Does Bond Liquidity Affect Financial Contracts?

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Abstract

This paper examines the relation between a firm's bond liquidity and the contractual terms of its newly issued bonds. We find firms with better bond liquidity issue bonds with lower borrowing cost, longer maturities, and fewer restrictive covenants. These results hold after we control for firm and year fixed effects, various bond and firm characteristics, and alternative proxies of bond liquidity. To identify the causal effect of bond liquidity on debt contracts, we study an exogenous shock to liquidity – the implementation of TRACE – and find that the increase of liquidity due to the incidence of TRACE indeed affects debt contracts as expected. We also find that the liquidity effect is more pronounced in firms with poorer credit rating, more short-term debt, and lower growth opportunity. These findings are consistent with the argument that better bond liquidity reduces a firm's rollover risk, credit risk, and agency conflicts between shareholders and bondholders so that the firm will obtain favorable contractual terms in future bond issues.

Key words: bond liquidity, cost of debt, debt covenants, and debt maturity

1. Introduction

Recently, the liquidity of U.S. bond markets has captured the great attention of researchers, practitioners and policy makers alike. A rapidly growing body of literature has provided theoretical insights and empirical evidence suggesting that illiquidity of the secondary debt market is important in the pricing of corporate bonds (Longstaff, Mithal, and Neis (2005), Chen, Lesmond and Wei (2007), Ericsson and Renault (2006), Bao, Pan and Wang (2011), He and Xiong (2012), and Dick-Nielsen, Feldhütter, and Lando (2012), among others). While previous studies focus mainly on the influence of bond liquidity on bond pricing in the secondary market, there is little known about whether bond liquidity affects corporate debt contracts in the primary financial market. In this paper, we examine the relationship between the bond liquidity and the financial contracts of corporate public bonds.

There are strong reasons to conjecture that liquidity shapes the contractual terms of corporate bonds. Liquidity is characterized by the degree to which a security can be bought or sold in the market without causing a significant movement in the price. Intuitively, liquidity may have an impact on bond contracts simply because the better tradability of a bond in the secondary market increases investors' incentive to buy. Issuers with better bond liquidity have stronger bargaining power and therefore would issue bonds with more favorable contractual terms.

More importantly, theoretical studies provide many insights on how liquidity affects corporate behaviors, which may in turn affect bond contracts. First, the negative liquidity shock in the secondary market has been shown to increase a firm's credit risk and raise a firm's default threshold (Ericsson and Renault (2006), and He and Xiong (2012)). The increase of credit risk will have an important impact on bond contracts. Second, agency-based theories suggest that liquidity influences investor activism. Liquidity can reduce investor monitoring incentives by

facilitating the exit of current blockholders (Coffee (1991), and Bhide (1993)), or increase monitoring incentives by helping the formation of blockholders (Maug (1998)), or mitigate agency problems of managerial opportunism through the governance of "threat of exit" (Edmans(2009), and Admati and Pfleiderer(2009)) [1]. Third, feedback-related theories argue that market prices contain important information that influences decisions of firm's stakeholders (Khanna and Sonti (2004), Subrahmanyam and Titman (2001), and Goldstein and Guembel (2008))[2]. Liquidity can either make prices more informative to stakeholders by encouraging the entry of informed investors, or reduce price efficiency by stimulating speculation of uninformed traders. Therefore, the debt market liquidity may shape contractual environment of debt through affecting credit risk of issuers, shaping monitoring incentive of creditors, and influencing price efficiency of bonds.

Despite the large number of theoretical papers with predictions related to the liquidity effect on debt financing, and the growing empirical evidence that advocates the importance of liquidity in determining bond prices in the secondary market, empirical researchers have not yet made efforts to explore the potential impact of liquidity on bond contracts. Our paper aims to fill this gap in the literature by examining whether and how market liquidity of a firm's existing bonds affects the borrowing cost, maturity, and restrictive covenants of its newly issued bonds. To the best of our knowledge, this is the first paper that examines the effect of liquidity on bond contracts.[3]

We first identify the causal relations between liquidity and the terms of debt contracts by investigating an exogenous shock to bond liquidity – the implementation of the Trade Reporting

