JOURNAL OF FINANCIAL AND QUANTITATIVE ANALYSIS Vol. 47, No. 2, Apr. 2012, pp. 333–364
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doi:10.1017/S0022109012000130

Asset Liquidity and Stock Liquidity

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Abstract

We study the relation between asset liquidity and stock liquidity. Our model shows that the relation may be either positive or negative depending on parameter values. Asset liquidity improves stock liquidity more for firms that are less likely to reinvest their liquid assets (i.e., firms with less growth opportunities and financially constrained firms). Empirically, we find a positive and economically large relation between asset liquidity and stock liquidity. Consistent with our model, the relation is more positive for firms that are less likely to reinvest their liquid assets. Our results also shed light on the value of holding liquid assets.

I. Introduction

An asset is liquid if it can be converted into cash quickly and at a low cost.[1] This definition applies both to real assets and to financial assets. Recent years have seen a secular increase in both stock liquidity and asset liquidity as measured by the level of cash on the firm's balance sheet (Chordia, Roll, and Subrahmanyam (2007), Foley, Hartzell, Titman, and Twite (2007)). Furthermore, during the recent financial crisis, there was a decline in the liquidity of the assets of financial firms (e.g., mortgage backed securities) and in the liquidity of their stock.[2] An interesting question that arises is whether these 2 trends are related. More generally,

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We thank Joel Hasbrouck for graciously providing data on stock liquidity measures and Vanderbilt University's Financial Markets Research Center for making available the data on bid-ask spreads. We are also grateful to Viral Acharya, Hendrik Bessembinder (the editor), Tarun Chordia, Paolo Fulghieri, Adriano Rampini, Gideon Saar (the referee), Ronnie Sadka, Mark Seasholes, and Avi Wohl; to seminar participants at American University, Barclays Global Investors, the 2009 European Finance Association meetings at Bergen and our discussant Erik Theissen, the 2009 Financial Intermediation Research Society conference at Prague and our discussant Sugato Bhattacharya, Hong Kong University of Science and Technology, George Mason University, Nanyang Technological University, Singapore Management University, the 2009 Microstructure conference at the Swiss National Bank and our discussant Gunther Wuyts, and Washington University for very helpful comments; and to Engin Kose and Anirudh Jonnavitula for assistance with data collection.

[1]This definition dates back to Keynes ((1930), p. 67) who considered one asset as more liquid than another "if it is more certainly realizable at short notice without loss."

[2]See Boehmer, Jones, and Zhang (2009) for some evidence of lower stock liquidity for financial firms during the crisis period even after short sale constraints were removed.

is there a relation between the liquidity of the firm's assets and the liquidity of financial claims on the assets? By addressing this question we highlight how corporate finance decisions can affect stock liquidity.

We argue that the balance sheet equivalence between the value of assets and liabilities/equity may not carry over to their respective liquidities. We formalize this point in a model that shows how managerial investment decisions can affect stock liquidity by converting liquid assets into illiquid ones. In our model, a firm has assets composed of cash, an illiquid project, and a growth option. The manager decides on the optimal allocation of cash between investment in the growth option and payment of dividends. A more productive growth option implies more investment, but firm financial constraints may limit the amount of investment. Reflecting frictions associated with raising external capital, we assume that the returns to investment are higher when financed with internal cash. The liquidity of the firm's stock is determined in a market similar to that in Kyle (1985). Managerial investment decisions affect the uncertainty of future cash flows, and consequently stock liquidity as measured by Kyle's lambda (the sensitivity of prices to order flow).

Our 1st result shows that the relation between asset liquidity (the proportion of cash on the firm's balance sheet) and stock liquidity can be either positive or negative depending on parameter values. On the one hand, more cash lowers valuation uncertainty associated with assets-in-place, and it improves stock liquidity. On the other hand, more cash also implies more future investments, since returns to investment of internal cash are higher. This leads to greater uncertainty about future assets and hence lower stock liquidity. Thus, our model highlights how the relation between asset liquidity and stock liquidity depends on the tendency of the firm to invest. The relation is more positive (or less negative) for firms that are less likely to convert liquid assets into uncertain investments: firms with fewer growth opportunities and those that are financially constrained.

We next turn to empirically testing the model's predictions. While our theoretical measure of stock liquidity is Kyle's (1985) lambda, there is no unanimity in the literature on how to empirically measure stock liquidity. In our tests we employ 4 alternative measures of stock liquidity: the illiquidity measure proposed by Amihud (2002), the implicit bid-ask spread proposed by Roll (1984) as estimated by Hasbrouck (2009), the effective bid-ask spread calculated from intraday data, and the Pastor-Stambaugh (2003) measure.[3] While stock liquidity is determined on a daily basis, measures of asset liquidity are only recorded periodically. Hence, in our tests we use annual averages of the 4 stock liquidity measures.

To measure asset liquidity, we sort the firm's assets based on their liquidity and assign liquidity scores of between 0 and 1 to each asset class. We then calculate a weighted liquidity score for the firm using the book value or market value of the different assets on the firm's balance sheet as weights. Finally, we normalize this weighted score by the lagged value of total assets of the firm. This approach

[3]The Pastor-Stambaugh ((2003), p. 679) measure is likely to be a noisy proxy for liquidity of individual stocks. We use it here to highlight the robustness of our results. We obtain similar results when we use the proportion of zero-return days proposed by Lesmond, Ogden, and Trzcinka (1999) as an alternative measure of stock liquidity.

to measuring asset liquidity is similar to that of Berger and Bouwman (2009). Using this approach we come up with 4 alternative measures of asset liquidity that vary based on the liquidity scores assigned to the different assets.

In our 1st set of tests we estimate the time-series and cross-sectional relation between asset liquidity and stock liquidity. These tests help us understand which among the 2 effects identified by our model dominates empirically. We use panel data of all Compustat firms during the time period 1962–2005. In our main tests, we employ a model with time and firm fixed effects to understand how deviations in asset liquidity and stock liquidity for individual firms from their sample average values are related. Our results indicate that after controlling for known determinants of stock liquidity, there is a positive, robust, and economically significant relation between the alternative measures of asset liquidity and those of stock liquidity. For example, for a firm with median level of stock liquidity, a 1-standard-deviation increase in asset liquidity results in a 15.7% decrease in Amihud's (2002) illiquidity measure. This relation is present in different industries and in different time periods. Using the Fama-MacBeth (1973) approach, we also find a strong, positive relation between asset liquidity and stock liquidity in the cross section. Thus, our empirical analysis shows that, on average, the balance sheet relation between asset liquidity and stock liquidity does hold. Improvements in asset liquidity decrease the uncertainty related to assets-in-place more than they increase the uncertainty about future investments. Moreover, asset liquidity appears to be a strong empirical determinant of stock liquidity.

The 2nd prediction of our model is that the relation between asset liquidity and stock liquidity should be less positive for firms with more growth opportunities. Using market-to-book (MB) ratio and capital expenditure (CAPEX) to identify growth firms, we find that the relation between asset liquidity and stock liquidity is indeed less positive for firms with more growth opportunities.

To further explore how the relation between asset liquidity and stock liquidity relates to investment decisions, we carry out an event study around seasoned equity offerings (SEOs). Eckbo, Masulis, and Norli (2000) document an increase in stock liquidity following an SEO. An SEO leads to an immediate inflow of cash and an increase in asset liquidity. Our model predicts that the increase in stock liquidity following the SEO will be lower for firms that invest the proceeds as compared to those that retain the proceeds as cash. Consistent with this prediction, we find that the change in stock liquidity in the post-SEO period is positively related to the fraction of the SEO proceeds the firm retains as cash at the end of the year.

We next test the prediction that the relation between asset liquidity and stock liquidity is more positive for financially constrained firms. Following prior literature, we use firm size, the presence of credit ratings, and the probability of default to proxy for the presence of financial constraints. Consistent with our prediction, we find that the relation between asset and stock liquidity is more positive for small firms, firms without credit ratings, and firms with above-median probability of default. Overall our empirical analysis offers significant support for our model predictions.

In a frictionless Modigliani-Miller (MM) (1958) world where returns to investments are independent of the source of finance, growth opportunities will not affect the relation between asset liquidity and stock liquidity. Our evidence to the contrary is consistent with the technology assumption in our model. Furthermore, the results provide new evidence supporting the importance of financial frictions for firm investment decisions. Unlike traditional tests of financial frictions, our tests do not rely on correctly modeling firm investments.

A final implication of the relation between asset liquidity and stock liquidity that we document is for the value of liquid assets on the firm's balance sheet. Indeed, the effect of high cash balances in improving stock liquidity is a hitherto unknown benefit of cash. If the improvements in stock liquidity that result from an increase in asset liquidity lead to higher firm value (e.g., by reducing the firm's cost of capital or by reducing the costs of providing managerial incentives), then asset liquidity should be valuable for firms. This is especially so for firms with illiquid stock, as improvements in stock liquidity are more likely for such firms. To test this prediction we use the methodology in Faulkender and Wang (2006) and estimate the value of corporate cash holdings for firms with more and less liquid stock. Consistent with our prediction, we find that an increase in corporate cash holdings is more valuable for firms with less liquid stock. As compared to a firm with above-median stock liquidity, a \$1 increase in cash holdings is worth 12¢ more for a firm with below-median stock liquidity.

The rest of the paper is organized as follows. In the next 2 sections, we describe our theoretical model and derive the main empirical predictions on the basis of this model. Section IV describes our data, and our measures of stock and asset liquidity. Section V discusses empirical tests of the model, while Section VI discusses implications for value. Section VII concludes.

II. Model

In this section we develop a simple model that highlights the relation between asset liquidity, future investments, and stock liquidity. The key feature of the model is that stock liquidity today depends on both the structure of the firm's assets today and on the expectations regarding future investments.

There are 3 dates: 0, 1, and 2. At date 0, we consider a firm with assets-in-place whose value is normalized to \$1. The assets comprise cash of value $\$\alpha$ and a project of value $\$[1-\alpha]$, $(\alpha \in [0,1])$. We refer to α as the "asset liquidity" of the firm. Each dollar of the project will return $\tilde{x}$ units of cash at date 2, where $\tilde{x} = \mu_x + \tilde{\varepsilon}_x$, and $\tilde{\varepsilon}_x \sim N\left(0, \sigma_x^2\right)$.

At date 1, the manager decides on the allocation of the cash between an interim dividend and a new project. We assume that the manager's objective is aligned with that of the current shareholders of the firm. Let $\gamma \geq 0$ represent the fraction of the cash invested in the new project, and $1-\gamma$ the fraction of cash that is paid out as dividends. Note that $\gamma > 1$ indicates investment in excess of the cash available with the firm at date 0. This will happen if the firm raises outside finance to invest in the project (similar to Miller and Rock (1985)).

The output from investing a dollar amount $\alpha\gamma$ in the project is given by the stochastic production function

$$\tilde{y} = k\alpha h(\gamma)(1+\tilde{\varepsilon}_y), \tag{1}$$

where $\tilde{\varepsilon}_y \sim N(0, \sigma_y^2)$ is an unexpected shock to production. Thus, the expected output from the project is $k\alpha h(\gamma)$. We assume that $h(\cdot) > 0$, $h'(\cdot) > 0$, and $h''(\cdot) < 0$.

Note that the expected output is concave in the fraction of cash invested in the project, γ. In other words, the marginal returns to investment depend on the source of finance. Marginal returns are higher if the firm has a high cash balance and uses part of it to invest in the project (instances when γ is low) as compared to when the firm raises external finance to invest in the project (instances when γ is high). This is a departure from an MM (1958) world, and we use this assumption to capture the presence of costs of raising external finance in a reduced form. These costs reduce the marginal returns from investing outside cash.

