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Asset Liquidity and Capital Structure

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Abstract

This paper tests alternative theories about the effect of asset liquidity on capital structure. Using data from a broad sample of U.S. public companies, I find that leverage is positively related to asset liquidity. Further analysis reveals that the relation between asset liquidity and secured debt is positive, whereas the relation between asset liquidity and unsecured debt is curvilinear. The results are consistent with the view that the costs of financial distress and inefficient liquidation are economically important and that they affect capital structure decisions. In addition, the results are consistent with the hypothesis that the costs of managerial discretion increase with asset liquidity.

I. Introduction

The impact of the liquidity of a firm's assets on optimal leverage has been a source of debate for many years.[1] Williamson (1988) and Shleifer and Vishny (1992) predict that asset liquidity increases optimal leverage, while Morellec (2001) and Myers and Rajan (1998) argue that its effect is negative or curvilinear. The rationale for a positive effect of asset liquidity on leverage relies on the idea that less liquid assets sell at higher costs, which increases the costs of liquidation, bankruptcy, and debt. Lower asset liquidity therefore creates the need to reduce the probability of costly default by lowering the leverage. Yet models that predict a nonpositive effect argue that lower asset liquidity makes it more costly for managers to expropriate value from bondholders. Thus, lower asset liquidity reduces the costs of debt, and as a result, companies use more debt. Despite substantial progress in modeling the relation between asset liquidity and leverage, limited empirical evidence pertains to this effect because of the difficulty of obtaining a

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[1] According to Keynes (1930), an asset is more liquid if it is "more certainly realizable at short notice without loss," where loss is defined as the difference between the value that can be realized from an optimal sale (sale with no time constraint) and that from an immediate sale. The definition of loss follows Hooker and Kohn (1994).

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measure of asset liquidity. In turn, existing studies that examine the relation between asset liquidity and leverage (e.g., Alderson and Betker (1995), Kim (1998), and Benmelech, Garmaise, and Moskowitz (2005)) tend to limit their attention to narrow and specific samples of firms or assets.

This paper extends existing literature in two crucial ways. First, I examine the relation between asset liquidity and leverage for a broad and comprehensive sample of U.S. public firms. To measure asset liquidity, I compute Schlingemann, Stulz, and Walkling's (2002) liquidity index, i.e., the value of corporate transactions in an industry standardized by the total book value of assets. The primary advantage of this index is that it is exogenous to a company and can be calculated for a wide sample of firms. Thus, although it is an industry-specific rather than a firm-specific measure, I argue and present evidence that the index is superior to alternative measures of asset liquidity. Second, I test the competing predictions of Myers and Rajan (1998) and Morellec (2001) regarding the effect of asset liquidity on leverage. To my knowledge, this is the first paper to test these theories with empirical data.

Through my examination of the relation between the liquidity index and leverage, I find that the level of leverage is positively and significantly related to the liquidity index. Additionally, controlling for other determinants of leverage changes, prior changes in the liquidity index are positively associated with subsequent changes in leverage and the likelihood of debt issues. These findings are consistent with the hypotheses offered by Williamson (1988) and Shleifer and Vishny (1992), namely, that asset liquidity increases optimal leverage, which implies that the expected costs of liquidation are economically significant and substantial compared with the benefits of debt.

Next, I test the predictions of Myers and Rajan (1998) and Morellec (2001) with regard to the relation between asset liquidity and leverage. Both studies argue that the effect of asset liquidity on leverage is positive only when managers have no discretion over firm assets, which reduces the risk of wealth expropriation (e.g., assets serve as collateral for debt). If managers have discretion over firm assets, Morellec (2001) predicts that asset liquidity will have a negative effect on leverage, whereas Myers and Rajan (1998) predict a curvilinear relation. The difference between these competing predictions stems from the argument by Myers and Rajan (1998) that managers will not sell assets and expropriate value if they gain little compared with the benefits they gain from operating these assets. I find that the relation between the liquidity index and the level of secured debt is positive, and the relation between the liquidity index and the level of unsecured debt is curvilinear, consistent with Myers and Rajan's (1998) hypothesis that asset liquidity increases the costs of managerial discretion. That is, managers can sell assets and divert value from bondholders, and higher asset liquidity makes it less costly to do so. Thus, higher asset liquidity increases the expected value dilution, increases the costs of debt, and causes firms to use less debt. However, the evidence also indicates that managers will not divert value by liquidating assets when the liquidity of those assets is low. This result is consistent with the idea that the private benefits of control outweigh the gains from costly asset transformations and thereby act as deterrents to asset liquidation and value expropriation by managers, which can alleviate agency problems. Finally, the evidence indicates that

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the effect of asset liquidity on leverage depends on the combination of the positive effect of asset liquidity on secured debt and the curvilinear effect of asset liquidity on unsecured debt.

I consider several alternative explanations for these findings. Although Shleifer and Vishny (1992), Maksimovic and Phillips (2001), and Schlingemann et al. (2002) offer evidence that the liquidity index is positively related to the liquidity of firms' assets, it is, nonetheless, related to corporate control transactions. This raises the possibility that the findings in this paper are driven by control considerations rather than liquidity. However, while the empirical findings in this article are consistent with the theories that predict the effect of liquidity on leverage, they are inconsistent with alternative hypotheses and theories that suggest the effects of the market for corporate control on leverage. Specifically, I find that the relation between leverage and the liquidity index is stronger for high-debt firms, low interest coverage firms, and firms with low property, plant, and equipment (PPE) relative to total debt outstanding, which is consistent with the liquidity interpretation but inconsistent with the effect of the market for corporate control. I also examine whether the results occur because the liquidity index captures the effect of asset fire sales, the effects of post-merger leverage increases, or the positive relation between the likelihood of a merger or acquisition and leverage.[2] However, I find no support for these alternative interpretations of the results.

The remainder of this article proceeds as follows. Section II includes the main hypotheses, reviews existing evidence on asset liquidity, and discusses the measures of asset liquidity. Section III describes the sample selection process and the construction of the liquidity index, and presents descriptive statistics. Section IV presents the main results. Robustness tests and tests of the alternative interpretations are provided in Section V. Section VI summarizes the paper's findings and discusses how those findings relate to recent studies that analyze the dynamics of the capital structure adjustment process.

II. Main Hypotheses, Existing Evidence, and Measures of Asset Liquidity

A. Positive Effects of Asset Liquidity on Leverage

Williamson (1988) and Shleifer and Vishny (1992) argue that more liquid assets increase optimal leverage. Williamson (1988) posits that assets that are more liquid, or more "redeployable," should be financed with debt more often, because banks and public debt markets incur lower costs from financing these assets. That is, liquid assets are less costly to monitor and liquidate for bondholders. Therefore, higher asset liquidity increases the amount of capital firms can borrow, as well as the optimal leverage. Shleifer and Vishny (1992) make a similar prediction about the relation between asset liquidity and capital structure,

[2]Ghosh and Jain (2000) document that the financial leverage of combined firms increases significantly after a merger. Because the dollar value of corporate transactions serves to construct the liquidity index, one alternative interpretation of the results indicates that they may be driven by the effect that Ghosh and Jain document.

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arguing that asset liquidity affects the expected costs of distress because less liquid assets sell at higher discounts relative to their fair values, which then increases the expected costs of asset liquidation in the event of financial distress. To avoid costly liquidation associated with illiquid assets, managers reduce leverage ex ante to lower the probability of default and reduce expected distress costs. Higher asset liquidity, on the other hand, decreases the expected costs of financial distress, allows companies to take on more debt ex ante, and increases the optimal amount of debt.

The positive relation between asset liquidity and optimal leverage is consistent with some trade-off models of capital structure. For example, Harris and Raviv (1990) argue that investors exploit debt to obtain information about a firm's profitability by first observing the firm's ability to make contractual payments at different levels of leverage, and then making necessary changes to the company's operating policies. When choosing the appropriate level of debt, investors trade off the expected costs of default against potential improvements in the operating policy of a firm. As asset liquidity increases, the costs of default drop, and investors are more likely to use debt to obtain information about the company. The role of asset liquidity in Harris and Raviv's (1990) and other trade-off models is similar to that in Shleifer and Vishny (1992), such that the expected costs of default, determined in part by asset liquidity, are balanced against the benefits of debt.