[1] These studies mainly focus on stock market liquidity. However, we believe this general principle of investor activism applies to bond market.
[2] Bond, Edmans, and Goldstein (2012) provide an excellent review on the feedback effect of financial markets.
[3] A stream of empirical literature examines the impact of stock liquidity on firm performance (Fang, Noe, and Tice (2009), among others.

and Compliance Engine (TRACE). Prior research has shown that bond liquidity has been improved since the introduction of TRACE (e.g., Bessembinder, Maxwell, and Venkataraman (2006), Edwards, Harris, and Piwowar (2007), and Goldstein, Hotchkiss, and Sirri (2007)). We therefore use the firm's incidence in TRACE as an exogenous shock to its bond liquidity. [4] Using a sample of newly issued bonds extracted from Fixed Investment Securities Database (FISD),we find that the inclusion of a firm's bonds in TRACE significantly reduces the number of restrictive covenants, and increases the debt maturity of the firm's newly issued bonds. This evidence suggests that firm with better bond liquidity can issue bond with more favorable terms. The results are robust to firm and year fixed effects.

After establishing the casual effect of bond liquidity on debt contract, we then examine the quantitative impact of bond liquidity. For each bond issue, we estimate firm-level bond liquidity measure (our main measure is Amihud Ratio, and we also consider a number of alternative measures) using transactions of a firm's existing bonds reported in TRACE. We estimate a system of simultaneous equations with offering yield spread, maturity, and covenants using the GMM.[5] We find that bond liquidity is significantly negatively related to yield spread and the use of covenants, but positively related to debt maturity. The results are robust to firm and year fixed effects and alternative measures of bond illiquidity. A decline of bond illiquidity by one standard deviation reduces offering yield spread by 21 basis points (7.16% of the average), decreases the number of covenants by 0.75 (16% of the average) and lengthens debt maturity by 0.96 year (8.7% of the average). In addition, we use instrumental variables to control for the potential endogeneity of market bond liquidity. Again, we find that the bond liquidity is significantly

[4] Since bonds are included in TRACE through multiple phases, our empirical model is essentially a difference-in-difference model.

[5] As a robustness check, we separately examine the offering yield spread, debt maturity, and the use of covenant, and obtain similar results.

negatively related to yield spread and the use of covenants, but positively related to debt maturity. We conclude that market liquidity of bond plays an important role in shaping debt contracts.

We further consider the potential mechanisms through which bond liquidity matters. Our empirical tests show that the liquidity effect on bond contracts is stronger for firms with lower market to book ratio, with poorer credit rating, and with more short-term debt relative to firm size. These results are consistent with both the credit risk channel and the agency cost related channel. A negative shock of bond market liquidity increases a firm's rollover risk, raises default risk, and exacerbates agency conflicts between shareholders and bondholders. Consequently, firms with lower market-to-book ratio, poorer credit ratings and more short-term debt are more sensitive to the bond liquidity effect.

Taken together, this paper contributes to the existing literature in a number of important ways. First, this study extends the line of research on the liquidity effect on corporate bonds pricing (Chen, Lesmond, and Wei (2007), Bao, Pan and Wang (2011), and Dick-Nielsen, Feldhütter, Lando (2012), and Lin, Wang and Wu (2011)). While prior studies focus on the single dimension of bond yield spreads in secondary market, we investigate both price term – offering yield spread, and non-pricing terms – maturity, and covenants. This empirical framework allows us to shed more light on the mechanism behind the liquidity effect on bond pricing, and the multidimensional empirical model paints a more complete picture of how bond liquidity shapes the external debt financing than the literature does.

Second, this paper contributes substantially to the research on optimal financial contracts. The design of optimal financial contracts is one of the most important topics in corporate finance. The existing literature has shown that external debt contracts are determined by firm's fundamentals such as financial distress risk and the degree of agency conflict, and contractual

environment such as legal creditor protections and monitoring incentive of creditors (Smith and Warner (1979), Diamond (1974), Qian and Strahan (2007), among others). The tradability of debt in the secondary market is somehow ignored in this line of research. This paper shows that the liquidity of bonds indeed affect the choice of contractual terms of debts.