We also assume that $h'(0) = \infty$, implying that some positive investment is optimal. Parameter $k > 0$ measures productivity. A higher k indicates higher marginal productivity at all investment levels, and thereby captures better growth opportunities. We let the correlation between $\tilde{\varepsilon}_x$ and $\tilde{\varepsilon}_y$ be $\rho \geq 0$.[4] At date 2 a liquidating dividend is paid to the equity holders. All agents are risk neutral, and the risk-free interest rate is 0.

At date 0, the firm's stock is traded in a market á la Kyle (1985). Specifically, there are 3 types of traders: an insider, noise traders, and a market maker. We assume that the insider knows the actual realizations of both $\tilde{\varepsilon}_x$ and $\tilde{\varepsilon}_y$.[5] Noise traders are uninformed and trade an exogenous amount distributed according to $\tilde{u} \sim N\left(0, \sigma_u^2\right)$, where $\tilde{u}$ is uncorrelated with either $\tilde{x}$ or $\tilde{y}$. The market maker observes the total order flow (both informed and uninformed) but cannot distinguish between the two. As in Kyle, we assume that the market maker sets a price equal to the expectation of firm value conditional on the observed order flow. The insider trades to maximize his profit, using the noise traders to hide his trades.

We solve the model backwards, restricting attention to equilibria, in which both the market maker and the insider use linear strategies. At date 1 the manager optimally decides on the allocation of cash between interim dividend and investment. Expected firm value as a function of the fraction of cash invested in the new project, γ, is

$$V(\gamma) \equiv (1-\alpha)\mu_x + k\alpha h(\gamma) + \alpha(1-\gamma). \tag{2}$$

The 1st term represents the expected cash flow from the existing project. The 2nd and 3rd terms represent the expected cash flows from the new project and the interim dividend, respectively. Thus, the manager's problem is

$$\max_{\gamma \geq 0} V(\gamma).$$

The 1st-order condition implies that the optimal proportion of cash invested is

$$\gamma^* = h'^{-1}\left(\frac{1}{k}\right). \tag{3}$$

[4]We limit ρ to nonnegative values, as we believe that better represents reality. Our results continue to hold for negative values of ρ as long as it is larger than some lower bound.

[5]Our results are robust to assuming that the insider obtains a partially informative signal about $\tilde{\varepsilon}_x$ and $\tilde{\varepsilon}_y$. We assume perfect knowledge to limit the complexity of the analysis.

The 2nd-order condition is satisfied due to the concavity of $h(\cdot)$. Firms with better investment opportunities invest a higher proportion of their cash:

$$(4)\qquad \frac{\partial \gamma^*}{\partial k} = -\frac{1}{k^2 h''\left(h'^{-1}\left(\frac{1}{k}\right)\right)} > 0.$$

Consider now the trading in the firm's shares at date 0. Both the market maker and the insider anticipate the optimal investment/payout decision of the manager at date 1. As a result, the expected firm value is $V(\gamma^*)$. The variance of the firm value at time 0 is given by

$$(5)\qquad \sigma_0^2 \equiv (1-\alpha)^2 \sigma_x^2 + \alpha^2 k^2 h(\gamma^*)^2 \sigma_y^2 + 2\alpha(1-\alpha) kh(\gamma^*) \sigma_x \sigma_y \rho.$$

The 1st term reflects the variability of the value of the assets-in-place. The 2nd term reflects the variability of the expected investment, taking into account the optimization of the manager. Finally, the 3rd term reflects the contribution of the correlation between the value of the current and future projects. In equilibrium, the market maker uses a linear pricing function with slope equal to Kyle's (1985) lambda (λ). That is, lambda measures the price impact per $1 of order flow and is a conventional measure of stock illiquidity. Applying the results in Kyle, we have

$$(6)\qquad \lambda = \frac{1}{2}\frac{\sigma_0}{\sigma_u},$$

where, unlike in Kyle's original model, σ_0 is endogenous and given by equation (5). As usual, λ is large when σ_0 is large in comparison to σ_u (i.e., when variations in fundamentals are large relative to variations in noise trading).

Our 1st result illustrates how asset liquidity is related to stock liquidity in our model.

Proposition 1. The relation between asset liquidity and stock liquidity can be either positive or negative. Higher asset liquidity is associated with higher stock liquidity (lower λ) if and only if $\alpha < \hat{\alpha}$, where

$$\hat{\alpha} \equiv \frac{\sigma_x^2 - kh(\gamma^*)\sigma_x\sigma_y\rho}{\sigma_x^2 + k^2 h(\gamma^*)^2 \sigma_y^2 - 2kh(\gamma^*)\sigma_x\sigma_y\rho},$$

and γ^* is given by equation (3).

All proofs are presented in Appendix A. An increase in α has 2 conflicting effects on the variance of the firm's cash flow, σ_0. First, a higher α corresponds to a higher proportion of cash within assets-in-place, contributing to a reduction in σ_0. However, a higher α also implies that the manager has more internal cash to invest in the project. Since returns to investment are higher for internal cash, this implies more investment. This contributes to an increase in σ_0. As long as α is small enough (smaller than $\hat{\alpha}$), the 1st effect dominates, and an increase in α translates into higher stock liquidity. Once α becomes sufficiently large, the 2nd effect dominates and an increase in α lowers stock liquidity.

We next study how the relation between asset liquidity and stock liquidity varies in the cross section. Our focus is on studying how variations in growth opportunities, financial constraints, and correlation in asset returns affect this relation. For this analysis we first restrict attention to the case where $\alpha \leq 0.5$.[6] The results when $\alpha > 0.5$ are identical under some additional parameter restrictions. We discuss this further at the end of the section.

Recall that a higher k indicates higher marginal productivity at all investment levels, and hence better growth opportunities.

Proposition 2. The relation between asset liquidity and stock liquidity is less positive (or more negative) for firms with more growth opportunities (higher k).

To understand the intuition for this result it is useful to consider the firm as a portfolio of assets-in-place and a new project. An increase in growth opportunities (higher k) affects the volatility of this portfolio (σ_0) in 3 ways. First, for a given α, a firm with higher k obtains a higher expected output for every dollar invested in the new project. Second, from expression (4), higher k implies that a larger fraction of the cash balance is invested in the project (higher γ^*). Third, the increase in the investment in the new project from a higher k increases the contribution of the correlation term to the volatility of the portfolio.[7] Thus, these 3 effects reinforce each other, leading to an increase in σ_0 relative to σ_u, thereby reducing stock liquidity.

Note that this result depends critically on our assumption that returns to investment are concave in γ. In the neoclassical world of MM (1958), the production function is concave in $\alpha\gamma$ rather than in γ. In such a scenario, the optimal level of investment, and thereby the uncertainty associated with future investment, is unaffected by the amount of cash held by the firm. Thus, growth opportunities do not affect the relation between asset liquidity and stock liquidity. Empirical tests of Proposition 2 can hence serve as validation of our technology assumption.

We next consider the effect of financial constraints on the relation between asset liquidity and stock liquidity. Our assumption of differential returns to investment of internal versus external cash can be considered as representing costs of raising external finance. Still, to better highlight the comparative statics of the presence of financial constraints, we model such constraints by assuming that there exists a $\hat{\gamma} > 0$ such that $\gamma \leq \hat{\gamma}$. This can be interpreted as representing a precautionary savings motive for financially constrained firms or a hard constraint on the amount of external finance that a firm can raise. Note that a firm that faces binding financial constraints will have $\gamma^* = \hat{\gamma}$. Thus, in general, the optimal investment level is given by

$$(7) \qquad \gamma^* = \min\left(\hat{\gamma}, h'^{-1}\left(\frac{1}{k}\right)\right).$$

[6]This corresponds to assuming that the majority of the firm's assets are not perfectly liquid. Such an assumption is consistent with our data, where cash and marketable securities on average constitute 14.2% of book value of total assets.

[7]An increase in project size will lead to an increase in the correlation term only if $\alpha < 0.5$. As we discuss later, when $\alpha > 0.5$, this effect is reversed.

The following proposition derives the effect of financial constraints on the relation between asset liquidity and stock liquidity.

Proposition 3. The relation between asset liquidity and stock liquidity is more positive (or less negative) for financially constrained firms.

Intuitively, a binding upper bound on γ^* means that for a constrained firm, a lower proportion of each additional dollar of cash is invested in a new project, reducing the total volatility of the firm, σ_0. Thus, the relation between asset liquidity and stock liquidity is more positive.

We now discuss the robustness of our results when $\alpha > 0.5$ (i.e., when cash and other liquid assets dominate the balance sheet of the firm). In this case we find that Propositions 2 and 3 still apply subject to an additional parameter restriction, which, among other things, depends on the structure of the production function.[8] The intuition for the additional restriction is as follows: When $\alpha > 0.5$, the new project is likely to be "big" relative to assets-in-place. In such a situation, an increase in the size of the new project resulting from an increase in k will lead to a *reduction* in the contribution of the covariance term to the volatility of the firm's cash flow. This happens because the covariance term is maximized at $\alpha = 0.5$. The other 2 effects discussed under Proposition 2 are unaffected. The parameter restriction ensures that the covariance effect does not dominate the other 2 effects.

Finally, the following proposition discusses how the relation between asset liquidity and stock liquidity depends on ρ, the extent of correlation between the cash flows from assets-in-place and new projects.

Proposition 4. If $\alpha < 0.5$ ($\alpha > 0.5$), the relation between asset liquidity and stock liquidity is more (less) positive for firms with a low (high) ρ.

When $\alpha < 0.5$, the covariance between the assets-in-place and the new project makes the relation between asset liquidity and stock liquidity less positive. Since the covariance term is increasing in ρ, it follows that the relation between asset liquidity and stock liquidity is more positive for firms with a low ρ. A similar logic applies in the case when $\alpha > 0.5$.

III. Empirical Implications

In this section, we describe the main empirical implications of our model. From Proposition 1 we know that the relation between asset liquidity and stock liquidity can be either positive or negative. While a higher proportion of liquid assets on the balance sheet reduces the uncertainty regarding assets-in-place, it also facilitates more future investment, thereby increasing the level of uncertainty.

[8]For example, it can easily be verified using equation (A-3) in Appendix A that Proposition 2 continues to hold when $\alpha > 0.5$ as long as

$$\rho \quad \leq \quad \frac{4\alpha k h\left(\gamma^*\right)^2 \sigma_y^2 + 4\alpha k^2 h\left(\gamma\right) h'\left(\gamma^*\right) \dfrac{d\gamma^*}{dk}}{2\left(2\alpha - 1\right)\sigma_x \sigma_y \left(h\left(\gamma^*\right) + k h'\left(\gamma^*\right) \dfrac{d\gamma^*}{dk}\right)}.$$

These 2 effects influence stock liquidity in opposite directions. In our empirical analysis we test to see which effect dominates.

Proposition 2 implies that the relation between asset liquidity and stock liquidity is less positive for firms with more growth opportunities. We use firm CAPEX and MB ratios to proxy for the level of growth opportunities. Our 1st prediction follows.

Prediction 1. The relation between asset liquidity and stock liquidity is less positive for firms with high CAPEX and high MB ratios.

As a further test of how managerial investment decisions affect the relation between asset liquidity and stock liquidity, we study the changes in stock liquidity following instances of firm financing. Say, when a firm raises finance through an SEO, the cash infusion is likely to result in high cash balances relative to total assets and hence high asset liquidity. However, if the manager is expected to invest the cash in projects and growth opportunities, then despite the high asset liquidity, there is likely to be a lot of uncertainty regarding future value. The rationale of our model suggests that the improvement in stock liquidity following firm financing depends on the future utilization of the proceeds.

Prediction 2. The improvement in stock liquidity following financing depends on the extent to which the proceeds are retained as cash.

Proposition 3 shows that the relation between asset liquidity and stock liquidity is more positive for firms that face constraints in raising external finance. We use firm size and the presence of credit ratings to identify constrained firms. Smaller firms and firms without credit ratings are more likely to face constraints in raising external finance. Furthermore, firms that are closer to financial distress are not only likely to face constraints in raising external finance, but they are also likely to be subject to an underinvestment problem (Myers (1977)).[9] For such firms as well, we expect the relation between asset liquidity and stock liquidity to be more positive. We proxy for firm financial distress using a modified version of the Merton-KMV expected default probability as first proposed in Bharath and Shumway (2008). Thus our 3rd prediction follows.