B. Negative or Insignificant Effects of Asset Liquidity on Leverage

Asset liquidity might not increase leverage for several reasons. First, Morellec (2001) argues that the effect of asset liquidity on leverage depends on whether restrictions are placed on asset disposition. Higher asset liquidity makes asset sales more likely because of the lower costs of selling assets and the higher liquidation values. In turn, asset sales reduce the size and value of a firm's assets upon closure and therefore are bad for creditors. Imposing restrictions on the firm's assets prevents asset sales and increases expected asset value in liquidation for creditors. Morellec (2001) therefore predicts a positive relation between asset liquidity and leverage when assets serve as collateral for debt contracts and managers have no discretion over those assets, and a negative relation between asset liquidity and leverage when the assets are not tied up as collateral.

Second, Myers and Rajan (1998) note that greater asset liquidity makes it less costly for managers to transform firm assets and expropriate value from investors. Greater asset liquidity also makes it less costly for investors to exercise control over managers, such as by liquidating the firm. These two effects result in a conflict between managers and outside investors, which increases with greater asset liquidity. The conflict may be resolved by limiting managers' ability to transform assets and expropriate value (i.e., reducing transformation risk). With lower transformation risk, investors face lower expected costs associated with providing funds, which means debt becomes cheaper and gets used more often. Myers and Rajan's (1998) model thus predicts that in the absence of transformation risk, optimal leverage increases in asset liquidity, whereas in the presence of transformation risk, the relation between leverage and asset liquidity is curvilinear.

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In other words, whereas Myers and Rajan (1998) and Morellec (2001) make similar predictions about the relation between asset liquidity and leverage when managers have no discretion over assets, their predictions diverge when managers can transform firm assets. The difference stems from Myers and Rajan's (1998) claim that even if managers can transform assets, they will not do so at low levels of asset liquidity, because they derive private benefits from operating firm assets that are greater than the gains they would receive from transforming the assets. In contrast, Morellec (2001) argues that the probability that managers will sell assets increases with asset liquidity, even at low liquidity levels, which imposes additional costs on financiers and reduces the optimal amount of debt.

Third, if the probability and expected costs of liquidation are economically small compared with the benefits of debt, asset liquidity should not affect capital structure decisions.[3] Fourth, due to agency problems, risk aversion, and a reluctance to face the performance pressures associated with debt, managers might prefer less debt than is optimal. Berger, Ofek, and Yermack (1997) reveal that entrenched managers take on less debt than is optimal, possibly to decrease the probability of distress and protect their human capital. If leverage and the probability of distress are low for agency or other reasons, the marginal effect of asset liquidity on expected distress costs should also be low, and the relation between asset liquidity and leverage will become weak or insignificant. Fifth, high capital structure adjustment costs might keep companies from adjusting their debt in response to changes in asset liquidity, in which case significant deviations from the optimum will attenuate the effect of asset liquidity on the capital structure.

C. Prior Evidence about Asset Liquidity

Several prior studies provide indirect evidence consistent with the view that asset liquidity affects capital structure. Pulvino (1998) shows that in times of distress, firms sell industry-specific assets at substantial discounts relative to the price during nondistress times. DeAngelo, DeAngelo, and Wruck (2002), in their investigation of the 1989–1998 collapse of L.A. Gear, note that the firm's generally liquid asset structure supported the distressed company for many years and suggest that asset liquidity is an important determinant of capital structure, as it affects the expected costs of financial distress and expected agency costs. Schlingemann et al. (2002) argue that because asset liquidity affects the costs of selling assets, it also should affect divestiture decisions. They find that firms are more likely to divest a segment that operates in an industry with greater asset liquidity. The evidence in these papers is consistent with the hypothesis that the costs of selling assets and the costs of distress are lower in industries with higher asset liquidity.

In a direct examination of the relation between capital structure and asset liquidity, Alderson and Betker (1995) consider the liquidation costs of assets and the composition of capital structure in 88 firms that reorganized under Chapter 11 of the Bankruptcy Code. Firms with high liquidation cost assets are more likely to propose capital structures that make distress less likely, such as less debt and

[3] In the words of Miller (1977), this is "horse and rabbit stew," with tax benefits as the former and expected costs of distress or liquidation as the latter.

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less restrictive covenants. Kim (1998) investigates the effects of asset liquidity in the contract drilling industry and finds that firms with liquid assets increase their borrowing during industry distress, whereas firms with illiquid assets do not. Benmelech et al. (2005) study the impact of asset liquidation value on debt contracting for commercial property, nonrecourse loan contracts and find that greater asset liquidity is associated with greater loan size. Although this evidence is consistent with a positive relation between asset liquidity and debt capacity, these authors confine their attention to specific firms, industries, or types of assets. What remains unclear is whether their findings are generalizable to other firms and assets.

D. Measure of Asset Liquidity

Research on asset liquidity faces the significant difficulty of measuring the liquidity of assets. No organized marketplace exists for corporate assets, and no observable daily quotes estimate the measures of liquidity commonly used in market microstructure literature. Recently, however, Schlingemann et al. (2002) proposed a new measure of asset liquidity, the liquidity index. The liquidity index is estimated in two steps. First, the industry liquidity index is estimated as the ratio of the total value of corporate transactions to the total book value of assets in the industry. Second, the firm liquidity index equals the average of the industry liquidity indices of segments' industries, weighted by the segments' total book value of assets. In essence, the liquidity index assumes that asset liquidity at the firm level depends primarily on the conditions in the firm's industry. Research evidence supports this claim. First, studies document that firms within a particular industry have similar assets and asset compositions (e.g., Shleifer and Vishny (1992)). Second, periods of illiquidity or asset fire sales occur primarily because of industry downturns and poor conditions throughout the industry (Shleifer and Vishny (1992), Pulvino (1998)). Thus, although the liquidity index is an industry-level measure, a measure at an industry level is suitable in a study of asset liquidity. In addition, the difference between asset liquidity at the firm level and at the industry level introduces noise and biases the analysis against rejecting the null hypothesis of no significant relations. That is, using an industry-level measure of asset liquidity is conservative in nature.

The rationale for the liquidity index as a measure of asset liquidity therefore follows Shleifer and Vishny (1992) and Schlingemann et al. (2002), who argue that discounts that sellers must offer to attract buyers are smaller in more active markets. That is, there are more buyers and there is a greater probability for a seller to find a buyer in an industry with more corporate transactions. A company that wants to sell an asset can ask, ceteris paribus, for an equal or higher price in an industry with more buyers. This higher price translates into lower liquidation discounts, and greater demand should result in faster asset sales, both of which signal higher liquidity. In turn, industries with more transactions (i.e., a higher liquidity index) should have higher asset liquidity on average. It is difficult to determine which comes first, asset liquidity or corporate transactions, but the important conclusion for this analysis is that the level of corporate transactions is positively associated with asset liquidity.

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Because it is based on corporate control transactions, the liquidity index arguably contains components of both corporate control effects and asset liquidity effects. Thus, while arguments in Shleifer and Vishny (1992) and evidence in Schlingemann et al. (2002), Maksimovic and Phillips (2001), and others support the use of the liquidity index as a measure of asset liquidity, it is, nonetheless, a noisy measure. With that said, however, the liquidity index has several theoretical and practical advantages over other liquidity measures that have been used in the literature. For example, Alderson and Betker (1995) use one minus the ratio of managerial estimates of the value of assets in liquidation to the value of assets as a going concern to measure liquidation costs. Not only are these estimates notoriously subjective and potentially biased, but they function only for the limited sample of firms that have filed and reorganized under Chapter 11 bankruptcy protection. Almeida and Campello (2007) measure asset specificity as the proportion of used equipment purchases to total equipment purchases in an industry. But this asset specificity ratio may decline with increased new equipment purchases, even though such purchases actually can signal greater demand for assets and higher asset liquidity in the industry.

Current asset holdings and fixed assets are also problematic measures of the liquidity of a firm's assets. Holdings of current assets even may relate negatively to the liquidity of other firm assets if the firm increases its cash holdings when asset liquidity is low to reduce the probability of selling productive assets for cash. Finally, asset tangibility, or the ratio of fixed assets to total assets, does not account for the liquidity of tangible assets[4] or for the fact that the company's intangible assets may be an important component of overall firm asset liquidity. The bottom line, therefore, is that the liquidity index appears to have both theoretical and practical advantages over alternative liquidity measures. This view is supported by additional tests reported in the following section.