Third, this paper serves as an important complement to studies on stock market liquidity (e.g. Fang, Noe, and Tice (2009), Edmans, Fang, and Zur (2012)). It is well recognized that prices in secondary financial markets contain important information and influence real economic activities. Most empirical studies on this feedback effect focus solely on stock market and show that stock market liquidity affect firm's investment, external financing, and firm value. In contrast, we emphasize the bond market. Compared with stock prices, bond prices are more likely to reflect investor's ex ante views on firms. We show that liquidity of bonds also contain important information and affects real decision of corporate stakeholders.

The rest of the paper is organized as follows. Section 2 summarizes related literature and develops empirical models. Section 3 details data collection and sample construction. Section 4 discusses empirical results and section 5 concludes.

2. Related Literature and Hypothesis Development

Conventional wisdom suggests that investors are more likely to acquire an asset that is relatively easy to sell afterward. The corporate bond market is notoriously known as a poor liquidity market. The tradability of a bond in secondary financial market is an important factor influencing its issuance. If the liquidity of a firm's existing bonds is a natural guess about the

tradability of the firm's new bonds, then the liquidity of existing bonds should play an important role in determining the contractual features of new bonds.

While intuition points to a simple relation between liquidity and bond contracts, existing literature provides many distinct mechanisms through which liquidity generates causal effect on firm behaviors. The purpose of this section is to review these theoretical works and use their predictions to form our hypotheses. We then develop empirical models and address econometric concerns.

2.1 Theoretical Studies on Liquidity Effect on Firms

2.1.1 Credit-Risk Related Theories

Liquidity risk can affect bond contract through impacting firms' credit risk. Recent theoretical works provide insightful explanations on how liquidity risk affects credit risk. Ericsson and Renault (2006) show that negative liquidity shocks increase a firm's credit risk by reducing its value in debt renegotiation when financial distress occurs. Therefore, illiquidity increases *ex ante* default risk of firms. He and Xiong (2012) suggest the rollover risk channel. Deterioration of bond liquidity in the secondary market causes firms to suffer losses in rolling over its maturing debts. Shareholders bear the rollover losses while matured debt holders are fully paid. This may lead the firm to default at higher fundamental threshold. Hence, negative liquidity shocks in the secondary market increase firms' default risk and exacerbates the agency conflict between shareholders and bondholders. The credit risk is one of the most important factors affecting the design of debt contracts. Therefore, we believe that bond liquidity shapes the debt contracts by influencing the ex-ante default risk of issuers.

2.1.2 Agency Based Theories

A large body of research about the effect of market liquidity on firm performance focuses on agency based theories. Earlier work in this vein includes Coffee (1991) and Bhide (1993). They argue that liquidity facilitates the exit of current blockholders who are potential activists. Hence, liquidity reduces the incentive of monitoring and exacerbates agency problems within a firm. These theories suggest the negative effect of liquidity on firm performance.

Maug (1998), however, argues that liquidity makes it less costly to hold larger stakes and easier to purchase additional shares, permitting non-blockholders to intervene and become blockholders. Therefore, liquidity is beneficial to firm because it makes corporate governance more effective. Admati and Pfleiderer (2009) argue that the threat of exit of large shareholders can function as an effective mechanism of monitoring. Liquidity helps mitigate agency costs by making the threat of exit credible. This stream of research advocates the positive effect of market liquidity. Recent empirical work supports the positive effect of liquidity (Edmans, Fang and Zur (2013), Edmans (2009), and Bharath, Jayaraman, and Nagar (2010)). These papers show that stock market liquidity helps improve the effectiveness of corporate governance and then contributes to firm value.

The important prediction of these agency-based theories is that liquidity affects firm performance through influencing the effectiveness of investor monitoring. Liquidity may cause a positive (negative) effect if it improves (reduces) the effectiveness of investor monitoring. The existing work mainly focuses on stock market liquidity. In contrast, institutional investors in bond market, such as insurance companies and pension funds, are often categorized as passive investors, who do not actively monitor a firm's operation. Recent empirical studies, however, advocate the importance of control rights of debtholders. Debt Covenant is an effective mechanism that allows debtholders intervene firms' operation (Chava and Roberts (2008),

Roberts and Sufi (2009), Chava, Kumar, and Warga (2009), Garleanu and Zwiebel (2009), and Nini, Smith and Sufi (2012)). We therefore expect that bond market liquidity affects the monitoring incentive of bondholders and in turn affects contractual terms in bonds.