Prediction 3. The relation between asset liquidity and stock liquidity will be more positive for financially constrained firms, in particular for smaller firms, firms without credit ratings, and firms with higher default likelihood.

IV. Data and Liquidity Measures

To test our predictions we construct a sample that spans 1962–2005. Our analysis focuses on annual firm-level data for all Compustat firms. We obtain data for 3 measures of stock liquidity from Joel Hasbrouck's Web site (http://people.stern.nyu.edu/jhasbrou/). We use TAQ data to construct one of our stock liquidity

[9]An alternative view emphasizes agency conflicts when firms are in financial distress and argues that asset liquidity may give managers of such firms greater discretion. Managers may be able to sustain inefficient operations by liquidating the assets (see DeAngelo, DeAngelo, and Wruck (2002)). Our empirical tests will help distinguish this view from the one described in the text.

measures. We complement these data with daily stock returns and trading volume from the Center for Research in Security Prices (CRSP) and annual firm financial data from Compustat. Finally, we use the Securities Data Company (SDC) database to identify SEOs. Apart from availability of liquidity measures and financial information in Compustat, we also limit our sample to firms with book value of assets greater than \$5 million and with a minimum of 2 years of financial data. These restrictions ensure that very small firms do not disproportionately influence our results.

We use 4 popular measures of stock liquidity. The first is the illiquidity measure proposed by Amihud (2002). Since the raw Amihud measure is highly skewed, we use the square root version of the raw measure in our empirical analysis. For every stock in our sample and for every year it is calculated as

$$\text{ILLIQ}_{i,t} = \frac{1}{N_{i,t}} \sum_{j=1}^{N_{i,t}} \sqrt{\frac{|R_{i,j}|}{\text{VOL}_{i,j} P_{i,j-1}}},$$

where $N_{i,t}$ is the number of trading days for stock i during year t, $R_{i,j}$ is the return on day j, $\text{VOL}_{i,j}$ is trading volume in millions of shares, and $P_{i,j-1}$ is the closing stock price. ILLIQ is a price impact measure. It captures the stock return per \$1 million of trading volume. This measure is constructed along the lines of Kyle's (1985) "lambda," with the important difference of using volume instead of signed order flow. We obtain the annual average ILLIQ measure for all the stocks in our sample from Joel Hasbrouck's Web site (http://people.stern.nyu.edu/jhasbrou/).

Our 2nd measure of stock liquidity is the implicit bid-ask spread, s, first proposed in Roll (1984). This measure is calculated as the square root of the negative daily autocorrelation of individual stock returns, that is,

$$s_{i,t} = \sqrt{-\text{cov}(R_{i,j}, R_{i,j-1})}.$$

Roll shows that this measure proxies for ½ of the bid-ask spread assuming that the fundamental value of the security is fixed through time and order flow is identically and independently distributed. Since the autocorrelation of stock returns is often positive, this measure is not well defined in many cases. To overcome this problem, Hasbrouck (2009) introduces a Gibbs sampler estimate of Roll's measure. Hasbrouck finds that the Gibbs estimator has a correlation of 0.965 with daily effective trading costs estimated from Trades and Quotes (TAQ) data. We use this Gibbs sampler estimate for our empirical analysis. We obtain data on this measure as well from Joel Hasbrouck's Web site (http://people.stern.nyu.edu/jhasbrou/).

Our 3rd measure of stock liquidity is the annual average effective bid-ask spread, SPREAD, calculated from intraday TAQ data. The bid and ask prices are identified from the intraday transaction data. The effective bid-ask spread for any trade is equal to the ratio of the absolute difference between the trade price and the midpoint of the associated quote and trade price. The effective spread is then averaged over the year to obtain SPREAD. This data on the average effective spread is obtained from the Web site of the University of Vanderbilt's Financial Markets Research Center (http://www.vanderbiltfmrc.org/) and is available only for the subperiod 1993–2003.

Our final measure of stock liquidity is the Pastor-Stambaugh measure, PS-GAMMA. This measure was first proposed by Pastor and Stambaugh (2003). The rationale for this measure is that if a stock is illiquid, then large buy or sell volumes are likely to move prices. Such temporary price movements are likely to be reversed subsequently. Thus, for illiquid stocks, large buy (sell) volumes are likely to result in subsequent negative (positive) returns. Following this logic, Pastor and Stambaugh propose regressing daily stock returns on lagged stock returns and lagged signed volume, where the sign of lagged volume is the same as the sign of lagged stock return. The coefficient on signed volume, which on average is expected to be negative, is a measure of stock liquidity. We obtain data on this measure at annual frequencies from Joel Hasbrouck's Web site (http://people.stern.nyu.edu/jhasbrou/), where higher values of PS-GAMMA indicate a more illiquid stock. To obtain reasonable coefficients, we normalize PS-GAMMA by multiplying with 1,000.

Our main independent variable is a measure of asset liquidity. We assign liquidity scores of between 0 and 1 to all the assets on a firm's balance sheet based on their level of liquidity. We then calculate a weighted asset liquidity score using the book value of the different assets as weights and normalize by the lagged value of total assets. Using this approach we come up with 4 alternative measures of asset liquidity. These measures differ in terms of the liquidity score assigned to the balance sheet items.

Our 1st measure of asset liquidity assigns a liquidity score of 1 to cash and equivalents and a score of 0 to all other assets of the firm. Formally, our 1st weighted asset liquidity (WAL) measure for firm i in year t is given by

$$\text{WAL1}_{i,t} = \frac{\text{Cash \& Equivalents}_{i,t}}{\text{Total Assets}_{i,t-1}} \times 1 + \frac{\text{Other Assets}_{i,t}}{\text{Total Assets}_{i,t-1}} \times 0.$$

Thus, effectively, WAL1 is the proportion of cash and equivalents to the firm's lagged total assets. Clearly, this measure leaves out a lot of information, as it presumes that all assets other than cash and equivalents are perfectly illiquid. Nevertheless, this measure is useful because it best captures the parameter α in our model.

While cash and equivalents are perfectly liquid, noncash current assets (CA) are semiliquid. That is, they can be converted to cash relatively quickly and at a low cost. Thus, for our 2nd measure of asset liquidity, we assign a liquidity score of ½ to noncash CA. Our 2nd WAL measure is

$$\begin{aligned}\text{WAL2}_{i,t} = {} & \frac{\text{Cash \& Equivalents}_{i,t}}{\text{Total Assets}_{i,t-1}} \times 1 + \frac{\text{Noncash CA}_{i,t}}{\text{Total Assets}_{i,t-1}} \times 0.5 \\ & + \frac{\text{Other Assets}_{i,t}}{\text{Total Assets}_{i,t-1}} \times 0.\end{aligned}$$

Noncurrent assets can be divided broadly into tangible and intangible assets. Tangible assets (e.g., property, plant, and equipment) are more liquid than intangible assets (e.g., growth opportunities and goodwill). Following this logic, we calculate our 3rd measure by assigning a liquidity score of 1 for cash, ¾ for noncash CA, ½ for tangible fixed assets, and 0 for the rest. We calculate tangible fixed assets as the difference between the book value of total assets and the sum of current assets, and book value of goodwill and intangibles.[10] This gives rise to our 3rd WAL measure,

$$\begin{aligned}\text{WAL3}_{i,t} \quad = \quad & \frac{\text{Cash \& Equivalents}_{i,t}}{\text{Total Assets}_{i,t-1}} \times 1 + \frac{\text{Noncash CA}_{i,t}}{\text{Total Assets}_{i,t-1}} \times 0.75 \\ & + \frac{\text{Tangible Fixed Assets}_{i,t}}{\text{Total Assets}_{i,t-1}} \times 0.5 + \frac{\text{Other Assets}_{i,t}}{\text{Total Assets}_{i,t-1}} \times 0.\end{aligned}$$

We construct our 4th and final measure of asset liquidity to capture the liquidity of both assets-in-place and growth options. We construct the market-weighted asset liquidity (MWAL) measure by assigning a liquidity score of 1 to cash and equivalents, ¾ to noncash CA, ½ to tangible fixed assets, and 0 to the rest. We calculate tangible fixed assets as the difference between the book value of total assets and the sum of current assets and goodwill. We normalize this weighted score by the lagged market value of total assets to obtain

$$\begin{aligned}\text{MWAL}_{i,t} \quad = \quad & \frac{\text{Cash \& Equivalents}_{i,t}}{\text{Market Assets}_{i,t-1}} \times 1 + \frac{\text{Noncash CA}_{i,t}}{\text{Market Assets}_{i,t-1}} \times 0.75 \\ & + \frac{\text{Tangible Fixed Assets}_{i,t}}{\text{Market Assets}_{i,t-1}} \times 0.5 + \frac{\text{Other Assets}_{i,t}}{\text{Market Assets}_{i,t-1}} \times 0.\end{aligned}$$

Note that MWAL assigns a liquidity score of 0 to growth options. Since we normalize the measure by the market value of assets—which is likely to include growth options—ceteris paribus, MWAL will be lower for firms with a higher proportion of growth options.[11]

We use additional independent variables to account for firm and market characteristics that are likely to affect stock liquidity. All variables are defined in Appendix B. We control for firm size, which is an important determinant of stock liquidity, using log(MRKT_CAP), for the extent of growth opportunities using MB, and CAPEX. We also control for firm performance using return on assets, ROA, and using the annual buy-and-hold abnormal return during the previous year, BHAR. Firms with more transparent earnings and firms with better disclosure policies are also likely to be associated with higher stock liquidity (Diamond and Verrecchia (1991), Bhattacharya, Desai, and Venkataraman (2007)). In most of our specifications we employ firm fixed effects, and this is likely to control for time-invariant differences across firms in disclosure policies. In addition, we control for the quality of a firm's earnings using the level of discretionary accruals normalized by lagged value of total assets, DISC_ACC.[12] Finally, we control for stock return volatility, log(VOLATILITY).

Table 1 presents summary statistics for the key variables in our sample. To reduce the effects of outliers, all of our variables are winsorized at the 1% level.

[10]We obtain book values of goodwill and intangibles from Data204 and Data33 in Compustat.

[11]We calculate the market value of assets as the sum of the book value of assets and the market value of equity less the book value of equity.

[12]The reported results use the signed discretionary accruals. The results are similar when using the absolute value of the discretionary accruals instead (not reported, but are available from the authors).

TABLE 1

Summary Statistics

Table 1 reports the summary statistics of the key variables used in our analysis. All variables are defined in Appendix B. The sample includes all firms with financial data in Compustat during the years 1962–2005. Effective spread data are only for 1993–2003. All variables are winsorized at the 1st and 99th percentiles.

Variable	*N*	Mean	Median	Std. Dev.
ILLIQ	88,360	0.579	0.285	0.754
s	88,360	0.01	0.006	0.011
SPREAD	38,086	0.009	0.006	0.008
PS-GAMMA	88,360	0.01	0	0.066
WAL1	88,360	0.142	0.065	0.196
WAL2	88,360	0.322	0.301	0.236
WAL3	88,360	0.664	0.64	0.237
MWAL	87,563	0.507	0.501	0.237
MRKT_CAP	88,360	1,637.837	146.354	9,889.643
MB	87,562	2.292	1.559	2.72
DEF_PROB	65,580	0.06	0	0.15
CAPEX	87,385	0.072	0.049	0.11
ROA	87,710	0.115	0.126	0.157
BHAR	88,227	0.049	0.02	0.478
RATED	88,360	0.209	0	0.406
DISC_ACC	76,245	0.069	0.045	0.084
VOLATILITY	88,360	0.032	0.028	0.019

The median value of ILLIQ in our sample is 0.285. Average Roll's (1984) estimate of the ½ spread is about 1%, implying an average relative spread during the entire sample period of approximately 2%. Consistent with this, the average effective ½ spread as estimated from the TAQ data, SPREAD, is about 0.9%. Recall that this measure is estimated only for the subperiod 1993–2003. The average value for PS-GAMMA is 0.01.