III. Data and the Liquidity Index

A. Sample Selection

The sample consists of U.S. public companies with financial data available from the Compustat Industrial Annual P-S-T, Research, and Full Coverage tapes at any time during the period 1982 to 2005.[5] Sample firms have at least $20 million in total assets in 1994 dollars. In addition, I exclude companies that belong to financial (Standard Industrial Classification (SIC) 6000–6999) and utility (SIC 4910–4940) industries, as well as multisegment firms that contain segments in the financial or utility industries, because of the possible effects of regulations. I also control for the Compustat backfill bias by removing observations during the initial two years that a company appeared in Compustat. These filters produce an initial

[4]For example, Pulvino (1998) shows that despite high asset tangibility, the airline industry's industry-specific aircrafts are highly illiquid during turbulent times.

[5]The analysis period is limited by the availability of Securities Data Corporation (SDC) M&A data, which I use to construct a measure of asset liquidity. The SDC M&A files start in 1979, but they contain few transactions in the first three years compared with subsequent years. Therefore, because the data from these three years may be unrepresentative, they do not appear in the analysis.

sample of 92,884 firm-year observations. The availability of the marginal tax rate estimate and other variables used in the analysis reduces the sample size by an additional 36,157 observations.[6] The final sample therefore consists of 56,727 firm-year observations that span 7,486 individual companies. Descriptive statistics for the sample are reported in Table 1. The variables exhibit substantial cross-sectional variation, which suggests that the sample includes a broad range of firms and is not confined to companies of certain characteristics.

TABLE 1

Summary Statistic

Table 1 reports data from Compustat Industrial Annual files (1982–2005). I exclude companies that belong to financial (SIC 6000–6999) and utility (SIC 4910–4939) industries, multisegment companies that operate in those industries, and firms with total book assets of less than $20 million in constant 1994 dollars. The liquidity index equals the ratio of the total value of corporate transactions (data from SDC M&A database) in the industry (defined at the two-digit SIC level) to total book value of assets of companies in that industry, and it is calculated for each industry-year. Total assets are total book assets measured in 1994 dollars (adjusted for the CPI). Cash holdings, total debt, capital expenditures, PPE, and EBIT are deflated by total book assets.

Statistics	Quartile 1	Median	Mean	Quartile 3	Std. Dev.
Cash holdings/Total book assets	0.019	0.066	0.151	0.201	0.198
Total debt/Total book assets	0.069	0.236	0.273	0.406	0.238
Total assets	59.4	181.8	1,832.0	721.5	8,819.6
R&D-to-sales	0.000	0.000	0.059	0.032	0.171
Capital expenditures/Total book assets	0.026	0.050	0.074	0.091	0.083
Market-to-book	1.062	1.380	1.840	2.036	1.403
PPE/Total book assets	0.131	0.268	0.327	0.478	0.242
EBIT/Total book assets	0.058	0.119	0.099	0.178	0.164
Liquidity index	0.0029	0.0078	0.0186	0.0214	0.0351

B. Details of the Liquidity Index Construction

Following Schlingemann et al. (2002), a firm's liquidity index is calculated as the average of the industry liquidity indices of segments' industries, weighted by the segments' total book value of assets. The industry liquidity index, in turn, equals the ratio of the total value of corporate transactions to the total book value of assets for each industry-year.[7] I define industry according to two-digit SIC levels and obtain data about corporate transactions from the Securities Data Corporation (SDC) Platinum Mergers and Acquisitions (M&A) database.[8] The book value of assets appears in the denominator of the industry liquidity index because the market value of assets can include the liquidity premium and be affected by

[6] If I estimate regressions on the larger sample and exclude the marginal tax rate estimate, I obtain qualitatively identical results.

[7] In a robustness check, I drop industries with fewer than 10 companies because of the concern that the liquidity index may be significantly affected by companies leaving and joining such small industries. The results remain qualitatively identical.

[8] Kahle and Walkling (1996) document that the SIC codes reported by Compustat differ from those of SDC, which introduces noise into the analysis. However, this noise does not significantly bias my results. First, the differences in SIC codes should be less significant at the two-digit SIC level. Second, I perform robustness tests by independently assigning Compustat and SDC observations to the 48 Fama and French (2002) industry portfolios and performing the analysis with these industry classifications. The results remain similar.

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asset liquidity.[9] For industry-years with no data on corporate transactions, the liquidity index is set equal to 0.

I construct the index using 15,795 corporate transactions completed between 1982 and 2005 whose value is available. The corporate transactions include all disclosed and completed leveraged buyouts, tender offers, exchange offers, stake purchases, privatizations, and equity carve-outs. Buybacks (e.g., repurchases, self-tenders) and spinoffs are excluded. A transaction gets assigned to the target's industry on the basis of the change in ownership of the target's industry assets. Furthermore, the target of the transaction must be classified as either a public company or a subsidiary, which ensures that the Compustat and SDC samples are similar in terms of companies covered.[10] As Table 1 reports, the average value of the liquidity index is 0.0186, and the median is 0.0078. The liquidity index ranges across industry-years from 0.0029 in the 25th percentile to 0.0214 in the 75th percentile, with a standard deviation of 0.0351.

To provide some assurance that the liquidity index is measuring the liquidity of the firm's assets, I analyze the relation between the liquidity index and the likelihood of PPE sales. Specifically, I estimate three separate conditional logit models in which the dependent variable is equal to 1 if the value of PPE sold is positive, positive but less than 10% of total book assets, and more than 10% of total book assets, respectively. If no asset sales are reported that year, the dependent variable equals 0. The explanatory variables include the liquidity index, firm size, research and development- (R&D-) to-sales ratio, market-to-book ratio, PPE over total assets, earnings before interest and tax (EBIT) over total book assets, and leverage. The models use an unbalanced panel of firm-year observations, and include firm fixed effects.

The results reported in Table 2 indicate that the coefficient on the liquidity index is positive and statistically significant in all three regressions, including the regression that models PPE sales of less than 10% of total book assets, which likely consist of smaller assets. Therefore, the likelihood of sales of small or large assets appears positively associated with the liquidity index. Because, ceteris paribus, companies are more likely to sell assets when their asset liquidity is higher and it is less costly to do so, this evidence provides reassurance that the liquidity index is associated with the liquidity of firm assets and is not confined to assets of a particular size. It is also consistent with the idea that the liquidity of small assets and the liquidity of large assets within an industry are driven by the same industry factors.

IV. Association between Leverage and Asset Liquidity

In this section, I first examine whether asset liquidity affects levels of leverage and changes in leverage. I then explore the relation between asset liquidity and secured debt, as well as between asset liquidity and unsecured debt. I conclude

[9] Maksimovic and Phillips (2001) demonstrate that asset liquidity affects the profitability of firms in the industry, which can affect the market values of those firms.

[10] This filter excludes transactions whose targets are classified as government, investor, joint venture, mutually owned, private, or unknown.

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TABLE 2

Determinants of Asset Sales

Table 2 reports data from Compustat Industrial Annual files (1982–2005). I exclude companies that belong to financial (SIC 6000–6999) and utility (SIC 4910–4939) industries, multisegment companies operating in those industries, and firms with total book assets of less than $20 million in constant 1994 dollars. The dependent variable in the three regressions equals 1 if a firm has positive PPE sales, PPE sales of less than 10% of total book assets, and PPE sales of more than 10% of total book assets, respectively. The dependent variable in the regressions equals 0 if no PPE sales were reported that year. The liquidity index equals the ratio of the total value of corporate transactions (data from SDC M&A database) in the industry (two-digit SIC level) to the total book value of assets of companies in that industry, calculated for each industry-year. Size is the log of total book assets measured in 1994 dollars (adjusted for CPI). The PPE and EBIT are deflated by total book assets. Total debt is total debt over total book assets. Regressions are estimated using conditional logit methodology with firm fixed effects. Statistical significance is based on autocorrelation and heteroskedasticity robust standard errors clustered at the firm level. ** and * denote significance at the 0.01 and 0.05 levels, respectively. Coefficient estimates are reported with *t*-statistics in parentheses.

Dependent Variable	Sell Assets	Sell > 10% of Total Book Assets	Sell < 10% of Total Book Assets
Liquidity index	0.841*	1.297*	0.899*
	(2.06)	(2.54)	(2.07)
Size	–0.039	–1.708**	–0.064
	(–1.19)	(–27.19)	(–1.77)
R&D-to-sales	–0.413*	0.724**	–0.211
	(–2.24)	(3.86)	(–0.99)
Market-to-book	–0.122**	0.331**	–0.139**
	(–7.62)	(23.29)	(–7.40)
PPE	0.842**	–2.321**	0.898**
	(4.26)	(–8.90)	(4.00)
EBIT	–0.421**	1.810**	–0.266
	(–3.14)	(11.25)	(–1.81)
Total debt	0.305*	–0.558**	0.290*
	(2.55)	(–3.72)	(2.25)
Observations	59,306	40,139	54,205

with the tests of additional cross-sectional differences in the relation between asset liquidity and leverage.

