



Stock market liquidity and firm value [☆]

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ABSTRACT

This paper investigates the relation between stock liquidity and firm performance. The study shows that firms with liquid stocks have better performance as measured by the firm market-to-book ratio. This result is robust to the inclusion of industry or firm fixed effects, a control for idiosyncratic risk, a control for endogenous liquidity using two-stage least squares, and the use of alternative measures of liquidity. To identify the causal effect of liquidity on firm performance, we study an exogenous shock to liquidity—the decimalization of stock trading—and show that the increase in liquidity around decimalization improves firm performance. The causes of liquidity's beneficial effect are investigated: Liquidity increases the information content of market prices and of performance-sensitive managerial compensation. Finally, momentum trading, analyst coverage, investor overreaction, and the effect of liquidity on discount rates or expected returns do not appear to drive the results.

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1. Introduction

There are strong theoretical reasons to suspect that market liquidity will positively affect firm performance. Because stock shares are the currency which commands both cash flow and control rights, the tradability of this currency plays a central role in the governance, valuation, and performance of firms. In theoretical analyses, liquid markets have been shown to permit non-blockholders to intervene and become blockholders (Maug, 1998), facil-

itate the formation of a toehold stake (Kyle and Vila, 1991), promote more efficient management compensation (Holmstrom and Tirole, 1993), reduce managerial opportunism (Edmans, 2009; Admati and Pfleiderer, 2009; Palmiter, 2002), and stimulate trade by informed investors thereby improving investment decisions through more informative share prices (Subrahmanyam and Titman, 2001; Khanna and Sonti, 2004). Thus, a priori, a positive relation between liquidity and performance is quite plausible. However, despite the large number of theoretical papers with predictions related to liquidity's effect on performance, empirical researchers have not made this relation the center of systematic empirical investigation. Our paper aims to fill this gap in the literature by examining whether and why liquidity affects firm performance.

First, this study shows that stocks with high liquidity have better performance as measured by the firm market-to-book ratio. This result is robust to the use of different measures of liquidity. The market-to-book ratio is then

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separated into the following components: price-to-operating earnings ratio; leverage ratio; and operating return on assets ratio.¹ More liquid stocks have higher operating returns on their assets and more equity in their capital structure. In contrast, their price-to-operating earnings ratios are similar to less liquid stocks. These results hold when we control for industry and firm fixed effects, the level of shareholder rights, stock return momentum, idiosyncratic risk, analyst coverage, and endogeneity using two-stage least squares.

Next, the direction of causality is established by examining the effect of an exogenous shock to liquidity (decimalization) on firm performance. Decimalization increased stock liquidity in general but it increased it more for actively traded stocks. The change in liquidity surrounding decimalization is used as an instrument for liquidity to document that stocks with a larger increase in liquidity following decimalization have a larger increase in firm performance.

Having established a causal relation between liquidity and performance we turn to the problem of identifying its foundation. In *Khanna and Sonti (2004)*, informed traders factor the effect of their trades on managerial behavior into their trading strategy, trading more aggressively, and thus making prices more informative to firm managers and other stakeholders. This feedback effect improves operating performance and relaxes financial constraints. *Subrahmanyam and Titman (2001)* establish that feedback is more important when the relationship between non-financial stakeholders and the firm is fragile or there is high cash flow uncertainty with respect to existing projects. In support, this study finds that the positive effect of liquidity on firm performance is greater for liquid stocks with high business uncertainty (high operating income volatility or high R&D intensity).

This study also shows that stock-market liquidity enhances the effect of pay-for-performance sensitivity on firm performance and operating profitability. This finding is consistent with *Holmstrom and Tirole (1993)*, who predict that liquidity enables informed investors to disguise private information and profit from it. The higher information flow that results from higher liquidity increases the signal-to-noise ratio in stock prices which increases the gain from using stock-based compensation.

We do not find support for other agency-based operating performance theories. Liquidity does not appear to improve firm performance through its effect on manager myopia. Though more liquid stocks have higher operating returns on their assets, their price-to-operating earnings ratios are similar to those of less liquid stocks. With myopia, a trade-off of current profits with long-term prospects should result in different price-to-operating earnings ratios for firms with different stock liquidity levels. Furthermore, we do not find evidence that liquidity either augments or diminishes the performance effect of

blockholders or shareholder rights. In summary, liquidity's positive effect on performance appears to stem from improving the incentive effects of stock-based compensation and the investment decisions of corporate insiders.

Investor sentiment and illiquidity risk are possible alternative explanations for the results as prior empirical work finds a negative correlation between stock liquidity and stock returns.² The most prevalent explanation given for a negative correlation between stock liquidity and returns is that illiquid stocks have higher transaction costs or a higher sensitivity to a liquidity risk factor (see, for instance, *Amihud and Mendelson, 1986*; *Acharya and Pedersen, 2005*). If liquid stocks have lower expected required returns they will trade at a premium all else held constant.³ More recently, *Baker and Stein (2004)* suggest that liquidity could be a sentiment indicator. In their model, high liquidity stocks are overvalued which is why they trade at a premium and have lower expected returns in the future. If higher firm values for firms with more liquid stocks are based on illiquidity risk or investor sentiment, high liquidity stocks should have higher price-to-operating income ratios but similar financial leverage and operating profitability ratios as low liquidity stocks. Since, on average, liquid stocks have similar price-to-operating income ratios as less liquid stocks but different financial leverage and profitability ratios, illiquidity risk and sentiment do not appear to be explanations for the higher firm values of more liquid stocks.

We conclude that 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. The paper outline is as follows: In Section 2, we review prior work and discuss the various ways in which stock market liquidity might affect governance and thus firm performance. Section 3 describes our sample, data sources, and variable measurements. Section 4 contains our empirical tests while Section 5 concludes.

2. Liquidity and firm performance

The relation between liquidity and performance has received considerable attention in financial economics from a variety of perspectives. Researchers have considered both the effect of liquidity on performance as well as the dependence of liquidity on performance.

The causative theories advance many distinct mechanisms through which liquidity affects performance. Most focus on the effect of liquidity on operating performance and are agency-based causative theories. Important theories in this vein include *Maug (1998)* which models

¹ The firm market-to-book ratio is defined as $(Vd+Ve)/(Assets)$. The components of the market-to-book ratio are defined as follows: $(Vd+Ve)/(Assets) = [Ve/Op. Income] \times [(Vd+Ve)/Ve] \times [Op. Income/Assets] = (\text{Market Value of Equity to Op. Income}) \times (\text{Firm Value to Market Value of Equity}) \times (\text{Op. Income to Book Value of Assets})$.

² See, for example, *Stoll and Whaley (1983)*, *Amihud and Mendelson (1986)*, *Brennan and Subrahmanyam (1996)*, *Chalmers and Kadlec (1998)*, *Pastor and Stambaugh (2003)*, and *Hasbrouck (2009)*.

³ Since firm performance is typically measured with Tobin's Q (proxied by the market value of equity plus the book value of debt standardized by total assets), a firm will most likely exhibit a higher firm market-to-book ratio if its equity trades at a premium.

a large relationship investor's monitoring decision. The investor monitors and trades with an aim to profit from the price appreciation caused by his monitoring activities. Maug concludes that liquid stock markets, far from being a hindrance to corporate control, tend to support effective corporate governance. Another causal mechanism through which liquidity may discipline management is identified in Edmans (2009), Admati and Pfleiderer (2009), and Palmiter (2002)—if management's compensation is tied to current stock prices, then increased liquidity increases the cost of opportunism to managers by facilitating informed selling or "dumping".⁴ The distinguishing characteristic of the causative agency theories is they predict that the effect of liquidity on performance will be related to the extent of the agency conflict within the firm.

In contrast to the agency-based causative theories, Subrahmanyam and Titman (2001) and Khanna and Sonti (2004) show liquidity can positively affect firm performance even when agency conflicts are absent. In this setting liquidity stimulates the entry of informed investors who make prices more informative to stakeholders. As shown in Khanna and Sonti (2004), informed traders factor the effect of their trades on managerial behavior into their trading strategy, trading more aggressively, and thus making prices more informative. This feedback effect improves operating performance and relaxes financial constraints. Both effects increase firm performance. Furthermore, non-financial stakeholders' decision to stay or go affects firm cash flows. This is particularly valuable when the relationship between stakeholders and the firm is fragile or there is high cash flow uncertainty with respect to existing projects. This is because positive cascades (success or good news begets more success) will be most valuable in this setting. Feedback theories imply that the effect of liquidity is proportional to the sensitivity of firm operations to the information content of stock prices.

While many models focus on the positive role of liquidity in resolving manager/shareholder agency problems, other researchers have noted potential adverse effects of market liquidity on agency problems within the firm. Coffee (1991) and Bhide (1993) note that though liquidity is a lubricant for share purchases by outside activists, it also facilitates the exit of current blockholders who are potential activists. Hence, liquidity may encourage blockholders to vote with their feet and sell their shares if they are unhappy with firm performance. Goldstein and Guembel (2008) show that negative feedback trading is also possible when speculators exploit liquidity with short-selling strategies that harm firm performance.

Both agency-based and feedback-based causative theories focus on the effect of liquidity on operating performance. However, liquidity might also affect firm

value by changing the discount rate. If the marginal investor values liquidity as in Holmstrom and Tirole (2001), then illiquid stocks should trade at a discount. This implies a positive relation between stock liquidity and market-price based performance measures such as Tobin's *Q*. More recently, Baker and Stein (2004) suggest that liquidity might be related to valuation as a sentiment indicator. In their model, high liquidity stocks are overvalued. Since they trade at a premium they have lower future expected returns.

In summary, causative theories are either operating-performance-based, asserting that liquidity affects operating performance, or pricing-based, asserting that the performance effect stems from an illiquidity premium or mispricing. Operating performance theories, in turn, can be divided into agency or feedback theories.

Moreover, the relation between liquidity and performance might not be based on a causal effect from liquidity. First, liquidity may simply be correlated with other variables that affect firm value. For example, Spiegel and Wang (2005) show that including stock idiosyncratic risk along with liquidity in equations that predict stock returns renders liquidity insignificant. Second, a strong case can be made for liquidity being the dependent variable in the liquidity/performance relation rather than the independent variable. The logic supporting dependent liquidity is that high performance firms will have high market-to-book ratios and high market-to-book ratios may attract institutional investors. Such trades increase market depth and augment stock liquidity. Thus, high firm performance generates liquidity by producing institutional investor demand. Under this theory of dependent liquidity, the relation between liquidity and performance should be driven by those manifestations of high performance that are most attractive to institutional investors.

In the next section we describe our data and the variables we use in our empirical specifications.

3. Data

3.1. Sample selection

We obtain daily and monthly stock return data from the Center for Research in Security Prices (CRSP), intraday trades and quotes from the Trade and Quote database (TAQ), shareholder rights data from the Investor Responsibility Research Center (IRRC), firm financial data from the Compustat Industrial Annual File, analyst coverage data from Institutional Brokers Estimates System (I/B/E/S), institutional holdings data from the CDA/Spectrum Institutional Holdings database, managerial compensation data from the Compustat Executive Compensation file, and Fama French factors and blockholder ownership data through Wharton Research Data Services (WRDS).⁵

⁴ See Kyle and Vila (1991), Holmstrom and Tirole (1993), Attari, Banerjee, and Noe (2006), and Edmans and Manso (2009) for additional arguments for how liquidity can reduce the costs of insider/outside agency problems through increasing the threat of activism or increasing the incentive effects of compensation contracts.

⁵ For details on the construction of the blockholder database, see Dlugosz, Fahlenbrach, Gompers, and Metrick (2006).

Table 1

Variable definitions and summary statistics.

Panel A reports variable definitions for the variables used in the study. Panel B reports summary statistics for the sample firm-year observations. The sample used for the baseline tests contains 8,290 firm-year observations. The sample used for robustness tests sometimes has a smaller number of observations due to data availability. The sample observations are from 1993, 1995, 1998, 2000, 2002, and 2004 as these are the years that shareholder rights data (*GIMINDEX*) is available.

