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Liquidity and capital structure

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Abstract

We examine the relation between equity market liquidity and capital structure. We find that firms with more liquid equity have lower leverage and prefer equity financing when raising capital. For example, after sorting firms into size quintiles and then into liquidity quintiles, the average debt-to-asset ratio of the most liquid quintiles is about 38% while the average for the least liquid quintiles is 55%. Similar results are observed in panel analyses with clustered errors and using instrumental variables. Our results are consistent with equity market liquidity lowering the cost of equity and, therefore, inducing a greater reliance on equity financing.

JEL classification: G12; G32

Keywords: Capital structure; Liquidity; Market microstructure

1. Introduction

Equity investors need to be compensated not only for the risks they bear but for the transaction costs they incur when buying and selling their shares.[1] Furthermore, issuing firms view the issuance costs as a component of the cost of equity financing and recent evidence suggests that less liquid stocks have higher issuance costs.[2] All else equal,

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[1]Stoll and Whaley (1983) suggest that investors adjust returns for expected transaction costs while Amihud and Mendelson (1986) present a formal model. The impact of transaction costs on required returns has also been used to explain the size effect (Stoll and Whaley, 1983), and the relative higher required rate of return on real estate (Fogler, 1984).

[2]Hennessy and Whited (2005) provide a model and Butler et al. (2005) provide empirical evidence.

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therefore, firms with more liquid equity will have a lower cost of equity than firms with less liquid equity. To the extent that capital structure decisions trade-off the net tax benefit of debt against the net cost of equity, more liquid firms should employ relatively more equity financing and therefore be less leveraged. This paper explores the existence and magnitude of this possible link between liquidity and capital structure.

We find that firms with more liquid equity tend to have lower leverage. For example, after sorting firms into size quintiles and then into liquidity quintiles based on proportional effective spreads, the average debt-to-book value of the most liquid quintiles is about 38% while the average for the least liquid quintiles is 55%. The 17% difference between the most liquid and least liquid quintiles is associated with a variation in spreads from about 0.90% to 5.01%. As a basis for comparison, if we sort firms by size and then market-to-book quintiles, the average debt-to-book value of the highest market-to-book quintiles is 36% and the lowest is 49%. The economic magnitude of this book-to-market effect is comparable to that of liquidity. In addition to effective spreads, we examine quoted spreads, volume, price impact, and a transaction price implied spread as liquidity measures. In all our tests, the results are essentially the same across these various measures.

The cross-sectional relation between liquidity and leverage we observe in sorted portfolios is confirmed in multivariate panel regressions adjusted for firm-level clustering, as recommended in Petersen (2009).[3] We also conduct two separate sets of instrumental variables regressions. First, Loughran and Schultz (2005) argue that liquidity is improved when more individuals are aware of a company and they find that firms located in urban areas have greater liquidity. We use location as one instrument for liquidity since the location of a firm's headquarters is not likely to have been determined by current capital structure. Second, Christie and Schulz (1994) and Christie et al. (1994) argue that NASDAQ market makers may have kept spreads (and therefore trading costs) in some stocks artificially high in the period prior to 1997 by avoiding the use of odd-eighths quotes. We use the proportion of odd-eights quotes as another instrument for liquidity.[4] In both these instrumental variables analyses, we find that firms with more liquid equity have lower leverage.[5]

To complement our cross-sectional tests, we examine year-to-year changes in capital structure that arise from capital market transactions. In particular, we examine the choice between debt and equity when firms have used debt market or equity market transactions to increase or reduce capital. This analysis is motivated by Mackie-Mason (1990) and others who argue that it is often more effective to isolate the impact of a factor on capital structure preferences when capital structure decisions are made, since many extraneous factors may drive capital structure levels.[6] We find that liquid firms are more likely to choose equity over debt when raising capital. In particular, a change in effective spreads

[3]To avoid any spurious relation between liquidity and capital structure induced by short-term market fluctuations, we control for past stock price movements, use lagged liquidity, and include analyses of book leverage.

[4]We thank the editor, Eugene Kandel, for suggesting this analysis.

[5]In an earlier version of this paper, we used the industry average number of analysts and industry average proportion of investors who are institutions as instruments. That approach was similar in spirit to Faulkender and Petersen (2006), who supplement firm-level instruments with industry-level instruments. Results in our earlier specification are comparable to our two instrumental variable analyses presented in this version and our panel regression results. We believe that the location variables and proportion of odd-eighths quotes are more likely to be exogenous than the industry-level variables and have, therefore, included them in this version of the paper.

[6]Mackie-Mason (1990) sets forth this approach in his study of the link between tax shields and leverage. Most recently, Hovakimian et al. (2001) employ a comparable analysis when looking at the speed of capital structure changes.

from one standard deviation above the mean to one standard deviation below the mean is associated with a 9% increase in the probability that equity was chosen over debt. Thus, even after controlling for factors that explain debt levels and controlling for factors that affect the choice between debt and equity, we find a significant relation between liquidity and capital structure decisions.

Taken together, our results imply a statistically and economically significant impact of liquidity on capital structure decisions. Our results are, of course, suggested by two separate strands of literature: the effect of transaction costs on the cost of equity and capital structure trade-off theories. However, this implied relation has never been directly tested. Furthermore, liquidity is notably absent in recent empirical studies of capital structure (e.g., Hovakimian et al., 2001; Fama and French, 2002). This may reflect uncertainty regarding the importance of liquidity beyond its effect on the cost of equity or residual uncertainty regarding the impact of trade-off considerations on capital structure (Baker and Wurgler, 2002; Lemmon and Zender, 2002). By documenting the magnitude of this relation, we draw attention to its absence as one of the "usual suspects" in capital structure studies.

Our results are related to a number of papers exploring the relation between capital structure decisions and security trading characteristics. Bharath et al. (2008) document a link between asymmetric information and capital structure using an index that captures the market's perception of adverse selection risk. Prior research has linked adverse selection to liquidity. Similarly, Loughran and Schultz (2008) find that urban firms are more likely to issue equity and have less debt in their capital structure and attribute this to a reduced level of information asymmetry since urban areas contain a large number of potential equity investors familiar with the firm. In contrast to these two papers, we consider liquidity broadly without a focus on its adverse selection component. Giannetti (2003) notes that leverage is higher in those countries where the stock market is less developed and attributes these differences to agency costs. Faulkender and Petersen (2006) note that firms with access to public debt (which would be relatively more liquid than non-public debt) tend to have higher leverage. However, none of these papers directly tests whether liquidity drives the results. Our paper complements Hovakimian et al. (2001) and Leary and Roberts (2005), who both focus on the speed of adjustment to a target capital structure. Leary and Roberts (2005), in particular, focus on the effects of adjustment costs, of which transaction costs would be a part. While we do not focus on adjustment issues, we do introduce liquidity in an analysis of capital structure changes in order to provide additional evidence that liquidity affects the relative desirability of equity or debt at the margin. Frieder and Martell (2006) extend our analysis to explore more directly the possibility of reverse-causality and reach similar conclusions.

Section 2 provides a more complete discussion of the effect of liquidity on capital structure decisions. Section 3 describes the data and methodology employed in our analysis. Sections 4 and 5 present and discuss the results, while Section 6 summarizes and concludes the paper.

2. Capital structure and liquidity

It is clear that liquidity is a major concern for those who trade shares and those who create, manage or regulate trading infrastructure. A growing body of research suggests that liquidity has a much broader relevance. Stoll and Whaley (1983) first note that stock transaction costs need to be taken into account when valuing equity investments and argue that this may explain the higher required rate of return on small stocks, which are relatively illiquid. Amihud and Mendelson (1986) provide a formal model where transaction costs, like a tax, increase required rates of return for equity investments. They note that this effect can explain a substantial faction of firm valuations. Looking just at issuance costs, Butler et al. (2005) find that investment banking fees are lower for more liquid firms. These issuance costs must be acknowledged when raising equity through external financing and are an implicit cost of external equity. A number of other studies provide evidence consistent with a significant effect of liquidity on expected returns.[7]

Taken together, this body of research suggests a link between liquidity and the cost of equity. To motivate a link between liquidity and capital structure, therefore, requires a link between the cost of equity and capital structure. This is most clearly articulated in the many papers that develop trade-off theories of capital structure—those based on the initial work by Modigliani and Miller (1958, 1963).[8] These theories essentially argue that an optimal capital structure is determined by trading the net cost of equity against the net cost of debt—where the net cost of debt is principally determined by the debt tax shield.[9] Variables that would reduce the net cost of equity, such as increased liquidity, would therefore induce a greater reliance on equity financing.

In many ways our motivation parallels Green and Hollifield (2003). They note that the ability to defer capital gains provides an advantage to equity that lowers the cost of equity. They proceed to demonstrate that this approach can provide a balance between the cost of debt and the cost of equity that yields reasonable capital structure predictions. In effect, rather than arguing that the tax advantage of debt is lower than originally believed, they argue that the advantages of equity are actually higher. We simply note that enhanced liquidity, as noted in Amihud and Mendelson (1986), also lowers the cost of equity. In our tests, we explore whether greater equity liquidity, which reduces the relative advantage of debt financing, leads to relatively lower usage of debt.

Of course, the trade-off theory we outline above is not a complete description of all relevant issues and there is reason to question whether a liquidity effect exits or, if it does, whether it is of appreciable magnitude. For example, as equity market liquidity increases, the liquidity of debt may also be increased. This would attenuate any relative preference for equity. Similarly, as spreads increase, equity investors may trade less and this would attenuate the effect of the transaction cost on the cost of equity these traders experience in

[7]Acharya and Pedersen (2005) provide a model of liquidity and returns while Easley and O'Hara (2004) provide a model where information asymmetries, which are related to liquidity, influence returns. Related empirical studies include Reinganum (1990), Brennan and Subrahmanyam (1996), Brennan et al. (1998), Amihud et al. (1997), Amihud (2002), Easley et al. (2002) and, most directly, Pástor and Stambaugh (2003).

[8]For recent examples, see Graham et al. (1998), Hovakimian et al. (2001), Fama and French (2002, 2004), and Hovakimian et al. (2004).

[9]One concern regarding models that trade tax effects against other frictions is that the tax effects are so large that they would dominate any other effects. A similar argument could apply to the liquidity effects we seek to measure—that any liquidity effect on the cost of equity would be swamped by the tax benefits of debt. What motivated this concern was that predicted levels of debt were lower than what models would have suggested. Subsequent studies demonstrated that the tax advantages may not be as high as originally assumed. For example, when one considers personal taxes (Miller, 1977; Graham, 2000, 2003), tax shields (DeAngelo and Masulis, 1980), or the ability of a firm to make repurchases rather than pay dividends (Lewellen and Lewellen, 2006), the tax effects are attenuated and optimal capital structures are predicted with debt levels close to what is empirically observed.

equilibrium.[10] In fact, it is hard to imagine any theoretical model so fully articulated that there remains no room for doubt (one way or another) regarding the hypothesized relation. Thus, it is all the more imperative that we conduct an empirical study of the relation between liquidity and capital structure—one that provides insight into the economic, as well as statistical, importance of the relation.