A. Level Regressions

To examine the association of leverage and asset liquidity, I perform multivariate regression analysis of the level of leverage on the liquidity index and a set of control variables that have been shown to correlate with leverage. The level of book leverage, defined as the ratio of total book debt to total book assets, serves as the dependent variable, and the liquidity index is the primary explanatory variable. The literature has identified firm size, growth opportunities, asset tangibility, profitability, and corporate tax status as important factors for explaining firm capital structure decisions.[11] To control for these well-known determinants of leverage, the level regressions include as explanatory variables the log of the total book assets adjusted by the Consumer Price Index (CPI); the ratio of R&D expenses to sales; the market-to-book ratio; the ratio of net PPE to total book assets; the ratio of earnings before interest, tax, and depreciation to total book assets; and an estimate of the before-financing corporate marginal tax rate. All variables in the regressions are contemporaneous. To avoid endogeneity between capital structure decisions and tax status, I follow Graham et al. (1998) and

[11]For example, Rajan and Zingales (1995), Fama and French (2002), and Graham, Lemmon, and Schallheim (1998).

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use an estimate of the marginal tax rate based on taxable income before financing (i.e., income before interest expense) as a control variable.[12] Previous studies find that the size, tangibility, and marginal corporate tax rate correlate positively with leverage, whereas profitability and the R&D-to-sales ratio correlate negatively with leverage. The evidence about the effect of the market-to-book ratio, however, remains mixed: Rajan and Zingales (1995) report a negative coefficient on market-to-book in leverage regressions, whereas Fama and French (2002) report a positive coefficient.

The results from the level regressions are reported in Table 3. Statistical significance is estimated using standard errors that are clustered at the firm level and are robust to heteroskedasticity and autocorrelation. The coefficient on the liquidity index is positive and statistically significant at the 0.01 level in the ordinary least squares (OLS) regression. Companies in industries with greater asset liquidity, as measured by the liquidity index, enjoy higher leverage. Because unobservable industry-specific factors can affect leverage, I reestimate the regression using industry fixed effects. In line with the OLS regression, the coefficient on the liquidity index in the fixed effects regression is positive and statistically significant at the 0.01 level. The effect of asset liquidity on a firm's debt level thus is economically significant. Given the standard deviation of the liquidity index of 0.0351, median leverage of 0.236, and the OLS coefficient on the liquidity index of 0.308, a one-standard-deviation change in asset liquidity results in a 0.0108 change in the firm's leverage and a 0.046 shift in the firm's outstanding debt.

In line with previous studies, the results indicate that larger firms and firms with more fixed assets should have higher leverage. The level of R&D expenses and the market-to-book ratio are negatively associated with leverage. The negative coefficient on market-to-book is consistent with results reported in Rajan and Zingales (1995) for U.S. firms. However, the negative coefficient on the marginal tax rate contrasts with the results of Graham et al. (1998). It may result from the relation of the tax rate estimate to other unobservable firm characteristics, though the results remain qualitatively similar when I exclude the marginal tax rate variable from the regressions. The EBIT coefficient is negative and significant, consistent with the hypothesis that internal cash flow acts as a substitute for external financing in the form of debt.

B. Change Regressions

In the next set of tests, I examine the dynamic aspect of the relation between asset liquidity and leverage by estimating the association between prior asset liquidity shocks and subsequent leverage adjustments and debt issues. Changes in leverage are regressed on the levels of the control variables and a prior change in the liquidity index.[13] I estimate the change regressions for one-, two-, and three-year future changes in leverage. The regressions include a two-year prior change

[12] I thank John Graham for providing the data on the estimates of the corporate marginal tax rates.

[13] The use of the levels of explanatory variables in the regressions implicitly assumes that there is some initial underreaction to shocks in the determinants of debt due to the fixed costs of capital structure adjustment. Results are similar, though, when changes in explanatory variables are used.

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TABLE 3

Determinants of Leverage

Table 3 presents data from Compustat Industrial Annual files (1982–2005). I exclude companies that belong to financial (SIC 6000–6999) and utility (SIC 4910–4939) industries, multisegment companies operating in those industries, and firms with total book assets of less than $20 million in constant 1994 dollars. The dependent variable is total book debt over total book assets. The liquidity index equals the ratio of the total value of corporate transactions (data from SDC M&A database) in the industry (industry defined at the two-digit SIC level) to the total book value of assets of companies in that industry, and it is calculated for each industry-year. Size is the log of total book assets measured in 1994 dollars (adjusted for CPI). The PPE and EBIT are deflated by total book assets. Tax rate is an estimate of the before-financing corporate marginal tax rate. Regressions are estimated using OLS and industry fixed effects methodologies. Statistical significance is based on autocorrelation and heteroskedasticity robust standard errors clustered at the firm level. R^2 excludes fixed effects. ** and * denote significance at the 0.01 and 0.05 levels, respectively. Coefficient estimates are reported with *t*-statistics in parentheses.

Estimation Methodology	OLS	Industry Fixed Effects
Liquidity index	0.308**	0.278**
	(7.96)	(7.86)
Size	0.013**	0.010**
	(10.68)	(9.02)
R&D-to-sales	–0.269**	–0.240**
	(–16.09)	(–14.02)
Market-to-book	–0.018**	–0.016**
	(–10.81)	(–9.87)
PPE	0.205**	0.213**
	(19.70)	(16.26)
EBIT	–0.300**	–0.293**
	(–14.65)	(–14.69)
Tax rate	–0.146**	–0.139**
	(–8.52)	(–8.68)
Intercept	0.242**	
	(27.13)	
Observations	56,727	56,727
Adjusted R^2	14.76%	10.14%

in the liquidity index, defined as the liquidity index in year t minus the liquidity index in year $t - 2$, as an explanatory variable. In addition to the change in the liquidity index and the common control variables, change regressions also include the level of leverage adjusted for the industry-year median to control for the fact that as leverage approaches 1, changes in debt more likely become nonpositive, indicating that leverage can only go down. Similarly, as leverage approaches 0, debt changes tend to become nonnegative, and leverage can only go up. I adjust the control leverage for the industry-year median to reduce possible endogeneity with the other explanatory variables. The regressions are estimated using industry fixed effects to control for unobservable industry characteristics.

The results appear in Table 4. In all regressions predicting future changes in leverage, the coefficient on the prior change in the liquidity index is positive and statistically significant. The magnitude of the coefficient increases for longer leverage change periods, which may indicate that leverage adjustment costs and initial underreaction delay firms' responses to changes in liquidity.[14] Companies tend to increase leverage following positive liquidity shocks and decrease it following negative shocks to their asset liquidity. The results stay qualitatively

[14]Underreaction to liquidity changes may be explained by the mean reversion exhibited by asset liquidity. In an unreported regression of change in the liquidity index on lagged change in the index, I obtain a statistically significant coefficient of −0.31. Thus, managers may be ignoring initial liquidity shocks because they expect them to revert in the future.

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similar for both one-year and three-year prior changes in the liquidity index as the main explanatory variable.

TABLE 4

Determinants of Future Leverage Changes and Debt Issues

Table 4 presents data from Compustat Industrial Annual files (1982–2005). I exclude companies that belong to financial (SIC 6000–6999) and utility (SIC 4910–4939) industries, multisegment companies operating in those industries, and firms with total book assets of less than $20 million in constant 1994 dollars. The dependent variable is change in total debt over total book assets from year t to year ($t + i$). The dependent variable in debt issue, substantial debt issue, and conditional debt issue logit regressions equals 1 if net long-term debt issues are positive, positive and greater than 10% of total debt outstanding, and positive when debt or equity is issued. Liquidity index change is the change in firm liquidity index from year $t - 2$ to year t. The liquidity index equals the ratio of the total value of corporate transactions (data from SDC M&A database) in the industry (two-digit SIC level) to the total book value of assets of companies in that industry, calculated for each industry-year. Size is the log of total book assets measured in 1994 dollars (adjusted for CPI). The PPE and EBIT are deflated by total book assets. Tax rate is an estimate of the before-financing corporate marginal tax rate. Adjusted total debt is total debt over total book assets adjusted for industry-year median. Leverage change regressions are estimated using industry fixed effects, and debt issues regressions are estimated using firm effects conditional logit methodology. Statistical significance is based on autocorrelation and heteroskedasticity robust standard errors clustered at the firm level. R^2 excludes fixed effects. Pseudo R^2 is reported in logit regressions. ** and * denote significance at the 0.01 and 0.05 levels, respectively. Coefficient estimates are reported with t-statistics (z-statistics for logit regressions) in parentheses.