Variable	Definition								
<i>Panel A: Variable definitions</i>									
<i>Q</i>	Market value of assets divided by book value of assets measured at fiscal year end, where market value of assets is defined as market value of equity (Compustat Annual Data #199 × Compustat Annual Data #25) plus book value of assets (Compustat Annual Data #6) minus book value of equity (Compustat Annual Data #60) minus balance sheet deferred taxes (Compustat Annual Data #74)								
<i>OIP</i>	Operating income after depreciation (Compustat Annual Data #178) divided by market value of equity measured at fiscal year end								
<i>LEVERAGE</i>	Market value of equity divided by market value of assets measured at fiscal year end								
<i>OIOA</i>	Operating income after depreciation divided by book value of assets measured at fiscal year end								
<i>LOG_RESPRD</i>	Natural logarithm of relative effective spread, <i>RESPRD</i> , measured over firm <i>i</i> 's fiscal year. <i>RESPRD</i> is defined as the difference between the execution price and the midpoint of the prevailing bid–ask quote divided by the midpoint of the prevailing bid–ask quote.								
<i>GIMINDEX</i>	Index of shareholder rights defined by Gompers, Ishii, and Metrick (2003)								
<i>DUM_SP500</i>	A dummy variable indicating inclusion in the S&P 500 (Compustat Annual Data #276)								
<i>DUM_DE</i>	A dummy variable indicating whether a firm is incorporated in the state of Delaware								
<i>LOG_AGE</i>	Natural logarithm of firm age, which is approximated as the number of years listed in Compustat prior to fiscal year end								
<i>LOG_BVTA</i>	Natural logarithm of book value of assets measured at fiscal year end								
<i>LOG_RESPRD_{t-1}</i>	One period lag of <i>LOG_RESPRD</i>								
<i>Z1</i>	Mean <i>LOG_RESPRD</i> of the two firms in firm <i>i</i> 's industry that have the closest market value of equity to firm <i>i</i> 's market value of equity								
<i>IDIORISK</i>	Standard deviation of OLS regression residuals where excess monthly return of firm <i>i</i> 's stock is regressed on the market risk premium, <i>SMB</i> , and <i>HML</i> . The OLS regressions are estimated using 60 monthly returns prior to fiscal year end. Minimum of 24 monthly return observations per stock required								
<i>LOG_#ANALYSTS</i>	Natural logarithm of the number of analysts from I/B/E/S following firm <i>i</i> during fiscal year <i>t</i>								
<i>CUMRET</i>	Compounded market-adjusted monthly returns for six months prior to fiscal year end for firm <i>i</i> 's stock								
<i>INCVOL</i>	Standard deviation of quarterly operating income before depreciation divided by quarterly book value of assets, measured over 20 quarters prior to fiscal year end. Minimum of eight quarterly observations per firm required								
<i>PPS</i>	Pay-performance sensitivity. See Appendix A for detailed information on the definition of <i>PPS</i>								
Variable	# of observations	Mean	SD	5%	25%	50%	75%	95%	
<i>Panel B: Summary statistics</i>									
<i>Q</i>	8290	1.828	1.360	0.905	1.096	1.384	2.009	4.149	
<i>OIP</i>	8290	0.089	0.409	−0.059	0.056	0.097	0.144	0.263	
<i>LEVERAGE</i>	8290	0.586	0.249	0.129	0.410	0.617	0.793	0.937	
<i>OIOA</i>	8290	0.084	0.107	−0.046	0.038	0.082	0.130	0.229	
<i>LOG_RESPRD</i>	8290	−5.815	1.002	−7.466	−6.495	−5.788	−5.159	−4.120	
<i>GIMINDEX</i>	8290	9.136	2.736	5.000	7.000	9.000	11.00	14.00	
<i>DUM_SP500</i>	8290	0.317	0.465	0.000	0.000	0.000	1.000	1.000	
<i>DUM_DE</i>	8290	0.555	0.497	0.000	0.000	1.000	1.000	1.000	
<i>LOG_AGE</i>	8290	2.976	0.745	1.609	2.398	3.091	3.638	3.912	
<i>LOG_BVTA</i>	8290	7.600	1.656	5.241	6.384	7.422	8.643	10.53	
<i>LOG_RESPRD_{t-1}</i>	7095	−5.755	0.922	−7.289	−6.384	−5.745	−5.138	−4.217	
<i>Z1</i>	7095	−5.652	0.979	−7.277	−6.325	−5.643	−4.990	−4.014	
<i>IDIORISK</i>	8290	0.103	0.057	0.044	0.065	0.090	0.126	0.208	
<i>LOG_#ANALYSTS</i>	8290	2.368	0.858	0.693	1.946	2.485	2.996	3.526	
<i>CUMRET</i>	8290	0.017	0.312	−0.417	−0.151	−0.009	0.139	0.547	
<i>INCVOL</i>	7728	0.016	0.018	0.002	0.006	0.011	0.019	0.045	
<i>PPS</i>	6221	0.007	0.017	0.000	0.000	0.000	0.009	0.035	

3.2. Variable construction

When constructing the sample of firm-year observations, we require that a stock be traded on the NYSE, Amex, or Nasdaq, and that a stock is traded in the same market for at least six months in the fiscal year. TAQ data are only available back to 1993. Moreover, given the data limitations associated with the index of shareholder rights, we further restrict our sample to the six years in which the IRRC has published data. The final sample consists of 8,290 firm-year observations with 2,642 firms for the following years: 1993, 1995, 1998, 2000, 2002, and 2004. Table 1 presents the variable definitions and

summary statistics for the main variables used in the study.

3.2.1. Liquidity measures

The main liquidity measure used in this paper is the relative effective spread calculated using the intraday TAQ data. Relative effective spread is defined as the difference between the execution price and the midpoint of the prevailing bid–ask quote (the effective spread) divided by the midpoint of the prevailing bid–ask quote. Like other cross-sectional studies such as Amihud and Mendelson (1986), the effective spread is standardized to adjust for the stock price level converting it to a relative effective

spread measure. The effective spread calculated using intraday TAQ data is considered to be one of the best proxies for stock liquidity. Liquidity proxies calculated using low frequency stock returns are frequently compared to benchmark liquidity measures calculated using high frequency data (i.e., effective spread measure using TAQ intraday data) to judge their effectiveness as a liquidity proxy (see, e.g., Hasbrouck, 2009; Goyenko, Holden, and Trzcinka, 2009). There is another benefit to using a high frequency effective spread measure. Statman, Thorley, and Vorkink (2006) show that high returns (which could result in a high firm Q) lead to additional trading activity. Hence, reverse causality is a potential concern for liquidity proxies that rely on trading activity as a measurement input. The effective spread measure is less subject to this concern than other measures of liquidity.

To construct effective spreads we follow Chordia, Roll, and Subrahmanyam (2001). Trades out of sequence, trades recorded before the open or after the close, and trades with special settlement conditions are deleted. Following Lee and Ready (1991), any trade from 1993–1998 is matched to the first quote at least five seconds before the trade. Any trade after 1998 is matched to the first quote prior to the trade. To eliminate potentially erroneous records, observations are dropped if they meet any of the following conditions:

- Quoted Spread $> \$5$;
- Effective Spread/Quoted Spread > 4.0 ; and
- Quoted Spread/Transaction Price > 0.4 ;

where quoted spread is defined as the quoted bid–ask spread of the transaction.

The annual relative effective spread, $RESPRD$, is calculated by first calculating the relative effective spread for each matched quote/trade during a trading day for a stock. The arithmetic mean of the relative effective spreads for each matched quote/trade over a trading day for a stock is defined as its daily relative effective spread. The annual relative effective spread for a stock is the arithmetic mean of the daily relative effective spreads over the stock's fiscal year. Due to the non-normality of effective spreads, the natural logarithm of $RESPRD$ is used in all cross-sectional regressions. Thus, LOG_RESPRD is constructed to be negatively related to stock market liquidity. In the sample, LOG_RESPRD ranges from -12.54 to -1.78 with a mean value of -5.81 , a median value of -5.79 , and a standard deviation of 1.00.

As a robustness check, we run all specifications using three alternative proxies for liquidity: the Amihud (2002) mean-adjusted illiquidity measure; the Lesmond, Ogden, and Trzcinka (1999) percentage of zero daily returns liquidity measure; and the relative quoted spread using TAQ data. The use of each alternative proxy for liquidity yields similar results.⁶

⁶ The results using alternative liquidity measures are not tabulated but are discussed in the text.

The sample using the Amihud mean-adjusted illiquidity measure is built following Amihud (2002). Stock i must meet the following restrictions to be in the sample for fiscal year t : must be traded on the NYSE; at least 200 days of return and volume data for stock i must exist; stock i must be listed at the end of its fiscal year t ; stock i 's price must be $> \$5$ at the end of fiscal year t ; stock i 's market cap must exist at the end of fiscal year t in CRSP; stock i 's Amihud mean-adjusted liquidity measure for stock i cannot be in the top or bottom 1% of the sample for year t .⁷

The sample using the Lesmond, Ogden, and Trzcinka (1999) liquidity measure is built following Lesmond (2005). For each stock-year, ZR is calculated as the number of trading days with zero daily returns and positive trading volume divided by the number of annual trading days over the firm's fiscal year. If the number of missing daily returns or zero daily returns in a firm-year exceeds 80% of the annual trading days for a firm's fiscal year, the firm-year is dropped from the sample. A stock must have at least 120 trading days in a fiscal year to be included in the sample. The liquidity proxy, $ZRINDEX$, is calculated by taking the natural logarithm of $1-ZR$. Thus, $ZRINDEX$ is constructed to be non-positive and positively related to stock market liquidity.

The sample using the relative quoted spread is constructed as follows: Using intraday trades and quotes from the TAQ database, the relative quoted spread measure, $RQSPRD$, is defined as quoted bid–ask spread divided by the midpoint of bid and ask price. The data selection procedures are similar to those for the relative effective spread. A stock must be traded on the NYSE, Amex, or Nasdaq, and a stock must trade in the same market for at least six months in a fiscal year to be included in the sample for the year. Trades recorded before the open or after the close are dropped. The $RQSPRD$ at each quote time is weighted equally to calculate the daily $RQSPRD$. Each daily $RQSPRD$ within a month is then weighted equally to calculate the monthly $RQSPRD$. Finally, the annual $RQSPRD$ is defined as the arithmetic mean of the monthly $RQSPRD$ s over a stock's fiscal year. The natural logarithm of $RQSPRD$ is used in regressions.

3.2.2. Firm performance

In studying the association between firm performance and stock market liquidity, a proxy for Tobin's Q , based on Kaplan and Zingales (1997), is used as the main measure of firm performance.⁸ Proxies for Tobin's Q (the ratio of the firm's market value to the replacement cost of its assets) have been used as a measure of firm performance in an enormous number of studies (see, e.g., Morck, Shleifer, and Vishny, 1988; Yermack, 1996; Gompers, Ishii, and Metrick, 2003). Q is measured as the market value of assets divided by the book value of assets measured at a

⁷ All robustness tests using the Amihud measure only use NYSE stocks as in Amihud (2002). Samples constructed for the other liquidity proxies do not have this data restriction.

⁸ See Table 1 Panel A for detailed information on the definition of Q , along with the other performance measures OIP , $LEVERAGE$, and $OIOA$.

firm's fiscal year end. The market value of assets is defined as the market value of equity plus the book value of assets minus the book value of equity and minus balance sheet deferred taxes. The denominator of Q , the replacement value of firm assets, is assumed to be the book value of firm assets. In the sample, Q ranges from 0.26 to 19.15 with a mean value of 1.83, a median value of 1.38, and a standard deviation of 1.36.