The mean value of WAL1 of 0.142 implies that on average book value of cash constitutes about 14.2% of the value of the previous year's total assets. The average market capitalization of equity in our sample is \$1,637.8 million, whereas the median is \$146.35 million. The average MB ratio of equity in our sample of 2.29 is comparable to other studies. The average default probability of our sample firms is 6%, while the 90th percentile is 21.3% (not reported in the table). This ensures sufficient variation in default probability in our sample. Firms in our sample have an average ROA of 11.5% and experience an average annual BHAR of 4.9%. The average abnormal return is positive because of our requirements of a minimum book value of total assets of \$5 million, and availability of more than 2 years of data tilts the sample toward the better-performing firms. About 20.9% of firms in our sample have long-term credit ratings from Standard & Poor's (S&P). The average daily stock volatility in our sample is 3.2%.

Table 2 presents the correlations among the key variables in our analysis. As expected, the 4 measures of stock liquidity are positively correlated with each other. Among the book-value-based asset liquidity measures, while WAL1 is negatively correlated with all 4 measures of stock illiquidity, the pattern with the other 2 is mixed. Both WAL2 and WAL3 are negatively correlated with 2 out of the 4 measures of stock illiquidity. MWAL, on the other hand, is unconditionally and positively correlated with the measures of stock illiquidity. The 3 book-value-based measures of asset liquidity are highly correlated with each other. MWAL is less correlated with the other measures, especially with WAL1. This is because a large fraction of the variation in MWAL is from changes in the MB ratio, as

TABLE 2

Correlations

Table 2 reports the correlations between the key variables used in our analysis. All variables are defined in Appendix B. The sample includes all firms with financial data in Compustat during the years 1962–2005. Effective spread data are only for 1993–2003. All variables are winsorized at the 1st and 99th percentiles.

	ILLIQ	s	SPREAD	PS-GAMMA	WAL1	WAL2	WAL3	MWAL	$\log(\text{MRKT\_CAP})_{t-1}$
ILLIQ	1.000								
s	0.811	1.000							
SPREAD	0.830	0.884	1.000						
PS-GAMMA	0.384	0.330	0.314	1.000					
WAL1	−0.086	−0.007	−0.021	−0.028	1.000				
WAL2	−0.020	0.051	0.066	−0.009	0.839	1.000			
WAL3	−0.030	0.028	0.051	−0.009	0.636	0.791	1.000		
MWAL	0.280	0.194	0.266	0.077	0.041	0.201	0.414	1.000	
$\log(\text{MRKT\_CAP})_{t-1}$	−0.130	−0.134	−0.173	−0.032	−0.026	−0.057	−0.028	−0.135	1.000
MB_{t-1}	−0.158	−0.078	−0.122	−0.034	0.278	0.253	0.212	−0.408	0.161
DEF_PROB	0.288	0.299	0.257	0.132	−0.100	−0.119	−0.167	0.025	−0.065
CAPEX	−0.048	−0.024	−0.017	−0.015	0.041	0.006	0.225	0.061	0.002
RATED	−0.331	−0.329	−0.413	−0.091	−0.205	−0.302	−0.207	−0.126	0.245
ROA	−0.139	−0.209	−0.184	−0.041	−0.297	−0.148	−0.015	0.034	0.105
BHAR_{t-1}	−0.119	−0.147	−0.139	−0.050	0.185	0.215	0.206	−0.098	0.012
$\log(\text{VOLATILITY})_{t-1}$	0.375	0.507	0.497	0.148	0.314	0.335	0.164	0.046	−0.155
DISC_ACC	0.070	0.118	0.124	0.035	0.143	0.312	0.296	0.078	−0.055

	MB_{t-1}	DEF_PROB	CAPEX	RATED	ROA	BHAR_{t-1}	$\log(\text{VOLATILITY}_{t-1})$
MB_{t-1}	1.000						
DEF_PROB	−0.079	1.000					
CAPEX	0.075	−0.061	1.000				
RATED	−0.004	0.003	0.003	1.000			
ROA	−0.079	−0.175	0.101	0.144	1.000		
BHAR_{t-1}	0.196	−0.231	0.081	−0.032	0.079	1.000	
$\log(\text{VOLATILITY})_{t-1}$	0.089	0.331	−0.007	−0.364	−0.345	0.128	1.000
DISC_ACC	0.110	0.057	0.105	−0.158	−0.093	0.083	0.225

can be seen from the correlation between MWAL and MB of −0.408.[13] Many of our control variables are also significantly correlated with the stock illiquidity measures, justifying the need to include them in the regressions.

V. Empirical Results

A. The Basic Effect

We begin our empirical analysis by testing whether on average there is a positive or negative relation between asset liquidity and stock liquidity. To do this we estimate panel models with both firm fixed effects and time effects as follows:

$$(8) \qquad Y_{i,t} \quad = \quad \alpha + \beta X_{i,t} + \gamma \text{CONTROLS}_{i,t} + \mu_i + \mu_t + \epsilon_{i,t}.$$

Here $Y_{i,t}$ is 1 of the 4 measures of stock liquidity for firm i during year t, $X_{i,t}$ is 1 of the 4 asset liquidity measures, μ_i are firm fixed effects, and μ_t are year dummy variables. The control variables are log(MRKT_CAP), CAPEX, MB, ROA, BHAR, log(VOLATILITY), and DISC_ACC. We use standard errors that are robust to heteroskedasticity and clustered at the firm level.[14]

[13]Since a lot of variation in our market value measure is driven by changes in market value of equity, we put more weight on the results with our book value measures.

[14]Since stock liquidity is correlated across stocks at a point in time, in alternative empirical specifications we repeat our tests clustering standard errors at the year level and obtain results similar to

In Table 3 we estimate the average relation between asset liquidity and stock liquidity in our sample. We employ the 16 different combinations of asset liquidity and stock liquidity measures. Since all 4 measures of stock liquidity are in fact measures of stock illiquidity, the sign of the relation between asset and stock liquidity is opposite to the sign of the coefficient.

In Panel A of Table 3 the dependent variable is either ILLIQ or s. Columns (1)–(4) have ILLIQ as the dependent variable and correspond to the 4 different measures of asset liquidity: WAL1, WAL2, WAL3, and MWAL. The coefficients on *all* 4 measures are negative and significant. Furthermore, the results are economically significant. For example, for a firm with a median level of stock liquidity, a 1-standard-deviation increase in WAL1 reduces ILLIQ by 15.7%. Similarly, a 1-standard-deviation increase in MWAL reduces ILLIQ by 11.9% for a firm with a median level of stock illiquidity. Note that the R^2s in all of our regressions are high because of the use of firm fixed effects.

All of our control variables are significant and indicate that smaller firms, firms with high MB ratio, firms with less discretionary accruals (weakly), firms that do not undertake large CAPEX, firms with low levels of profitability and abnormal stock returns, and those with more volatile stock have less liquid stock.

In Columns (5)–(8) of Table 3 we repeat our estimation with Roll's (1984) measure as the dependent variable and obtain results consistent with those in the earlier columns. Here again we find that an increase in the proportion of liquid assets in the firm's balance sheet increases stock liquidity. The results are also economically significant. For example, the estimate in Column (5) indicates that for a firm with the median level of stock liquidity, a 1-standard-deviation increase in WAL1 improves stock liquidity by 9.8%. In Panel B we repeat the estimation using the SPREAD and PS-GAMMA as the dependent variables. The results are similar to those in the previous panel.

The results in Table 3 provide strong support for a positive average relation between asset liquidity and stock liquidity. This indicates that in our sample the effect of higher asset liquidity in increasing the liquidity of assets-in-place outweighs its effect of reducing the liquidity of future assets.[15,16]

To see if and how the relation between asset liquidity and stock liquidity changes with time, in unreported tests we split our sample into 4 subperiods (1962–1975, 1976–1985, 1986–1995, and 1996–2005) and repeat our estimates. Our results indicate a positive association between asset liquidity and stock liquidity in all but the 1st subperiod. Furthermore, we find that the relation becomes

those reported. Alternatively, we also tried clustering standard errors both at the firm and year levels, but given the large number of fixed effects in our specifications, the estimates failed to converge.

[15]In unreported tests we divide our sample firms into 3 broad industry groups: *Financial services* (firms with Standard Industrial Classification (SIC) codes 6000–6999), *Utilities* (firms with SIC codes 4000–4999), and *Industrials* (firms with SIC codes 2000–3999) and repeat our tests in the subsamples. We find that asset liquidity and stock liquidity are positively related within all 3 industry groups. There is some evidence that the relation is strongest among industrial firms.

[16]To ensure that across-industry differences in the level of cash balance do not bias our results, we repeat our tests replacing WAL1 with ABNORMAL_WAL1, where ABNORMAL_WAL1 is the difference between the firm's WAL1 and the median WAL1 of all firms in the same 3-digit SIC code industry during the year. Our results indicate a positive association between stock liquidity and ABNORMAL_WAL1.

TABLE 3

Asset Liquidity and Stock Liquidity: Time-Series Evidence

Table 3 reports the results of the regression relating a firm's asset liquidity to stock liquidity. Specifically, we estimate the panel ordinary least squares (OLS) regression: $Y_{i,t} = \alpha + \beta X_{i,t} + \gamma \text{CONTROLS}_{i,t} + \mu_i + \mu_t + \epsilon_{i,t}$, where $Y_{i,t}$ is a measure of stock liquidity for firm *i* during year *t*, $X_{i,t}$ is a measure of asset liquidity, μ_i are firm fixed effects, and μ_t are year dummy variables. *Y* is ILLIQ in Columns (1)–(4) of Panel A, *s* in Columns (5)–(8) of Panel A, SPREAD in Columns (1)–(4) of Panel B, and PS-GAMMA in Columns (5)–(8) of Panel B. All variables are defined in Appendix B. The sample includes all firms with financial data in Compustat during the years 1962–2005. Effective spread data are only for 1993–2003. The standard errors are clustered at the individual firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. ILLIQ and Roll's Measure (s)

	ILLIQ				Roll's Measure (*s*)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WAL1	−0.228 (0.018)***				−0.003 (0.0003)***			
WAL2		−0.278 (0.016)***				−0.004 (0.0002)***		
WAL3			−0.200 (0.011)***				−0.003 (0.0002)***	
MWAL				−0.143 (0.020)***				−0.003 (0.0002)***
$\log(\text{MRKT\_CAP})_{t-1}$	−0.213 (0.005)***	−0.216 (0.005)***	−0.217 (0.005)***	−0.228 (0.006)***	−0.002 (0.00006)***	−0.002 (0.00006)***	−0.002 (0.00006)***	−0.002 (0.00007)***
DISC_ACC_t	−0.086 (0.028)***	−0.003 (0.029)	−0.005 (0.028)	−0.091 (0.028)***	−0.0004 (0.0004)	0.0009 (0.0004)**	0.001 (0.0004)**	−0.0003 (0.0004)
MB_{t-1}	0.010 (0.001)***	0.011 (0.001)***	0.011 (0.001)***	0.007 (0.001)***	0.0001 (1.00e-05)***	0.0001 (1.00e-05)***	0.0001 (1.00e-05)***	0.00007 (1.00e-05)***
CAPEX_t	−0.161 (0.035)***	−0.142 (0.032)***	−0.091 (0.021)***	−0.154 (0.032)***	−0.003 (0.0005)***	−0.003 (0.0005)***	−0.002 (0.0003)***	−0.003 (0.0004)***
ROA_t	−0.364 (0.026)***	−0.297 (0.027)***	−0.296 (0.026)***	−0.374 (0.027)***	−0.007 (0.0004)***	−0.006 (0.0004)***	−0.006 (0.0004)***	−0.007 (0.0004)***
$\log(\text{VOLATILITY})_{t-1}$	0.237 (0.012)***	0.234 (0.012)***	0.233 (0.012)***	0.231 (0.012)***	0.007 (0.0002)***	0.007 (0.0002)***	0.007 (0.0002)***	0.007 (0.0002)***
BHAR_{t-1}	−0.146 (0.005)***	−0.140 (0.005)***	−0.142 (0.005)***	−0.155 (0.005)***	−0.003 (0.00007)***	−0.003 (0.00007)***	−0.003 (0.00007)***	−0.003 (0.00007)***
No. of obs.	74,795	74,795	74,795	74,795	74,795	74,795	74,795	74,795
R^2	0.78	0.781	0.781	0.78	0.772	0.773	0.773	0.772