Furthermore, even the existence of an optimal or target capital structure has been questioned. The principal alternative is that capital structure represents the simple accumulation of individual capital raising choices. The most common theoretical framework for these is the pecking order theory of Myers and Majluf (1984). This theory suggests that due to adverse selection, firms will prefer internal equity financing over debt, and debt over external equity. We note that for our purposes, one can also motivate the relation between liquidity measures and capital structure using pecking order arguments. Specifically, the adverse selection conditions that drive pecking order preferences may be reflected in trading costs to the extent that asymmetry between market participants is correlated with asymmetry between managers and the market. Under this interpretation, higher liquidity would imply lower adverse selection and possibly more equity. A prediction that is observationally equivalent to the trade off theories we have discussed. We do note, however, that a number of studies suggest that pecking order theories, whose clearly demarcated preferences leave no room for concerns other than information asymmetry, are not sufficient to explain all capital structure choices (Fama and French, 2005; Leary and Roberts, 2008).

A liquid security is essentially one that can be bought and sold easily. Empirical studies of liquidity tend to focus on transactions costs. These typically acknowledge the spread (difference between the ask and bid quotes) and often acknowledge price impact as well (that a desire to trade may move prices in a manner that increases the cost of execution). Trading volume (turnover) is often the measure of liquidity examined in theoretical analyses of markets. Volume is also used as an empirical measure of liquidity and is, as one would expect, negatively correlated with trading costs. We do not focus on any particular measure and present results for a number of different measures—those based on spreads, price impact, and volume. Our conclusions are essentially identical across our liquidity measures.

We should note that our objective is not to test the validity of a particular set of theories or to distinguish the empirical importance of one theory relative to another. Rather, we note that there exists ample evidence to suggest a plausible relationship between liquidity and capital structure, and our goal is to evaluate the existence and economic magnitude of this relation.

3. Data and methodology

We measure stock market liquidity in five ways. We use the Gibbs sampler estimate of the Roll (1984) trading cost measure proposed in Hasbrouck (2009), which is calculated using stock returns; the illiquidity measure proposed in Amihud (2002), which is calculated using stock returns and trading volume; share turnover, which is calculated from trading volume and shares outstanding; and both the quoted and effective spreads, which are calculated from trade and quote data. The quoted and effective spreads are the direct

[10] See Constantinides (1986) and Vayanos (1998) for theoretical models.

measures of trading costs, while the first three measures are indirect measures. Direct spread measures are based on high frequency data, which are available for a relatively short time series. The indirect measures are available for a significantly longer period and allow us to analyze a more comprehensive sample. Note that all our measures are inverse measures of liquidity (essentially measures of trading costs or illiquidity), with the exception of turnover. These measures are described in greater detail below.

Roll (1984) proposes a method to estimate bid-ask spreads from the time series of daily price changes. Specifically, he notes that positive spreads will induce negative serial correlation in transaction price changes and that spreads can be estimated from that serial correlation. We employ an updated measure developed by Hasbrouck (2009) that addresses certain econometric problems with the Roll measure.[11]

The liquidity measure in Amihud (2002) is the daily ratio of the absolute stock return to its dollar volume:

$$Amihud = |ret|Dvol. \tag{1}$$

It can be interpreted as the daily price response associated with one dollar of trading volume, thus serving as a rough measure of price impact. Price impact, in turn, reflects the information content and difficulty of a trade and is a major determinant of spreads. In our analysis, we use the average across each firm-year of this daily measure of liquidity.[12]

Share turnover is simply the monthly volume as a percentage of shares outstanding. We use the firm-year average of this measure. Since volume on NASDAQ is known to be overstated as a result of trades between dealers, we divide volume on NASDAQ-listed firms by two when computing the Amihud (2002) and turnover measures (see Atkins and Dyl, 1997).

When calculating our liquidity measures using high frequency (Trade and Quote, or TAQ) data from 1993 to 2005, we proceed as follows. The effective spread is twice the absolute value of the difference between the transaction price and the mid-quote (the average of the bid and ask quotes) prevailing at the time the transaction was executed, divided by the mid-quote (Eq. (2)). The quoted spread is computed as the difference between the ask and bid quotes relative to the mid-quote (Eq. (3)). Note that in both definitions, we calculate relative spreads–spreads as a proportion of price since dollar-denominated spreads are positively correlated with price. To calculate annual liquidity measures, we first calculate daily liquidity measures by averaging quoted and effective spreads across all trades. We then average the daily measures across each firm-year.

$$\text{Effective spread} = 2 \times \frac{|\text{Price} - (\text{Ask} + \text{Bid})/2|}{(\text{Ask} + \text{Bid})/2}. \tag{2}$$

$$\text{Quoted spread} = \frac{\text{Ask} - \text{Bid}}{(\text{Ask} + \text{Bid})/2}. \tag{3}$$

The bid and the ask quotes are the best bid and offers (BBO) of the firm's home market. To minimize data errors, we apply filters similar to those used in Huang and Stoll (1996). We

[11]The Roll (1984) measure will generate estimates of spreads that are negative when stock price changes are, on average, positively correlated. We are grateful to Joel Hasbrouck for providing this data.

[12]We define year as the firm's fiscal year period, so liquidity measures coincide with the accounting data measurement period. Thus, when using lagged measures, there is no period overlap.

exclude the following observations (t subscripts indicate the sequence of trades or quotes):

- Trades or quotes that occurred before 9:30AM or after 4PM.
- Quotes with zero sizes on either the bid or ask sides (this rule is not applied to NASDAQ quotes before April 7, 1993 because these quote sizes are invalid and have been zero-filled).
- Trades and quotes with non-positive prices, quotes or spreads.
- Trades and quotes when $(p_t - p_{t-1})/p_{t-1} > 0.25$, or $(a_t - a_{t-1})/a_{t-1} > 0.25$, or $(b_t - b_{t-1})/b_{t-1} > 0.25$.
- Trades and quotes with quoted or effective spreads larger than \$10 when prices are larger than \$100; spreads larger than \$5 when prices are between \$5 and \$100; spreads larger than \$1 when prices are lower than \$5.

Hasbrouck (2009) compares several indirect measures of liquidity to TAQ measures of spreads and price impact (a component of trading costs related to adverse selection). He finds that the Gibbs sampler estimate of the Roll (1984) model is the best measure of effective trading costs and the Amihud (2002) measure is the best measure of price impact. Turnover has been previously found to be strongly related to measures of trading costs (see Benston and Hagerman, 1974; Stoll, 1978). Given the differences across these three indirect measures of trading costs, we minimize concerns related to mis-measurement. Results that hold across most measures are less likely to be driven by spurious relations.

Our initial sample consists of all firms with data available on both CRSP and Compustat for any year between 1985 and 2006 (inclusive). We start in 1985 because this is the year Compustat starts coverage for the debt rating variable. Results are, however, identical if instead we start in 1965, and omit the debt rating variable. We also require that firms have data available on TAQ for regressions on spreads. We further restrict the sample to exclude financial and utility firms (SIC codes between 4900–4999 and 6000–6999). We require that asset size and sales volume be greater than \$1 million, average price throughout the year be greater than \$5, and the firm traded in at least 50 days during the year.

We require research spending levels, net operating loss carry-forwards, and debt due in three years to be greater than or equal to 0. We require leverage to be between 0% and 100%. The remaining observations are filtered for outliers by excluding observations that are less than 0.5% from the distribution tails (see Hovakimian et al., 2001).

We construct regressions where the regressors (including liquidity measures) are lagged one year in relation to the dependent variables. We take into consideration the different fiscal year ends in calculating the lags for variables using stock market data. As a result, we delete firms that are reported by Compustat as ending their fiscal years in month zero (month unavailable).

Due to the availability of trading cost data and the lagging of explanatory variables as described above, effective and quoted spreads analyses start in 1994 (spread data are available starting in 1993 and are lagged one year). For other liquidity variables, we start our analysis in 1986 (which requires trading cost estimates as early as 1984 due to occasional two-year lags).[13] We refer to the samples by the time period for which the

[13]For example, the Gibbs sampler estimate of the Roll (1984) model is available for calendar years only, and to ensure that there is no overlap with our dependent variables, for firms ending their fiscal years in months other than December, we lag Gibbs for two calendar years. So, if the firm's fiscal year ends in January 2000, we use the Gibbs estimate for the calendar year of 1998.

dependent variables are measured. Thus, we refer to the 1994–2006 and 1986–2006 samples. There are 30,668 firm-year observations in the 1994–2006 sample and 46,685 firm-year observations for the 1986–2006 sample.

We define accounting measures in accordance with Baker and Wurgler (2002) and Fama and French (2002). Specifically, we define book debt as total assets (Item 6) minus the book value of equity. Book equity is computed as total assets less total liabilities (Item 181) and preferred stock (Item 10) plus deferred taxes (Item 35) and convertible debt (Item 79). When preferred stock is missing, it is replaced with the redemption value (Item 56), and when this is missing, it is replaced with carrying value (Item 130). Book leverage is then computed as book debt to total assets. Market leverage is book debt divided by the market value of assets, where the market value of the assets is total assets minus book equity plus market equity. Market equity is the common shares outstanding (Item 25) multiplied by price (Item 199).

Market-to-book is market value of assets divided by the book value of assets. Earnings before interest are earnings before extraordinary items (Item 18) plus interest expense (Item 15), and earnings before interest and taxes are earnings before interest plus tax expense (Item 16). We also extract from Compustat depreciation (Item 15) and R&D (Item 46). If R&D is missing, we assume it is equal to zero. Finally, we compute an indicator variable for the firm having rated debt, which takes the value of one if the firm has a bond rating (Item 280) or a commercial paper rating (Item 283). If the firm has either (or both), we code the firm as having a public debt rating.

Table 1 presents summary statistics. The left side contains summary statistics for the 1986–2006 sample, while the right side for the 1994–2006 sample. Mean market value of assets are comparable for the 1986–2006 and the 1994–2006 samples; they are \$2,267 million and \$2,463 million, respectively; corresponding standard deviations are \$8,615 million and \$8,709 million. The turnover ratios for each of the sub-samples are 7.64% and 8.84%, respectively, reflecting an upward trend in volume. As for the other two indirect measures of trading costs, it is interesting to note that the Gibbs and Amihud measures differ in their characterizations of liquidity changes across the two samples; the Gibbs estimate is identical across the two samples while the Amihud measure is lower in the more recent sample.

We use the ratios of book debt to book value of assets and book debt to market value of assets as our dependent variables—our measures of leverage. These measures are similar in magnitude to other studies. Specifically, book and market leverage are about 45% and 35%, and are identical across sub-samples.

Table 2 presents the correlations among our variables. The simple correlation between our liquidity measures and leverage based on market values is what we would expect if liquid equity leads to an equity preference (a negative relation between liquidity and leverage); turnover is negatively correlated with leverage and the other measures (which are essentially trading costs) are positively correlated. The results for book leverage are far smaller in magnitude and of the wrong sign in three cases. Of course, these correlations do not control for other relations. For example, since the log of total assets (firm size) is positively related to leverage and positively related to liquidity, firm size may drive a positive observed correlation between liquidity and leverage, contrary to our expectations. Controlling for other explanatory variables, especially firm size, is therefore critical.

Table 1
Summary statistics.