We next break the firm market-to-book ratio into three components: price-to-operating earnings, financial leverage, and operating profitability based on the following equation:

$$Q_{it} = \frac{\text{Market Value of Assets}}{\text{Book Value of Assets}} = \frac{1}{OIP_{it}} \times \frac{1}{LEVERAGE_{it}} \times OIOA_{it}. \quad (1)$$

The operating earnings-to-price ratio, OIP , is equal to operating income after depreciation divided by market value of common equity. The financial leverage ratio, $LEVERAGE$, is defined as the fraction of the market value of a firm's assets coming from common equity. Operating return on assets, $OIOA$, is equal to operating income after depreciation divided by the book value of assets. Operating income after depreciation is used instead of net income to exclude the effect of financial leverage on profits. Q and its three components are all measured at a firm's fiscal year end.

3.2.3. Control variables in baseline specification

The control variables used by Gompers, Ishii, and Metrick (2003) in their firm performance regressions are included in the baseline specification in this study. These controls include the natural logarithm of total assets (LOG_BVTA), a dummy variable indicating the inclusion in the S&P 500 (DUM_SP500), a dummy variable indicating whether a firm is incorporated in the state of Delaware (DUM_DE), and the natural logarithm of firm age (LOG_AGE).⁹ Firm age is defined as the number of years of financial data available in Compustat prior to a firm's fiscal year end.

The Gompers, Ishii, and Metrick (2003) index of shareholder rights, $GIMINDEX$, is used to control for the level of shareholder rights. $GIMINDEX$ is based on the 24 distinct provisions provided by the IRRC. To construct the $GIMINDEX$, one point is added for each provision that restricts shareholder rights. Cumulative voting rights for shareholders and secret ballot are two provisions whose presence actually increases shareholder rights. Thus, for each, one point is added to the $GIMINDEX$ when firms do not have it. By construction, the $GIMINDEX$ is negatively related to the strength of a firm's shareholder rights. For the sample, $GIMINDEX$ ranges from 1.0 to 18.0 with a mean

value of 9.14, a median value of 9.0, and a standard deviation of 2.74. The summary statistics for $GIMINDEX$ are comparable to those reported by Gompers, Ishii, and Metrick (2003).

Firm idiosyncratic risk is included as a control in firm performance regressions. Spiegel and Wang (2005) examine two well-known empirical findings: liquidity is negatively correlated with returns while idiosyncratic risk is positively correlated with returns. They examine whether this is one effect or two effects and find that idiosyncratic risk is a much stronger predictor of returns than liquidity. In other words, controlling for idiosyncratic risk eliminates the power of liquidity to explain returns. To control for the possibility that idiosyncratic risk is the underlying factor which drives the relation between firm performance and stock liquidity, a stock's idiosyncratic risk, $IDIORISK$, is included in the firm performance regressions as an explanatory variable. Following Spiegel and Wang (2005), the excess monthly return of firm i 's stock is regressed on the market risk premium and two Fama-French factors, SMB and HML , using ordinary least squares (OLS) procedures. $IDIORISK$ is then defined as the standard deviation of the OLS residuals. The regressions are estimated using 60 monthly returns prior to fiscal year end with a minimum of 24 monthly return observations required.

Analyst coverage is included as an explanatory variable in the firm performance regressions. Analysts may tend to cover "growth stocks" more than value stocks or analyst coverage may create attention which may lead to higher equity market-to-book ratios.¹⁰ Furthermore, Roulstone (2003) finds that stocks with more analyst coverage tend to be more liquid. Since analyst coverage and liquidity are correlated and both are also potentially correlated with firm Q , the relation between firm Q and analyst coverage might be causal while the relationship between firm Q and liquidity is spurious. Analyst coverage, $\#ANALYSTS$, is defined as the number of analysts covering firm i during its fiscal year t . It is measured as the number of analysts who have issued at least one earnings forecast for firm i in the I/B/E/S database during firm i 's fiscal year t .

Stock return momentum is included as a control in the firm performance regressions. The compensation structure of mutual fund managers may cause mutual fund managers to trade stocks of high Q firms. Mutual fund managers are compensated based on the dollar amount of assets under management. If investors have a behavioral preference for momentum stocks (cross-sectional winners), mutual fund managers will invest in them or risk losing assets under management. They will move around between various momentum stocks buying them when they are rising and selling them when they start to underperform. Since cross-sectional winners would most likely experience a rise in firm Q , and momentum may be correlated with liquidity, momentum might be driving higher firm Q , not liquidity. In fact, Gutierrez and Pirinsky

⁹ The Compustat historical S&P major index code (Data276) is used to identify companies in the S&P 500 Index. This two-digit code identifies the corresponding index constituents. Beginning January 1, 2002, the indexes were reclassified. Only the codes 10, 91, and 92 continue to exist. History was only reclassified back to December 31, 1994. We identify companies with codes 10, 40, 49, 60, and 90 as S&P 500 companies before December 31, 1994 and companies with code 10 as S&P 500 companies after December 31, 1994.

¹⁰ Since our measure of Q is the market-to-book ratio of the firm and the book value of debt is used as a proxy for the market value of debt, firms with high equity market-to-book ratios most likely have high firm Q ratios.

(2007) find empirical support for the prediction that institutions chase high relative returns and buy cross-sectional return winners. They also find that cross-sectional return winners tend to be stocks with high market-to-book ratios. To control for this possibility, a measure of momentum is included in the baseline specification as an explanatory variable.¹¹ Momentum, *CUMRET*, is defined as the compounded market-adjusted monthly return for stock *i* over the six months prior to the end of fiscal year *t*.

Industry fixed effects are included in most of the reported regressions. We use 49 industries as defined in Fama and French (1997) but use a slightly updated version provided by French's Web site. In regressions including firm fixed effects, industry fixed effects are excluded but the dependent and independent variables (excluding the dummy variables *DUM_SP500* and *DUM_DE*) are industry-adjusted by subtracting the median value in the firm's industry for the year.

3.2.4. Additional explanatory variables

As a robustness check, additional controls used in *Q* regressions in the literature are included in the specification. They are advertising expenditures, R&D expenditures, and long-term debt, all scaled by total assets. The inclusion of the additional control variables produces similar results so the results are not shown for brevity.

To differentiate between theories which explain why liquidity affects firm performance, we construct several additional variables: operating income volatility; R&D intensity; and pay-for-performance sensitivity. Operating income volatility is a proxy for business risk. For each firm *i*, *INCVOL* is defined as the standard deviation of quarterly operating income before depreciation divided by quarterly book value of assets. It is measured over 20 quarters prior to the end of fiscal year *t* with a minimum of eight quarterly observations. R&D intensity is another proxy for business risk. Following Eberhart, Maxwell, and Siddique (2004), R&D intensity, *RDITA*, is measured as R&D expenditure during firm *i*'s fiscal year *t* scaled by book value of total assets at fiscal year end. When the sample is divided into terciles based on the level of *RDITA*, observations with missing R&D expenditure are deleted. *PPS*, pay-for-performance sensitivity, is defined similarly to Yermack (1995) and Core and Guay (1999) as the change in value of a Chief Executive Officer's stock option award for every dollar change in the value of the firm's common equity.¹²

3.3. Correlation matrix

Table 2 presents Pearson and Spearman rank correlations between the main liquidity measure (*LOG_RESPRD*),

¹¹ The reported tests are repeated using the compounded abnormal return over the past nine months or the past 12 months instead of the past six months and the results are similar. The results are also similar if the momentum decile rank for the past six months is used instead of the cumulative abnormal return.

¹² See Appendix A for a detailed definition of the pay-for-performance sensitivity measure.

Table 2 Correlation matrix for baseline specification variables. Definitions of variables are in Table 1 Panel A. Number of observations used in the correlation matrix is 8,290. Pearson correlations are reported above the main diagonal and Spearman correlations are reported below the diagonal. *** (**) (*) Indicates significance at 1% (5%) (10%) two-tailed level.

	<i>Q</i>	<i>OIP</i>	<i>LEVERAGE</i>	<i>OIOA</i>	<i>LOG_RESPRD</i>	<i>GIMINDEX</i>	<i>DUM_SP500</i>	<i>DUM_DE</i>	<i>LOG_AGE</i>	<i>LOG_BVTA</i>	<i>IDIORISK</i>	<i>LOG_#ANALYSTS</i>	<i>CUMRET</i>
<i>Q</i>													
<i>OIP</i>	-0.450***												
<i>LEVERAGE</i>	0.789***	-0.545***											
<i>OIOA</i>	0.601***	0.223***	0.546***										
<i>LOG_RESPRD</i>	-0.190***	-0.009	-0.073***	-0.162***									
<i>GIMINDEX</i>	-0.062***	0.129***	-0.142***	0.015	-0.128***								
<i>DUM_SP500</i>	0.108***	0.045***	-0.021*	0.117***	-0.400***	0.202***							
<i>DUM_DE</i>	0.082***	-0.126***	0.082***	-0.017	-0.019*	-0.121***	-0.008						
<i>LOG_AGE</i>	-0.120***	0.239***	-0.188***	0.072***	-0.231***	0.339***	0.380***	-0.215***					
<i>LOG_BVTA</i>	-0.226***	0.309***	-0.457***	-0.128***	-0.562***	0.180***	0.592***	-0.047***	0.361***				
<i>IDIORISK</i>	0.107***	-0.325***	0.232***	-0.120***	0.187***	-0.213***	-0.309***	0.215***	-0.462***	-0.402***			
<i>LOG_#ANALYSTS</i>	0.178***	-0.058***	0.064***	0.079***	-0.430***	0.089***	0.570***	0.054***	0.087***	-0.140***	-0.118***		
<i>CUMRET</i>	0.227***	-0.045***	0.095***	0.115***	-0.124***	0.041***	0.054***	-0.062***	0.048***	0.122***	-0.088***	0.046***	0.019*

the firm performance measures, and all control variables used in our baseline specifications. Pearson correlations are reported above the main diagonal and Spearman correlations are reported below the diagonal.

As shown in Table 2, relative effective spread, LOG_RESPRD , has significantly negative Pearson (Spearman) correlations with three firm performance measures: Q , $LEVERAGE$, and $OIOA$. In other words, firms with liquid stocks tend to have better firm performance, less debt in their capital structure, and higher operating profitability. LOG_RESPRD , has a significant negative Pearson correlation with operating income to price, but the Spearman correlation between the two variables is not significant. The different significance levels could be due to non-linearity or outliers. As discussed in Section 2, numerous theoretical studies predict a positive relation between stock market liquidity and firm market-to-book ratio. However, the different theories have different predictions regarding the relation between liquidity and the three components of Q .

The shareholder rights measure, $GIMINDEX$, has significant negative Pearson (Spearman) correlations with Q . Since $GIMINDEX$ is constructed to be negatively related to the strength of a firm's shareholder rights, this suggests that firms with stronger shareholder rights have higher firm value. This finding is consistent with the findings of Gompers, Ishii, and Metrick (2003). The negative Pearson (Spearman) correlations between $GIMINDEX$ and financial leverage, $LEVERAGE$, suggest that firms with stronger shareholder rights tend to use more equity in their capital structure. There are significant negative correlations between relative effective spread, LOG_RESPRD , and the shareholder rights measure, $GIMINDEX$. Although this result appears to imply that firms with liquid stocks tend to have weaker shareholder rights, we do not attempt to draw a conclusion about the causal direction.

4. Empirical results

In this section, the effect of liquidity on firm performance and the mechanisms through which liquidity affects firm value are investigated. The relevant theoretical papers suggest the following hypotheses:

H1. Liquid stocks have a higher firm Q .

H1A. Liquidity Premium: High liquidity firms have higher firm Q ratios due to a lower required rate of return. If the marginal investor values liquidity, liquid stocks should trade at a premium (Holmstrom and Tirole, 2001).