	Change in Total Debt/ Total Book Assets			Debt Issue	Substantial Debt Issue	Conditional Debt Issue
Dependent Variable from Year t to Year	$t + 1$	$t + 2$	$t + 3$			
Estimation Methodology	Industry Fixed Effects	Industry Fixed Effects	Industry Fixed Effects	Logit	Logit	Logit
Liquidity index change	0.057**	0.100**	0.148**	1.239**	1.155**	2.606**
	(2.95)	(4.16)	(5.86)	(3.97)	(3.49)	(4.08)
Size	0.001	0.001	0.001	–0.108**	–0.172**	0.362**
	(0.24)	(0.41)	(0.40)	(–3.63)	(–5.25)	(5.37)
R&D-to-sales	0.001	0.015	0.034	0.765*	1.358**	–0.576
	(0.01)	(1.04)	(1.66)	(2.19)	(3.22)	(–0.60)
Market-to-book	0.001	0.001	0.002	0.136**	0.172**	–0.133**
	(0.34)	(0.40)	(1.03)	(6.49)	(7.35)	(–2.83)
PPE	0.023**	0.038**	0.050**	1.478**	1.306**	1.411**
	(5.40)	(4.84)	(4.82)	(7.22)	(6.09)	(3.62)
EBIT	–0.038**	–0.037*	–0.055**	0.983**	1.307**	2.601**
	(–3.19)	(–2.11)	(–2.82)	(4.35)	(5.20)	(4.57)
Tax rate	0.001	0.028*	0.072**	0.889**	0.948**	1.090**
	(0.21)	(2.15)	(4.43)	(5.00)	(4.92)	(3.05)
Adjusted total debt	–0.108**	–0.213**	–0.289**	–2.113**	–3.763**	–3.662**
	(–9.25)	(–12.38)	(–14.04)	(–15.33)	(–23.60)	(–12.19)
Observations	46,613	41,119	36,287	36,544	35,379	12,363
Adjusted R^2	3.23%	7.24%	10.43%	2.70%	5.81%	5.52%

To supplement the change regressions, I estimate regressions of the probability of net long-term debt issues (i.e., debt issuance minus debt reduction) as a function of the main control variable used in change regressions and the liquidity index. In the three firm fixed effects conditional logit regressions, the dependent variables equal 1 if the net long-term debt issues are positive, are positive and greater than 10% of total outstanding debt, and are positive when debt or equity is issued. In all three regressions, the coefficient on the prior change in the liquidity index is positive and significant, consistent with the idea that prior changes in the liquidity index have a positive and significant effect on the likelihood that a firm issues debt.

Overall, the results from leverage regressions indicate that, after controlling for other variables, leverage is positively associated with the liquidity index, and

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changes in leverage are positively associated with prior changes in the liquidity index. These findings therefore support the hypothesis that asset liquidity has a positive effect on optimal leverage; moreover, they are consistent with the idea that the expected costs of financial distress and asset liquidation are sizeable, so managers attempt to control these costs by adjusting leverage and the probability of incurring liquidation costs.

C. Secured and Unsecured Debt Regressions

In this subsection, I test the predictions of Myers and Rajan (1998) and Morellec (2001) that the effect of asset liquidity on debt depends on whether the disposition of assets is restricted. One way to test these predictions is to recognize that secured debt limits managers' ability to transform assets and expropriate asset value, whereas unsecured debt typically does not. If asset liquidity increases the optimal leverage when the assets are tied up as collateral, firms with greater asset liquidity should issue more secured debt; if asset liquidity reduces optimal leverage when assets are not tied up as collateral, firms with greater asset liquidity should issue less unsecured debt. From this perspective, Morellec (2001) predicts that asset liquidity relates negatively to the level of unsecured debt, but Myers and Rajan (1998) predict a curvilinear relation as the level of unsecured debt first increases and then declines with greater asset liquidity. Both models, however, would predict a positive relation between asset liquidity and the level of secured debt. I test both models by estimating regressions of the determinants of the levels of secured and unsecured debt, standardized by total book assets. The common variables used to explain leverage serve as the control variables, along with the liquidity index as the main variable of interest. To allow for possible nonlinearities in the effect of asset liquidity on debt levels, the regressions include the liquidity index squared.

However, a caveat is in order. The data distinguish only between secured and unsecured debt. Debt contracts, however, could include covenants that restrict the disposition of assets, but firms could still classify debt with these covenants as unsecured. In terms of its effect on managerial discretion and asset sales, unsecured debt with restrictions on the disposition of assets is similar to secured debt. That is, managers can liquidate neither assets that serve as collateral nor assets with restricted disposition. This factor introduces a bias into the analysis that argues against finding a difference between the effect of liquidity on secured and unsecured debt.

The results of the regressions are reported in Table 5. In secured debt regressions, the coefficient on the liquidity index is positive and statistically significant and the coefficient on the liquidity index squared is statistically insignificant. Therefore, the liquidity index appears positively associated with the level of secured debt. In unsecured debt regressions, however, the coefficient on the liquidity index is positive and statistically significant, whereas the coefficient on the liquidity index squared is negative and statistically significant for OLS and fixed effects regressions, which reveals a curvilinear relation.

The results from secured debt regressions are therefore consistent with both Myers and Rajan (1998) and Morellec (2001). When managers have no discretion

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TABLE 5

Determinants of Secured and Unsecured Debt

Table 5 presents data from Compustat Industrial Annual files (1982–2005). I exclude companies that belong to financial (SIC 6000–6999) and utility (SIC 4910–4939) industries, multisegment companies operating in those industries, and firms with total book assets of less than $20 million in constant 1994 dollars. The dependent variables are secured debt over total book assets, unsecured debt over total book assets, and total debt over total book assets. The liquidity index equals the ratio of the total value of corporate transactions (data from SDC M&A database) in the industry (two-digit SIC level) to the total book value of assets of companies in that industry, calculated for each industry-year. Size is the log of total book assets measured in 1994 dollars (adjusted for CPI). The PPE and EBIT are deflated by total book assets. Tax rate is an estimate of the before-financing corporate marginal tax rate. Regressions are estimated using OLS and industry fixed effects. Statistical significance is based on autocorrelation and heteroskedasticity robust standard errors clustered at the firm level. R^2 reported excludes fixed effects. ** and * denote significance at the 0.01 and 0.05 levels, respectively. Coefficient estimates are reported with *t*-statistics in parentheses.

Dependent Variable	Secured Debt		Unsecured Debt		Total Debt	
Estimation Methodology	OLS	Industry Fixed Effects	OLS	Industry Fixed Effects	OLS	Industry Fixed Effects
Liquidity index	0.123**	0.134**	0.143**	0.105**	0.368**	0.392**
	(2.72)	(3.44)	(3.57)	(2.83)	(6.74)	(8.33)
Liquidity index squared	0.010	–0.120	–0.210**	–0.172**	–0.181	–0.334**
	(0.09)	(–1.38)	(–3.10)	(–2.78)	(–1.75)	(–3.61)
Size	–0.015**	–0.016**	0.032**	0.031**	0.013**	0.010**
	(–18.96)	(–20.16)	(34.03)	(33.33)	(10.74)	(9.07)
R&D-to-sales	–0.113**	–0.093**	–0.027*	–0.017	–0.268**	–0.239**
	(–13.67)	(–10.75)	(–2.12)	(–1.21)	(–16.08)	(–14.02)
Market-to-book	–0.008**	–0.007**	–0.005**	–0.005**	–0.018**	–0.016**
	(–9.27)	(–8.05)	(–3.98)	(–3.75)	(–10.82)	(–9.86)
PPE	0.175**	0.169**	0.048**	0.040**	0.205**	0.213**
	(20.20)	(17.27)	(6.47)	(3.90)	(19.70)	(16.26)
EBIT	–0.078**	–0.067**	–0.086**	–0.092**	–0.300**	–0.293**
	(–6.97)	(–6.37)	(–6.22)	(–6.53)	(–14.63)	(–14.67)
Tax rate	–0.073**	–0.078**	–0.021	–0.005	–0.147**	–0.141**
	(–6.04)	(–6.96)	(–1.79)	(–0.46)	(–8.58)	(–8.80)
Intercept	0.166**		–0.049**		0.241**	
	(27.21)		(–7.92)		(27.02)	
Observations	50,530	50,530	50,506	50,506	56,727	56,727
Adjusted R^2	12.40%	8.84%	12.81%	10.55%	14.77%	10.16%

over the disposition of firm assets, asset liquidity has a positive effect on debt. However, the findings from the unsecured debt regressions are consistent only with Myers and Rajan (1998), who argue that when managers have that discretion and transformation risk exists, the relation between asset liquidity and the level of debt is curvilinear. Specifically, asset liquidity has a positive effect on the amount of firm debt when liquidity is low but a negative effect when liquidity is high.

