects		YES	YES
Cluster by Year		YES	YES

In Table 9, the coefficient on change in illiquidity is negative and statistical significant. The more negative the change in illiquidity, the greater the value added from investments. In other words, as liquidity improves, the market places higher values on firms' investments, consistent with Hypothesis 5. Fang et al. (2009) use Tobin's Q (calculated as market value of assets divided by book value of assets) as the main measure of firm performance and show a positive relationship between stock market liquidity and Tobin's Q. Since this variable can also be considered a measure of how the market values the book assets, their finding is consistent with my results. The signs on control variables are also as predicted. Firms with more cash flows and more cash are viewed more positively by the market. Firms that pay dividends are not. This is consistent with the lack of information content of dividends. Firms with more growth opportunities are also viewed more positively.

7.4 Risk

Investors care about stock liquidity. It affects their ability to trade the quantity of stocks they want to buy or sell within their desired time-framework at low cost and without price impact. Most importantly, investors fear that in the event of a financial crisis, they may not be able to exit the market fast enough to contain their losses. These considerations may lead them to avoid illiquid securities, or require a liquidity-related risk premium to hold them (Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005). This implies risk is higher for illiquid stocks. As share repurchases enhance liquidity, I expect reduced risk. However, the effect of improved liquidity may be different for systematic and idiosyncratic risk, given that systematic risk can be hedged. Baruch, Karolyi, and Lemmon (2007) and Baruch and Saar (2009) argue that stock return co-movement affects the trading activity of a stock and therefore its liquidity. This is because the correlation of stock returns with the market measures the amount of market-wide information relative to firm-specific information. While market makers can observe the market-wide information easily, it is more difficult for them to observe firm-specific information. When an individual stock is highly

correlated with the market, market makers can rely more on the information they observe from market movements, so stock price adjustments are less sensitive to its own order flow. Conversely, when stocks are more liquid, investors rely more on market-wide information, increasing their systematic risk. This implies a positive correlation between systematic risk and improved liquidity. Chan et al (2013) confirm this prediction and demonstrate that this relationship is stronger for stocks with a higher degree of information asymmetry. Therefore, I predict enhanced liquidity reduces risk via reduced idiosyncratic risk, and increases systematic risk, as stated in Hypothesis 6.

I test for this prediction using the following specification:

$$Risk_{i,t} = f(\Delta Illiquidity_{i,t}, Illiquidity_{i,t-1}, Firm\ characteristics_{i,t}) \qquad (11)$$

where *Risk* is either total risk, systematic risk or idiosyncratic risk. Total risk is defined as the annualized standard deviation of daily stock returns during the fiscal year. Systematic risk is defined as the market return slope coefficient (beta) estimated from Fama and French's (1993) 3-factor model. Idiosyncratic risk is defined as the annualized standard deviation of the residuals from Fama and French's (1993) 3-factor model. Table 10 reports the OLS results for this analysis, controlling for industry fixed effects and clustering by year. Intercepts are not reported. The control variables are the KZ components.