H1B. Sentiment: High liquidity firms have higher firm Q ratios as they are overvalued. Overconfident investors underreact to the information in order flow which lowers the price impact of trades and boosts liquidity. With short-sales constraints, the presence of irrational investors suggests that liquid stocks will trade at a premium (Baker and Stein, 2004).

H1C. Positive Feedback: High liquidity firms have higher firm Q ratios as liquidity stimulates the entry of informed investors who make prices more informative to stakeholders.

This improves operating performance and relaxes financial constraints (Khanna and Sonti, 2004; Subrahmanyam and Titman, 2001).

H1D. Pay-for-Performance Sensitivity: High liquidity firms have higher firm Q ratios as liquidity enables informed investors to trade more aggressively on their information. The increased information flow increases the information content in stock prices. This enables firms to design more efficient managerial compensation contracts (Holmstrom and Tirole, 1993).

H1E. Blockholder Intervention: High liquidity firms have higher firm Q ratios as liquidity will increase the gains to activists from buying shares and intervening (Maug, 1998).

H2. Liquid stocks have a lower firm Q .

H2A. Activist Exit: High liquidity firms have lower firm Q ratios as liquidity will decrease the cost of exit to blockholders who are potential activists (Coffee, 1991; Bhide, 1993).

H2B. Negative Feedback: High liquidity firms have lower firm Q ratios as speculators exploit liquidity with short-selling strategies that cause managers to invest inefficiently (Goldstein and Guembel, 2008).

We next report the results for a series of empirical tests designed to distinguish between these hypotheses.

4.1. Baseline specification

To assess whether stock liquidity improves, harms, or has no effect on firm performance, a proxy for Tobin's Q is regressed on the liquidity measure and several control variables. The baseline specification is defined as follows:

$$Q_{it} = a + bLOG_RESPRD_{it} + cGIMINDEX_{it} + dDUM_SP500_{it} + eDUM_DE_{it} + fLOG_AGE_{it} + gLOG_BVTA_{it} + hIDIORISK_{it} + kLOG_\#ANALYSTS_{it} + lCUMRET_{it} + IND_j + YR_t + error_{it}, \quad (2)$$

where Q is measured at the end of firm i 's fiscal year t . The liquidity measure, relative effective spread (LOG_RESPRD), is measured for firm i over its fiscal year t . The control variables in the regression are an index of shareholder rights ($GIMINDEX$), an S&P 500 dummy (DUM_SP500), a Delaware incorporation dummy (DUM_DE), the natural logarithm of firm age (LOG_AGE), the natural logarithm of the book value of total assets (LOG_BVTA), firm i 's idiosyncratic risk ($IDIORISK$), the natural logarithm of the number of analysts following firm i ($LOG_ANALYSTS$), firm i 's recent stock return momentum ($CUMRET$), an industry effect for industry j (IND_j), and a year effect for year t (YR_t).¹³

¹³ Our results are similar if we industry-adjust all variables instead of including industry fixed effects.

4.1.1. Baseline Q specification

Eq. (2) is first estimated using pooled OLS. Eq. (2) is also estimated for each year individually excluding the year fixed effects. Table 3 Panel A contains the OLS regression estimates of the baseline specification. The coefficients on the relative effective spread (*LOG_RESPRD*) are negative and significant at the 1% level for each of the six years in the sample period and in the pooled specification. These results support Hypothesis H1 since higher stock market liquidity (lower relative effective spread) is correlated with higher firm performance as measured by *Q*. The results appear economically significant as well. The marginal effects from the pooled specification suggest that an increase in liquidity (a decrease in *LOG_RESPRD*) of one standard deviation or -1.00 leads to an increase in *Q* of 0.61.

Some of the control variables in the regression are significant. The coefficient on the shareholder rights measure (*GMINDEX*) is negative and significant at the 1% level in the pooled specification. It is also negative in every year and statistically significant at the 1% level in all but one year in the sample period. This suggests that weaker shareholder rights are correlated with lower firm performance which is consistent with the findings of Gompers, Ishii, and Metrick (2003). *LOG_BVTA* has a significant negative coefficient in every year, which implies that small companies have higher firm performance on average. S&P 500 companies have higher firm performance than non-S&P 500 companies, as *DUM_SP500* has significant positive coefficients throughout. This is not surprising as S&P tends to select the “leaders” in each industry to be in the S&P 500. Younger firms tend to have higher firm performance as the coefficients on *LOG_AGE* in the pooled regression and annual regressions are negative in every year and statistically significant in all but one year. Delaware incorporation, *DUM_DE*, seems to have an insignificant effect on firm performance. The coefficients on idiosyncratic risk *IDIORISK*, are mostly negative but not significant.¹⁴ The sign on *IDIORISK* is consistent with the predictions of Spiegel and Wang (2005) as they predict stocks with high idiosyncratic risk have higher required returns and will tend to sell at a discount all else held constant. The more analysts following a stock the higher the firm’s *Q* as the coefficient on the *LOG_#ANALYSTS* variable is positive and significant for each of the six years in the sample period and in the pooled specification. This is consistent with either analysts tending to cover stocks of firms with a high firm *Q* or with more analyst coverage leading to higher firm valuations. As expected, the higher the recent cross-sectional momentum in a stock’s return, the higher its firm *Q* as *CUMRET* has significant and positive coefficients for each of the six years in the sample period and in the pooled specification.

The baseline results are robust to the use of alternative measures of liquidity. If the effective spread is replaced with the Amihud (2002) illiquidity measure, the Lesmond,

Ogden, and Trzcinka (1999) percentage of zero daily returns liquidity measure, or the relative quoted spread, the coefficient on the liquidity proxy remains significant at the 1% level in the pooled specification and significant at the 5% level or better in the annual specifications (results not shown for brevity). We conclude that stocks with high liquidity have a higher firm performance (firm *Q*).

4.1.2. Baseline specification—components of Q

To gain further insight into the source of higher firm performance for stocks with high liquidity, the firm performance measure, *Q*, is broken down into three components: operating income-to-price ratio; financial leverage ratio; and operating income-to-assets ratio. In Eq. (2), *Q* is replaced with each of its components. The pooled OLS results are shown for each of the three dependent variables in Table 3 Panel B. Year and industry fixed effects are included in each specification.

First, *Q* is replaced with the operating income-to-price ratio, *OIP*, in Eq. (2). This ratio captures investors’ perceptions of the future growth and riskiness of operating earnings. The coefficient estimates are shown in column 1 of Table 3 Panel B. As the panel shows, liquidity does not significantly affect *OIP*. Next *LEVERAGE* is used as the dependent variable in Eq. (2). *LEVERAGE* measures the fraction of equity in a firm’s capital structure. The coefficient estimates of this specification are shown in column 2 of Table 3 Panel B. Stocks with high stock market liquidity (or lower relative effective spreads) tend to have a higher fraction of equity in their capital structure or less financial leverage. Finally, operating income-to-assets, *OIOA*, is used as the dependent variable in Eq. (2). The coefficient estimates are shown in column 3 of Table 3 Panel B. Stocks with high stock market liquidity (or lower relative effective spreads) tend to have higher operating profitability. The results appear economically significant as well. The marginal effects suggest that an increase in liquidity (a decrease in *LOG_RESPRD*) of one standard deviation or -1.00 leads to an increase in *OIOA* of 0.056% or 5.6%. These results are also robust to the use of the Amihud (2002) illiquidity measure, the Lesmond, Ogden, and Trzcinka (1999) percentage of zero daily returns liquidity measure, or the relative quoted spread as alternative measures of liquidity.

If higher firm values for firms with more liquid stocks are based on a liquidity premium (Hypothesis 1A) or investor sentiment (Hypothesis 1B), high liquidity stocks should have higher price-to-operating income ratios but similar financial leverage and operating profitability ratios as low liquidity stocks. Since on average, liquid stocks have similar price-to-operating income ratios as less liquid stocks but different financial leverage and profitability ratios, illiquidity risk and sentiment do not appear to be explanations for the higher firm values of more liquid stocks.

Higher operating profitability for firms with higher liquidity could mean that managers exhibit myopic preferences. However, with manager myopia we would also expect to see a higher operating income-to-price ratio, *OIP*, for stocks with higher liquidity since projects

¹⁴ *IDIORISK* is negative and significant when the alternative measures of liquidity are used in Eq. (2).

Table 3

Ordinary least squares regressions: baseline specification.

Pooled ordinary least squares (OLS) regression results for the baseline specification model $Q_{it} = a + b\text{LOG_RESPRD}_{it} + c\text{GIMINDEX}_{it} + d\text{DUM_SP500}_{it} + e\text{DUM_DE}_{it} + f\text{LOG_AGE}_{it} + g\text{LOG_BVTA}_{it} + h\text{IDIORISK}_{it} + k\text{LOG_\#ANALYSTS}_{it} + \text{ICUMRET}_{it} + \text{IND}_j + \text{YR}_t + \text{error}_{it}$, are shown in column 1 and regressions by year are shown in columns 2–7 of Panel A. Definitions of variables are in Table 1 Panel A. IND_j is an industry effect for industry j and YR_t is a year effect for year t . Industry fixed effects are included in all regressions but the coefficients are not reported. The industry classifications are defined by Fama and French. Year fixed effects are included in the first regression (pooled) but the coefficients are not reported. Coefficient estimates are shown in bold and their standard errors are displayed in parentheses below. Standard errors are adjusted for both heteroskedasticity and within correlation clustered by firm. *** (**) (*) Indicates significance at 1% (5%) (10%) two-tailed level.

Dependent variable	Panel A: Baseline specification with Q as dependent variable						
	Q						
	Pooled (1)	1993 (2)	1995 (3)	1998 (4)	2000 (5)	2002 (6)	2004 (7)
No. of obs. used	8,290	1,098	1,135	1,427	1,320	1,556	1,754
INTERCEPT	1.798*** (0.21)	2.337*** (0.36)	3.074*** (0.54)	1.662*** (0.39)	1.686*** (0.49)	1.382*** (0.28)	2.032*** (0.34)
LOG_RESPRD	-0.606*** (0.04)	-0.412*** (0.06)	-0.335*** (0.05)	-0.776*** (0.09)	-0.797*** (0.09)	-0.474*** (0.05)	-0.534*** (0.06)
GIMINDEX	-0.032*** (0.01)	-0.040*** (0.01)	-0.046*** (0.01)	-0.035*** (0.01)	-0.047*** (0.02)	-0.015* (0.01)	-0.027*** (0.01)
DUM_SP500	0.485*** (0.07)	0.148* (0.08)	0.234*** (0.07)	0.441*** (0.09)	0.826*** (0.18)	0.614*** (0.12)	0.689*** (0.11)
DUM_DE	-0.025 (0.04)	-0.015 (0.06)	-0.058 (0.06)	-0.045 (0.07)	0.002 (0.09)	0.014 (0.05)	0.035 (0.05)
LOG_AGE	-0.134*** (0.05)	-0.141** (0.06)	-0.117** (0.05)	-0.168*** (0.05)	-0.242** (0.11)	-0.062 (0.06)	-0.102** (0.05)
LOG_BVTA	-0.455*** (0.03)	-0.410*** (0.04)	-0.453*** (0.04)	-0.540*** (0.05)	-0.562*** (0.06)	-0.364*** (0.04)	-0.524*** (0.04)
IDIORISK	-0.269 (0.45)	-0.312 (1.30)	-1.390 (1.47)	-1.200 (0.79)	-0.311 (0.86)	-0.355 (0.48)	0.130 (0.92)
LOG_#ANALYSTS	0.302*** (0.03)	0.402*** (0.05)	0.503*** (0.05)	0.468*** (0.06)	0.449*** (0.09)	0.104** (0.04)	0.258*** (0.04)
CUMRET	0.966*** (0.07)	0.762*** (0.12)	1.597*** (0.21)	1.926*** (0.18)	0.711*** (0.18)	0.661*** (0.08)	1.250*** (0.14)
Adj. R-square	0.37	0.40	0.48	0.49	0.41	0.37	0.39

Pooled ordinary least squares (OLS) regression results for the baseline specification model OIPit (LEVERAGE_{it} or OIOA_{it}) = $a + b\text{LOG_RESPRD}_{it} + c\text{GIMINDEX}_{it} + d\text{DUM_SP500}_{it} + e\text{DUM_DE}_{it} + f\text{LOG_AGE}_{it} + g\text{LOG_BVTA}_{it} + h\text{IDIORISK}_{it} + k\text{LOG_\#ANALYSTS}_{it} + \text{ICUMRET}_{it} + \text{IND}_j + \text{YR}_t + \text{error}_{it}$ are shown in Panel B. Definitions of variables are in Table 1 Panel A. IND_j is an industry effect for industry j and YR_t is a year effect for year t . Industry and year fixed effects are included in all regressions but the coefficients are not reported. The industry classifications are defined by Fama and French. Coefficient estimates are shown in bold and their standard errors are displayed in parentheses right below. Standard errors are adjusted for both heteroskedasticity and within correlation clustered by firm. *** (**) (*) Indicates significance at 1% (5%) (10%) two-tailed level.