2.1.3 Information and Feedback Related Theories

The third channel of liquidity effect is the feedback effect. The theories show that liquidity affects information efficiency of market prices. A firm's investors and stakeholders learn about the firm's quality by observing its security price in the secondary market. Hence, the price efficiency might cause real effect on firm performance. Subrahmanyam and Titman (2004) show that if informed traders are risk neutral, increased liquidity stimulates the entry of informed investors, and makes prices more informative to stakeholders. This positive feedback relaxes a firm's financial constraint, enlarging its investment set. Therefore, liquidity has a beneficial effect on a firm's external financing. In contrast, Goldstein and Guembel (2008) argue that liquidity stimulates speculations of uninformed trades, reducing price efficiency. Therefore, increased liquidity can cause negative feedback effect, and damages a firm's value and hurt external financing of firms.

The distinguishing feature of these feedback related theories is that liquidity matters through impacting information contained in market prices. The effect is expected to be stronger for firms relying more on external financing and facing more operation uncertainty.

2.2 Hypothesis Development

In this subsection, we develop our testable hypotheses about the impact of bond liquidity on debt contracts. A debt contract consists of many terms such as borrowing cost of debt, maturity, collateral, embedded options, and a set of complex covenants, among others. While we cannot

explore every aspect of a debt contract, we focus on the three most important dimensions of a debt contract: cost of debt, debt maturity, and covenants. These features have captured a lot of attention in prior literature.[6] We use the theoretical predictions in prior literature to form empirical hypotheses. For simplicity, we hypothesize the effect of bond liquidity on cost of debt, maturity, and covenants, separately. We then consider the joint determination of these terms in empirical design subsection.

2.2.1. The Effect of Bond Liquidity on Cost of Debt

It is commonly believed that a firm's cost of debt is determined by its credit risk, and agency cost of debt (Merton (1974), Myers (1977), and Jensen and Meckling (1976)). We expect that improved liquidity reduce offering spread of newly issued bonds. First, deterioration of liquidity increases the credit risk of firm (Ericsson and Renault (2006); and He and Xiong (2012)). Therefore, firms with poorer liquidity would issue bond with higher cost. Second, positive agency-based theory argues that liquidity facilitates the investor activism and mitigates agency problems. Therefore, a firm with better liquidity is associated with lower agency cost of debt and more effective monitoring of creditors, leading to a lower interest rate. Third, the positive feedback effect suggests that liquidity enhances the price efficiency and relaxes a firm's financial constraints. Hence, a firm with better bond liquidity should be able to borrow with lower interest rate. Our testable hypothesis and its alternative are as follows:

H1: A firm with higher bond liquidity in the secondary market issues bonds with lower borrowing cost in primary financial market.

[6] The relevant literature is too large to be completely summarized here. We therefore only discuss papers which are mostly related.

H1A: A firm with higher bond liquidity in the secondary market issues bonds with higher borrowing cost in primary financial market.

The alternative hypothesis, *H1A*, can arise from the two channels. First, the negative feedback effect suggests that liquidity stimulates price manipulation and may cause negative cascade. This deteriorates a firm's contractual environment leading to higher borrowing cost. Second, liquidity facilitates investors to dump the securities, reducing monitoring incentive and exacerbating agency problems. Therefore, liquidity leads to higher cost of debt.

2.2.2. The Effect of Bond Liquidity on the Use of Covenants

Smith and Warner (1977) develop the costly contracting hypothesis suggesting that debt covenants help mitigate the agency cost of debt by preventing the manager from exploiting bondholders. The optimal use of covenants is balanced by the degree of agency conflict between shareholder and bondholder, and the loss of operation flexibility due to restrictive covenants. The debt covenants have been long recognized as an effective method to monitor firms and mitigate agency cost of debt (Smith and Warner (1977), Berlin and Mester (1992), Rajan and Winton (1995)).

We conjecture that firms with better bond liquidity include fewer restrictive covenants in debt contracts. First, illiquidity increases firms' credit risk exaggerating agency conflict between bondholders and shareholders. Therefore, firms with poorer liquidity are more likely to include restrictive covenants to mitigate the agency cost of debt. Second, agency-based theories suggest that better liquidity increases the incentive and effectiveness of investors' monitoring through facilitating the entry or exit of blockholders. This increase of investors' monitoring reduces the motivation of using covenants. Third, positive feedback theories suggest that liquidity enhances price efficiency and reduces information asymmetry. The reduction of information asymmetry

reduces the motivation of including covenants in debt contracts. Our hypothesis is stated as following:

H2: A firm with better bond liquidity in the secondary market includes fewer debt covenants in its debt contracts.