Table 10. Illiquidity and Risk

	Total Risk$_{i,t}$ (1)	Systematic Risk$_{i,t}$ (2)	Idiosyncratic Risk$_{i,t}$ (3)	Total Risk$_{i,t}$ (4)	Systematic Risk$_{i,t}$ (5)	Idiosyncratic Risk$_{i,t}$ (6)
$\Delta Illiquidity_{i,t}$	0.015***	-0.014***	0.015***			
	(8.30)	(-3.03)	(8.52)			
Predicted $\Delta Illiquidity_{i,t}$				0.016***	-0.010**	0.016***
				(9.31)	(-2.20)	(9.62)
Residuals $\Delta Illiquidity_{i,t}$				0.015***	-0.013**	0.015***
				(8.41)	(-2.93)	(8.63)
Illiquidity$_{i,t-1}$	0.020***	-0.016***	0.021***	0.020***	-0.015***	0.021***
	(11.90)	(-5.42)	(11.65)	(12.63)	(-5.02)	(12.39)
Cash Flows$_{i,t}$	-0.202***	0.154	-0.211***	-0.202***	0.156	-0.211***
	(-7.43)	(1.54)	(-8.89)	(-7.40)	(1.57)	(-8.85)
Cash$_{i,t}$	0.027	0.328***	0.002	0.028	0.334***	0.003
	(0.73)	(9.21)	(0.08)	(0.75)	(9.25)	(0.11)
Dividend$_{i,t}$	-1.046***	-2.076***	-0.979***	-1.049***	-2.093***	-0.982***
	(-4.12)	(-3.61)	(-4.06)	(-4.18)	(-3.80)	(-4.12)
Leverage$_{i,t}$	0.067*	0.177	0.040	0.066*	0.172	0.039
	(2.11)	(1.73)	(1.34)	(2.07)	(1.74)	(1.31)
Tobin's Q$_{i,t}$	0.004*	0.040***	0.003	0.004*	0.040***	0.003
	(1.92)	(4.49)	(1.43)	(1.97)	(4.60)	(1.49)
N	2,282	2,282	2,282	2,282	2,282	2,282
Adjusted R-square	0.408	0.164	0.422	0.409	0.172	0.423
Industry Fixed Effects	YES	YES	YES	YES	YES	YES
Cluster by Year	YES	YES	YES	YES	YES	YES

In Table 10, signs of coefficients on change in illiquidity confirm my predictions, and are all statistically significant. The more negative the change in illiquidity, the less the total risk and idiosyncratic risk, and the greater the systematic risk. As liquidity improves, total risk and idiosyncratic risk are reduced, and systematic risk increases, consistent with Hypothesis 6. Lagged illiquidity is included as a control for the level of illiquidity in the previous

year. The signs of the coefficients on this variable are also consistent with previous literature. Illiquid stocks have more idiosyncratic risk and less systematic risk. Other control variables also show consistent signs. Firms with more cash flows, more dividends, and lower leverage have lower risk. Firms with greater growth opportunities have more risk, due to the uncertainty of their future cash flows. Additionally, even after controlling for factors affecting risk, liquidity still shows up as an important factor. This is consistent with the notion of liquidity risk documented in the previous literature (Pastor & Stambaugh, 2003; Acharya & Pedersen, 2005; Amihud, Mendelson & Pedersen, 2006). Lin and Paravisini (2012) argue that financial constraints increase cash flow volatility by making investments sensitive to internal cash and reduce a firm's ability to mitigate the impact of aggregate shocks on dividend streams. As financial constraint increases a firm's risk, share repurchase alleviates this problem by enhancing liquidity, thereby reducing risk.

8. Conclusions

In this paper, I study the liquidity choice of firms. Although many of a firm's actions are known to influence stock liquidity, the literature views stock liquidity as an exogenously determined variable. I directly test firms' influence on stock liquidity by focusing on firms most likely to value stock liquidity due to their costly external financing and stock illiquidity, i.e., financially constrained firms. The existing literature shows such constraints have substantial effects on a variety of corporate decisions, including investment and capital structure choices. Financially constrained firms take actions that help improve their stock liquidity, notably by engaging in share repurchases.

I find strong empirical evidence in support of this prediction in my sample of 183 financially constrained public U.S. firms between 1992 and 2006. Financially constrained firms have less liquid stocks, but those that have greater repurchase intensity are more likely to become unconstrained ex-post. This suggests these firms take steps to improve stock liquidity. I find that lagged illiquidity prompts firms to engage in share repurchase, concurrently improving their stock liquidity. The preference of financially constrained firms for greater liquidity is reflected in a variety of favorable corporate decisions and in market perception. I find that increases in liquidity are related to more equity issuance, greater investment, greater value added from market perception per dollar of incremental investments, and reduced idiosyncratic risk.

Overall, I find strong evidence that firms are able to influence stock liquidity by engaging in share repurchases that mitigate information asymmetry. This is especially true for firms that are most vulnerable to, and most affected by, information asymmetry. This paper also explains a counter-intuitive fact about share repurchase in constrained firms. While share repurchases reduce cash balances and add financial leverage, constrained firms seem to be especially sensitive to this decline in corporate liquidity. However, by acting as buyers of last resort, these firms see their stock liquidity improve and advance their financial status. These findings have economic meaning by linking market microstructure with corporate finance.