Dependent variable	Panel B: Baseline specification with OIP, LEVERAGE, and OIOA as dependent variables		
	OIP (1)	LEVERAGE (2)	OIOA (3)
No. of obs. used	8,290	8,290	8,290
INTERCEPT	-0.216*** (0.05)	0.835*** (0.03)	0.016 (0.03)
LOG_RESPRD	-0.043 (0.04)	-0.132*** (0.01)	-0.056*** (0.00)
GIMINDEX	0.000 (0.00)	-0.009*** (0.00)	-0.001*** (0.00)
DUM_SP500	-0.047*** (0.02)	0.082*** (0.01)	0.005 (0.01)
DUM_DE	-0.008 (0.01)	-0.016*** (0.01)	-0.010*** (0.00)
LOG_AGE	0.012 (0.01)	-0.008* (0.00)	-0.002 (0.00)
LOG_BVTA	0.022 (0.02)	-0.133*** (0.00)	-0.025*** (0.00)
IDIORISK	-0.160 (0.16)	-0.530*** (0.10)	-0.428*** (0.12)
LOG_#ANALYSTS	-0.022** (0.01)	0.068*** (0.00)	0.011*** (0.00)
CUMRET	0.058 (0.04)	0.121*** (0.01)	0.034*** (0.01)
Adj. R-square	0.05	0.70	0.31

Table 4

Endogeneity and reverse causality: controlling for reverse causality.

Ordinary least squares (OLS) regression results of model $\Delta Q_{i,t-1 \text{ to } t+1}$ ($\Delta OIP_{i,t-1 \text{ to } t+1}$ or $\Delta LEVERAGE_{i,t-1 \text{ to } t+1}$ or $\Delta OIOA_{i,t-1 \text{ to } t+1}$) = $a+b\Delta LOG_RESPRD_{i,t-1 \text{ to } t+1}+c\Delta DUM_SP500_{i,t-1 \text{ to } t+1}+d\Delta LOG_BVTA_{i,t-1 \text{ to } t+1}+e\Delta IDIORISK_{i,t-1 \text{ to } t+1}+f\Delta LOG_ANALYSTS_{i,t-1 \text{ to } t+1}+g\Delta CUMRET_{i,t-1 \text{ to } t+1}+IND_j+error_{i,t-1 \text{ to } t+1}$ are shown in Panel A. Δ denotes the change in each variable from the fiscal year before decimalization to the fiscal year after decimalization. IND_j is an industry effect for industry j . Industry fixed effects are included but the coefficients are not reported. The industry classifications are defined by Fama and French. Coefficient estimates are shown in bold and their standard errors are displayed in parentheses right below. Standard errors are adjusted for heteroskedasticity. *** (**) (*) Indicates significance at 1% (5%) (10%) two-tailed level.

Dependent variable	Panel A: Decimalization test			
	ΔQ (1)	ΔOIP (2)	$\Delta LEVERAGE$ (3)	$\Delta OIOA$ (4)
No. of obs. used	1,613	1,613	1,613	1,613
<i>INTERCEPT</i>	-1.007*** (0.12)	-0.163*** (0.03)	-0.101*** (0.01)	-0.062*** (0.01)
ΔLOG_RESPRD	-1.068*** (0.17)	-0.167*** (0.05)	-0.155*** (0.01)	-0.055*** (0.01)
ΔDUM_SP500	-0.590 (0.74)	-0.022 (0.03)	-0.012 (0.02)	-0.012 (0.02)
ΔLOG_BVTA	-1.687*** (0.29)	0.153*** (0.05)	-0.068*** (0.01)	0.049** (0.02)
$\Delta IDIORISK$	-0.204 (3.14)	0.816 (0.86)	0.317** (0.16)	0.315 (0.27)
$\Delta LOG_ANALYSTS$	-0.291*** (0.11)	-0.047** (0.02)	-0.008 (0.01)	-0.005 (0.01)
$\Delta CUMRET$	-1.494*** (0.20)	-0.065** (0.03)	-0.086*** (0.01)	-0.022*** (0.01)
Adj. R-square	0.26	0.07	0.38	0.13

Endogeneity and reverse causality: controlling for firm fixed effects.

Pooled ordinary least squares (OLS) regression results for the baseline specification model IND_Q_{it} (IND_OIP_{it} or $IND_LEVERAGE_{it}$ or IND_OIOA_{it}) = $a+bIND_LOG_RESPRD_{it}+cIND_GIMINDEX_{it}+dDUM_SP500_{it}+eDUM_DE_{it}+fIND_LOG_AGE_{it}+gIND_LOG_BVTA_{it}+hIND_IDIORISK_{it}+kIND_LOG_ANALYSTS_{it}+IND_CUMRET_{it}+FIRM_i+YR_t+error_{it}$ are shown in Panel B. Definitions of variables are in Table 1 Panel A. Variables (with the exception of the dummy variables) are industry-adjusted by subtracting the median value of the firm's industry. The industry classifications are defined by Fama and French. $FIRM_i$ is a firm effect for firm i and YR_t is a year effect for year t . Firm and year fixed effects are included in all regressions but the coefficients are not reported. Coefficient estimates are shown in bold and their standard errors are displayed in parentheses right below. Standard errors are adjusted for heteroskedasticity. *** (**) (*) Indicates significance at 1% (5%) (10%) two-tailed level.

Dependent variable	Panel B: Firm-fixed effects			
	IND_Q (1)	IND_OIP (2)	$IND_LEVERAGE$ (3)	IND_OIOA (4)
No. of obs. used	8,290	8,290	8,290	8,290
<i>INTERCEPT</i>	0.912*** (0.13)	-0.087** (0.04)	0.055*** (0.01)	0.038*** (0.01)
IND_LOG_RESPRD	-0.467*** (0.04)	-0.065 (0.06)	-0.116*** (0.01)	-0.046*** (0.00)
$IND_GIMINDEX$	0.007 (0.01)	0.010 (0.01)	0.003* (0.00)	0.002* (0.00)
DUM_SP500	-0.021 (0.09)	-0.079** (0.03)	0.032*** (0.01)	-0.009** (0.00)
DUM_DE	-0.017 (0.12)	-0.016 (0.01)	-0.011 (0.01)	-0.001 (0.01)
IND_LOG_AGE	-0.016 (0.05)	0.018 (0.02)	-0.014** (0.01)	0.007* (0.00)
IND_LOG_BVTA	-0.466*** (0.05)	0.030** (0.01)	-0.081*** (0.01)	-0.013*** (0.00)
$IND_IDIORISK$	0.885 (0.59)	0.611* (0.36)	-0.372*** (0.07)	0.041 (0.05)
$IND_LOG_ANALYSTS$	0.099*** (0.03)	-0.007 (0.01)	0.027*** (0.00)	0.005** (0.00)
IND_CUMRET	0.697*** (0.06)	0.022 (0.03)	0.099*** (0.01)	0.009** (0.00)
Adj. R-square	0.73	0.43	0.87	0.79

Endogeneity and reverse causality: two stage least squares. Two-stage least squares (2SLS) regression results of model $LOG_RESPRD_{it} = a+bLOG_RESPRD_{it-1}+cZ1+dGIMINDEX_{it}+eDUM_SP500_{it}+fDUM_DE_{it}+gLOG_AGE_{it}+hLOG_BVTA_{it}+kIDIORISK_{it}+lLOG_ANALYSTS_{it}+mCUMRET_{it}+IND_j+YR_t+error_{it}$, and Q_{it} (OIP_{it} , or $LEVERAGE_{it}$ or $OIOA_{it}$) = $a+bFIT_LOG_RESPRD_{it}+cGIMINDEX_{it}+dDUM_SP500_{it}+eDUM_DE_{it}+fLOG_AGE_{it}+gLOG_BVTA_{it}+hIDIORISK_{it}+kLOG_ANALYSTS_{it}+lCUMRET_{it}+IND_j+YR_t+error_{it}$ are shown in Panel C. Column 1 presents the first-stage regression results and columns 2–5 of Panel C present the second-stage regression results with Q , OIP , $LEVERAGE$, and $OIOA$ as dependent variables, respectively. IND_j is an industry effect for industry j and YR_t is a year effect for year t . Industry and year fixed effects are included in all regressions but the coefficients are not reported. The industry classifications are defined by Fama

Table 4. (continued)

and French. Coefficient estimates are shown in bold and their standard errors are displayed in parentheses right below. Standard errors are adjusted for both heteroskedasticity and within correlation clustered by firm. *** (***) (*) Indicates significance at 1% (5%) (10%) two-tailed level.

Dependent variable	Panel C: Two stage least squares				
	First-stage LOG_RESPRD (1)	Q (2)	OIP (3)	Second-stage LEVERAGE (4)	OIOA (5)
No. of obs. used	7,095	7,095	7,095	7,095	7,095
INTERCEPT	-0.273*** (0.10)	2.976*** (0.28)	-0.073 (0.10)	0.908*** (0.07)	0.079** (0.04)
FIT_LOG_RESPRD		-0.573*** (0.05)	-0.013 (0.06)	-0.124*** (0.01)	-0.044*** (0.01)
LOG_RESPRD _{t-1}	0.786*** (0.01)				
Z1	0.134*** (0.01)				
GIMINDEX	0.002 (0.00)	-0.032*** (0.01)	-0.001 (0.00)	-0.009*** (0.00)	-0.001** (0.00)
DUM_SP500	0.007 (0.01)	0.532*** (0.07)	-0.041** (0.02)	0.091*** (0.01)	0.007 (0.01)
DUM_DE	-0.002 (0.01)	-0.020 (0.04)	-0.008 (0.01)	-0.016*** (0.01)	-0.010*** (0.00)
LOG_AGE	-0.006 (0.01)	-0.113*** (0.04)	0.017 (0.01)	-0.007 (0.00)	0.001 (0.00)
LOG_BVTA	-0.026*** (0.00)	-0.450*** (0.03)	0.027 (0.02)	-0.130*** (0.00)	-0.021*** (0.00)
IDIORISK	0.824*** (0.09)	-0.493 (0.45)	-0.284 (0.23)	-0.533*** (0.11)	-0.470*** (0.14)
LOG_#ANALYSTS	-0.028*** (0.01)	0.312*** (0.03)	-0.012 (0.02)	0.064*** (0.00)	0.014*** (0.00)
CUMRET	-0.095*** (0.01)	0.978*** (0.08)	0.071* (0.04)	0.123*** (0.01)	0.038*** (0.01)
Adj. R-square	0.91	0.37	0.05	0.70	0.31

that generate long-term value creation would be substituted with projects that help meet short-term earning goals. Since high and low liquidity stocks have similar OIP ratios, it does not appear that myopic manager behavior is behind the higher operating profitability of firms with highly liquid stocks.

In summary, we find that stocks with high liquidity have better firm performance (higher firm Q), more equity in their capital structure (or low financial leverage), and higher operating profitability levels.