H2A: A firm with better bond liquidity in the secondary market includes more debt covenants in its debt contracts.

The alternative hypothesis H2A arises from negative feedback argument. Liquidity may stimulate speculations of uninformed investors, which reduces price efficiency and hurts firms' external financing. This may lead to the use of more covenants in debt contracts.

2.2.3. The Effect of Bond Liquidity on Debt Maturity

A number of prior studies examine the determinants of debt maturity. Barnea, Haugen, and Senbet (1980, 1985) suggest that shortening maturity of debt is an effective means of resolving the agency problems of debt associated with informational asymmetry, risk incentives, and underinvestment. Barclay and Smith (1995) finds firms with larger information asymmetries issue more short-term debt. Diamond (1991, 1993) suggests that the optimal debt maturity is determined by the tradeoff of debt rollover risk and potential gains due to the improved firm fundamental in future. Firms with private information about future credit prospects prefer short-term debt, but rollover risk reduces the incentives to use shorter-term debt.

We conjecture that firms with better bond liquidity are more likely to use long-term debt. Agency-based theories argue that bond liquidity enhances investors' monitoring effectiveness, and reduce agency conflict. Therefore, the enhanced investor monitoring reduces the necessity to use short-term debt. Positive feedback theories suggest bond liquidity help improve price efficiency and reduce information asymmetry. This reduction in information asymmetry about

the firm future credit prospects lowers the incentive of firms to use short-term debt. Our hypothesis is stated as follows:

H3: Firms with better bond liquidity in the secondary market are more likely to issue long-term debt.

H3A: Firms with better bond liquidity in the secondary market are more likely to issue short-term debt.

The alternative hypothesis H3A can arise from negative feedback effect, and the rolling risk channels. The negative feedback effect suggests that liquidity makes the price noisier and hurts price efficiency. The increase in information asymmetry about the firm value encourages firms to use short-term debt. Meanwhile, firms with better liquidity are subject to lower rollover risk, which encourages the use short-term debt.

2.3 Empirical Design

The above subsection discusses the impact of bond liquidity on interest rate, covenants, and debt maturity separately whereas these terms should be jointly determined by the firm characteristics and contractual environment. Following Billet, King and Mauer (2007), and Saretto and Tookes (2013), we employ a system of simultaneous equations of bond offering spread, covenants and maturity in order to take into account the interaction among the three terms. Our baseline model is stated as follow:

$$\begin{aligned} Offering\_Spread_{i,j,t} &= \alpha_1 + \beta_1 Illiqudity_{i,t} + \theta_1 Covenant_{i,t,j} + \lambda_1 Maturity_{i,j,t} + \delta_1 Controls + \varepsilon_{i,j,t} \\ Covenant_{i,j,t} &= \alpha_2 + \beta_2 Illiqudity_{i,t} + \gamma_2 Offering\_spread_{i,t,j} + \lambda_2 Maturity_{i,j,t} + \delta_2 Controls + \varsigma_{i,j,t} \\ Maturity_{i,j,t} &= \alpha_3 + \beta_3 Illiqudity_{i,t} + \gamma_3 Offering\_spread_{i,t,j} + \theta_3 Covenant_{i,j,t} + \delta_3 Controls + \xi_{i,j,t} \end{aligned} \quad (1)$$

where i, j, t represent respectively firm, bond, and time; offering spread is estimated as the difference between offering yield and the yield of duration-matched Treasury bonds; *Covenant* is of the number of covenants included in a bond contract. *Maturity* is the debt maturity in years. For each bond issue, we construct the issuer-level illiquidity measures using the trading data of the issuer's existing bonds. We use GMM to estimate this system of equations. In order to identify these equations, we follow prior studies and control for bond, firm, macro, and exogenous variables. See detailed discussion of variables in data section.