(continued on next page)

TABLE 3 (continued)

Asset Liquidity and Stock Liquidity: Time-Series Evidence

Panel B. Effective Bid-Ask Spread and Pastor-Stambaugh Measure

	Effective Bid-Ask Spread (SPREAD)				Pastor-Stambaugh Measure (PS-GAMMA)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WAL1	−0.002 (0.0002)***				−0.007 (0.002)***			
WAL2		−0.002 (0.0002)***				−0.010 (0.002)***		
WAL3			−0.002 (0.0001)***				−0.008 (0.001)***	
MWAL				−0.002 (0.0002)***				−0.004 (0.002)
log(MRKT_CAP)$_{t-1}$	−0.002 (0.00006)***	−0.002 (0.00006)***	−0.002 (0.00006)***	−0.002 (0.00007)***	−0.006 (0.0005)***	−0.006 (0.0005)***	−0.006 (0.0005)***	−0.007 (0.0006)***
DISC_ACC$_t$	−0.0009 (0.0003)***	−0.0002 (0.0003)	−0.0003 (0.0003)	−0.0008 (0.0003)***	−0.0006 (0.004)	0.003 (0.004)	0.003 (0.004)	−0.0009 (0.004)
MB$_{t-1}$	0.00006 (1.00e-05)***	0.00006 (1.00e-05)***	0.00006 (1.00e-05)***	0.00003 (1.00e-05)***	0.0006 (0.0001)***	0.0006 (0.0001)***	0.0006 (0.0001)***	0.0005 (0.0001)***
CAPEX$_t$	−0.0009 (0.0002)***	−0.0008 (0.0002)***	−0.0006 (0.0002)***	−0.0008 (0.0002)***	−0.007 (0.002)***	−0.006 (0.002)***	−0.004 (0.002)*	−0.007 (0.002)***
ROA$_t$	−0.004 (0.0003)***	−0.003 (0.0003)***	−0.003 (0.0003)***	−0.004 (0.0003)***	−0.014 (0.003)***	−0.011 (0.003)***	−0.011 (0.003)***	−0.015 (0.003)***
log(VOLATILITY)$_{t-1}$	0.004 (0.0002)***	0.004 (0.0002)***	0.004 (0.0002)***	0.004 (0.0002)***	0.014 (0.001)***	0.014 (0.001)***	0.014 (0.001)***	0.014 (0.001)***
BHAR$_{t-1}$	−0.001 (0.00005)***	−0.001 (0.00005)***	−0.001 (0.00005)***	−0.001 (0.00005)***	−0.006 (0.0006)***	−0.005 (0.0006)***	−0.005 (0.0006)***	−0.006 (0.0006)***
No. of obs.	31,690	31,690	31,690	31,690	74,795	74,795	74,795	74,795
R^2	0.874	0.874	0.873	0.873	0.235	0.235	0.235	0.235

more positive in the latter subperiods. To conserve space, we do not report these results, but they are available from the authors.

Since we employ firm fixed effects in all of our specifications, the correlations that we document are between deviations in asset liquidity and stock liquidity from their average value for an individual firm in our sample. Does the same relation between asset liquidity and stock liquidity hold in the cross section as well? To answer this question, in Table 4 we employ the Fama-MacBeth (1973) approach. We conduct annual cross-sectional regressions of stock liquidity on measures of asset liquidity and the full set of control variables, and report the average coefficients along with the standard errors. Since stock liquidity is quite persistent, we adjust for autocorrelation by correcting the reported standard errors. To do this, we follow Fama and French (2002) and Cooper, Gulen, and Schill (2008), and multiply the standard errors of the average parameters by $\sqrt{(1+\rho)/(1-\rho)}$, where ρ is the 1st-order autocorrelation of annual parameter estimates. To conserve space, we suppress the coefficients on the control variables. The results in Panels A and B of Table 4 are consistent with a positive relation between asset

TABLE 4

Asset Liquidity and Stock Liquidity: Cross-Sectional Evidence

Table 4 reports the results of Fama-MacBeth (1973) regressions relating a firm's asset liquidity to stock liquidity. Specifically, we estimate the annual OLS regression, $Y_{i,t} = \alpha + \beta X_{i,t} + \gamma \text{CONTROLS}_{i,t} + \epsilon_{i,t}$, and report the average of the annual coefficients. Here, $Y_{i,t}$ is a measure of stock liquidity for firm i during year t and $X_{i,t}$ is a measure of asset liquidity; Y is ILLIQ in Columns (1)–(4) of Panel A, s in Columns (5)–(8) of Panel A, SPREAD in Columns (1)–(4) of Panel B, and PS-GAMMA in Columns (5)–(8) of Panel B. The specification is similar to the ones in Panels A and B of Table 3. We suppress the coefficients of the control variables in order to conserve space. To adjust for autocorrelation, we correct the reported standard errors of the average parameters by multiplying with $\sqrt{(1+\rho)/(1-\rho)}$, where ρ is the 1st-order autocorrelation in yearly parameter estimates. The sample includes all firms with financial data in Compustat during the years 1962–2005. Effective spread data are only for 1993–2003. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. ILLIQ and Roll's Measure (s)

	ILLIQ				Roll's Measure (s)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WAL1	–0.269 (0.089)***				–0.004 (0.001)***			
WAL2		–0.279 (0.129)***				–0.005 (0.002)***		
WAL3			–0.245 (0.049)***				–0.004 (0.0009)***	
MWAL				–0.019 (0.035)				–0.002 (0.0007)***
No. of obs.	43	43	43	43	43	43	43	43

Panel B. Effective Bid-Ask Spread and Pastor-Stambaugh Measure

	Effective Bid-Ask Spread (SPREAD)				Pastor-Stambaugh Measure (PS-GAMMA)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WAL1	–0.004 (0.0002)***				–0.006 (0.006)			
WAL2		–0.004 (0.0006)***				–0.017 (0.004)***		
WAL3			–0.002 (0.006)***				–0.015 (0.005)***	
MWAL				0.0004 (0.003)				–0.0001 (0.0002)
No. of obs.	12	12	12	12	43	43	43	43

liquidity and stock liquidity in the cross section. We find that 12 of the 16 coefficients are negative and statistically significant. The coefficient estimates are in some cases larger than the estimates in Table 3.

In summary, asset liquidity and stock liquidity are positively related both across time and in the cross section. This suggests that the observed WAL1 in our sample is lower than $\hat{\alpha}$ (Proposition 1). The magnitude of the effect is also large. Since asset liquidity and stock liquidity are likely to be endogenous, one concern with our estimates is of omitted variable bias. Say firms with growth opportunities may have high asset liquidity and stock liquidity. If we do not adequately control for growth opportunities, our estimates are likely to be biased. To see if our results are robust to partially controlling for endogeneity, we employ the linear generalized method of moments (GMM) estimator proposed by Arellano and Bond (1991). This procedure uses lagged values to instrument for asset liquidity and estimates the regression using the GMM procedure. We find that our results are robust to using this procedure. This indicates that the positive correlation between asset liquidity and stock liquidity is not driven by omitted variables bias.[17]

B. Growth Opportunities and the Relation between Asset Liquidity and Stock Liquidity

Having established a positive average relation between asset liquidity and stock liquidity, we now turn to test Prediction 1: The relation between asset liquidity and stock liquidity is less positive for firms with more growth opportunities.

In Panel A of Table 5 we use CAPEX to identify firms with growth opportunities. We divide our sample into firms with above- and below-median CAPEX each year and repeat our tests in the 2 subsamples. To conserve space, we only report the results for Amihud's (2002) stock illiquidity measure. Similar results obtain for the other 3 stock liquidity measures. While our specification is similar to the one we employ in Table 3, we suppress the coefficients on the control variables other than log(MRKT_CAP) to conserve space.

One way to test Prediction 1 is to repeat the estimation of equation (8) after including an interaction term between the measures of asset liquidity and a dummy variable that identifies firms with high CAPEX. Prediction 1 would imply a positive coefficient on the interaction term. Instead of employing such a procedure, we repeat the estimation of equation (8) on 2 subsamples of firms with high and low CAPEX, and we test to see if the coefficient on the asset liquidity measure is different across the 2 subsamples. Our methodology is a more general way of estimating interaction effects, because we do not constrain the coefficients on the control variables to be the same for firms with high and low CAPEX. Thus, our procedure is equivalent to estimating the interaction effect after including a full set of interaction terms for all the control variables including the fixed effects.[18] We employ this procedure for its generality.

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[17]We thank Christopher Baum for suggesting this test.

[18]To test if the relation between asset liquidity and stock liquidity is significantly different across the 2 subsamples, we estimate a single equation with a full set of interaction terms between all

TABLE 5

Asset Liquidity and Stock Liquidity

Panel A of Table 5 reports the results of the regression relating a firm's asset liquidity to stock liquidity with the sample split into firms with above- and below-median levels of CAPEX. Specifically, we estimate the panel OLS regression, $Y_{i,t} = \alpha + \beta X_{i,t} + \gamma \text{CONTROLS}_{i,t} + \mu_i + \mu_t + \epsilon_{i,t}$, where $Y_{i,t}$ is a measure of stock liquidity for firm i during year t, $X_{i,t}$ is a measure of asset liquidity, μ_i are firm fixed effects, and μ_t are year dummy variables. Y is ILLIQ. All variables are defined in Appendix B. To test if the coefficient on the measures of asset liquidity is significantly different across the 2 subsamples, we estimate a single equation with a full set of interaction terms between all the independent variables and a dummy variable that identifies firms with above-median CAPEX and test if the coefficient on the asset liquidity interaction term is significantly different from 0. We present the results of the test in the row titled ΔCOEFF. Panel B reports the results of the regression relating a firm's asset liquidity to stock liquidity with the sample split into firms with above- and below-median levels of MB ratio. The dependent variable is ILLIQ. All variables are defined in Appendix B. To test if the coefficient on the measures of asset liquidity is significantly different across the 2 subsamples, we estimate a single equation with a full set of interaction terms between all independent variables and a dummy variable that identifies firms with above-median MB ratios and test if the coefficient on the asset liquidity interaction term is significantly different from 0. We present the results of the test in the row titled ΔCOEFF. All variables are winsorized at the 1st and 99th percentiles. The sample includes all firms with financial data in Compustat during the years 1962–2005. The standard errors are clustered at the individual firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. High versus Low CAPEX Firms

	CAPEX							
	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WAL1	−0.200 (0.020)***	−0.279 (0.030)***						
WAL2			−0.228 (0.018)***	−0.322 (0.026)***				
WAL3					−0.156 (0.013)***	−0.230 (0.020)***		
MWAL							−0.081 (0.025)***	−0.218 (0.028)***
log(MRKT_CAP)$_{t-1}$	−0.173 (0.006)***	−0.255 (0.008)***	−0.176 (0.006)***	−0.260 (0.008)***	−0.176 (0.006)***	−0.262 (0.008)***	−0.181 (0.007)***	−0.282 (0.009)***
No. of obs.	41,818	32,977	41,818	32,977	41,818	32,977	41,818	32,977
R^2	0.806	0.804	0.806	0.804	0.806	0.804	0.805	0.803
ΔCOEFF	0.079 (0.036)**		0.094 (0.032)***		0.074 (0.024)***		0.137 (0.037)***	

Panel B. High versus Low MB Firms

	MB							
	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WAL1	−0.185 (0.015)***	−0.339 (0.045)***						
WAL2			−0.215 (0.014)***	−0.374 (0.039)***				
WAL3					−0.158 (0.010)***	−0.233 (0.027)***		
MWAL							−0.177 (0.024)***	−0.186 (0.028)***
log(MRKT_CAP)$_{t-1}$	−0.160 (0.006)***	−0.274 (0.009)***	−0.163 (0.006)***	−0.279 (0.009)***	−0.164 (0.006)***	−0.279 (0.009)***	−0.176 (0.007)***	−0.293 (0.010)***
No. of obs.	37,835	36,960	37,835	36,960	37,835	36,960	37,835	36,960
R^2	0.803	0.809	0.804	0.809	0.803	0.809	0.802	0.809
ΔCOEFF	0.154 (0.047)***		0.159 (0.041)***		0.075 (0.029)***		0.008 (0.036)	

independent variables and a dummy variable that identifies firms with above-median CAPEX and test if the coefficient on the asset liquidity interaction term is significantly different from 0. We present the results of the test in the row titled ΔCOEFF in the tables.