4.2. Endogeneity and reverse causality

In this section robustness tests are discussed which control for the presence of unobservable omitted variables and reverse causality.

4.2.1. Reverse causality

An alternative explanation for the results is that high Q firms are sought after by institutions for prudent-man (fiduciary responsibility) reasons. Institutions may want to hold stocks of “good” companies like Microsoft. If institutional investors are compelled to diversify across industries they will invest in stocks with high industry-adjusted market-to-book ratios. Liquidity is high because institutions trade these stocks resulting in reverse causality.

The change in liquidity caused by the exogenous shock of decimalization can be used to identify the causal effect of liquidity on firm performance. In other words, the change in liquidity around decimalization can be used as an instrument for liquidity. We are not the first to use decimalization as an exogenous shock to liquidity. To address a different research question, Chordia, Roll, and Subrahmanyam (2008) use the change in liquidity around decimalization to show that increases in liquidity enhance market efficiency for NYSE stocks.

On January 29, 2001 the NYSE and Amex began trading all listed stocks in decimals while Nasdaq converted all stocks from fractional price form to decimal price form over the interval of March 12, 2001–April 9, 2001.¹⁵ The switch from fractional prices to decimal prices in 2001 lowered spreads since there are now 100 price points instead of 16 price points within a dollar where buyers and sellers can trade. Lower spreads will lower the cost of trading and should increase liquidity. However, liquidity might increase more for some stocks than for others. Both predictions are supported by research. For example, using a sample of NYSE and Nasdaq stocks, Bessembinder (2003) shows that quoted bid–ask spreads fall following

¹⁵ Over August 2000–January 2001 the NYSE ran pilot programs with selected stocks but only 158 out of 3,525 stocks were trading in decimals prior to January 29, 2001.

decimalization and the largest declines were for the most actively traded stocks. Similarly, [Furfine \(2003\)](#) uses a sample of NYSE stocks and concludes that decimalization resulted in an increase in liquidity as the price impact of a trade went down, particularly for the most actively traded stocks. Infrequently traded stocks had no change in liquidity following decimalization.

In summary, the change in liquidity caused by the exogenous shock of decimalization can be used to identify the causal effect of liquidity on firm performance. More specifically, the change in firm Q surrounding decimalization is regressed on the change in liquidity from the fiscal year prior to decimalization to the fiscal year after decimalization. The specification is shown in

$$\begin{aligned} \Delta Q_{i,t-1 \text{ to } t+1} = & a + b\Delta LOG_RESPRD_{i,t-1 \text{ to } t+1} \\ & + c\Delta DUM_SP500_{i,t-1 \text{ to } t+1} \\ & + d\Delta LOG_BVTA_{i,t-1 \text{ to } t+1} + e\Delta IDIORISK_{i,t-1 \text{ to } t+1} \\ & + f\Delta LOG_ANALYSTS_{i,t-1 \text{ to } t+1} \\ & + g\Delta CUMRET_{i,t-1 \text{ to } t+1} + IND_j \\ & + error_{i,t-1 \text{ to } t+1}, \end{aligned} \quad (3)$$

where t is the fiscal year during which decimalization occurred for firm i .¹⁶ The use of a relatively long window surrounding decimalization provides time for the change in liquidity to affect firm operating performance. Of course, the explicit assumption is that the change in liquidity that occurs in the fiscal years surrounding the decimalization year is due entirely to decimalization.

Eq. (3) is estimated using ordinary least squares (OLS) procedures. The results are shown in column 1 of [Table 4](#) Panel A. An increase in liquidity surrounding decimalization results in an increase in firm Q . According to the illiquidity factor asset pricing explanation, the increase in firm Q could be caused by a reduction in the illiquidity premium (a lower discount rate) holding firm cash flows fixed. To investigate this possibility, the change in firm Q , ΔQ , is replaced with the change in the components of firm Q (ΔOIP or $\Delta LEVERAGE$ or $\Delta OIOA$). These results are shown in columns 2–4 of [Table 4](#) Panel A. An increase in liquidity leads to an increase in operating income-to-price, an increase in equity as a fraction of assets, and an increase in operating profits-to-assets. If the entire increase in firm Q due to decimalization was caused by a decrease in illiquidity risk, an increase in liquidity surrounding decimalization should be correlated with a decrease in operating income-to-price. The results do not support this prediction. Furthermore, an increase in firm Q surrounding decimalization is correlated with an increase in operating profits-to-assets. This improvement in firm operating performance is the driving force behind the increase in firm Q .

The results in [Table 4](#) Panel A are similar using the alternative measures of liquidity. The coefficient on the change in liquidity variable remains significant at the 1% level in the firm Q regressions (column 1) using the

[Lesmond, Ogden, and Trzcinka \(1999\)](#) percentage of zero daily returns liquidity measure, the relative quoted spread, or the [Amihud \(2002\)](#) illiquidity measure as a proxy for liquidity. The coefficient on the change in liquidity variable remains significant at the 1% level in the $OIOA$ regressions (column 4) using the [Lesmond, Ogden, and Trzcinka \(1999\)](#) percentage of zero daily returns liquidity measure, or the relative quoted spread, while it is significant at the 10% level using the [Amihud \(2002\)](#) illiquidity measure as a proxy for liquidity. We conclude that the results are consistent with liquidity having a causal effect on firm performance.

4.2.2. Endogeneity—firm fixed effects

An unobservable correlated with both stock market liquidity and firm performance may be present and would make coefficient estimates biased. For example, high quality managers may tend to manage companies with more liquid stocks. High quality managers would also result in high firm performance. In this case, manager quality is unobservable and correlated with both liquidity and firm performance. Thus, stock liquidity will be positively correlated with firm performance; however, better firm performance is not due to liquidity.

Firm fixed effects can be used as an endogeneity control if the unobservable correlated with stock market liquidity and industry-adjusted performance is constant over time. In [Table 4](#) Panel B industry fixed effects are replaced with firm fixed effects in the baseline specification Eq. (2) and all variables except the dummy variables are industry-adjusted. The estimates in column 1 show that an increase in industry-adjusted stock liquidity (or a decrease in the relative effective spread) leads to an increase in the industry-adjusted Q ratio. The estimates shown in columns 2–4 indicate that an increase in industry-adjusted liquidity leads to an increase in the fraction of equity in a firm's capital structure and an increase in industry-adjusted operating profitability. These results are similar to the baseline specification results shown in [Table 3](#). Results using the [Amihud \(2002\)](#) illiquidity measure, the [Lesmond, Ogden, and Trzcinka \(1999\)](#) percentage of zero daily returns liquidity measure, or the relative quoted spread as proxies for liquidity are also similar to the baseline specification results. We conclude that the results are robust to the inclusion of firm fixed effects.

4.2.3. Endogeneity—two-stage least squares

The results in the previous sections show that high stock market liquidity is positively correlated with firm performance after running a test to control for reverse causality, including firm fixed effects, or including additional control variables that are likely to be correlated with both liquidity and firm performance. In this section two-stage least squares is used to control for endogeneity. One benefit to this method is that the unobservable does not have to be constant across time. We use one lag of the liquidity measure (LOG_RESPRD_{t-1}) and the mean LOG_RESPRD of the two firms in firm i 's industry that have the closest size (market value of equity) to firm i ($Z1$) as exogenous variables that are correlated with liquidity but

¹⁶ The results are similar if we examine the change in each variable from the fiscal year before decimalization to the fiscal year during which decimalization occurred.

uncorrelated with the error term in Eq. (2).¹⁷ The use of one lag of stock market liquidity as an exogenous variable helps mitigate concerns that an unobservable in fiscal year t is correlated with both stock market liquidity and firm performance at time t . Regarding the use of the average liquidity of two competitors with similar stock market capitalization, the portion of firm i 's liquidity that is correlated with the liquidity of its competitors is less likely to be correlated with unobservables that affect firm i 's performance than its own liquidity. The reduced-form equation for LOG_RESPRD (the linear combination of the exogenous variables in the system) is shown below as Eq. (4). Eq. (4) is estimated using OLS and the fitted value, FIT_LOG_RESPRD , is used as an instrumental variable for liquidity in Eq. (5).

$$\begin{aligned} LOG_RESPRD_{it} = & a + bLOG_RESPRD_{i,t-1} + cZ1_{it} \\ & + dGIMINDEX_{it} + eDUM_SP500_{it} \\ & + fDUM_DE_{it} + gLOG_AGE_{it} \\ & + hLOG_BVTA_{it} + kIDIORISK_{it} \\ & + lLOG_\#ANALYSTS_{it} + mCUMRET_{it} \\ & + IND_j + YR_t + error_{it}, \end{aligned} \quad (4)$$

$$\begin{aligned} Q_{it}(OIP_{it}, \text{ or } LEVERAGE_{it} \text{ or } OIOA_{it}) \\ = & a + bFIT_LOG_RESPRD_{it} + cGIMINDEX_{it} \\ & + dDUM_SP500_{it} + eDUM_DE_{it} + fLOG_AGE_{it} \\ & + gLOG_BVTA_{it} + hIDIORISK_{it} + kLOG_\#ANALYSTS_{it} \\ & + lCUMRET_{it} + IND_j + YR_t + error_{it}. \end{aligned} \quad (5)$$

The first-stage coefficient estimates are shown in column 1 of Table 4 Panel C. The coefficients on the second stage of two-stage least squares regression results are shown in columns 2–5 of Table 4 Panel C. The results are very similar to the results estimated in the baseline specification results shown in Table 3. The coefficient on the liquidity variable is negative and statistically significant at the 1% level in the specification with firm Q as the dependent variable. Similarly, the results using the components of Q as the dependent variable are also robust. In other words, high liquidity stocks (stocks with low relative effective spreads) have less financial leverage and higher operating profitability. The results are also robust to using either LOG_RESPRD_{t-1} or $Z1$ alone in Eq. (4) (results not tabulated).¹⁸ Two-stage least squares results using the Amihud (2002) illiquidity measure, the Lesmond, Ogden, and Trzcinka (1999) percentage of zero daily returns liquidity measure, or the relative quoted spread as proxies for liquidity are also similar to the results using the relative effective spread measure. We conclude that the results are robust to the use of two-stage least squares.

¹⁷ If a firm has the highest (lowest) market cap in the industry, the liquidity of the firm with the market cap right below (right above) firm i is used to proxy for firm i 's liquidity.

¹⁸ Using the Hausman test, we cannot reject that OLS is consistent when using only LOG_RESPRD_{t-1} as an exogenous variable in Eq. (4). We can reject that OLS is consistent when using $Z1$ alone as an exogenous variable in Eq. (4) or when using both LOG_RESPRD_{t-1} and $Z1$ as exogenous variables in Eq. (4).

Economic theory would suggest that the index of shareholder rights ($GIMINDEX$) is endogenously determined by firm characteristics. As a result, a firm's governance structure is a choice variable that results from maximizing firm value given the firm's particular operating and information environment (Core, Holthausen, and Larcker, 1999). Therefore, both the measure of liquidity and the measure of shareholder rights may be endogenous. Since the inputs to the shareholder rights index, $GIMINDEX$, tend to change slowly over time, we treat shareholder rights, $GIMINDEX$, as exogenous and the liquidity, $ZRINDEX$, as endogenous.

4.3. How does liquidity improve firm performance?

Liquidity may improve firm performance by: making prices more informative to stakeholders (Hypothesis 1C: *Positive Feedback*); permitting more effective contracting on stock price regarding management compensation (Hypothesis 1D: *Pay-for-Performance Sensitivity*); allowing non-blockholders to intervene and become blockholders or facilitating the formation of a toehold stake (Hypothesis 1E: *Blockholder Intervention*). In the next section we run several tests to differentiate the various explanations for why liquidity improves firm performance.