D. Level Regressions Revisited

A curvilinear relation between asset liquidity and unsecured debt raises some natural questions: Is the relation between asset liquidity and leverage determined by the combined effect of asset liquidity on secured and unsecured debt? Is the relation between asset liquidity and leverage curvilinear? I examine possible nonlinearity by reestimating the leverage regression with the liquidity index squared as an additional explanatory variable, as reported in Table 5. The coefficient on the liquidity index is positive and significant at the 0.01 level. In addition, the coefficient on the liquidity index squared is negative for OLS and industry fixed effects regressions, significant at the 0.10 and 0.01 levels, respectively. This

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evidence is consistent with the conjecture that the effect of asset liquidity on leverage depends on the combination of the effect of asset liquidity on both secured and unsecured debt.

E. Tests of Additional Implications of the Liquidity Theories

To provide further evidence regarding the liquidity hypotheses, I develop and examine some additional implications of Williamson's (1988) and Shleifer and Vishny's (1992) research on the basis of the effects of the amount of tangible assets in place and the probability of bankruptcy on the relation between asset liquidity and leverage. Therefore, this analysis differentiates between the liquidity theories and alternative explanations and interpretations of the results.

First, Williamson (1988) argues that low asset liquidity increases the costs of liquidation for financiers, who then limit the amount or increase the cost of debt for companies. However, this relation holds only if the expected liquidation value of the assets is less than the value of debt, such as when there are not enough assets to liquidate and the liquidation proceeds will be insufficient to retrieve the full value of debt. Liquidation proceeds and asset liquidity therefore are more likely to determine the expected payout to debtholders if there are fewer assets relative to the value of debt. That is, if the expected liquidation values are greater than the value of debt, asset liquidity does not determine the payout to debtholders in the event of liquidation, so the relation between asset liquidity and leverage will be stronger (weaker) for firms with fewer (more) tangible assets relative to debt.

Second, Shleifer and Vishny (1992) argue that the positive relation between asset liquidity and leverage results from managers who control the expected costs of distress and liquidation by reducing leverage levels when asset liquidity is low. However, the marginal effect of asset liquidity on the expected costs of distress weakens if the probability of distress is low. Thus, regardless of asset liquidity, managers will not reduce leverage if the probability of distress is low in the first place, which makes the expected costs of distress low. In such circumstances, the relation between asset liquidity and leverage becomes weak or insignificant. Thus, their argument implies a weaker (stronger) relation between asset liquidity and leverage for firms with a lower (higher) probability of default.

To test these implications, I partition the study sample according to relative asset tangibility and the interest coverage ratio. The interest coverage ratio proxies for the probability of default, assuming that the probability of default is lower for firms with a higher ratio. High and low relative asset tangibility companies are those firms whose ratio of PPE value to the value of total debt outstanding falls above or below 1.3, respectively. Similarly, high and low interest coverage ratio companies are those whose ratio of EBIT to interest expense is greater or less than 1.3, respectively.[15] The results are in Table 6.

[15]I set the cutoff at 1.3 rather than 1.0 to ensure that the high interest coverage ratio group does not include companies that have little net working capital, which would mean they face a higher possibility of not being able to pay their current liabilities with current assets. Similar reasoning applies to the relative asset tangibility cutoff. Moreover, the results with a 1.0 cutoff are similar.

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TABLE 6

Determinants of Leverage by Asset Tangibility and Interest Coverage

Table 6 presents data from Compustat Industrial Annual files (1982–2005). I exclude companies that belong to financial (SIC 6000–6999) and utility (SIC 4910–4939) industries, multi-segment companies with segments operating in those industries, and firms with total book assets of less than $20 million in constant 1994 dollars. The sample is partitioned by relative asset tangibility and the interest coverage ratio. High (low) relative asset tangibility companies are those whose ratio of PPE value to the value of total debt outstanding is greater (less) than 1.3. High (low) interest coverage ratio companies are those whose ratio of EBIT to interest expense is greater (less) than 1.3. The dependent variable is total debt over total book assets. The liquidity index equals the ratio of total value of corporate transactions (data from SDC M&A database) in the industry (two-digit SIC level) to the total book value of assets of companies in that industry, calculated for each industry-year. Although unreported, regressions also include size, R&D-to-sales ratio, market-to-book ratio, net PPE over total book assets, EBIT over total book assets, and tax rate. Size is the log of total book assets measured in 1994 dollars (adjusted for CPI). Tax rate is an estimate of the before-financing corporate marginal tax rate. Regressions are estimated using industry fixed effects methodology. Statistical significance is based on autocorrelation and heteroskedasticity robust standard errors clustered at the firm level. R^2 excludes fixed effects. ** and * denote significance at the 0.01 and 0.05 levels, respectively. Coefficient estimates are reported with *t*-statistics in parentheses.

	Low	High	*p*-Value	Low	High	*p*-Value
Panel A. Relative Asset Tangibility						
Liquidity index	0.177**	0.051	0.010	0.252**	0.025	0.001
	(4.51)	(1.88)	(2.59)	(4.47)	(0.68)	(3.34)
Liquidity index squared				–0.212*	0.078	0.025
				(–2.00)	(1.28)	(2.25)
Observations	25,235	26,539		25,235	26,539	
Adjusted R^2	20.06%	36.36%		20.07%	36.36%	
Panel B. Interest Coverage Ratio						
Liquidity index	0.390**	0.171**	0.008	0.469**	0.243**	0.060
	(4.52)	(4.99)	(2.64)	(3.40)	(5.21)	(1.88)
Liquidity index squared				–0.212	–0.215*	0.786
				(–0.89)	(–2.43)	(0.27)
Observations	8,884	44,285		8,884	44,285	
Adjusted R^2	8.94%	7.87%		8.93%	7.88%	

After partitioning the sample by relative asset tangibility, the coefficient on asset liquidity for the low tangibility category emerges as positive and significant at the 0.01 level, whereas the coefficient for the high asset tangibility category is lower in magnitude and statistically significant at only the 0.10 level. The Wald test rejects the equality of the coefficients for the two subsamples, with a *p*-value of 0.07. That is, the relation between asset liquidity and leverage is stronger when there are fewer fixed assets relative to the debt outstanding. This result is consistent with the hypothesis that financiers are more likely to account for the effect of firm asset liquidity on the cost of debt when the liquidation proceeds should be insufficient to retrieve the value of debt outstanding. When I partition the sample by interest coverage ratio, the coefficient on asset liquidity for the low interest coverage subsample is greater than that for the high interest coverage group, though both coefficients are statistically significant at the 0.01 level. The Wald test rejects the equality of the coefficients at the 0.01 level of significance. The relation between asset liquidity and leverage is stronger for companies with a higher probability of default, which is consistent with the hypothesis that if the probability of distress is low, the marginal effect of asset liquidity on the expected costs of distress will be low. These findings also are consistent with Williamson (1988) and Shleifer and Vishny (1992) and with the effect of asset liquidity on leverage.

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V. Robustness Tests and Alternative Interpretations

Although the results from the primary tests are consistent with the hypothesis that asset liquidity affects leverage, I examine some alternative explanations for the findings, namely, i) the effect of merger waves, ii) the effect of asset fire sales, iii) the effect of post-merger increases in leverage, and iv) the positive relation between the probability of a corporate control transaction and leverage.

A. Are the Results Driven by Merger Waves?

To ensure that the findings are not driven by periods of unusually high corporate control activity, I perform several robustness checks. First, I estimate the regressions for the periods 1982–1991 and 1992–2005 and report the results in Table 7. The relations between the liquidity index and leverage, the liquidity index and secured debt, and the liquidity index and unsecured debt in the subperiods are similar to those obtained for the main results.