The results in Columns (1) and (2) of Table 5 indicate that WAL1 has a more positive relation with stock liquidity for firms with below-median CAPEX (−0.279) in comparison to firms with above-median CAPEX (−0.200). The row titled ΔCOEFF shows that the coefficients across the 2 subsamples are significantly different from each other. Qualitatively similar differences obtain from comparing Columns (3)–(4), (5)–(6), and (7)–(8).[19]

In Panel B of Table 5 we repeat the analysis using the firm's MB ratio to proxy for the extent of growth opportunities. Since firms with a high MB ratio (above median) are likely to have more growth opportunities, following Prediction 1, we expect asset liquidity to have a less positive effect on stock liquidity for such firms. Consistent with our prediction, the results in Columns (1) and (2) of Panel B show that WAL1 has a more positive relation with stock liquidity for firms with low MB ratio. From ΔCOEFF we find that the coefficients are significantly different from each other across the 2 subsamples. In Columns (3)–(8) we repeat our estimates successively with WAL2, WAL3, and MWAL. All the results, except for those with MWAL, show a significantly more positive effect of asset liquidity on stock liquidity for firms with low MB ratios.

We now proceed to tests of Prediction 2. To recall, Prediction 2 suggests that the improvement in stock liquidity following firm financing should be greater if the firm retains a larger fraction of the issue proceeds as cash. To test the prediction, we focus on SEOs and relate the change in stock liquidity in the post-issue period to the fraction of issue proceeds that the firm retains as cash.

We obtain a sample of SEOs from SDC with issue date during the period 1970–2006 and with nonmissing and positive values for number of primary shares offered, issue proceeds, and issue price. We also confine the sample to SEOs with a minimum size of $10 million. We combine the SEO data with CRSP and Compustat to obtain stock price information during the pre- and post-issue periods and firm financial data. This procedure results in a sample of 5,756 SEOs.

The summary statistics for the key variables for this SEO sample are provided in Panel A of Table 6. The average size of the issue in our sample is $103.31 million, which constitutes about 31% of the book value of total assets as of the end of the previous year. We use daily stock return data to calculate ILLIQ during the pre- and post-issue periods. $\text{ILLIQ}_{-30,0}$ ($\text{ILLIQ}_{-60,0}$) is Amihud's (2002) illiquidity measure estimated during the 30 (60) days prior to the SEO, while $\text{ILLIQ}_{15,45}$ ($\text{ILLIQ}_{15,75}$) represents a similar measure estimated during the 30 (60) days following the SEO. In calculating the illiquidity measures for the post-issue period, we ignore the 15-day period immediately following the SEO to avoid any bias due to abnormal trading immediately following the SEO. Stock liquidity significantly improves after the SEO. This is evident from the fact that $\text{ILLIQ}_{15,45}$ and

[19]Since the normal level of CAPEX may differ across industries, we perform additional tests to ensure that our results are not simply capturing across-industry differences in the relation between asset liquidity and stock liquidity. To do this, we repeat our tests in subsamples of firms with positive and negative ABNORMAL_CAPEX, where ABNORMAL_CAPEX measures the difference between the firm's CAPEX and the median CAPEX of all firms in the same 3-digit SIC code industry during the year. Consistent with our reported results, we find that the relation between asset liquidity and stock liquidity is less positive in the subsample of firms with positive abnormal CAPEX. The results are available from the authors.

TABLE 6

Proceeds Retained in SEOs and Stock Liquidity

Table 6 reports the results of tests relating post-SEO stock liquidity to the fraction of SEO proceeds retained by the firm. Panel A reports summary statistics for the key variables that we use in the tests. Panel B reports the results of the multivariate regressions. The dependent variable is a measure of the change in stock liquidity around the SEO. It is ΔILLIQ$_{30}$ in Column (1) and ΔILLIQ$_{60}$ in Columns (2)–(4), where ΔILLIQ$_{30}$ is ILLIQ$_{-30,0}$ – ILLIQ$_{15,45}$ and ΔILLIQ$_{60}$ is ILLIQ$_{-60,0}$ – ILLIQ$_{15,75}$. In Column (3) the sample is confined to SEOs that happen more than 2 months before the financial year-end. All variables are defined in Appendix B. The regression includes year fixed effects. All variables are winsorized at the 1st and 99th percentiles. The sample includes all SEOs from SDC database floated during the years 1970–2006, with a minimum size of $10 million, by firms with financial data in Compustat. The standard errors are clustered at the individual firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Summary Statistics

Variable	*N*	Mean	Min	Median	Max	Std. Dev.
PROCEEDS ($ million)	5,134	103.310	10.000	62.000	989.300	126.765
PROCEEDS/TA$_{t-1}$	4,935	0.308	0.001	0.155	76.158	1.420
ILLIQ$_{-30,0}$	5,134	0.173	0.012	0.096	1.502	0.235
ILLIQ$_{15,45}$	5,134	0.111	0.012	0.075	0.750	0.116
ILLIQ$_{-60,0}$	5,134	0.159	0.013	0.092	1.337	0.206
ILLIQ$_{15,75}$	5,134	0.118	0.012	0.077	0.824	0.127
MRKT_CAP ($ million)	5,065	1,438	1.567	517.421	85,499	3,428.41
FRACTION_RETAINED	4,898	0.430	−2.628	0.198	5.991	1.017

Panel B. Proceeds Retained in SEOs and Stock Liquidity

	Δ ILLIQ$_{30}$	Δ ILLIQ$_{60}$		
	(1)	(2)	(3)	(4)
FRACTION_RETAINED	−0.002 (0.0007)***	−0.003 (0.0007)***	−0.002 (0.001)	−0.014 (0.002)***
PROCEEDS/TA$_{t-1}$				0.002 (0.001)**
FRACTION_RETAINED × PROCEEDS/TA$_{t-1}$				−0.046 (0.008)***
ILLIQ$_{-30,0}$	−0.688 (0.024)***			
ILLIQ$_{-60,0}$		−0.553 (0.028)***	−0.715 (0.036)***	−0.564 (0.028)***
MB$_{t-1}$	−0.0001 (0.0002)	0.0001 (0.0002)	−0.0002 (0.0003)	0.0005 (0.0002)**
ROA	−0.024 (0.005)***	−0.023 (0.006)***	−0.025 (0.005)***	−0.027 (0.006)***
log(MRKT_CAP)$_{t-1}$	−0.020 (0.002)***	−0.015 (0.002)***	−0.018 (0.003)***	−0.017 (0.002)***
No. of obs.	4,064	4,064	2,819	4,064
R^2	0.809	0.694	0.66	0.698

ILLIQ$_{15,75}$ are smaller than ILLIQ$_{-30,0}$ and ILLIQ$_{-60,0}$, respectively. This result is consistent with the finding in Eckbo et al. (2000). FRACTION_RETAINED is the ratio of the difference in cash balance between the end of the financial year immediately following and immediately before the SEO to the total SEO proceeds. We use this as a measure of the amount of the SEO proceeds that the firm retains as cash by the end of the year. We find that firms on average retain 43% of the SEO proceeds as cash by the end of the year of the SEO.

We use a model similar to equation (8) to estimate how the change in stock liquidity in the post-SEO period is related to the fraction of the SEO proceeds that the firm retains as cash. Since our analysis here is cross-sectional, we do not employ firm fixed effects. Our main dependent variable for this analysis is either ΔILLIQ$_{30}$ or ΔILLIQ$_{60}$, where ΔILLIQ$_{30}$ is ILLIQ$_{15,45}$ − ILLIQ$_{-45,0}$ and ΔILLIQ$_{60}$ is ILLIQ$_{15,75}$ − ILLIQ$_{-60,0}$. The main independent variable is

FRACTION_RETAINED. Note that in relating the change in stock liquidity in the immediate post-issue period to the fraction of cash retained (which is only known in the future), we implicitly assume that the market rationally anticipates the amount of cash the firm is going to retain and reacts accordingly. We control for the stock liquidity in the pre-issue period, MB, log(MRKT_CAP), and ROA.

In Column (1) of Panel B in Table 6 we have $\Delta ILLIQ_{30}$ as the dependent variable and find that the coefficient on FRACTION_RETAINED is negative and significant. This is consistent with Prediction 2. In Column (2) we repeat our estimation with $\Delta ILLIQ_{60}$ as our dependent variable and obtain similar results. In Column (3) we repeat our estimation after dropping the SEOs that happen within a period of 2 months before the year-end. We do this to avoid any overlap between the time period we use to calculate the post-issue illiquidity measures and the date we use to calculate the cash balance. This test is consistent with the notion that the change in stock liquidity in the post-issue period is related to the amount of cash that the firm is *expected* to retain by the end of the year.

The results in all the specifications show that the change in stock liquidity in the post-issue period is positively related to the fraction of the issue proceeds that the firm retains as cash. In Column (4) we repeat our estimation after including an interaction term FRACTION_RETAINED $\times$ PROCEEDS/TA_{t-1} to see if the change in stock liquidity in the post-issue period is greater for firms that conduct a larger SEO in comparison to firm size and retain a larger fraction of the issue. The results indicate that this is indeed the case.

C. Financing Constraints and the Relation between Asset Liquidity and Stock Liquidity

In this section we perform tests of Prediction 3, which suggests that the relation between asset liquidity and stock liquidity should be more positive for firms that face external finance constraints. We use 3 proxies to identify constrained firms. Our 1st proxy is firm size. Based on prior literature, we expect smaller firms to face greater constraints in raising external finance as compared to larger firms. In Panel A of Table 7, we classify firms into those with below- and above-median book value of total assets and repeat our estimation of equation (8) in the 2 subsamples. Our results indicate that an increase in asset liquidity has a much greater effect on stock liquidity for firms with below-median size in comparison to firms with above-median size. For example, from Columns (1) and (2) one can see that the effect of asset liquidity on stock liquidity is more positive by a factor of more than 8 for small firms. Similar results hold for the other asset liquidity measures.