Summary statistics for the 1986–2006 sample on the left, and 1994–2006 on the right. The samples include all firm-years with available data. We exclude firms in the financial and utility sectors, firms with asset size or sales volume less than $1 million, firms that have traded in less than 50 days during the fiscal year and firms with an average price less than $5. We further exclude firms with variable outliers to minimize their effect on the analysis. Accounting data is from Compustat. Volume, price, and shares outstanding are from CRSP. Spreads and odd-eighths are from TAQ. Gibbs is supplied by Hasbrouck, and is the Gibbs sampler estimate of the Roll's measure of spreads. Volume and turnover are measured over a month and averaged across the fiscal year. Quoted and effective spreads are computed as a percentage of prevailing prices, are measured daily, and averaged across the fiscal year. Illiquidity is a measure of price impact developed by Amihud, and is computed daily, and averaged across the fiscal year. Research indicator is a dummy variable that takes the value of 1 when the firm reports 0 or no R&D expenses.

		1986–2006 (46,685 obs.)			1994–2006 (30,668 obs.)		
		Mean	Median	Std	Mean	Median	Std
Financial characteristics							
A_{t-1}	Total book assets (millions)	1,484	222	6,851	1,516	267	6,662
V_{t-1}	Total value assets (millions)	2,267	348	8,615	2,463	443	8,709
EV_{t-1}	Equity value (millions)	1,389	220	4,621	1,558	291	4,734
EB_{t-1}	Equity at book (millions)	606	116	2,167	611	140	1,793
D_{t-1}	Debt at book (millions)	877	86	5,314	905	99	5,472
DR_{t-1}	Rated debt indicator	0.28	0.00	0.45	0.28	0.00	0.45
VOL_{t-1}	Share volume (thousands)	24,605	5,549	80,633	32,701	8,512	97,296
PRC_{t-1}	Price of stock (dollars)	37	16	996	23	16	166
Leverage							
D_t/A_t	Book leverage (%)	45.14	44.98	21.28	44.66	44.32	21.74
D_t/V_t	Market leverage (%)	35.03	31.76	22.89	33.30	29.24	22.82
Operating characteristics							
V_{t-1}/A_{t-1}	Market-to-book	1.89	1.41	1.48	2.03	1.51	1.62
ET_{t-1}/A_{t-1}	Operating return (%)	6.73	9.05	15.51	5.36	8.41	17.08
DP_{t-1}/A_{t-1}	Depreciation (%)	4.64	4.07	3.05	4.62	4.04	3.11
RDD_{t-1}	Research indicator	0.52	1.00	0.50	0.52	1.00	0.50
RD_{t-1}/A_{t-1}	Research level (%)	3.73	0.00	7.48	4.19	0.00	8.32
Liquidity							
G_{t-1}	Gibbs estimate (%)	0.89	0.59	0.84	0.85	0.57	0.80
I_{t-1}	Amihud estimate	1.53	0.09	5.00	1.21	0.05	4.39
T_{t-1}	Turnover (%)	7.64	5.55	7.18	8.84	6.58	7.94
ES_{t-1}	Effective spread (%)	n/a	n/a	n/a	1.41	0.96	1.45
QS_{t-1}	Quoted spread (%)	n/a	n/a	n/a	1.99	1.30	2.12
	Odd eighths	n/a	n/a	n/a	0.58	0.57	0.27

4. Leverage and liquidity

In this section, we study the relation between liquidity and the chosen levels of leverage. As discussed earlier, we expect more liquid firms (those with lower trading costs) to have a lower cost of equity. Hence, we expect liquid firms to employ a greater degree of equity financing and, therefore, to have a lower target leverage.

Table 2
Correlation coefficients.

This table presents correlation coefficients for dependent variables, liquidity measures, and other explanatory variables. Note the timing of measurement of variables—these follow their use in our regressions. For example, we lag liquidity measures and other explanatory variables. All correlations are significant at the 1% level, with the exception of the correlation between depreciation as a fraction of assets (DP_{t-1}/A_{t-1}) and research and development as a fraction of assets (RD_{t-1}/A_{t-1}), which is insignificant.

	D_t/A_t	D_t/V_t	T_{t-1}	I_{t-1}	G_{t-1}	QS_{t-1}	ES_{t-1}	DR_{t-1}	V_{t-1}/A_{t-1}	ET_{t-1}/A_{t-1}	DP_{t-1}/A_{t-1}	RDD_{t-1}	RD_{t-1}/A_{t-1}
D_t/V_t	0.787												
T_{t-1}	−0.114	−0.147											
I_{t-1}	0.024	0.098	−0.218										
G_{t-1}	−0.028	0.064	−0.232	0.705									
QS_{t-1}	−0.008	0.098	−0.341	0.705	0.886								
ES_{t-1}	−0.012	0.099	−0.330	0.709	0.890	0.982							
DR_{t-1}	0.355	0.274	0.135	−0.156	−0.297	−0.357	−0.367						
V_{t-1}/A_{t-1}	−0.273	−0.479	0.185	−0.091	−0.037	−0.081	−0.074	−0.161					
ET_{t-1}/A_{t-1}	−0.027	−0.025	−0.080	−0.025	−0.122	−0.115	−0.141	0.088	−0.091				
DP_{t-1}/A_{t-1}	0.071	0.031	−0.031	0.033	0.041	0.032	0.033	0.028	−0.066	−0.122			
RDD_{t-1}	0.216	0.292	−0.119	0.039	0.012	0.040	0.034	0.086	−0.226	0.171	0.067		
RD_{t-1}/A_{t-1}	−0.252	−0.336	0.145	−0.034	0.063	0.043	0.055	−0.189	0.361	−0.497	−0.003	−0.525	
$Log(A_{t-1})$	0.328	0.255	0.191	−0.305	−0.526	−0.618	−0.636	0.680	−0.212	0.202	0.015	0.098	−0.262

4.1. Univariate results

Table 3 provides a univariate analysis of leverage and liquidity after controlling for size (book value quintile). Leverage decisions are complex and determined by numerous additional variables. However, the univariate comparisons provide a sense of the economic significance of the relations we will study. Table 3 presents results for one of the liquidity measures from the 1986–2006 sample, the Gibbs estimate, and one from the 1994–2006 sample, the effective spread. We present results for book leverage. Results for the other liquidity measures are very similar and, if anything, the results are more pronounced when using market leverage.[14]

In Table 3 we group sample firms by quintile according to the book value of assets, and within each size quintile, we divide firms into liquidity quintiles. Liquidity quintile 1 contains the lowest Gibbs estimates of trading costs and spreads, and hence the most liquid firms. Firm size in quintile 1 contains the smallest firms. Sorting is done yearly and the table presents the average book value leverage for the categories in the year following the sort. We calculate the difference between quintile 5 and quintile 1 for liquidity ranks, and asterisks denote statistical significance at the conventional levels based on *t*-tests.

Previous research shows a positive relation between size and leverage. This is because size proxies for a number of factors that are positively related to leverage, such as reduced volatility of earnings and cash flows, and firm age. For example, less volatile and more mature firms are less likely to go bankrupt and are expected to have higher levels of leverage. Results in Table 3 are consistent with these prior studies. We find a positive and mostly monotonic relation between size and leverage for each of the liquidity quintiles.

[14] We chose to present the book leverage results, though slightly weaker than market leverage results, since the simple correlations were contrary to our expectations for book leverage in some cases. Controlling for size alone, as we do in these two-way sorts, uncovers the expected relation.

Table 3
Leverage by size and liquidity.

Book leverage (D_t/A_t) and liquidity (measured by both Gibbs sample estimates of Roll's measure of spreads and effective spreads) partitioned by asset size quintiles, and within each size quintile partitioned by liquidity. Quintile 1 contains the lowest values. Thus, for liquidity, quintile 1 contains the lowest levels of Gibbs estimates and spreads, and hence the most liquid firms. For firm size, quintile 1 has the smallest firms. The sorts are done yearly and the table presents the average leverage at book value for the categories in the year following the sort. Liquidity levels are for the year of the sort. We document the differences between quintiles 5 and 1 for the liquidity ranks. Asterisks denote statistical significance at the conventional levels based on *t*-tests. Gibbs results are for 1986–2006 and the effective spread results are for 1994–2006. * Significant at the 10% level, ** significant at the 5% level and *** significant at the 1% level.

	A_{t-1} Rank					Column mean
	1 (smallest)	2	3	4	5 (largest)	
Leverage						
Gibbs rank (1986–2006)						
1 (smallest)	33.25	37.18	40.79	48.33	56.88	43.29
2	34.67	37.04	39.97	48.15	56.11	43.19
3	35.01	38.58	42.30	47.89	56.26	44.01
4	37.03	39.75	44.31	49.46	56.00	45.31
5 (largest)	41.90	45.31	50.62	54.36	57.34	49.91
Difference	8.65***	8.13***	9.83***	6.03***	0.46***	6.62***
Effective spread rank (1994–2006)						
1 (smallest)	34.06	29.39	30.78	39.42	55.25	38.01
2	38.69	33.35	34.31	41.65	51.87	40.12
3	41.20	36.92	39.39	44.37	53.09	43.13
4	43.46	42.43	44.89	51.23	55.83	47.70
5 (largest)	46.27	52.63	54.19	60.25	61.58	55.12
Difference	12.21***	23.24***	23.41***	20.83***	6.33***	17.11***
Liquidity						
Gibbs rank (1986–2006)						
1 (smallest)	0.55	0.39	0.28	0.21	0.17	0.32
2	0.97	0.67	0.47	0.33	0.24	0.54
3	1.36	0.96	0.68	0.46	0.32	0.76
4	1.85	1.33	0.97	0.65	0.42	1.04
5 (largest)	3.07	2.28	1.73	1.15	0.72	1.79
Difference	2.52***	1.89***	1.45***	0.94***	0.55***	1.47***
Effective spread rank (1994–2006)						
1 (smallest)	2.05	1.17	0.73	0.4	0.16	0.9
2	3.33	1.83	1.12	0.62	0.27	1.43
3	4.55	2.49	1.53	0.87	0.38	1.97
4	6.16	3.5	2.2	1.27	0.58	2.74
5 (largest)	9.74	6.44	4.47	2.89	1.51	5.01
Difference	7.69***	5.27***	3.74***	2.49***	1.35***	4.11***

More importantly, Table 3 shows an inverse and mostly monotonic relation between liquidity and leverage within each firm size quintile. For the Gibbs estimate (1986–2006 sample period), differences in leverage between the least liquid and most liquid stocks varies from about 0.5% to almost 10%, and is always significant. Results for the effective spread measure (1994–2006 sample) are even more striking: the difference in mean leverage between extreme liquidity quintiles varies from 6% to 23% across size quintiles, a difference that is both statistically and economically significant in every case. For example, for small firms, the most liquid quintile of firms averages about 34% debt, while the least liquid quintile of firms averages about 46% debt. In terms of liquidity, the variation across quintiles corresponds to a difference of about 8% in effective spreads. Put another way, for small firms, a decrease in the effective spread of 8% translates into a 12% decrease in debt to book value.

Table 3 also shows that the difference across leverage levels is generally greater for smaller firms. However, the difference in liquidity levels is also greater for smaller firms. For the largest firms, the difference in debt levels is 6%, but the difference in effective spreads is only 1%. In tests we have conducted, but do not report (such as performing our analysis separately on small and large firms), we find that the link between liquidity and leverage is not restricted to a certain firm size, nor does the magnitude of the effect appear to be related to firm size. What we see in Table 3 is simply that there is more variation in liquidity across small firms and, therefore, more variation in debt levels.