4.3.1. Is there a stock price feedback effect?

This section examines whether liquidity stimulates the entry of informed investors who make prices more informative to stakeholders. To test whether the feedback effect increases operating performance and relaxes financial constraints we examine whether the effect of high liquidity on firm performance is magnified for firms with a high level of business risk or uncertainty. Operating income volatility is used as a proxy for business risk and the sample is divided into operating income volatility, $INCVOL$, quintiles.¹⁹ First, Eq (2) is estimated for each operating income volatility quintile. Though not tabulated, the liquidity measure (LOG_RESPRD) remains negative and significant at the 1% level in all five quintiles and the strength of the effect monotonically increases (coefficient becomes more negative) as one moves from the lowest to the highest $INCVOL$ quintiles. Next, the observations in the top and the bottom $INCVOL$ quintiles are used to form a sub-sample. The $INCVOL$ variable is replaced with a dummy variable, DUM_INCVOL , where DUM_INCVOL equals one if the stock is in the top $INCVOL$ quintile and equals zero if the stock is in the bottom $INCVOL$ quintile. DUM_INCVOL and an interaction of DUM_INCVOL with LOG_RESPRD are added to Eq. (2) as additional independent variables. The results using the sub-sample of top and bottom $INCVOL$ quintile observations are shown in Table 5. The interaction of DUM_INCVOL with LOG_RESPRD is negative and significant at the 1% level in the regression with firm Q as the dependent variable. Consistent with the feedback hypothesis, the positive effect of liquidity on firm performance is magnified for

¹⁹ Zhang (2006) and Berkman, Dimitrov, Jain, Koch, and Tice (2009) also use operating income volatility as a measure of business risk.

Table 5

Testing the positive feedback hypothesis.

Pooled ordinary least squares (OLS) regression results of model Q_{it} (OIP_{it} or $LEVERAGE_{it}$ or $OIOA_{it}$) = $a + bLOG_RESPRD_{it} + cDUM_INCVOL_{it} + dLOG_RESPRD_{it} \times DUM_INCVOL_{it} + eGIMINDEX_{it} + fDUM_SP500_{it} + gDUM_DE_{it} + hLOG_AGE_{it} + kLOG_BVTA_{it} + lIDIORISK_{it} + mLOG_\#ANALYSTS_{it} + nCUMRET_{it} + IND_j + YR_t + error_{it}$. Definitions of variables are in Table 1 Panel A. DUM_INCVOL is a dummy variable that equals one if the observation is in the top $INCVOL$ quintile and equals zero if the observation is in the bottom $INCVOL$ quintile. IND_j is an industry effect for industry j and YR_t is a year effect for year t . Industry and year fixed effects are included in all regressions but the coefficients are not reported. The industry classifications are defined by Fama and French. Coefficient estimates are shown in bold and their standard errors are displayed in parentheses right below. Standard errors are adjusted for both heteroskedasticity and within correlation clustered by firm. *** (***) (*) Indicates significance at 1% (5%) (10%) two-tailed level.

Dependent variable	Q (1)	OIP (2)	LEVERAGE (3)	OIOA (4)
No. of obs. used	3,092	3,092	3,092	3,092
<i>INTERCEPT</i>	1.899*** (0.34)	0.189 (0.23)	0.835*** (0.05)	0.083*** (0.03)
<i>LOG_RESPRD</i>	-0.534*** (0.05)	-0.050 (0.09)	-0.116*** (0.01)	-0.044*** (0.01)
<i>DUM_INCVOL</i>	-1.004*** (0.33)	-1.068*** (0.36)	-0.058 (0.04)	-0.244*** (0.03)
<i>LOG_RESPRD</i> × <i>DUM_INCVOL</i>	-0.270*** (0.06)	-0.159*** (0.05)	-0.020*** (0.01)	-0.049*** (0.01)
<i>GIMINDEX</i>	-0.020** (0.01)	-0.003 (0.00)	-0.006*** (0.00)	-0.001 (0.00)
<i>DUM_SP500</i>	0.471*** (0.10)	-0.005 (0.06)	0.089*** (0.01)	-0.007 (0.01)
<i>DUM_DE</i>	-0.029 (0.05)	-0.029 (0.03)	-0.010 (0.01)	-0.016*** (0.00)
<i>LOG_AGE</i>	-0.078 (0.05)	0.010 (0.03)	-0.012** (0.01)	-0.001 (0.00)
<i>LOG_BVTA</i>	-0.433*** (0.04)	-0.012 (0.04)	-0.120*** (0.00)	-0.020*** (0.00)
<i>IDIORISK</i>	-0.465 (0.86)	0.324 (0.44)	-0.677*** (0.09)	-0.696*** (0.10)
<i>LOG_#ANALYSTS</i>	0.239*** (0.04)	-0.046*** (0.02)	0.052*** (0.01)	0.006 (0.00)
<i>CUMRET</i>	1.082*** (0.12)	0.150** (0.07)	0.106*** (0.01)	0.041*** (0.01)
Adj. R-square	0.43	0.09	0.79	0.37

liquid stocks with high operating income volatility. Lastly, firm Q is replaced with the components of Q as the dependent variables. These results are shown in columns 2–4 in Table 5. Once again the results are consistent with the feedback hypothesis as the positive effect of liquidity on firm operating profitability is magnified for liquid stocks with high business uncertainty. Since stock price feedback to managers would be the most valuable in situations where uncertainty is the greatest, we conclude that stock liquidity improves firm operating performance through a feedback effect.²⁰

To examine whether the results are robust to the liquidity proxy, the regressions shown in Table 5 are rerun using alternative measures of liquidity. In the firm Q regression shown in column 1 the coefficient on the (Liquidity Proxy × DUM_INCVOL) term remains significant at the 1% level using the Lesmond, Ogden, and Trzcinka (1999) percentage of zero daily returns liquidity measure, the relative quoted spread measure, or the Amihud (2002) illiquidity measure as a proxy for liquidity. In the $OIOA$

regression shown in column 4 the coefficient on the (Liquidity Proxy × DUM_INCVOL) term remains significant at the 1% level using the Lesmond, Ogden, and Trzcinka (1999) percentage of zero daily returns liquidity measure or the relative quoted spread measure, while it remains significant at the 5% level using the Amihud (2002) measure as a proxy for liquidity. These results are not shown for brevity. We conclude that the results are robust to alternative measures of liquidity.

4.3.2. Does liquidity enhance manager pay-for-performance sensitivity?

This section examines whether liquidity leads to more efficient managerial compensation. To test this, we examine whether the effect of liquidity on firm performance is magnified for firms with a high pay-for-performance sensitivity. Following Yermack (1995) and Core and Guay (1999), pay-for-performance sensitivity (PPS) is measured as the change in value of a CEO's stock option award for every dollar change in the value of a firm's common equity. The sample is divided into pay-for-performance sensitivity, PPS , quintiles. First, Eq (2) is estimated for each PPS quintile. Though not tabulated, the liquidity measure (LOG_RESPRD) remains negative and significant at the 1% level in all five quintiles and the

²⁰ As a robustness check, operating income volatility is replaced with R&D intensity as a proxy for business risk. Results using R&D terciles are similar to those using operating income volatility quintiles and are not tabulated for brevity.

strength of the effect monotonically increases (coefficient becomes more negative) as one moves from the lowest to the highest *PPS* quintiles. Second, the observations in the top and the bottom *PPS* quintiles are used to form a subsample and the *PPS* variable is replaced with a dummy variable, *DUM_PPS*, where *DUM_PPS* equals 1 if the stock is in the top *PPS* quintile and equals zero if the stock is in the bottom *PPS* quintile. *DUM_PPS* and an interaction of *DUM_PPS* with *LOG_RESPRD* are added to Eq. (2) as additional independent variables. The results are shown in Table 6. The interaction of *DUM_PPS* with *LOG_RESPRD* is negative and significant at the 1% level in the regression with firm *Q* as the dependent variable. In other words, stock liquidity enhances the effect of manager pay-for-performance sensitivity on firm *Q*. Next, firm *Q* is replaced with the components of *Q* as the dependent variables. These results are shown in columns 2–4 in Table 6. The coefficient on the interaction term in column 4 is significant at the 1% level. Hence, the positive effect of liquidity on firm operating profitability is magnified for stocks with high pay-for-performance sensitivity. The coefficients on the interaction terms in columns 2 and 3 are not significant. We conclude that stock liquidity enhances firm performance through the effect of enhanced pay-for-performance sensitivity on operating performance.

To examine whether the results are robust to the liquidity proxy, the regressions shown in Table 6 are rerun using alternative measures of liquidity. In the firm *Q* regression shown in column 1 the coefficient on the (Liquidity Proxy \times *DUM_INCVOL*) term remains significant at the 1% level using the Lesmond, Ogden, and Trzcinka (1999) percentage of zero daily returns liquidity measure, and the relative quoted spread measure, while it remains significant at the 5% level using the Amihud (2002) illiquidity measure as a proxy for liquidity. In the *OIOA* regression shown in column 4 the coefficient on the (Liquidity Proxy \times *DUM_INCVOL*) term remains significant at the 1% level using the Lesmond, Ogden, and Trzcinka (1999) percentage of zero daily returns liquidity measure, the relative quoted spread measure, or the Amihud (2002) illiquidity measure as a proxy for liquidity. These results are not shown for brevity. We conclude that the results are robust to the measure of liquidity.

4.3.3. Do blockholders intervene?

Although for completeness all important theories for the origin of liquidity's effect on performance should be considered, all theories are not equally amenable to testing. Because of the rather complex causal nexus in hypotheses, shareholder activism is a particularly difficult

Table 6

Testing the enhanced pay-for-performance sensitivity hypothesis.

Pooled ordinary least squares (OLS) regression results of model Q_{it} (OIP_{it} or $LEVERAGE_{it}$ or $OIOA_{it}$) = $a + bLOG_RESPRD_{it} + cDUM_PPS_{it} + dLOG_RESPRD_{it} \times DUM_PPS_{it} + eGIMINDEX_{it} + fDUM_SP500_{it} + gDUM_DE_{it} + hLOG_AGE_{it} + kLOG_BVTA_{it} + lIDIORISK_{it} + mLOG_ANALYSTS_{it} + nCUMRET_{it} + IND_j + YR_t + error_{it}$. Definitions of variables are in Table 1 Panel A. *DUM_PPS* is a dummy variable that equals one if the observation is in the top *PPS* quintile and equals zero if the observation is in the bottom *PPS* quintile. IND_j is an industry effect for industry *j* and YR_t is a year effect for year *t*. Industry and year fixed effects are included in all regressions but the coefficients are not reported. The industry classifications are defined by Fama and French. Coefficient estimates are shown in bold and their standard errors are displayed in parentheses right below. Standard errors are adjusted for both heteroskedasticity and within correlation clustered by firm. *** (***) (*) Indicates significance at 1% (5%) (10%) two-tailed level.

Dependent variable	Q (1)	OIP (2)	LEVERAGE (3)	OIOA (4)
No. of obs. used	2,489	2,489	2,489	2,489
INTERCEPT	1.982*** (0.38)	-0.110 (0.10)	0.797*** (0.06)	0.015 (0.05)
LOG_RESPRD	-0.554*** (0.06)	-0.032 (0.03)	-0.126*** (0.01)	-0.048*** (0.01)
DUM_PPS	-0.855*** (0.33)	0.036 (0.10)	0.007 (0.05)	-0.114*** (0.04)
LOG_RESPRD \times DUM_PPS	-0.168*** (0.06)	0.001 (0.02)	-0.001 (0.01)	-0.022*** (0.01)
GIMINDEX	-0.033*** (0.01)	-0.001 (0.00)	-0.008*** (0.00)	-0.001 (0.00)
DUM_SP500	0.519*** (0.10)	-0.013 (0.01)	0.082*** (0.01)	0.007 (0.01)
DUM_DE	0.024 (0.06)	-0.023* (0.01)	-0.008 (0.01)	-0.004 (0.01)
LOG_AGE	-0.093* (0.06)	0.000 (0.01)	-0.010 (0.01)	0.002 (0.00)
LOG_BVTA	-0.471*** (0.04)	0.020** (0.01)	-0.127*** (0.00)	-0.024*** (0.00)
IDIORISK	0.511 (0.55)	-0.102 (0.13)	-0.304*** (0.09)	-0.268 (0.17)
LOG_#ANALYSTS	0.278*** (0.04)	-0.029*** (0.01)	0.064*** (0.01)	0.010* (0.01)
CUMRET	0.905*** (0.11)	0.035 (0.03)	0.117*** (0.01)	0.038*** (0.01)
Adj. R-square	0.40	0.11	0.74	0.30

Table 7

Shareholder rights quintiles.