In Panel B of Table 7 we use the presence of credit ratings as a measure of financial constraints. Firms with credit ratings are likely to be more transparent and to have more options when it comes to raising external finance. The results in Columns (1) and (2) indicate that, consistent with our prediction, an increase in WAL1 has more than twice the effect on stock liquidity for firms without credit ratings as compared to firms with credit ratings (-0.103 in comparison to -0.221). In Columns (3) and (4) we repeat our estimates using WAL2, and in Columns (5) and (6) we use WAL3 and obtain similar results. Our results with

TABLE 7

Asset Liquidity and Stock Liquidity

Panel A of Table 7 reports the results of the regression relating a firm's asset liquidity to stock liquidity. Specifically, we estimate the panel OLS regression: $Y_{i,t} = \alpha + \beta X_{i,t} + \gamma \text{CONTROLS}_{i,t} + \mu_i + \mu_t + \epsilon_{i,t}$, where $Y_{i,t}$ is a measure of stock liquidity for firm i during year t, $X_{i,t}$ is a measure of asset liquidity, μ_i are firm fixed effects, and μ_t are year dummy variables. Y is ILLIQ. In Panel A we estimate the regression in subsamples with above- and below-median book value of total assets. All variables are defined in Appendix B. To test if the coefficient on the measures of asset liquidity is significantly different across the 2 subsamples, we estimate a single equation with a full set of interaction terms between all independent variables and a dummy variable that identifies firms with above-median book value of total assets and test if the coefficient on the asset liquidity interaction term is significantly different from 0. We present the results of the test in the row titled ΔCOEFF. The sample includes all firms with financial data in Compustat during the years 1962–2005. Panel B reports the results of the regression relating a firm's asset liquidity to stock liquidity with the sample split into firms with and without short-term credit ratings. The dependent variable is ILLIQ. All variables are defined in Appendix B. To test if the coefficient on the measures of asset liquidity is significantly different across the 2 subsamples, we estimate a single equation with a full set of interaction terms between all independent variables and a dummy variable that identifies rated firms and test if the coefficient on the asset liquidity interaction term is significantly different from 0. We present the results of the test in the row titled ΔCOEFF. All variables are winsorized at the 1st and 99th percentiles. The sample includes all firms with financial data in Compustat during the years 1962–2005. Panel C reports the results of the regression relating a firm's asset liquidity to stock liquidity with the sample split into firms with above- and below-median default probability. We measure default probability using the Bharath and Shumway (2008) methodology. The dependent variable is ILLIQ. All variables are defined in Appendix B. To test if the coefficient on the measures of asset liquidity is significantly different across the 2 subsamples, we estimate a single equation with a full set of interaction terms between all independent variables and a dummy variable that identifies firms with above-median default likelihood and test if the coefficient on the asset liquidity interaction term is significantly different from 0. We present the results of the test in the row titled ΔCOEFF. The sample includes all firms with financial data in Compustat during the years 1970–2006. All variables are winsorized at the 1st and 99th percentiles. The standard errors are clustered at the individual firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Small versus Large Firms

	Large	Small	Large	Small	Large	Small	Large	Small
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WAL1	−0.031 (0.009)***	−0.260 (0.022)***						
WAL2			−0.059 (0.010)***	−0.314 (0.020)***				
WAL3					−0.037 (0.007)***	−0.249 (0.015)***		
MWAL							−0.064 (0.014)***	−0.400 (0.026)***
log(MRKT_CAP)$_{t-1}$	−0.071 (0.003)***	−0.338 (0.007)***	−0.072 (0.003)***	−0.342 (0.007)***	−0.072 (0.003)***	−0.344 (0.007)***	−0.077 (0.004)***	−0.401 (0.009)***
No. of obs.	33,818	40,977	33,818	40,977	33,818	40,977	33,818	40,977
R^2	0.784	0.763	0.784	0.764	0.784	0.764	0.784	0.766
ΔCOEFF	0.229 (0.024)***		0.255 (0.022)***		0.212 (0.017)***		0.336 (0.029)***	

Panel B. Rated versus Unrated Firms

	Rated	Unrated	Rated	Unrated	Rated	Unrated	Rated	Unrated
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WAL1	−0.103 (0.027)***	−0.221 (0.020)***						
WAL2			−0.138 (0.022)***	−0.275 (0.018)***				
WAL3					−0.090 (0.015)***	−0.212 (0.013)***		
MWAL							−0.235 (0.027)***	−0.237 (0.022)***
log(MRKT_CAP)$_{t-1}$	−0.085 (0.007)***	−0.260 (0.006)***	−0.087 (0.007)***	−0.264 (0.006)***	−0.087 (0.007)***	−0.264 (0.006)***	−0.105 (0.008)***	−0.291 (0.007)***
No. of obs.	14,629	60,166	14,629	60,166	14,629	60,166	14,629	60,166
R^2	0.809	0.779	0.81	0.78	0.81	0.78	0.813	0.78
ΔCOEFF	0.119 (0.034)***		0.137 (0.028)***		0.121 (0.02)***		0.002 (0.035)	

(continued on next page)

TABLE 7 (continued)

Asset Liquidity and Stock Liquidity

Panel C. High versus Low Default Probability Firms

	Default							
	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WAL1	−0.276 (0.036)***	−0.154 (0.019)***						
WAL2			−0.347 (0.030)***	−0.167 (0.016)***				
WAL3					−0.242 (0.022)***	−0.111 (0.011)***		
MWAL							−0.301 (0.031)***	−0.025 (0.020)
log(MRKT_CAP)$_{t-1}$	−0.282 (0.009)***	−0.118 (0.005)***	−0.286 (0.009)***	−0.121 (0.005)***	−0.286 (0.009)***	−0.122 (0.005)***	−0.316 (0.010)***	−0.119 (0.006)***
No. of obs.	27,601	29,051	27,601	29,051	27,601	29,051	27,601	29,051
R^2	0.795	0.852	0.796	0.852	0.796	0.852	0.796	0.851
ΔCOEFF	−0.122 (0.041)***		−0.180 (0.034)***		−0.131 (0.025)***		−0.277 (0.037)***	

MWAL suggest no significant difference in the relation between asset liquidity and stock liquidity for rated and unrated firms.

Finally, in Panel C of Table 7 we measure the extent of financial distress in a firm and classify firms in financial distress as facing greater constraints in raising external finance. We use the Merton-KMV measure of the expected default likelihood as a proxy for financial distress. We estimate this measure using a methodology similar to that in Bharath and Shumway (2008). We outline the methodology in Appendix C. We distinguish between firms whose expected default probability is above and below the sample median. The results in Columns (1) and (2) of Panel C show that WAL1 has almost twice the effect on stock liquidity for firms with high default probability in comparison to firms with low default probability (−0.276 in comparison to −0.154). We also find that the coefficients are statistically different from each other. In Columns (3)–(8) we repeat our estimates successively using WAL2, WAL3, and MWAL and find that in all cases asset liquidity improves stock liquidity more for firms that are closer to default.

VI. Value of Asset Liquidity

In our final set of tests, we estimate the value implications of the relation between asset liquidity and stock liquidity that we uncover. Our results so far show that an increase in asset liquidity is accompanied by an improvement in stock liquidity. Prior research in market microstructure shows that an increase in stock liquidity may increase firm value either by reducing the cost of capital (Amihud and Mendelson (1986)) or by enabling design of better incentive contracts (Holmström and Tirole (1993)). If the improvements in stock liquidity that result from an increase in asset liquidity lead to higher firm value, then asset liquidity will likely be more valuable for firms with an illiquid stock.

To test this prediction we use the methodology in Faulkender and Wang (2006) and estimate the value of corporate cash holdings for firms with more and less liquid stock. In brief, their methodology involves regressing annual size and book-to-market adjusted abnormal stock returns on changes in cash balance and a set of control variables. The control variables include the initial cash balance, CASH_{t-1}, changes in PROFITS, NONCASH_ASSETS, R&D, INTEREST, DIVIDENDS, and the level of LEVERAGE, and a variable that measures the net financing raised by the firm during the year, NET_FINANCING. We define all the variables in Appendix B.

In Column (1) of Table 8 we repeat the estimation of Faulkender and Wang (2006) for comparison. The coefficient on ΔCASH is an estimate of the value of the marginal dollar of cash. The results in Column (1) show that in our sample, a dollar of cash is worth 77¢ for the average firm. This estimate is very close to the 75¢ estimated by Faulkender and Wang. In Column (2) we repeat the estimates after including firm and year fixed effects, with winsorized variables and after confining the sample to firms for which we have data on ILLIQ for the

TABLE 8

Asset Liquidity, Stock Liquidity, and the Value of Cash

Table 8 reports the results of the regression relating the abnormal stock return on a firm's stock to changes in cash balance. The dependent variable is ABNORMAL, the size and book-to-market adjusted abnormal stock return. All variables are defined in Appendix B. Here, ΔCOEFF represents the difference between the coefficients on ΔCASH across the subsamples with high- and low-stock liquidity. The sample includes all firms with financial data in Compustat during the years 1970–2001. We cut off the sample in 2001 to be comparable to the sample in Faulkender and Wang (2006). All variables are winsorized at the 1st and 99th percentiles. The standard errors are clustered at the individual firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Size and Book-to-Market Adjusted Annual Return					
					Unrated	
	All Firms		Low ILLIQ_{t-1}	High ILLIQ_{t-1}	Low ILLIQ_{t-1}	High ILLIQ_{t-1}
	(1)	(2)	(3)	(4)	(5)	(6)
ΔCASH	0.766 (0.022)***	0.811 (0.033)***	0.595 (0.045)***	0.715 (0.039)***	0.409 (0.089)***	0.860 (0.116)***
CASH_{t-1}	0.270 (0.013)***	0.725 (0.031)***	0.580 (0.038)***	0.644 (0.037)***	0.582 (0.109)***	0.918 (0.121)***
ΔPROFITS	0.543 (0.014)***	0.379 (0.016)***	0.285 (0.021)***	0.408 (0.022)***	0.217 (0.051)***	0.293 (0.058)***
ΔNONCASH_ASSETS	0.226 (0.007)***	0.141 (0.008)***	0.097 (0.012)***	0.157 (0.011)***	0.060 (0.029)**	0.089 (0.033)***
ΔR&D	0.939 (0.144)***	0.194 (0.185)	0.044 (0.237)	0.311 (0.268)	−2.113 (0.695)***	0.297 (1.017)
ΔINTEREST	−1.156 (0.045)***	−0.768 (0.056)***	−0.492 (0.078)***	−0.807 (0.072)***	−0.228 (0.227)	0.023 (0.260)
ΔDIVIDENDS	3.933 (0.258)***	1.711 (0.304)***	1.245 (0.407)***	2.219 (0.429)***	0.467 (0.945)	0.439 (1.108)
LEVERAGE	−0.394 (0.008)***	−1.059 (0.024)***	−0.744 (0.028)***	−1.084 (0.033)***	−0.986 (0.076)***	−1.409 (0.096)***
NET_FINANCING	−0.002 (0.014)	0.073 (0.018)***	0.018 (0.023)	0.039 (0.023)*	0.010 (0.057)	−0.099 (0.062)
Constant	−0.015 (0.003)***	0.235 (0.029)***	0.169 (0.022)***	0.274 (0.026)***	−0.376 (0.032)***	−0.321 (0.027)***
No. of obs.	80,166	45,811	17,324	28,487	3,844	4,635
R^2	0.138	0.359	0.471	0.462	0.519	0.541
ΔCOEFF			0.120 (0.057)**		0.451 (0.159)***	

previous year. We include the last criteria because the sample in the subsequent columns is confined to such firms. The results in Column (2) indicate that $1 of cash is worth 81¢ on average. In Columns (3)–(4) we divide our sample into firms with above- and below-median stock liquidity (as measured by ILLIQ) and repeat the estimation in the 2 subsamples. Faulkender and Wang show that cash is more valuable for smaller firms that may face greater external financial constraints. Since smaller firms are also likely to have illiquid stock, we need to control for firm size in our estimation. We do this by dividing our sample into market capitalization deciles and identifying high- and low-liquidity firms within the deciles. This ensures that the median market capitalization of firms in both the high- and low-liquidity subsamples are the same. Our results in Columns (3)–(4) of Table 8 show that consistent with our conjecture, an additional dollar of cash is more valuable for firms with less liquid stock. The row titled ΔCOEFF indicates that a dollar of cash is worth 12¢ more for firms with below-median stock liquidity.[20] In Columns (5)–(6) we further control for access to external finance by limiting our sample to firms without long-term bond ratings. Our results again show that cash is more valuable for firms with below-median stock liquidity.