4.2. Panel regressions

The univariate results suggest a link between liquidity and leverage, but they control only for firm size and no other documented relations. Table 4 presents the multivariate analyses. We use a panel regression analysis similar to Hovakimian et al. (2001, 2004). We control for industry (defined at the 4-digit SIC level) and year fixed effects, and calculate standard errors that acknowledge clustering to account for correlation within firms, as recommended in Petersen (2009). The main regression results are presented for the raw explanatory variables. To provide some additional economic meaning to the magnitude of the effects and, more importantly, to provide a means to compare effects across variables, we report the coefficients (without *p*-values) for select variables from identical regressions, where the selected independent variables are standardized to have a zero mean and a standard deviation of 1.

We use both book and market leverage as dependent variables. In addition to the liquidity variables described previously, we include a number of control variables. Whether a firm has a debt rating is our proxy for the firm having debt market accessibility—firms having rated debt, therefore, are expected to have more leverage (Faulkender and Petersen, 2006). Share price is known to be a determinant of liquidity. As price levels are likely to also reflect other factors, we include logged price to minimize the effects of liquidity on leverage that are due to other factors.

The control variables discussed next were those used in Fama and French (2002) in their leverage level regressions. Market-to-book ratio proxies for investment opportunities and whether market prices are relatively high. High investment firms are not as affected by free cash flow problems (Jensen, 1986) and are less dependent on the disciplinary role of debt. Thus, high market-to-book firms are expected to have lower leverage. On the other hand, firms typically finance investments in excess of net income using debt. Thus, given profitability, leverage is expected to be higher for firms with more investments. Finally, firms are likely to issue equity when equity is overvalued (Myers and Majluf, 1984). To the

Table 4
Panel regressions for capital structure.

Panel data regressions of book and market leverage. Regressions are run for various measures of liquidity. Each liquidity measure is indicated at the top of the column and its corresponding coefficient appears on the line marked *LIQ*. *A*, *V,* and *D* are book value of assets, market value of assets, and total debt, respectively. *DR* is an indicator for the firm having its debt rated. *PRC* is average trading price during the fiscal year. *ET*, *DP*, and *RD* are earnings before interest and taxes, depreciation expense, and R&D expense, respectively. *RDD* is an indicator that takes the value of 1 when the firm reports 0 or no R&D expenses. The index *t* denotes the year in which these variables are measured. Effective and quoted spreads results are for 1994–2006, the other liquidity measures results are for 1986–2006. The last three rows contain coefficients from normalized independent variables to have mean 0 and standard deviation of 1. We control for industry and year effects (not tabulated). Industry is defined at the 4-digit SIC level. Regression standard errors are adjusted for heteroscedasticity and clustering following Petersen (2009). Corresponding *p*-values are in parenthesis. * Significant at the 10% level, ** significant at the 5% level and *** significant at the 1% level.

	1986–2006 (46,685 obs)						1994–2006 (30,668 obs.)			
	Gibbs		Amihud		Turnover		Effective spread		Quoted spread	
	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t
Intercept	39.5411***	47.0468***	41.6811***	49.8027***	43.5755***	52.5476***	25.3493***	28.1601***	26.3444***	29.1444***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LIQ_{t-1}	1.5433***	2.0271***	0.2262***	0.3033***	−0.0561**	0.0159	1.7716***	2.3267***	1.1344***	1.5372***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.011)	(0.434)	(0.000)	(0.000)	(0.000)	(0.000)
DR_{t-1}	5.5943***	3.5124***	5.5902***	3.5038***	5.7741***	3.6437***	7.7849***	4.5209***	7.8410***	4.5841***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
V_{t-1}/A_{t-1}	−0.4943***	−3.6428***	−0.4881***	−3.6328***	−0.5210***	−3.7290***	−0.3461***	−3.0479***	−0.3534***	−3.0505***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.002)	(0.000)
$Ln(PRC_{t-1})$	−7.4410***	−9.2942***	−7.6724***	−9.5922***	−7.8061***	−9.9094***	−6.4204***	−8.3580***	−6.5099***	−8.4460***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ET_{t-1}/A_{t-1}	−0.1929***	−0.2393***	−0.1944***	−0.2413***	−0.1952***	−0.2385***	−0.1583***	−0.1813***	−0.1605***	−0.1842***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
DP_{t-1}/A_{t-1}	0.1527**	−0.3435***	0.1486**	−0.3492***	0.1559**	−0.3316***	0.2718***	−0.2879***	0.2709***	−0.2892***
	(0.019)	(0.000)	(0.022)	(0.000)	(0.017)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 4 (*continued*)

	1986–2006 (46,685 obs)						1994–2006 (30,668 obs.)			
	Gibbs		Amihud		Turnover		Effective spread		Quoted spread	
	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t
RDD_{t-1}	2.0669***	2.7478***	2.0675***	2.7500***	2.0085***	2.6809***	1.8281***	3.1925***	1.8335***	3.2002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.006)	(0.000)	(0.005)	(0.000)
RD_{t-1}/A_{t-1}	−0.1363***	−0.3148***	−0.1361***	−0.3144***	−0.1421***	−0.3212***	−0.0588*	−0.2467***	−0.0622*	−0.2507***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.072)	(0.000)	(0.057)	(0.000)
$Ln\ (A_{t-1})$	4.7453***	4.3375***	4.6371***	4.2008***	4.4590***	3.9197***	4.6763***	4.3942***	4.5867***	4.3068***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.368	0.498	0.368	0.498	0.366	0.495	0.402	0.520	0.402	0.520
Normalized coefficients										
LIQ_{t-1}	1.3020***	1.7102***	1.1303***	1.5155***	−0.4026***	0.1143	2.4950***	3.3370***	2.3361***	3.2251***
V_{t-1}/A_{t-1}	−0.7333***	−5.4041***	−0.7241***	−5.3893***	2.5989***	−5.5319***	−0.5708***	−4.9625***	−0.5823***	−4.9663***
ET_{t-1}/A_{t-1}	−2.9928***	−3.7111***	−3.0139***	−3.7408***	−3.0263***	−3.6979***	−2.7087***	−3.1028***	−2.7455***	−3.1513***

extent that overvalued firms have a high market-to-book ratio, it follows that a high market-to-book ratio should result in lower leverage. For these reasons, there is no clear theoretical prediction on the relation between market-to-book ratios and leverage. Empirically, market-to-book ratios have been found to be negatively related to leverage.

Pre-interest and pre-tax earnings divided by assets measures profitability. Profitable firms are more vulnerable to free cash flow problems, and may use more debt to force managers to pay out a firm's excess cash. On the other hand, more profitable firms may accumulate equity to avoid having to raise funds through risky securities. Again, there is no clear theoretical prediction. Empirically, profitability is negatively related to leverage.

The ratio of R&D expenditures to assets is one other proxy for the investment opportunities of a firm. R&D, along with depreciation to assets, also proxies for non-debt tax shields. DeAngelo and Masulis (1980) develop a model where optimal leverage depends on a firm's non-debt tax shields, such as R&D expenditures and depreciation. Larger non-debt tax shields imply a larger chance of having no taxable income, a lower expected corporate tax rate, and a lower expected payoff from interest tax shields, and hence lower leverage. R&D and depreciation have been documented to be negatively related to leverage.

We also include an R&D dummy (*RDD*) that takes the value of 1 for firms with zero or no reported R&D. Such firms comprise 50% of the sample. This dummy (in conjunction with the inclusion of R&D level) captures non-linearities in the relation between R&D and leverage. Finally, we control for size using the natural log of assets. Summary statistics for our dependent and explanatory variables are presented in Table 1, along with variable designations (such as A_t for assets in year t).

In Table 4, we see a significant negative relation between leverage and measures of liquidity in the prior year (LIQ_{t-1}). Specifically, the coefficients on trading cost measures (Gibbs, Amihud, and both spreads, which are, of course, inverse measures of liquidity) are positive, and that on turnover is negative. Thus, more liquid firms (lower cost of trading) choose a lower level of leverage. The results are similar for both book and market value measures of leverage, but are larger in magnitude for market value.

The economic magnitude of the liquidity effect is also meaningful. Looking at the normalized coefficients for the Gibbs estimate in the debt to book value regressions, the parameter estimate is 1.30. Given that independent variables are standardized to have a zero mean and a standard deviation of one, this suggests that a change from one standard deviation below the mean to one standard deviation above the mean implies about a 2.6% (2×1.30) change in the debt to book value ratio. For the spread measures, the change is about 5%. It is notable that a similar change in market-to-book yields about a 1.5% change in the debt to book value ratio. For operating return, the change is about 6%. Similar patterns are observed for most of the other regressions with the exception of the regressions using turnover to measure liquidity, where the liquidity effect is much smaller (though still significant).

Coefficient signs on control variables are consistent with prior studies. Firms having rated debt have more leverage. Leverage is negatively related to market-to-book, price, earnings, and R&D expenses. The coefficient on the R&D dummy is positive, suggesting that there is a non-linear relation between leverage and R&D expenses (as documented in

Fama and French, 2002). Depreciation is negatively related to leverage in market leverage regressions, but positively related in book market regressions. Finally, size is positively related to leverage.

The structure of our tests and the choice of explanatory variables closely follow prior research. We considered a number of alternative specifications. First, changes in leverage will affect the risk of equity, which may affect liquidity. If we include the standard deviation of returns to capture the change in risk, the results are unchanged. Second, firms typically issue equity after stock price increases. While the use of market-to-book ratio, price, and the one period lag of liquidity measures should mitigate the effects of short-term fluctuations in equity value on the tests, we also have included the prior year return and the results are unchanged. Third, the results are identical, if not stronger, when we use the log of sales as a measure of firm size. Fourth, if we examine the cross-sectional regression each year, the Gibbs, and Amihud measures are of the expected sign in all of the 19 years from 1986 to 2004; the turnover measure is of the expected sign in 13 of those years. The spread measures are also of the expected sign every year during 1994–2006. Thus, results hold for tests similar to those in many early studies of capital structure (see, for example, Bradley et al., 1984; Titman and Wessels, 1988; Rajan and Zingales, 1995). Of course, these single year cross-sectional regressions do not control for correlation across firms that is induced by industry factors. In the analysis presented, we follow Hovakimian et al. (2004) in using industry and year fixed effects, and standard errors robust to clustering. If we use a standard (firm level) fixed effects model (as opposed to the industry effects in the model presented), the results remain unchanged. Finally, it could be argued that the liquidity of a firm's debt may play an important role. In fact, a positive relationship between debt liquidity and equity liquidity could mitigate the equity liquidity effect on capital structure. If we examine only the portion of our sample that does not have rated debt and therefore firms where debt liquidity would be constant for all the firms (over half our sample), our results are identical, if not stronger.[15]

4.3. *Instrumental variables*

As with many corporate decisions, endogeneity and reverse causality are potential concerns. This is certainly true in our analysis. In fact, Amihud and Mendelson (1986) suggest that a variety of financing decisions could be influenced by anticipated liquidity effects. While we have used lagged liquidity measures in our earlier analyses to avoid the more mechanical and direct linkages that might arise from the effects of stock price changes, in this section we present two instrumental variable analyses that more directly address endogeneity concerns.