TABLE 7

Determinants of Secured and Unsecured Debt by Time Period

Table 7 presents data from Compustat Industrial Annual files (1982–2005). Regressions are estimated for the periods 1982–1991 and 1992–2002. I exclude companies that belong to financial (SIC 6000–6999) and utility (SIC 4910–4939) industries, multisegment companies operating in those industries, and firms with total book assets of less than $20 million in constant 1994 dollars. The dependent variables are secured debt over total book assets, unsecured debt over total book assets, and total debt over total book assets. The liquidity index equals the ratio of total value of corporate transactions (data from SDC M&A database) in the industry (two-digit SIC level) to the total book value of assets of companies in that industry, calculated for each industry-year. Size is the log of total book assets measured in 1994 dollars (adjusted for CPI). The PPE and EBIT are deflated by total book assets. Tax rate is an estimate of the before-financing corporate marginal tax rate. Regressions are estimated using industry fixed effects. Statistical significance is based on autocorrelation and heteroskedasticity robust standard errors clustered at the firm level. R^2 excludes fixed effects. ** and * denote significance at the 0.01 and 0.05 levels, respectively. Coefficient estimates are reported with *t*-statistics in parentheses.

	Period					
	Pre-1991			Post-1992		
Dependent Variable	Total Debt	Secured	Unsecured	Total Debt	Secured	Unsecured
Liquidity index	0.255**	0.127**	0.144**	0.627**	0.245**	0.235**
	(5.60)	(3.30)	(3.78)	(5.86)	(2.95)	(2.79)
Liquidity index squared	–0.166	–0.089	–0.240**	–2.497**	–0.398	–1.146*
	(–1.82)	(–1.02)	(–3.55)	(–3.75)	(–0.71)	(–2.08)
Size	0.004*	–0.019**	0.026**	0.015**	–0.014**	0.033**
	(2.27)	(–15.67)	(20.33)	(11.84)	(–15.57)	(30.80)
R&D-to-sales	–0.389**	–0.114**	–0.073**	–0.193**	–0.085**	–0.006
	(–12.16)	(–7.32)	(–3.23)	(–10.50)	(–8.67)	(–0.40)
Market-to-book	–0.017**	–0.006**	–0.009**	–0.015**	–0.008**	–0.004**
	(–5.20)	(–2.89)	(–4.30)	(–8.68)	(–8.09)	(–2.72)
PPE	0.194**	0.194**	0.012	0.216**	0.156**	0.054**
	(10.61)	(12.74)	(0.98)	(13.34)	(13.57)	(4.01)
EBIT	–0.387**	–0.115**	–0.093**	–0.220**	–0.040**	–0.087**
	(–7.98)	(–5.30)	(–4.69)	(–10.44)	(–3.42)	(–4.76)
Tax rate	–0.201**	–0.053**	–0.001	–0.172**	–0.093**	–0.015
	(–6.43)	(–2.61)	(–0.06)	(–8.79)	(–6.58)	(–1.00)
Observations	21,791	18,603	18,598	34,936	31,927	31,908
Adjusted R^2	12.44%	10.38%	9.23%	9.74%	8.04%	11.34%

Second, I remove observations that fall into periods marked by merger waves, as defined by Harford (2005). The findings remain qualitatively similar, and the coefficient on the liquidity index in leverage regressions is positive and

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statistically significant. Third, to ensure that the findings are not driven by firms' endogenous responses to corporate control activity, I exclude all firms involved in corporate control transactions used to construct the liquidity index in the year of the transaction, as well as the adjacent years before and after the completed transaction. The coefficient on the liquidity index in leverage regressions remains positive and statistically significant. Fourth, I control for year fixed effects by estimating the regressions with calendar-year dummies. The main relation between the liquidity index and leverage remains similar, although the magnitude of the relation weakens. This may occur because the liquidity index is an industry-year measure, and adding industry and then calendar year fixed effects takes away explanatory power of the liquidity measure. However, whereas the coefficient on the liquidity index in secured debt regressions weakens in magnitude but remains positive and significant, the relation between the liquidity index and unsecured debt becomes statistically insignificant.

B. Does the Liquidity Index Measure Asset Fire Sales?

The value of corporate transactions may be related negatively to asset liquidity, not related positively as hypothesized in this study. When many firms in an industry sell their assets in distress, the value of corporate transactions is high but liquidity is low, and the assets sell at substantial discounts relative to their values in optimal sale. Asset fire sales occur during periods of poor industry performance and enable firms to liquidate their assets to generate cash because their cash flow is insufficient or external capital is expensive.[16] Therefore, if asset liquidity drives the relationship between the liquidity index and leverage, it cannot be confined just to periods of asset fire sales.

I partition the sample into quartiles of industry-year performance, measured by median firm cash flow, median firm operating performance, and the value-weighted and equally weighted average returns of firms in an industry. In unreported tests, for all these measures of performance, the relationship between leverage and the liquidity index is positive and significant for the lowest quartile, as well as for quartiles two through four. Overall, the significantly positive relationship between the liquidity index and leverage is not confined to industry-years with low performance. The relationship remains strong even when the liquidity index likely does not measure the level of asset fire sales, which suggests that the results do not occur because the liquidity index captures the effect of asset fire sales.

C. Are the Results Driven by Post-Merger Increases in Leverage?

Ghosh and Jain (2000) argue that the financial leverage of combined firms increases after mergers because of the increased debt capacity, which suggests a positive relation between leverage and the liquidity index, because increases in leverage should occur after high merger and acquisition activity in an industry. Ghosh and Jain (2000) also demonstrate that leverage changes after a merger are

[16] See Shleifer and Vishny (1992) and Pulvino (1999).

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rather permanent, maintained for all five post-merger years they examine. If the findings herein result from firms increasing their leverage following mergers, no leverage and debt reductions should occur when merger activity declines and the liquidity index drops.

To explore this prediction, I investigate the effect of positive and negative liquidity index changes on future leverage changes. I construct a negative liquidity shock dummy equal to 1 if changes in the liquidity index are negative in each of the past two years and 0 otherwise. A similar positive liquidity shock dummy indicates positive prior shocks to the liquidity index. I require two consecutive years of same-sign changes in the liquidity index to ensure that the shock to the index is significant and nontransitory.[17] Then, the liquidity shock dummies are interacted with the prior change in the liquidity index. The positive (negative) interaction captures the shift in the coefficient for prior liquidity index changes when these changes are significant and nontransitory as a result of a positive (negative) liquidity shock. The results appear in Table 8.

Negative shocks have a more significant effect on leverage changes than other changes in the liquidity index. When I include the shock interactions in the change regressions, the coefficient on the prior liquidity change remains positive and significant. The coefficient on the negative liquidity shock interaction is positive and significant in the three-year leverage change regressions, but the coefficient on the positive liquidity shock interaction is negative and statistically significant for both one- and three-year regressions. Additional tests indicate that the effect of the negative liquidity shocks on leverage changes is positive and significantly greater in magnitude than that of positive liquidity shocks. The Wald test rejects the equality of the coefficients on the negative and positive liquidity shock interactions for one-, two-, and three-year regressions. These findings therefore contrast with Ghosh and Jain's (2000) effect and indicate they probably are not driven by post-merger increases in leverage.

D. Are the Results Driven by a Positive Relation between the Likelihood of a Corporate Control Transaction and Leverage?

If the probability of a corporate control transaction increases with the total value of transactions in an industry, the liquidity index may relate positively to the likelihood that a company engages in a merger or acquisition. Several reasons support a positive relation between leverage and the likelihood of a corporate control transaction. For a potential target, Israel (1991) argues that high leverage reduces the likelihood of an acquisition attempt. When the probability of a corporate control transaction is high, a firm may increase leverage to reduce the chances of becoming a target. A potential acquirer may increase leverage to signal the higher quality of the decision to acquire another firm and increase the expected profitability of its future acquisitions.[18] Maloney, McCormick, and Mitchell (1993) reveal that high-leverage firms make better acquisitions and that announcement

[17]The liquidity index exhibits a high degree of mean reversion, with a coefficient on the lagged change of −0.31.

[18]See Jensen (1986) and Harris and Raviv (1990).