VII. Conclusion

In this paper we study the balance sheet of liquidity: the relation between the liquidity of the firm's assets and the liquidity of financial claims on the assets, thereby linking corporate finance decisions to stock liquidity. Our model highlights that the relation may be either positive or negative depending on parameter values. Greater asset liquidity reduces uncertainty regarding valuation of assets-in-place, but it also increases future investments and the associated uncertainty. The model departs from the perfect MM (1958) world by assuming that the source of capital affects investment decisions. As a result, the model shows that asset liquidity improves stock liquidity more for firms that are less likely to reinvest their liquid assets: firms with less growth opportunities, financially constrained firms, and firms with low correlation between assets-in-place and new projects.

Empirically, we find a positive and economically large relation between asset liquidity and stock liquidity. Consistent with our model, the relation is more positive for firms with low growth opportunities and for financially constrained firms. The results hold both in the time series and in the cross section, and are reinforced by an event study.

The relation between asset liquidity and stock liquidity also has value implications. Indeed, the effect of a high cash balance in improving stock liquidity is a hitherto unknown benefit of cash. We find that an increase in corporate cash holding is significantly more valuable for firms with less liquid stock.

Finally, our analysis linking corporate finance to stock liquidity has further implications, the empirical study of which is beyond the scope of this paper. One example is the result that the relation between asset liquidity and stock liquidity is more positive for firms with low correlation between assets-in-place and

[20]In unreported tests we find our estimates robust to estimating a single regression on the full sample with an interaction term, HIGH_ILLIQ $\times$ ΔCASH.

new projects. The 2nd example is commonality in stock liquidity. We show that the relation between asset liquidity and stock liquidity depends strongly on investment opportunities. Such opportunities covary at the industry, economy, and global level. This suggests that stock liquidity may have a common component not only at the market level, but also at the industry and global levels. Another implication is the long-term stock underperformance after firm financing. The improvement in stock liquidity following such financing (as highlighted by our results) is likely to reduce the liquidity risk premium for the stock, which in turn is likely to reflect as underperformance based on the ex ante risk characteristics.

Appendix A. Proofs

Proof of Proposition 1. Recall that λ is a measure of stock illiquidity. Thus, $\partial\lambda/\partial\alpha \leq 0$ means that higher asset liquidity is associated with higher stock liquidity. Differentiating equation (6) with respect to α we have

$$\text{(A-1)} \qquad \frac{\partial\lambda}{\partial\alpha} = \frac{1}{2\sigma_u}\frac{\partial\sigma_0^2}{\partial\alpha}.$$

Since $\sigma_u > 0$, $\partial\lambda/\partial\alpha \leq 0$ is equivalent to $\partial\sigma_0^2/\partial\alpha \leq 0$. Differentiating equation (5) with respect to α we obtain

$$\text{(A-2)} \qquad \frac{\partial\sigma_0^2}{\partial\alpha} = -2(1-\alpha)\sigma_x^2 + 2\alpha k^2 h(\gamma^*)^2\sigma_y^2 + 2(1-2\alpha)kh(\gamma^*)\sigma_x\sigma_y\rho.$$

Thus, $\partial\sigma_0^2/\partial\alpha \leq 0$ if and only if

$$\alpha\left(\sigma_x^2 + k^2 h(\gamma^*)^2\sigma_y^2 - 2kh(\gamma^*)\sigma_x\sigma_y\rho\right) \leq \sigma_x^2 - kh(\gamma^*)\sigma_x\sigma_y\rho,$$

or[21]

$$\alpha \leq \frac{\sigma_x^2 - kh(\gamma^*)\sigma_x\sigma_y\rho}{\sigma_x^2 + k^2h(\gamma^*)^2\sigma_y^2 - 2kh(\gamma^*)\sigma_x\sigma_y\rho} \equiv \hat{\alpha}. \qquad \square$$

Proof of Proposition 2. Differentiating equation (A-2) with respect to k, we obtain

$$\text{(A-3)} \qquad \frac{\partial^2\sigma_0^2}{\partial k\partial\alpha} = 4\alpha kh(\gamma^*)^2\sigma_y^2 + 4\alpha k^2 h(\gamma^*)h'(\gamma^*)\frac{\partial\gamma^*}{\partial k} + 2(1-2\alpha)\sigma_x\sigma_y\rho\left(h(\gamma^*) + kh'(\gamma^*)\frac{d\gamma^*}{dk}\right).$$

Using equation (4), this expression is clearly positive for $\alpha \leq$ ½. Consequently, $\partial^2\lambda/(\partial k\partial\alpha) > 0$. Since λ is a measure of stock illiquidity, this means that the relation between asset liquidity and stock liquidity is weaker (less positive or more negative) for firms with higher values of k (higher growth opportunities). $\square$

Proof of Proposition 3. Since γ^* is higher for an unconstrained firm and since $h(\cdot)$ is increasing in γ, the 2nd term in equation (A-2) is larger for an unconstrained firm as opposed to a constrained firm. Similarly, since $\alpha \leq 0.5$, and $\rho \geq 0$, the 3rd term is also larger for

[21]Note that

$$\sigma_x^2 + k^2h(\gamma^*)^2\sigma_y^2 - 2kh(\gamma^*)\sigma_x\sigma_y\rho > 0,$$

and hence dividing by this term does not reverse the inequality.

an unconstrained firm. Hence, $\partial\sigma_0^2/\partial\alpha$ is smaller for a constrained firm as compared to an unconstrained firm. □

Proof of Proposition 4. Differentiating equation (A-2) with respect to ρ, we obtain

$$\text{(A-4)} \qquad \frac{\partial^2\sigma_0^2}{\partial\rho\partial\alpha} = 2\,(1-2\alpha)\,kh\,(\gamma^*)\,\sigma_x\sigma_y.$$

Thus, $(\partial^2\sigma_0^2)/(\partial\rho\partial\alpha)$ is clearly positive (negative) for $\alpha < 0.5$ ($\alpha > 0.5$). □

Appendix B. Description of Variables

ABNORMAL: Size and book-to-market adjusted abnormal stock return.

BHAR: Buy-and-hold annual abnormal stock return. It is the difference between the annual return on the firm's stock and the return on the value-weighted portfolio of all NYSE, AMEX, and NASDAQ stocks.

CAPEX: Ratio of a firm's capital expenditures (Data128) to lagged total assets (Data6). When Data128 is missing, this variable is set to 0.

CASH: Ratio of book value of cash over lagged market value of equity.

DEF_PROB: Expected default probability estimated using the approach in Bharath and Shumway (2008) (see Appendix C).

ΔCASH: Ratio of change in the book value of cash over lagged market value of equity.

ΔDIVIDENDS: Ratio of change in dividends over lagged market value of equity.

ΔINTEREST: Ratio of change in interest expense over lagged market value of equity.

ΔNONCASH_ASSETS: Ratio of change in net assets, which is the difference between book value of total assets and book value of cash over lagged market value of equity.

ΔPROFITS: Ratio of change in operating profits over lagged market value of equity.

ΔR&D: Ratio of change in R&D expenditure over lagged market value of equity.

DISC_ACC: Measure of a firm's abnormal accruals originally proposed in Jones (1991) and modified to control for performance per Kothari, Leone, and Wasley (2005).

FRACTION_RETAINED: Ratio of the change in cash balance between the year ending after the SEO to the year ending before the SEO deflated by the size of the SEO.

ILLIQ: Square root of average annual Amihud (2002) illiquidity measure. Amihud's measure is the ratio of the absolute daily stock return and the daily dollar volume. Data for this variable were obtained from Hasbrouck's Web site (http://people.stern.nyu.edu/jhasbrou/).

ILLIQ$_{-30,0}$: Average ILLIQ over the 30 trading days prior to the SEO.

ILLIQ$_{-60,0}$: Average ILLIQ over the 60 trading days prior to the SEO.

ILLIQ$_{15,45}$: Average ILLIQ over the period of 15–45 trading days following the SEO.

ILLIQ$_{15,75}$: Average ILLIQ over the period of 15–75 trading days following the SEO.

LEVERAGE: Book value of long- and short-term debt over lagged market value of equity.

log(MRKT_CAP): Natural log of a firm's market value of equity (Data25 $\times$ Data199).

MB: The ratio of market value of equity to book value of equity.

MWAL: Ratio of the sum of cash, 0.75 $\times$ the value of noncash current assets and 0.5 $\times$ the value of other tangible fixed assets, to lagged market value of total assets. We calculate market value of total assets as the sum of book value of total assets and market value of equity less book value of equity.

NET_FINANCING: Ratio of net financing, which is the sum of equity issued and long-term debt issued less shares repurchased and long-term debt repurchased over lagged market value of equity.

PROCEEDS/TA: The ratio of SEO proceeds to lagged book value of total assets.

PS-GAMMA: Annual Pastor and Stambaugh (2003) gamma coefficient obtained from Hasbrouck's Web site (http://people.stern.nyu.edu/jhasbrou/).

s: Gibbs sampler estimate of Roll's (1984) implicit measure of trading costs. Data for this variable were also obtained from Hasbrouck's Web site (http://people.stern.nyu.edu/jhasbrou/).

RATED: A dummy variable that identifies firms with nonmissing S&P long-term credit ratings in Compustat.

ROA: Ratio of earnings before depreciation, interest, and taxes over lagged value of total assets.

SPREAD: Average intraday daily effective percentage bid-ask spread estimated from TAQ. The data on the effective spread were obtained from the Web site of the University of Vanderbilt's Financial Markets Research Center (http://www.vanderbiltfmrc.org/) and are available only for the subperiod 1993–2003.

WAL1: Ratio of the sum of cash and cash equivalents to lagged value of total assets.

WAL2: Ratio of the sum of cash and 0.5 $\times$ the value of noncash current assets, to lagged value of total assets.

WAL3: Ratio of the sum of cash, 0.75 $\times$ the value of noncash current assets and 0.5 $\times$ the value of other tangible fixed assets, to lagged value of total assets.

VOLATILITY: Standard deviation of a firm's stock returns over the 60 months preceding the beginning of a current fiscal year.

Appendix C. Details of the Calculation of the Modified Merton-KMV Default Probability

We calculate the expected default probability using the modified Merton-KMV procedure. This involves viewing the firm's equity as a call option on the underlying assets with a strike price equal to the book value of total debt. We use the Black-Scholes (1973) option pricing formula for European call options to estimate the default probability. The key parameters required to calculate the default probability are listed below. We first propose an initial value of the volatility of the firm's assets, σ_V, and use it along with the book value of total debt F, the market value of total assets V (the sum of the market value of equity and the book value of debt), and the risk-free rate r and apply equation (C-1) to infer the market value of the firm's equity, E. We use the market value of the firm's equity along with the book value of total debt to estimate the market value of the firm's total assets at the end of every day during the previous year. We use these market values to calculate the log return on assets each day and use the return series to generate a new estimate for the volatility of the assets, σ_V, and the expected return on the assets, μ. We iterate on σ_V in this manner until it converges (so the absolute difference in adjacent σ_Vs is less than 10^{-3}). We then calculate the expected default probability, DEF_PROB using equation (C-3).

$$E = VN(d_1) - e^{-rT}FN(d_2), \tag{C-1}$$

where E is the market value of the firm's equity and

$$d_1 = \frac{\ln(V/F) + \left(r + 0.5\sigma_V^2\right)T}{\sigma_V\sqrt{T}}, \tag{C-2}$$

and d_2 is just $d_1 - \sigma_V\sqrt{T}$.

$$\text{DEF\_PROB} = N\left(-\left(\frac{\ln(V/F) + \left(\mu - 0.5\sigma_V^2\right)T}{\sigma_V\sqrt{T}}\right)\right). \tag{C-3}$$

σ_V: Volatility of the firm's assets.

μ: Expected return on the firm's assets.

F: Book value of total debt.

r: Risk-free rate.

V: Market value of total assets.

T: Time to maturity (1 year).

E: Market value of the firm's equity.

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