Instrumental variables can solve significant econometric problems, but they are not without their own limitations. Finding a variable(s) sufficiently correlated to the characteristic of interest while at the same time uncorrelated with the regression's error term is often a challenge. Inappropriate instruments may lead to biased, inconsistent and/or inefficient coefficients. In the case of liquidity, any of the commonly established firm-level variables that have been shown to be linked to liquidity could easily be challenged as endogenous, which would not solve the potential inconsistency of the

[15]Faulkender and Petersen (2006) argue that firms without rated debt will rely primarily on private or bank debt.

coefficients, but add to their inefficiency. However, in a recent paper, Loughran and Schultz (2005) argue that the location of a firm's headquarters will affect liquidity since liquidity is a function of the number of people who are potential investors in the firm (see Merton, 1987). Specifically, they provide evidence that suggests that firms located in more densely populated areas will be more liquid. We believe that the location of a company's headquarters, on the other hand, is unlikely to be determined by capital structure and may, in fact, have been determined long before capital structure decisions were made. We therefore employ the location measures used by Loughran and Schultz as an instrument.[16]

Loughran and Schultz (2005) develop indicators for each of 10 major metropolitan areas, for small cities/suburban, and rural locations. To employ the full set of potential location effects, we use as instruments all the indicators with the exception of rural locations (which is left out to prevent a perfectly linear combination of explanatory variables). Our first-stage regression (see Table 5) confirms that the location variables significantly influence liquidity. The small city variable is significant and of the expected sign in every regression and over half of the large cities are also significant and of the expected sign in each regression. We use an F-statistic to test for the null hypothesis that the location variables together are unable to explain any variation in liquidity. The F-statistic rejects the null at the 1% significance level in every case.

In the second-stage regressions (see Table 6), we include the predicted values from the first stage as measures of liquidity, and all of the control variables used in the previous analysis. The results for the liquidity variables continue to be statistically significant and of the correct sign. We note that in this specification, the normalized coefficients for the instrumental variables are often greater than those for market-to-book and for earnings. The remaining coefficients are similar in magnitude and significance to those observed previously in Table 4.

We run a second set of instrumental variable regressions with an instrument more directly related to stock transaction costs. However, this instrument is applicable only to NASDAQ stocks for the period from 1993 to 1997, which reduces our sample size significantly. Christie and Schultz (1994) and Christie et al. (1994) provide evidence that NASDAQ market makers avoided odd-eighths quotes. This practice would artificially increase spreads, and thereby market maker revenues, for those stocks where it was most common. In 1997, NASDAQ introduced a set of market reforms aimed at curbing collusion, which reduced trading costs significantly (Weston, 2000).

In a preliminary analysis, we found that leverage was higher for NASDAQ stocks prior to 1997, as might be predicted if the increased spreads imposed an additional cost of equity financing. Our instrumental variables analysis takes a closer look at this relation by using the proportion of odd-eighths quotes (an inverse measure of odd-eighths avoidance) as an instrument for liquidity for NASDAQ-listed stocks before 1997. The sample period for this analysis starts in 1993 because we use quote data from TAQ to compute the proportion of odd-eighths, which is available only starting in 1993. In our first-stage regression, presented in Table 7, we find that liquidity is (as expected) decreasing in the degree of odd-

[16]We are grateful to Tim Loughran and Paul Schultz for providing us with the firm location dataset, which classifies each firm as belonging to one of the 10 largest metropolitan areas, small city/sub-urban area, or rural area, as described in Loughran and Schultz (2005). They use a coarser partitioning of firm location and focus on the difference between cities and rural locations; we use all information, including individual city indicators.

Table 5
First-stage instrumental variables analysis: location.

OLS regressions of various measures of liquidity (indicated at the top of each column) on a set of instruments and exogenous determinants of leverage. Variables named by metropolitan areas are indicators for the firm being headquartered in that metropolitan area. These metropolitan areas correspond to the ten largest metropolitan areas of the US according to the 2000 Census. *Small city/sub-urban* is an indicator variable for the firm being located in a small city or suburban area. These firms are headquartered within 100 miles from the center of any of the 49 US metropolitan areas of 1 million or more people according to the 2000 Census. A, V, and D are book value of assets, market value of assets, and total debt, respectively. DR is an indicator for the firm having its debt rated. PRC is average trading price during the fiscal year. ET, DP, and RD are earnings before interest and taxes, depreciation expense, and R&D expense, respectively. RDD is an indicator that takes the value of 1 when the firm reports 0 or no R&D expenses. The index t denotes the year in which these variables are measured. Effective and quoted spreads results are for 1994–2006, the other liquidity measures results are for 1986–2006. Year dummies are included though not reported. Regression standard errors are adjusted for heteroscedasticity and clustering following Petersen (2009). Corresponding p-values are in parenthesis. * Significant at the 10% level, ** significant at the 5% level and *** significant at the 1% level.

	1986–2006 (44,063 obs.)			1994–2006 (28,666 obs.)	
	Gibbs	Amihud	Turnover	Effective spread	Quoted spread
Intercept	2.7294***	9.2351***	−1.9194***	5.0447***	6.9830***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Instruments					
New York	−0.0790*	−0.2888	1.1302***	−0.1048	−0.1664*
Los Angeles	−0.1184**	−0.8541***	1.3793***	−0.1914**	−0.2324*
Chicago	−0.1496***	−0.6279**	−0.5001	−0.1668**	−0.2169*
Wash/Baltimore	0.0831	0.3981	1.3140***	0.1893	0.2991*
San Francisco	−0.0664*	−0.7653***	4.6911***	−0.1934***	−0.2642***
Philadelphia	−0.1324***	−0.7182**	0.4535	−0.1787**	−0.2644**
Boston	−0.0319	−0.2736	1.6101***	−0.1197	−0.1585
Detroit	−0.0111	0.1999	−0.0580	−0.0199	−0.0357
Dallas	−0.1428***	−0.7480**	1.9506***	−0.2299***	−0.3042***
Houston	−0.1667***	−0.9850***	2.4323***	−0.2835***	−0.4174***
Small city/sub-urban	−0.0757**	−0.5043**	0.9535***	−0.1248**	−0.1653**
Controls					
DR_{t-1}	0.0822***	0.6348***	0.8518***	0.2056***	0.2653***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
V_{t-1}/A_{t-1}	−0.0404***	−0.3464***	0.6874***	−0.1080***	−0.1624***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Ln(PRC_{t-1})$	−0.2970***	−0.8873***	0.7740***	−0.4696***	−0.6556***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ET_{t-1}/A_{t-1}	−0.0003	0.0050*	−0.0303***	−0.0023***	−0.0015*
	(0.512)	(0.058)	(0.000)	(0.000)	(0.093)
DP_{t-1}/A_{t-1}	0.0059***	0.0490***	−0.0568***	0.0031	0.0055
	(0.007)	(0.001)	(0.008)	(0.413)	(0.303)
RDD_{t-1}	0.0153	−0.0356	−0.3459**	0.0464*	0.0766*
	(0.362)	(0.747)	(0.021)	(0.095)	(0.058)
RD_{t-1}/A_{t-1}	−0.0034***	−0.0366***	0.0680***	−0.0100***	−0.0132***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)
$Ln(A_{t-1})$	−0.1959***	−0.8967***	0.4538***	−0.4526***	−0.6290***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared	0.372	0.150	0.199	0.536	0.536
F-test	146.002	26.516	84.502	261.082	256.223
F-test IV only	3.407	3.126	16.109	3.562	3.726

Table 6

Second-stage instrumental variables analysis: location.

Second-stage instrumental variable regressions of book and market leverage. Regressions are run for various measures of liquidity, which are instrumented for using predicted values from the first-stage regressions reported in Table 5. The instruments used are indicators for each of the 10 largest metropolitan areas and a small city/suburban indicator. Each liquidity measure is indicated at the top of the column and its corresponding coefficient appears on the line marked *IV Estimator*. *A*, *V*, and *D* are book value of assets, market value of assets, and total debt, respectively. *DR* is an indicator for the firm having its debt rated. *PRC* is average trading price during the fiscal year. *ET*, *DP*, and *RD* are earnings before interest and taxes, depreciation expense, and R&D expense. *RDD* is an indicator that takes the value of 1 when the firm reports 0 or no R&D expenses. The index *t* denotes the year in which these variables are measured. Effective and quoted spreads results are for 1994–2006, the other liquidity measures results are for 1986–2006. The last three rows contain coefficients from normalized independent variables to have mean 0 and standard deviation of 1. Year dummies are included though not reported. Regression standard errors are adjusted for heteroscedasticity and clustering following Petersen (2009). Corresponding *p*-values are in parenthesis. * Significant at the 10% level, ** significant at the 5% level and *** significant at the 1% level.

	1986–2006 (44,063 obs.)						1994–2006 (28,666 obs.)			
	Gibbs		Amihud		Turnover		Effective spread		Quoted spread	
	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t
Intercept	21.0295	24.1633**	8.3654	20.2135**	41.9802***	51.8120***	−53.0711**	−28.3529	−42.3121**	−21.4995
	(0.105)	(0.049)	(0.350)	(0.014)	(0.000)	(0.000)	(0.021)	(0.133)	(0.023)	(0.157)
$IV\ Estimator_{t-1}$	8.5631*	10.9237**	4.0190***	3.7436***	−1.7488***	−1.3574***	15.9055***	12.7687***	11.0027***	8.7915***
	(0.079)	(0.018)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
DR_{t-1}	5.0152***	2.8646***	3.1460***	1.3593	7.0087***	4.7541***	5.1947***	2.7214***	5.5468***	3.0149***
	(0.000)	(0.000)	(0.000)	(0.103)	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.001)
V_{t-1}/A_{t-1}	−0.7213***	−4.0348***	0.3377	−3.1674***	0.2072	−3.4870***	0.6484	−2.5908***	0.7178	−2.5419***
	(0.002)	(0.000)	(0.372)	(0.000)	(0.334)	(0.000)	(0.145)	(0.000)	(0.123)	(0.000)
$Ln(PRC_{t-1})$	−4.9700***	−6.7156***	−3.9727***	−6.6601***	−6.2867***	−9.0052***	0.1919	−4.1173***	−0.0717	−4.3558***

Table 6 (*continued*)

	1986–2006 (44,063 obs.)						1994–2006 (28,666 obs.)			
	Gibbs		Amihud		Turnover		Effective spread		Quoted spread	
	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.920)	(0.008)	(0.969)	(0.004)
ET_{t-1}/A_{t-1}	−0.2234***	−0.2650***	−0.2445***	−0.2856***	−0.2776***	−0.3085***	−0.1531***	−0.1743***	−0.1742***	−0.1913***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
DP_{t-1}/A_{t-1}	−0.0869	−0.5015***	−0.2206**	−0.6103***	−0.1311*	−0.5130***	0.0636	−0.3867***	0.0506	−0.3970***
	(0.210)	(0.000)	(0.016)	(0.000)	(0.064)	(0.000)	(0.462)	(0.000)	(0.562)	(0.000)
RDD_{t-1}	3.1828***	3.8711***	3.4659***	4.1688***	2.6640***	3.5177***	2.6491***	4.3121***	2.5471***	4.2331***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RD_{t-1}/A_{t-1}	−0.4450***	−0.5551***	−0.3108***	−0.4400***	−0.2886***	−0.4481***	−0.2512***	−0.3965***	−0.2671***	−0.4099***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Ln(A_{t-1})$	6.5302***	6.5854***	8.4711***	7.8132***	5.7450***	5.1340***	11.6538***	9.8520***	11.3818***	9.6075***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
F-test	141.064	312.349	110.248	262.148	115.330	279.428	127.195	314.986	127.317	321.791
Normalized coefficients										
$IV\ Estimator_{t-1}$	7.1950*	8.7287**	19.9645***	18.1955***	−12.1584**	−9.4760***	23.2504***	18.7814***	23.6489***	18.9284***
V_{t-1}/A_{t-1}	−1.0881***	−6.0590***	0.4450***	−4.8127***	0.3066***	−5.1898***	1.0322***	−4.2561***	1.1563***	−4.1780***
ET_{t-1}/A_{t-1}	−3.4474***	−4.0907***	−3.7646***	−4.3942***	−4.2841***	−4.7622***	−2.6218***	−2.9744***	−2.9746***	−3.2615***

eighths avoidance. In our second-stage regression, presented in Table 8, we find that the instrumented liquidity variable is significantly related to leverage in the manner we would expect if improved liquidity led to a greater reliance on equity financing. In particular, turnover is negatively related and trading cost measures are positively related to leverage. These relations are all statistically significant at the 1% significance level, and are also economically significant. A one standard deviation change in liquidity has an economic

Table 7
First-stage instrumental variables analysis: odd-eighths.