Ordinary least squares (OLS) regression results of model Q_{it} (OIP_{it} or $LEVERAGE_{it}$ or $OIOA_{it}$) = $a + bLOG_RESPRD_{it} + cDUM_SH_{it} + dDUM_SH_{it} \times LOG_RESPRD_{it} + eDUM_SP500_{it} + fDUM_DE_{it} + gLOG_AGE_{it} + hLOG_BVTA_{it} + iKIDIORISK_{it} + jLOG_\#ANALYSTS_{it} + mCUMRET_{it} + nIND_j + YR_t + error_{it}$ using the sub-sample of firms with $GIMINDEX > or = 12$ or $GIMINDEX < or = 5$. Definitions of variables are in Table 1 Panel A. DUM_SH is a dummy variable that equals one if $GIMINDEX > or = 12$ and equals zero if $GIMINDEX < or = 5$. IND_j is an industry effect for industry j and YR_t is a year effect for year t . Industry and year fixed effects are included in all regressions but the coefficients are not reported. The industry classifications are defined by Fama and French. Coefficient estimates are shown in bold and their standard errors are displayed in parentheses right below. Standard errors are adjusted for both heteroskedasticity and within correlation clustered by firm. *** (**) (*) Indicates significance at 1% (5%) (10%) two-tailed level.

Dependent variable	Q (1)	OIP (2)	LEVERAGE (3)	OIOA (4)
No. of obs. used	2,502	2,502	2,502	2,502
<i>INTERCEPT</i>	1.793*** (0.41)	-0.295** (0.15)	0.776*** (0.06)	0.018 (0.05)
<i>LOG_RESPRD</i>	-0.504*** (0.07)	-0.010 (0.04)	-0.129*** (0.01)	-0.050*** (0.01)
<i>DUM_SH</i>	-0.027 (0.33)	0.189 (0.14)	-0.032 (0.05)	0.021 (0.03)
<i>DUM_SH</i> × <i>LOG_RESPRD</i>	0.044 (0.06)	0.032 (0.02)	0.008 (0.01)	0.005 (0.01)
<i>DUM_SP500</i>	0.291*** (0.07)	-0.084*** (0.03)	0.065*** (0.01)	-0.006 (0.01)
<i>DUM_DE</i>	-0.082 (0.07)	-0.005 (0.02)	-0.013 (0.01)	-0.009* (0.00)
<i>LOG_AGE</i>	-0.085 (0.06)	0.014 (0.01)	-0.005 (0.01)	0.002 (0.00)
<i>LOG_BVTA</i>	-0.432*** (0.05)	0.052*** (0.02)	-0.131*** (0.01)	-0.025*** (0.00)
<i>IDIORISK</i>	-0.571 (0.77)	-0.329 (0.28)	-0.677*** (0.21)	-0.430*** (0.16)
<i>LOG_#ANALYSTS</i>	0.381*** (0.05)	-0.005 (0.02)	0.080*** (0.01)	0.015*** (0.00)
<i>CUMRET</i>	0.913*** (0.16)	0.015 (0.07)	0.137*** (0.01)	0.044*** (0.01)
Adj. R-square	0.35	0.07	0.72	0.30

theory to test. A direct test would require identifying the level of liquidity trader demand and the costs of activism faced by activist investors and simultaneously estimating liquidity and performance while allowing the coefficients associated with these endogenous variables to vary with the levels of exogenous variables. Such a test is beyond the scope of this paper. Although we cannot test the activism theory directly, the explanatory power of activism is explored in the cross-section. We find that the interaction of liquidity with contemporaneous or lagged institutional ownership (or blockholdings) is not a significant predictor of firm performance.²¹

4.3.4. Shareholder rights

The findings in the previous sections support the hypothesis that liquidity provides efficient feedback to managers (Hypothesis 1C) and the hypothesis that liquidity enhances performance contracting (Hypothesis 1D). These explanations for the positive association between liquidity and firm performance do not rely on a

reduction in the shareholder/manager agency conflicts while blockholder intervention does rely on a reduction of agency conflicts. This insight leads to an additional test. If higher firm performance is caused by liquidity enhancing the feedback of information to firm stakeholders or liquidity enhanced performance contracting, liquidity should have a similar effect on the performance of firms with low versus high shareholder rights. The results are shown in Table 7. The effect of liquidity on firm Q is similar for firms with high and low shareholder rights.²² The result is similar using each of the three alternative proxies for liquidity. These results provide additional support for positive feedback and for enhanced pay-for-performance sensitivity as mechanisms which explain the causal link between liquidity and firm performance. Since our sample consists of stocks that trade in the US, it might be the case that there is simply not enough cross-sectional variation in shareholder rights within our sample to identify a shareholder rights effect.

²¹ Institutional ownership is measured as the mean percentage of common stock held by institutional holders who hold at least 5% of shares outstanding during the four calendar quarters prior to fiscal year end. As an additional check we also measure the percentage of shares held by outside blockholders.

²² This test suggests that if liquidity affects shareholder rights (anti-takeover measures), its marginal effect on governance is the same regardless of the firm's ownership structure. This seems unlikely given that the need for sophisticated investors to buy up additional shares to monitor should depend on their initial holdings.

5. Summary and conclusion

Many theoretical models predict a positive relation between stock liquidity and firm performance. The theories provide agency, stock price feedback, illiquidity risk, or sentiment reasons for why liquidity positively affects firm performance. A small number predict a negative relation between stock liquidity and firm performance. However, no comprehensive empirical studies have been done to investigate this topic. This paper explores whether liquidity improves, harms, or has no effect on firm performance as measured by a firm's Tobin's Q ratio. The study also explores the distinct mechanism through which liquidity improves firm performance by testing several causative theories in the literature.

This study shows that liquidity positively affects firm performance and operating profitability. Next, the underlying mechanism responsible for this finding is explored. Empirical support is provided for the stock price feedback models and for liquidity enhancing the value of performance-sensitive managerial compensation. In each case, liquidity enhances firm performance primarily through higher operating profitability. Though blockholder intervention models cannot be tested directly, we fail to find support for liquidity enhancing the ability of blockholders to intervene to mitigate manager/shareholder agency conflicts in the cross-section.

One alternative explanation for the results is that high Q firms are sought after by institutions for prudent-man (fiduciary responsibility) reasons, or reverse causality. To identify the causal effect of liquidity on firm performance, the effect of an exogenous shock to liquidity (decimalization) on firm performance is examined. The change in liquidity around decimalization is used as an instrument for liquidity. An increase in liquidity in the months surrounding decimalization increases firm performance by increasing firm operating profitability. We conclude that liquidity has a causal effect on firm performance.

Alternative explanations for the results such as momentum trading, investor overreaction, and illiquidity risk are also explored. These explanations do not rely on a causative relationship between liquidity and firm performance. The results are robust to controls for these effects.

We conclude that information feedback from stock prices to firm managers and other stakeholders is one mechanism responsible for better firm performance for firms with higher stock market liquidity. As predicted, liquidity enhances firm performance through higher operating profitability. We also find evidence that liquidity enhances firm performance by increasing the incentive effects of managerial pay-for-performance contracts.

Appendix A

A.1. Pay-performance sensitivity: Black-Scholes (1973) sensitivities of individual stock options

We follow both the Yermack (1995) method and the Core and Guay (1999) method to estimate pay-performance sensitivity. Specifically, for a stock option award,

pay-performance sensitivity (*PPS*) is defined as the product of two terms: the Black-Scholes formula's partial derivative (also called "hedge ratio") with respect to stock price times the fraction of equity represented by the award:

$$PPS \approx \Delta \times \left(\frac{\text{shares represented by option award}}{\text{shares outstanding at start of year}} \right),$$

where

$$\begin{aligned} \Delta &= \frac{\partial(\text{Black-Scholes value})}{\partial P} \\ &= e^{-dt} \Phi \left(\frac{\ln(P/E) + T(r - d + \sigma^2/2)}{\sigma\sqrt{T}} \right). \end{aligned}$$

Thus, we measure *PPS* as the change in value of a CEO's stock option award for every dollar change in the value of a firm's common equity.

A.2. Estimating *PPS*

To calculate *PPS*, we need to know the amount of stock holdings; the amount, strike price, and maturity of options; and other parameters that affect option value such as volatility of stock, dividend yield, riskless interest rate, and current stock price. We obtain data on an executive's option portfolio from ExecuComp.

When data are not readily available, we make certain assumptions. Data and assumptions are summarized and listed below:

(a) *Assumptions for most recent year's granted options:* ExecuComp has complete information on the current year options grant. Thus, the number of options and exercise price are readily available for new stock options. However, some assumptions need to be made about the stock price at time of award and expiration date as they are often missing in the database.

P Price of the underlying stock at time of award. When *P* is missing, we assume *P* equals *E*, the exercise price of the options, because most firms set exercise price to stock price at the time of grant

T Options were assumed to be granted on July 1st of the particular year for which data were reported. The time-to-maturity is then calculated as the time span between July 1st of the year of grant and the actual expiration date, as reported by ExecuComp. Figures calculated are then rounded to the nearest whole year. We set *T* to 10 years if the expiration date is missing

(b) *Assumptions for previously granted options:* Unlike the most recent years' grant, ExecuComp does not provide full information about previously granted options. Instead, the database divides previously granted options into exercisable and unexercisable options and reports for each category the amount and current realizable value. To estimate the number and realizable value of exercisable and unexercisable options, we use a method developed by Core and Guay (1999). Specifically, the number and

realizable value of the unexercisable options are reduced by the number and realizable value of the current year's grant. If the number of options in the most recent year's grant exceeds the number of unexercisable options, the number and realizable value of the exercisable options are reduced by the excess of the number and realizable value of the current year's grant over the number and realizable value of the unexercisable options.

Price of the underlying stock of previously granted stock is set to year end stock price. Additional assumptions are made about exercise price and time-to-maturity:

- E* Average exercise price of exercisable and unexercisable options is estimated as [year end stock price—(realizable value/number of options)]
- T* For unexercisable options, *T* is set to one year less than *T* of most recent year's grant or nine years if no new grant was made; for exercisable options, *T* is set to three year less than *T* of most recent year's grant or six years if no new grant was made

(c) *Additional assumptions about Black-Scholes model parameters:*

- d* $\ln(1+\text{dividend rate})$, where dividend rate is defined as the three year average dividend yield prior to fiscal year end
- r* $\ln(1+\text{interest rate})$, where interest rate is defined as the yield on 10-year US Treasury bonds during the last month of the fiscal year
- σ annualized volatility, estimated over the 60 months prior to fiscal year end

Based on the assumptions above, we calculate Black-Scholes sensitivity to stock price for most recent year's granted options (Δ_1), for previously granted exercisable options (Δ_2), and for previously granted unexercisable options (Δ_3), respectively. We then calculate our *PPS* measure as

$$PPS \approx \frac{\Delta_1 \times \text{number of most recent year's options}}{\text{shares outstanding at start of year}} + \frac{\Delta_2 \times \text{number of previously granted exercisable options}}{\text{shares outstanding at start of year}} + \frac{\Delta_3 \times \text{number of previously granted unexercisable options}}{\text{shares outstanding at start of year}}$$

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