Limitations of the study include the modest sample sizes given the data availability issue, as well as the choice of using the stock liquidity measure against a variety of different measures. Future research should focus on expanding the study period and checking the validity of the findings with alternative measures of liquidity.

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Appendix – Variable Definition

Variable	Definition
Amihud illiquidity	The average ratio of the daily absolute return to the dollar trading volume on that day.
Illiquidity	Amihud illiquidity adjusted for the three main exchanges NYSE, AMEX and NASDAQ.
Cash	Cash balances over lagged book assets
Cash flows	Cash flow over lagged book assets
Debt issuance	Sum of long-term debt issuance and change in current debt over lagged book assets
Dividend	Cash dividends over lagged book assets
Dividend dummy	Equals one if the firm pays cash dividend and zero otherwise
Equity issuance	Sales of common and preferred stock over lagged book assets
HP index	Hadlock and Pierce's (2010) index
Idiosyncratic risk	Annualized standard deviation of the residuals from Fama - French's (1993) 3-factor model
Income	Income before extraordinary items
Industry sales growth	The firm's three-digit industry sales growth
Investment	Sum of capital expenditure and R&D expense over lagged book assets
Leverage	Sum of long-term debt and current debt over lagged book assets
Long-term debt	Long-term debt over lagged book asssets
Market capitalization	Market value of common equity
Repurchase amount	Item PRSTKC in Compustat - purchase of common and preferred stocks
Repurchase intensity	Repurchase amount divided by the total dollar trading volume over the fiscal year
Sales growth	The firm's sales growth
Stock returns	Annualized daily stock returns
Stock volatility	Annualized standard deviation of daily stock returns
Systematic risk	Market return slope coefficient (beta) estimated from Fama-French's (1993) 3-factor model
Tobin's Q	The ratio of the market-to-book value of the firm's assets
Total assets	Book assets
Value added	Value added per dollar of incremental investment

Notes

Note 1. Brennan and Subramanyam (1996) and Brennan, Chordia, Subramanyam and Tong (2012) document a positive relationship between average stock returns and liquidity costs. Amihud (2002), Pastor and Stambaugh (2003) and Acharya and Pedersen (2005) argue that illiquidity is a priced risk factor.

Note 2. Barclay and Smith (1988), and Acharya and Pedersen (2005) provide theoretical models that predict a positive relationship between the cost of capital and the bid-ask spread. Empirical work by Brennan and Subrahmanyam (1996), Amihud (2002), Pastor and Stambaugh (2003), and Lee (2011) provides support for this prediction.

Note 3. Amihud and Mendelson (2012) argue that corporate managers should adopt liquidity-increasing corporate financial policies, including lower leverage ratios, the substitutions of dividends for stock repurchases, more effective disclosure, and increases in investor base.

Note 4. Grullon and Ikenberry (2000) and Hillert et al (2016) find evidence that repurchases provide liquidity support in a declining market.

Note 5. As Almeida and Campello (2002) put it, "constrained firms are at the point where the supply of capital becomes inelastic".

Note 6. See, for example, Kaplan and Zingales (1997), Almeida et al. (2004), Whited and Wu (2006), Almeida and Campello (2007), Hennessy and Whited (2007), and Li (2011), among many others.

Note 7. Hadlock and Pierce (2010) point out the endogenous nature of common predictors in previous literature, such as leverage and cash flow, to constraint status, and recommend that researchers rely solely on firm size and age, two relatively exogenous firm characteristics, to identify constrained firms.

Note 8. Hadlock and Pierce (2010) provide evidence that "the only truly new variable from the WW index that offers marginal explanatory power" over the KZ index is firm size.

Note 9. Campello, Graham and Harvey (2010) document that constrained firms have deeper cuts in tech spending, employment, and capital spending. They also burn through more cash, draw more heavily on lines of credit, and sell more assets to fund their operations. In additional, the inability to borrow externally causes many firms to bypass attractive investment opportunities.