OLS regressions of various measures of liquidity (indicated at the top of each column) on one instrument and exogenous determinants of leverage. The sample is composed of NASDAQ-listed firms for the sample period 1994–1997. The instrumental variable is *odd-eights* and is the percentage of the trading day that the bid or ask quotes are an odd-eighth. We average the values for the bid and ask, and then compute the average for the fiscal year. *A*, *V,* and *D* are book value of assets, market value of assets and total debt, respectively. *DR* is an indicator for the firm having its debt rated. *PRC* is average trading price during the fiscal year. *ET*, *DP*, and *RD* are earnings before interest and taxes, depreciation expense, and R&D expense, respectively. *RDD* is an indicator that takes the value of 1 when the firm reports 0 or no R&D expenses. The index *t* denotes the year in which these variables are measured. Year dummies are included though not reported. Regression standard errors are adjusted for heteroscedasticity and clustering following Petersen (2009). Corresponding *p*-values are in parenthesis. * Significant at the 10% level, ** significant at the 5% level and *** significant at the 1% level.

	NASDAQ listed 1994–1997 (6,085 obs.)				
	Gibbs	Amihud	Turnover	Effective spread	Quoted spread
Intercept	6.0128***	24.0187***	−6.8018***	10.5196***	15.8013***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Instrument					
Odd-eighths (%)	−2.3732***	−12.7204***	13.1723***	−4.0298***	−6.7325***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Controls					
DR_{t-1}	0.1301**	1.1411***	0.3329	0.1854**	0.2183**
	(0.014)	(0.002)	(0.461)	(0.010)	(0.034)
V_{t-1}/A_{t-1}	−0.0535***	−0.2746***	0.1406	−0.1218***	−0.1786***
	(0.000)	(0.002)	(0.103)	(0.000)	(0.000)
$Ln(PRC_{t-1})$	−1.1533***	−5.7160***	5.7957***	−1.8608***	−2.9688***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ET_{t-1}/A_{t-1}	0.0011	0.0208***	−0.0103	−0.0037***	−0.0039**
	(0.197)	(0.002)	(0.125)	(0.008)	(0.038)
DP_{t-1}/A_{t-1}	0.0047	0.0860**	−0.0999***	−0.0031	0.0045
	(0.277)	(0.026)	(0.002)	(0.624)	(0.631)
RDD_{t-1}	−0.0221	−0.3164	−1.0122***	−0.0282	−0.0460
	(0.550)	(0.347)	(0.000)	(0.636)	(0.593)
RD_{t-1}/A_{t-1}	−0.0080***	−0.0557***	0.0757***	−0.0154***	−0.0190***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
$Ln(A_{t-1})$	−0.1988***	−0.7760***	−0.5670***	−0.4175***	−0.4926***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared	0.508	0.231	0.259	0.572	0.601
F-test	129.37	28.19	62.46	62.46	178.12
F-test IV only	538.66	154.82	327.96	327.96	797.63

Table 8
Second-stage instrumental variables analysis: odd-eighths.

Second-stage instrumental variable regressions of book and market leverage. The sample is composed of NASDAQ-listed firms for the sample period 1994–1997. Regressions are run for various measures of liquidity, which are instrumented for using predicted values from the first-stage regressions reported in Table 7. The instrument used is the percentage of time that the bid or ask are quoted in odd-eighths. Each liquidity measure is indicated at the top of the column and its corresponding coefficient appears on the line marked *IV Estimator*. *A*, *V*, and *D* are book value of assets, market value of assets, and total debt, respectively. *DR* is an indicator for the firm having its debt rated. *PRC* is average trading price during the fiscal year. *ET*, *DP*, and *RD* are earnings before interest and taxes, depreciation expense, and R&D expense. *RDD* is an indicator that takes the value of 1 when the firm reports 0 or no R&D expenses. The index *t* denotes the year in which these variables are measured. The last three rows contain coefficients from normalized independent variables to have mean 0 and standard deviation of 1. Year dummies are included though not reported. Regression standard errors are adjusted for heteroscedasticity and clustering following Petersen (2009). Corresponding *p*-values are in parenthesis. * Significant at the 10% level, ** significant at the 5% level and *** significant at the 1% level.

	1994–1997 NASDAQ listed (6,085 obs.)									
	Gibbs		Amihud		Turnover		Effective spread		Quoted spread	
	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t	D_t/A_t	D_t/V_t
Intercept	26.9701***	14.1135***	31.3534***	23.3247***	40.6697***	42.9020***	26.4777***	13.0942***	28.2633***	16.8458***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
$IV\ Estimator_{t-1}$	2.8616***	6.0134***	0.5339***	1.1219***	−0.5156***	−1.0834***	1.6819***	3.5340***	1.0067***	2.1153***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
DR_{t-1}	5.2357***	4.4732***	4.9989***	3.9756***	5.7797***	5.6165***	5.2990***	4.6098***	5.3912***	4.8034***
	(0.001)	(0.002)	(0.001)	(0.007)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
V_{t-1}/A_{t-1}	−0.6617***	−2.8374***	−0.6681***	−2.8510***	−0.7422***	−3.0067***	−0.6084**	−2.7234***	−0.6335***	−2.7761***
	(0.005)	(0.000)	(0.006)	(0.000)	(0.002)	(0.000)	(0.013)	(0.000)	(0.009)	(0.000)
$Ln(PRC_{t-1})$	−7.2051***	−7.9500***	−7.4539***	−8.4728***	−7.5174***	−8.6064***	−7.3776***	−8.3232***	−7.5186***	−8.6194***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ET_{t-1}/A_{t-1}	−0.2736***	−0.2089***	−0.2815***	−0.2255***	−0.2757***	−0.2133***	−0.2642***	−0.1890***	−0.2664***	−0.1938***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
DP_{t-1}/A_{t-1}	0.0859	−0.2646***	0.0534	−0.3330***	0.0478	−0.3447***	0.1052	−0.2235**	0.0954	−0.2441**

	(0.441)	(0.008)	(0.642)	(0.002)	(0.676)	(0.002)	(0.341)	(0.022)	(0.389)	(0.013)
RDD_{t-1}	6.9655***	6.2412***	7.0711***	6.4631***	6.3803***	5.0115***	6.9497***	6.2035***	6.9487***	6.2014***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RD_{t-1}/A_{t-1}	−0.2987***	−0.3793***	−0.2919***	−0.3649***	−0.2826***	−0.3454***	−0.2958***	−0.3731***	−0.3025***	−0.3873***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Ln(A_{t-1})$	6.2823***	7.6486***	6.1277***	7.3237***	5.4211***	5.8387***	6.4159***	7.9311***	6.2095***	7.4975***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
F-test	104.023	196.637	101.600	180.652	100.226	161.301	104.269	200.965	104.218	200.824
Normalized coefficients										
$IV\ Estimator_{t-1}$	3.1220***	6.5606***	4.1043***	8.6222***	−3.3443***	−7.0244***	3.0447***	6.3976***	2.6560***	5.5822***
V_{t-1}/A_{t-1}	−1.1097***	−4.7606***	−1.1205***	−4.7848***	−1.2458***	−5.0441***	−1.0214***	−4.5713***	−1.0624***	−4.6592***
ET_{t-1}/A_{t-1}	−5.0759***	−3.8748***	−5.2227***	−4.1825***	−5.1147***	−3.9584***	−4.9017***	−3.5076***	−4.9427***	−3.5955***

effect comparable to other variables known to have a significant effect on leverage—market-to-book ratio and profitability.

Though we follow the definition of leverage employed by Baker and Wurgler (2002) and Fama and French (2002), we also conducted the analysis using a definition that recognized as debt financing only long-term debt and short-term debt. The results are essentially unchanged. The specifications presented in this paper, therefore, appear robust to the definition of leverage.

5. Capital structure choices and liquidity

In the previous section, we provided evidence of a negative relation between leverage and liquidity essentially from information in the cross-section. In this section, we supplement that analysis by looking at capital structure choices at the time of capital structure changes. In particular, we study the extent to which firms select either debt or equity at the time the firm raises or returns capital through either debt or equity market transactions. This approach is a common method for avoiding concerns about unmeasured factors that might influence debt levels. The approach was initiated by MacKie-Mason (1990) in his study that provided the first strong evidence of a tax effect on capital structure choices. When a firm makes a financing choice, it will consider all factors and make a choice reflect the relevant tradeoffs. If equity liquidity is a relevant factor, then equity liquidity should impact the capital structure choices at the time of financing.

For our specification, we follow Hovakimian et al. (2001). Their objective is to document the extent and speed of adjustment by firms to their optimal capital structure. They essentially model the financing choice including as one variable the deviation of existing capital structure from an estimate of the optimum. In particular, in an initial regression, they identify the firm's target capital structure and then include in a second regression the deviation from this target. Since we do not need to isolate the adjustment factor, we employ a single regression that contains variables from both regressions. Our principal difference is to include liquidity as a variable affecting the financing choice.

Also following Hovakimian et al. (2001), we separately examine net increases and reductions of capital. The separation allows for different determinants of choices under these two conditions. We define net equity increases and reductions using the statement of cash flows. Specifically, we define net equity changes as the difference between equity issues and equity repurchases divided by total assets ((Item 108–Item 115)/Item 6). Net increases and reductions of debt are identified by tracking the change in total debt defined as long-term debt (Item 9) plus short-term debt (Item 34). In general, we assume there is a net increase or reduction in a capital account if its change is greater than or equal to 1% of assets. As in the papers we have cited, we analyze only those capital changes that are associated with either debt or equity, and delete those events where the firm simultaneously changes both debt and equity. Furthermore, our definition restricts our analysis to capital structure changes involving debt or equity market transactions. We do not examine equity changes associated with retained earnings effects (net income or dividends).