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TABLE 8

Determinants of Leverage Changes with Liquidity Shocks

Table 8 presents data from Compustat Industrial Annual files (1982–2005). I exclude companies that belong to financial (SIC 6000–6999) and utility (SIC 4910–4939) industries, multisegment companies operating in those industries, and firms with total book assets of less than $20 million in constant 1994 dollars. The dependent variable is change in total debt over total book assets from year t to year ($t + i$). Liquidity index change is the change in firm liquidity index from year $t - 2$ to year t. The liquidity index equals the ratio of the total value of corporate transactions (data from SDC M&A database) in the industry (two-digit SIC level) to the total book value of assets of companies in that industry, calculated for each industry-year. The negative (positive) liquidity shock dummy equals 1 if the liquidity index change is negative (positive) in each of the past two years and 0 otherwise. Size is the log of total book assets measured in 1994 dollars (adjusted for CPI). The PPE and EBIT are deflated by total book assets. Tax rate is an estimate of the before-financing corporate marginal tax rate. Adjusted total debt is total debt over total book assets, adjusted for industry-year median. Regressions are estimated using industry fixed effects methodology. Statistical significance is based on autocorrelation and heteroskedasticity robust standard errors clustered at the firm level. R^2 excludes fixed effects. ** and * denote significance at the 0.01 and 0.05 levels, respectively. Coefficient estimates are reported with t-statistics in parentheses.

Dependent Variable	Change in Total Debt/ Total Book Assets		
from Year t to Year	$t + 1$	$t + 2$	$t + 3$
Liquidity index	0.088*	0.101**	0.155**
	(2.21)	(2.90)	(3.44)
Negative liquidity shock	0.006	0.053	0.132*
	(0.10)	(0.86)	(2.19)
Positive liquidity shock	–0.096	–0.054	–0.144*
	(–1.80)	(1.09)	(–2.33)
Size	0.001	0.001	0.001
	(0.19)	(0.37)	(0.34)
R&D-to-sales	0.001	0.015	0.035
	(0.04)	(1.06)	(1.68)
Market-to-book	0.001	0.001	0.002
	(0.32)	(0.38)	(0.99)
PPE	0.023**	0.038**	0.050**
	(5.42)	(4.85)	(4.84)
EBIT	–0.037**	–0.037*	–0.055**
	(–3.17)	(–2.11)	(–2.82)
Tax rate	0.002	0.028*	0.072**
	(0.21)	(2.17)	(4.45)
Adjusted total debt	–0.108**	–0.213**	–0.289**
	(–9.25)	(–12.37)	(–14.04)
Observations	46,613	41,119	36,287
Adjusted R^2	3.24%	7.25%	10.47%

period returns are higher for high-leverage bidders. Chowdhry and Nanda (1993) also argue that the higher leverage of a bidder deters potential entry by subsequent bidders and allows the initial bidder to acquire the target at a bargain price, which increases the expected profitability of the acquisition. I therefore explore whether the main results of this study are driven by any of these effects.

First, according to Israel (1991), Maloney et al. (1993), and Chowdhry and Nanda (1993), low-leverage firms benefit from leverage increases in anticipation of mergers and acquisitions at least as much as high-leverage firms do, as long as the costs of increasing that leverage are not higher for low-leverage firms. Under these theories, the relationship between the liquidity index and leverage should be at least as strong for low-leverage firms as it is for high-leverage firms. I estimate the leverage regressions for subsamples of low- and high-leverage firms by partitioning the sample according to the median total book debt to total book assets.[19]

[19]The sample median book leverage is 0.236. The results are qualitatively identical if firms with a leverage above (below) industry-year median are classified as high (low) leverage.

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The coefficient on the liquidity index is higher in magnitude and stronger in statistical significance for high-debt firms in OLS and fixed effects regressions. The Wald test also rejects the equality of the coefficients for high- and low-leverage firms, opposite to what Israel (1991), Maloney et al. (1993), and Chowdhry and Nanda (1993) would predict. The relation between asset liquidity and leverage is stronger for companies with high leverage, consistent with the joint hypothesis that asset liquidity affects the costs of default and that managers control these costs by adjusting leverage. Everything else being equal, firms with higher leverage face a higher probability of default than do firms with lower leverage. Therefore, the marginal effect of asset liquidity on the expected costs of financial distress and, in turn, leverage is higher for high-leverage firms than for low-leverage firms.

Second, the effect of the market for corporate control does not reconcile with the stronger association between the liquidity index and leverage for low interest coverage firms and low relative asset tangibility firms. That is, the effect of the market for corporate control implies that firms balance the costs and benefits of issuing debt in response to a more active market for corporate control. However, the costs of issuing debt are highest for low interest coverage and low relative asset tangibility firms, which implies a weaker, not stronger, relation between the liquidity index and leverage.

Third, I construct a modified private acquirer liquidity index using only transactions whose acquirer is categorized as private, investor, or government,[20] and thereby reduce the probability that the transactions used to construct the liquidity index are susceptible to Chowdhry and Nanda's (1993) hypothesized effects, which apply only to transactions with buyers with publicly observable capital structures (i.e., public firms). The main results of this study remain qualitatively the same, which indicates they are not driven by the effect of Chowdhry and Nanda (1993).

Overall, these findings suggest that the main results of this study are not driven by the effects of the market for corporate control and contradict the theories of Israel (1991), Maloney et al. (1993), and Chowdhry and Nanda (1993).

VI. Conclusions and Discussion

The liquidity index is positively associated with leverage, and prior changes in the liquidity index are positively associated with subsequent changes in leverage. The findings are consistent with the hypotheses of Williamson (1988) and Shleifer and Vishny (1992); that is, asset liquidity increases optimal leverage. The costs of illiquidity and inefficient liquidation are economically significant and substantial compared with the benefits of debt, and managers attempt to control these costs by adjusting leverage and the probability of incurring liquidation costs.

I also find that the relation between the liquidity index and the level of secured debt is positive, and that the relation between the liquidity index and

[20]This effort eliminates all transactions with public companies or subsidiaries as the acquirers from the original liquidity index.

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unsecured debt is curvilinear. These findings are consistent with the predictions of Myers and Rajan (1998); that is, the effect of asset liquidity on debt depends on whether managers have disposition over those assets. Asset liquidity has a positive effect on firm debt when managers cannot dispose of firm assets, and it has a curvilinear effect on firm debt when they can. The findings further suggest that asset liquidity increases the costs of managerial discretion, because higher asset liquidity makes it less costly for managers to sell assets and divert value from bondholders. Restrictions on asset disposition effectively reduce the liquidity costs of managerial discretion, and managers do not divert value by liquidating assets when their liquidity is low, because the private benefits of managing those assets outweigh the gains from the costly asset transformation. Thus, the private benefits of control act as a deterrent to asset liquidation and value expropriation by managers, alleviating agency problems. Overall, the results suggest that the effect of asset liquidity on leverage depends on a combination of its effects on both secured and unsecured debt.

Additional tests uncover cross-sectional differences in the relation between asset liquidity and leverage that are consistent with Williamson (1988) and Shleifer and Vishny (1992). Specifically, the relation between asset liquidity and leverage is stronger for companies that have fewer fixed assets relative to debt and for companies with greater probability of default.

Furthermore, these results are consistent with the arguments of Welch (2004), Ju, Parrino, Poteshman, and Weisbach (2005), and Strebulaev (2007) that capital structure adjustments are infrequent, and firms often deviate from target leverage ratios, possibly because of the significant leverage adjustment costs. This claim mirrors evidence of a delay in responses of leverage to liquidity shocks, and a stronger effect of negative liquidity shocks on leverage documented in this paper, which is consistent with the existence of sizeable leverage adjustment costs. Specifically, assume that the leverage adjustment costs are positive and that managers trade off the costs and benefits of adjusting leverage. According to Shleifer and Vishny (1992), negative liquidity shocks should increase the expected costs of financial distress, and managers reduce leverage if the resulting change in the expected costs of financial distress is greater than leverage adjustment costs. Following positive liquidity shocks, however, managers trade off the incremental benefits of debt against leverage adjustment costs. The more likely adjustment in the former case, compared with the latter, suggests that the marginal effect of asset liquidity on the expected costs of financial distress is greater than the leverage adjustment costs, which in turn are greater than the incremental benefits of debt. This discussion and the asymmetry of the effect suggest that leverage adjustment points can be asymmetrically located around the target leverage ratio. Additionally, the location of the adjustment points may be determined by the probability of default (e.g., the level of debt) and the relative asset tangibility.

The results in this paper provide strong evidence that the expected costs of distress are economically sizeable and substantial as compared to leverage adjustment costs and the benefits of debt. This is consistent with Ju et al. (2005), who argue that bankruptcy and distress costs are higher than previously thought, which may be a factor that drives the seemingly low leverage ratios.

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