It should be noted that we do not identify particular issues, retirements or repurchases. Instead, we focus on the *net* increases or reductions of equity and debt. This is because the focus of our analysis is how factors affect the selection of debt or equity sources, not the desirability of a particular issuance at a particular time. Of course, our explanatory variables include factors that might affect issuance choices (such as the prior change in equity prices), but our examination is at the level of annual capital structure changes, not at the level of specific issues. Also, we measure liquidity in the year prior to the capital structure changes, so any issuance or retirement related trading activity should not affect our results.

Summary statistics for net capital changes in equity and debt accounts are presented in Table 9. The number of firms increasing or reducing debt is significantly greater than those increasing or reducing equity. This is consistent with prior studies. Firms increasing equity are, on average, less liquid than those increasing debt (with the exceptions of the Amihud and Turnover estimates), and those reducing equity tend to be more liquid than those reducing debt. These averages suggest that the lack of liquidity actually encourages increases in equity. However, firms increasing equity are also much smaller, and the size effect is likely to mask the actual relation.

Table 10 contains results for the logistic regressions modeling changes in capital. Panel A examines cases where firms increase net capital, while Panel B examines the cases where firms reduce net capital. The dependent variable is set to 1 when a firm chooses to increase or reduce equity rather than debt. Thus, in Panel A (Panel B), a positive coefficient implies a greater probability of increasing (reducing) equity, while a negative coefficient implies a greater probability of increasing (reducing) debt. The regressions reported on the left are for the 1986–2006 sample, while those on the right are for the 1994–2006 sample.[17] Inferences are based on cluster-adjusted standard errors.

In addition to including various measures of liquidity, our tests control for the determinants of leverage (the same variables included in the analysis presented in Table 4) and factors that are likely to affect the debt/equity choice. Specifically, we include an estimate of debt and equity issuance costs (one based on Altinkilic and Hansen, 2000).[18] We expect high equity (debt) issuance costs to reduce (increase) the probability of a net equity increase.

Firms that have had a history of high (low) earnings may have a tendency to be under (over) leveraged because of accumulated earnings (losses). In their debt/equity choice, we expect these firms to be more likely to increase (reduce) leverage. We measure this effect with net operating loss carry-forwards scaled by total assets, and expect this variable to have a positive coefficient. Profitability, already included as a determinant of leverage, also captures this same effect.

Certain effects may encourage deviations from target leverage, such as very high or very low market valuations. Firms with very high stock valuations are expected to be more likely to take advantage of market appreciation for the stock by issuing equity. We include the average of monthly returns for the year prior to the issue to control for this effect. We expect this variable to have a positive coefficient. We also control for variance of stock returns. Firms with a high variance of stock returns are more difficult to value and are more likely to suffer from the adverse selection behavior described in Myers and Majluf (1984). We expect this variable to have a negative coefficient.

Firms will avoid issuing equity when doing so is likely to dilute the value of existing claims. We include a dummy that takes the value of 1 when market-to-book is lower than 1. We expect this variable to have a negative coefficient. The problem of dilution of

[17]Since the results for the Gibbs and Amihud measures in the 1994–2006 sample are very similar to the results for the longer time series (as with our earlier analyses), they are omitted.

[18]This addition was suggested by the referee, to whom we are grateful for a number of improvements.

Table 9
Summary statistics for changes in debt or equity balances.

Summary statistics for firm-years having net changes in debt or equity balances. We define equity changes using the statement of cash flows. Specifically, we define an equity change as the difference between equity issues and equity repurchases (Item 108−Item 115). Net changes in debt are identified by tracking the change in total debt defined as long-term debt (Item 9) plus short-term debt (Item 34). We assume there is a net equity or debt increase whenever the net change is greater than or equal to 1% of total assets, and a net equity or debt decrease whenever the change is less than or equal to −1% of total assets.

		1986–2006				1994–2006			
		Equity		Debt		Equity		Debt	
		Net Increase	Net Decrease	Net Increase	Net Decrease	Net Increase	Net Decrease	Net Increase	Net Decrease
Characteristics of issues/retirements									
Number		6,623	6,450	13,744	10,756	4,246	4,234	8,081	6,174
Size (dollars)		3,289	9,086	11,794	9,599	3,056	10,288	12,395	10,959
Financial characteristics									
A_{t-1}	Total assets (millions)	747	1,855	1,500	1,531	639	2,045	1,596	1,744
V_{t-1}	Market value (millions)	1,258	3,440	2,361	2,164	1,275	3,994	2,723	2,607
DR_{t-1}	Rated debt indicator	0.18	0.35	0.31	0.31	0.16	0.35	0.31	0.32
PRC_{t-1}	Price of stock (dollars)	23	28	39	42	25	28	49	58
$GSdebt_{\ t-1}$	Gross spread debt (%)	11.32	7.54	6.52	7.45	10.70	6.48	5.70	6.57
$GSequity_{\ t-1}$	Gross spread equity (%)	16.26	15.24	16.54	16.69	15.25	14.02	15.32	14.97
RET_{t-1}	Stock return (%)	2.79	1.32	1.59	0.94	2.85	1.32	1.62	0.99
$Var(Ret_{\ t-1})$	Variance of returns	0.03	0.01	0.02	0.02	0.03	0.02	0.02	0.02
DD_{t-1}/D_{t-1}	Debt due in 3 years (%)	11.59	9.73	12.98	16.83	10.95	9.71	13.24	17.48
D_{t-1}/A_{t-1}	Book leverage (%)	38.04	42.98	51.39	46.12	36.08	43.30	51.52	46.05
Operating characteristics									
V_{t-1}/A_{t-1}	Market-to-book	2.57	1.88	1.76	1.56	2.79	2.02	1.88	1.66
ET_{t-1}/A_{t-1}	Operating return (%)	4.29	13.03	8.50	6.22	2.14	12.89	7.52	5.18
DP_{t-1}/A_{t-1}	Depreciation (%)	4.58	4.54	4.63	4.88	4.55	4.51	4.66	4.84
RDD_{t-1}	Research indicator	0.42	0.52	0.59	0.54	0.41	0.55	0.62	0.56
RD_{t-1}/A_{t-1}	Research level (%)	6.58	2.57	2.53	2.85	7.31	2.46	2.58	2.99
$NOLC_{t-1}/A_{t-1}$	Loss carry-forwards (%)	22.13	3.37	8.19	9.51	28.07	4.22	11.07	12.19
Liquidity									
G_{t-1}	Gibbs estimate (%)	0.94	0.69	0.89	0.92	0.91	0.64	0.85	0.86
I_{t-1}	Amihud estimate	1.21	0.95	1.55	1.82	0.94	0.67	1.24	1.42
T_{t-1}	Turnover (%)	9.15	7.22	6.94	6.70	10.39	8.37	8.08	7.87
ES_{t-1}	Effective spread (%)	n/a	n/a	n/a	n/a	1.49	0.99	1.44	1.46
QS_{t-1}	Quoted spread (%)	n/a	n/a	n/a	n/a	2.10	1.41	2.06	2.06

existing shareholders' wealth is likely to be more severe for firms that have a greater proportion of long-term debt. We include a variable that measures the proportion of debt that is due in the next three years, and the fraction of debt that is due within the next three years whenever the firm has suffered a loss. We expect these firms to be more likely to issue equity, because the dilution effect is less severe for these firms.

Table 10
The choice of equity vs. debt when increasing or reducing capital.

Logistic regressions of equity versus debt increases (Panel A), and reductions (Panel B), for various measures of liquidity (identified at the top of each column). We define equity changes using the statement of cash flows. Specifically, we define an equity change as the difference between equity issues and equity repurchases (Item 108−Item 115). Net changes in debt are identified by tracking the change in total debt defined as long-term debt (Item 9) plus short-term debt (Item 34). We assume there is a net equity or debt increase whenever the net change is greater than or equal to 1% of total assets, and a net equity or debt decrease whenever the change is less than or equal to −1% of total assets. We exclude cases of simultaneous increases (reductions) in debt and equity. *LIQ* is liquidity. *A*, *V*, and *D* are book value of assets, market value of assets and debt. *Ind*(D/A) is average industry leverage. *DR* is an indicator for the firm having its debt rated. *PRC* is average trading price during the fiscal year. *ET*, *DP*, and *RD* are earnings before interest and taxes, depreciation expense, and R&D expense. *RDD* is an indicator that takes the value of 1 when the firm reports 0 or no R&D expenses. *GSdebt* and *GSequity* are estimated underwriter gross spreads from Altinkilic and Hansen (2000). *MBD* is a dummy variable that takes the value of 1 if $V/A<1$. *NOLC*, *RET*, and *Var*(*Ret*) are net operating loss carryforwards, average of monthly returns, and variance of monthly returns for the fiscal year. *DD* is debt due in three years as a proportion of total debt, and *NED* is a dummy variable that takes the value 1 if $E<0$. The index t denotes the year in which these variables are measured. Logistic regressions include yearly dummies, not reported. We report regression coefficients (on the left) and elasticities (on the right), which indicate the change in the implied probability of a change in equity for a change in an independent variable of one standard deviation centered around its sample mean (or from zero to one for dummy variables), holding other variables constant at their respective means. Regression standard errors are adjusted for heteroscedasticity, as well as clustering, and corresponding p-values are in parenthesis. * Significant at the 10% level, ** significant at the 5% level and *** significant at the 1% level.

	1986–2004 (10,903 obs.)						1994–2004 (6,539 obs.)			
	Gibbs		Amihud		Turnover		Effective spread		Quoted spread	
	Coeff.	Elast	Coeff.	Elast	Coeff.	Elast	Coeff.	Elast	Coeff.	Elast
Panel A: Increasing capital										
Intercept	0.579**		0.373		0.256		2.429***		2.317***	
	(0.039)		(0.147)		(0.309)		(0.000)		(0.000)	
LIQ_{t-1}	−0.156***	−0.025	−0.033***	−0.028	0.034***	0.044	−0.162***	−0.046	−0.101***	−0.043
	(0.001)		(0.000)		(0.000)		(0.001)		(0.001)	
DR_{t-1}	−0.065	−0.012	−0.069	−0.013	−0.141	−0.027	0.053	0.011	0.049	0.010
	(0.449)		(0.424)		(0.102)		(0.643)		(0.669)	
V_{t-1}/A_{t-1}	0.289***	0.071	0.285***	0.070	0.281***	0.069	0.290***	0.079	0.291***	0.079
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
$Ln(PRC)$	−0.247***	−0.033	−0.220***	−0.029	−0.251***	−0.033	−0.209**	−0.029	−0.200**	−0.027
	(0.000)		(0.001)		(0.000)		(0.016)		(0.020)	
ET_{t-1}/A_{t-1}	−0.016***	−0.041	−0.016***	−0.041	−0.015***	−0.039	−0.019***	−0.060	−0.019***	−0.060
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
DP_{t-1}/A_{t-1}	0.012	0.007	0.013	0.007	0.015	0.008	0.010	0.006	0.010	0.006

Table 10 (*continued*)

	1986–2004 (10,903 obs.)						1994–2004 (6,539 obs.)			
	Gibbs		Amihud		Turnover		Effective spread		Quoted spread	
	Coeff.	Elast	Coeff.	Elast	Coeff.	Elast	Coeff.	Elast	Coeff.	Elast
	(0.189)		(0.171)		(0.101)		(0.436)		(0.427)	
RDD_{t-1}	−0.190**	−0.038	−0.192**	−0.038	−0.216***	−0.042	−0.225**	−0.047	−0.225**	−0.047
	(0.014)		(0.013)		(0.005)		(0.021)		(0.021)	
RD_{t-1}/A_{t-1}	0.068***	0.086	0.067***	0.085	0.063***	0.079	0.071***	0.103	0.071***	0.103
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
$Ln(A_{t-1})$	−0.133***	−0.044	−0.126***	−0.041	−0.124***	−0.041	−0.263***	−0.091	−0.254***	−0.088
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
$GSdebt_{\ t-1}$	0.016***	0.063	0.017***	0.066	0.016***	0.061	0.023***	0.092	0.023***	0.092
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
$GSequity_{\ t-1}$	−0.009***	−0.056	−0.009***	−0.056	−0.009***	−0.056	−0.012***	−0.070	−0.012***	−0.071
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
MBD_{t-1}	−0.301***	−0.080	−0.278***	−0.081	−0.290***	−0.080	−0.257**	−0.104	−0.261**	−0.105
	(0.000)		(0.001)		(0.001)		(0.035)		(0.032)	
$NOLC_{t-1}/A_{t-1}$	−0.001	−0.010	−0.001	−0.010	−0.001	−0.008	−0.003*	−0.023	−0.003*	−0.023
	(0.279)		(0.280)		(0.375)		(0.058)		(0.057)	
RET_{t-1}	0.064***	0.051	0.064***	0.051	0.063***	0.050	0.051***	0.045	0.051***	0.045
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
$Var(Ret)$	1.756	0.011	1.623	0.010	−1.079	−0.006	0.269	0.002	0.174	0.001
	(0.194)		(0.227)		(0.324)		(0.834)		(0.892)	
DD_{t-1}	−0.000	−0.001	−0.001	−0.001	−0.001	−0.002	−0.000	−0.001	−0.000	−0.001
	(0.826)		(0.737)		(0.689)		(0.898)		(0.888)	
$DD_{t-1} \times NED_{t-1}$	0.013***	0.018	0.013***	0.018	0.013***	0.018	0.009*	0.014	0.009*	0.014
	(0.002)		(0.002)		(0.001)		(0.089)		(0.092)	
D_{t-1}/A_{t-1}	−0.011***	−0.040	−0.010***	−0.039	−0.009***	−0.033	−0.018***	−0.073	−0.018***	−0.074
	(0.000)		(0.000)		(0.002)		(0.000)		(0.000)	
$D_{t-1}/A_{t-1}-Ind(D_{t-1}/A_{t-1})$	0.016***	0.051	0.016***	0.050	0.015***	0.046	0.018***	0.062	0.018***	0.062
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Pseudo R2	0.1928		0.1936		0.1967		0.2327		0.2325	

	1986–2006 (10,032 obs.)						1994–2006 (6,029 obs.)			
	Gibbs		Amihud		Turnover		Effective Spread		Quoted Spread	
	Coeff.	Elast	Coeff.	Elast	Coeff.	Elast	Coeff.	Elast	Coeff.	Elast
Panel B: Reducing capital										
Intercept	−1.289***		−1.292***		−1.243***		−1.402***		−1.433	
	(0.000)		(0.000)		(0.000)		(0.004)		(0.004)	
LIQ_{t-1}	0.024	0.003	0.011	0.009	−0.001	−0.001	−0.069	−0.019	−0.043	−0.017
	(0.655)		(0.165)		(0.897)		(0.198)		(0.242)	
DR_{t-1}	−0.144	−0.025	−0.146	−0.025	−0.142	−0.024	−0.076	−0.015	−0.078	−0.015
	(0.106)		(0.102)		(0.111)		(0.512)		(0.504)	
V_{t-1}/A_{t-1}	−0.006	−0.001	−0.005	−0.001	−0.006	−0.001	0.026	0.006	0.027	0.006
	(0.881)		(0.894)		(0.882)		(0.562)		(0.550)	
$Ln(PRC)$	0.145*	0.018	0.144*	0.017	0.139*	0.017	0.091	0.012	0.093	0.012
	(0.056)		(0.052)		(0.062)		(0.314)		(0.307)	
ET_{t-1}/A_{t-1}	0.070***	0.170	0.070***	0.170	0.070***	0.170	0.074***	0.216	0.074***	0.216
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
DP_{t-1}/A_{t-1}	−0.013	−0.006	−0.013	−0.007	−0.012	−0.006	−0.014	−0.008	−0.014	−0.008
	(0.284)		(0.273)		(0.288)		(0.318)		(0.321)	
RDD_{t-1}	0.039	0.006	0.040	0.008	0.041	0.007	0.110	0.011	0.109	0.010
	(0.632)		(0.627)		(0.618)		(0.286)		(0.289)	
RD_{t-1}/A_{t-1}	−0.007	−0.007	−0.007	−0.007	−0.007	−0.007	−0.008	−0.009	−0.008	−0.009
	(0.469)		(0.476)		(0.487)		(0.569)		(0.565)	
$Ln(A_{t-1})$	0.224***	0.068	0.228***	0.069	0.221***	0.067	0.241***	0.079	0.244***	0.080
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
$GSdebt_{\ t-1}$	0.003**	0.011	0.003**	0.012	0.003**	0.012	0.003**	0.015	0.003**	0.015
	(0.039)		(0.042)		(0.038)		(0.036)		(0.037)	
$GSequity_{\ t-1}$	0.000	0.003	0.000	0.002	0.000	0.003	0.002*	0.014	0.002*	0.013
	(0.665)		(0.722)		(0.651)		(0.088)		(0.089)	
MBD_{t-1}	−0.497***	−0.036	−0.503***	−0.036	−0.495***	−0.036	−0.603***	−0.045	−0.605***	−0.045
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
$NOLC_{t-1}/A_{t-1}$	−0.001	−0.004	−0.001	−0.003	−0.001	−0.004	0.001	0.010	0.001	0.010
	(0.768)		(0.786)		(0.758)		(0.355)		(0.356)	
RET_{t-1}	−0.035***	−0.024	−0.036***	−0.024	−0.035***	−0.024	−0.036***	−0.029	−0.036***	−0.028
	(0.000)		(0.000)		(0.000)		(0.001)		(0.001)	
$Var(Ret)$	−13.88***	−0.079	−13.75***	−0.078	−13.74***	−0.078	−11.38***	−0.087	−11.416***	−0.087
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	

Table 10 (*continued*)

	1986–2004 (10,903 obs.)						1994–2004 (6,539 obs.)			
	Gibbs		Amihud		Turnover		Effective spread		Quoted spread	
	Coeff.	Elast	Coeff.	Elast	Coeff.	Elast	Coeff.	Elast	Coeff.	Elast
DD_{t-1}	−0.030***	−0.086	−0.030***	−0.086	−0.030***	−0.086	−0.029***	−0.097	−0.030***	−0.097
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
$DD_{t-1} \times NED_{t-1}$	−0.014	−0.023	−0.014	0.023	−0.014	−0.023	−0.012	−0.023	−0.012	−0.228
	(0.132)		(0.130)		(0.132)		(0.241)		(0.239)	
D_{t-1}/A_{t-1}	−0.032***	−0.108	−0.032***	−0.109	−0.032***	−0.108	−0.030***	−0.115	−0.030***	−0.115
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
$D_{t-1}/A_{t-1} - Ind(D_{t-1}/A_{t-1})$	−0.005	−0.013	−0.005	−0.013	−0.005	−0.013	−0.005	−0.017	−0.005	−0.017
	(0.247)		(0.254)		(0.249)		(0.237)		(0.235)	
Pseudo R2	0.2514		0.2516		0.2514		0.2632		0.2632	

Firms are likely to consider their current leverage when increasing or reducing capital. In particular, we expect firms to be less likely to increase debt if leverage is high. We include the deviation of a firm's lagged leverage from its industry average (defined at the 4-digit SIC code) to capture any determinants of deviations from target leverage not captured by the previous variables. Finally, we control for yearly effects by including year dummy variables, though we do not report these coefficients. In our analysis of the cases where firms reduce capital, we expect our control variables to have the opposite relation to that described above.

In both Panels A and B of Table 10, the coefficients on the control variables, are for the most part consistent with prior results. Panel A shows that more liquid firms prefer to increase capital with equity. The coefficients on the liquidity measures are significant in all of the five cases. To provide some indication of the economic magnitude of our results, Table 10 presents the change in the probability of a net increase in equity associated with a change of one standard deviation around the mean for each variable, while holding all other variables at their respective means (the elasticity). The five liquidity variables have effects ranging from about 2.5% to 4.6%. The magnitude of these effects is comparable to those of the other explanatory variables.

Panel B of Table 10 presents our analysis when firms reduce capital. In this analysis, liquidity has no effect. Based on the intuition from our analysis of levels, we would expect that when reducing capital, firms would prefer to retire debt when their equity is more liquid. Hence we would expect a positive coefficient. This suggests that there are possible specification problems related to capital reductions or that there are factors that affect the capital reduction decision that we have not acknowledged in our motivation. For example, it may be that offsetting the desire to keep equity outstanding is the effect of liquidity on payout policy. In fact, Brockman et al. (2008) show that the relative cost of distributing equity with repurchases (as opposed to dividends) is inversely related to liquidity. Another possibility is that subsequent issues of equity might be more easily facilitated if equity is liquid, thereby increasing firms' willingness to reduce equity today.

For robustness, we have also employed Fama and French (2005) definitions of net changes in capital and cutoffs at 5%, 2.5%, and 1%. We chose not to report these results for the sake of brevity. This represents 60 different combinations of capital increases and reductions.[19] Our results for capital increases are always as predicted and remain significant for all liquidity measures with the exception of effective spreads at the 5% cut-off (one result out of the fifteen different combinations of cash flow definitions of capital increases). As for results using Fama and French (2005) definitions, again the results are as predicted and significant in every case except for Gibbs and both effective and quoted spreads at the 5% cut-off level.

6. Summary and conclusions

In this paper, we study the link between liquidity and capital structure decisions. Since enhanced liquidity reduces the required return on equity and the cost of issuing equity, we expect more liquid firms to prefer equity in their capital structures. Thus, in the cross-

[19]Five measures of liquidity multiplied by three different cut-offs multiplied by two different definitions of capital changes (cash flow and Fama and French) multiplied by two types of adjustments to the capital accounts (capital increases and reductions).

section we expect more liquid firms to have less leverage and that when firms increase capital we expect them to prefer to increase it with equity. We provide evidence consistent with these expectations. Of particular importance is the magnitude of the relation. The effects we document are not dissimilar in many cases to the economic magnitude of the variables that have drawn substantial attention in prior research, such as the market-to-book ratio.

Stock market liquidity is a major concern to all those involved in one way or another in equity trading, and for that reason there are many studies devoted to investigating factors affecting liquidity, and how liquidity relates to asset values and expected returns. There are relatively few papers investigating how stock market liquidity affects corporate decisions. This paper highlights one important role liquidity plays on one corporate decision—it has a significant impact on capital structure.

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