One challenge of this study is that bond liquidity, and the terms in debt contracts may be jointly affected by omitted variables. Therefore, the significant relationship between bond liquidity and debt contractual terms does not indicate a causal relationship. We therefore use an exogenous shock to bond liquidity—the implementation of TRACE system to conduct a natural experiment test. The implementation of TRACE is believed to be an exogenous shock of liquidity improvement (Bessembinder, Maxwell, and Venkataraman, 2006, and Edwards, Harris, and Piwowar, 2007, among others). If this exogenous increase of liquidity in bond market affects the debt contracts as the way we predict, then the causal relationship holds. We therefore use an indicator of TRACE implantation as a proxy of liquidity shock in equation (1). We then consider other liquidity measures such as Amihud ratio and imputed roundtrip cost.

3. Data

Our bond data come from two major sources: the FINRA's TRACE (Transaction Reporting and Compliance Engine) and the FISD (Fixed Investment Securities Database). Price and trade data of corporate bonds are from TRACE, and ratings and bond-specific characteristic

information are from the FISD. We collect firm-level variables and general market variables from CRSP, COMPUSTAT and DataStream.

Since January 2001, members of the Financial Industry Regulatory Authority have been required to report their secondary over-the-counter corporate bond transactions through TRACE. On July 1, 2002, TRACE began to report bond transactions, requiring that transaction information be disseminated for investment grade securities with an initial issue size of $1 billion or greater. TRACE was expanded in stages and was fully implemented in February 2005, covering essentially all publicly traded bonds. There are a number of problematic trades during the early period of the database. Consequently, we eliminate canceled, corrected, and commission trades from the data. Bond transactions under $100,000 are deleted to avoid the effects of retail investors. We also remove bonds with time to maturity less than one year because of high pricing errors.

The FISD reports detailed information about U.S. corporate, U.S. Agency, and supranational debt securities, including issue- and issuer-specific information such as coupon rate, maturity, issue amount, provisions, and credit ratings for all US corporate bonds maturing in 1989 or later. We merge TRACE and FISD to create a panel of bond transactions and characteristics. The dataset is further merged with Compustat to obtain a firm's accounting information, with CRSP to extract stock information.

3.1 Bond Liquidity Measures

We use TRACE to construct several proxies of bond liquidity. In order to obtain the *firm-level* bond liquidity in the secondary market, we follow the procedures below. We first calculate the daily *bond-level* liquidity using high-frequency transaction data. And then, we take the

median liquidity of each bond as its monthly liquidity. This bond-level liquidity is then computed by taking the moving average of every three months. These procedure yields the time series of bond-level liquidity in monthly frequency.

Finally, we obtain the firm-level bond liquidity by calculating the offering-amount weighted average of bond-level liquidity. We winsorize the highest and lowest liquidity, so that liquidity above the 99% percentile is set to the 99% percentile and liquidity below the 1% percentile is set to the 1% percentile.

In this study, we consider the following four liquidity measures: *Amihud*, *Price Dispersioin* (*PD*), *Imputed Roundtrip Cost* (*IRC*), and *Inter-quartile Range* (*IQR*). We also consider the introduction of TRACE as an exogenous shock to bond liquidity. It is worth noting that a smaller (larger) magnitude of these measures indicate better (poorer) bond liquidity. Therefore, our constructed measures represent the degree of illiquidity of a firm's bond in secondary market.

3.1.1 Amihud Measure

The Amihud measure is calculated using high-frequency transaction data from TRACE and is defined as the daily average of absolute returns of consecutive transactions divided by the trade size (in million $):

$$Amihud_t = \frac{1}{N_t} \sum_{j=1}^{N_t} \frac{| P_{j,t} - P_{j-1,t} | / P_{j-1,t}}{Q_{j,t}} \tag{2}$$

where N_t is the number of returns on day *t*; P_j and P_{j-1} are prices of two consecutive trades; and Q_j is the trading volume of the trade *j*. At least two transactions are required on a given day to calculate the measure.

3.1.2 Price Dispersion (PD)

Jankowitsch, Nashikkar, and Subrahmanyam (2008) and Friewald, Jankowitsch, and Subrahmanyam (2012) model price dispersion effects in over-the-counter (OTC) markets to show that in the presence of inventory risk for dealers and search costs for investors, traded prices may deviate from the expected market valuation of an asset. They interpret this deviation as a liquidity effect and develop a new liquidity measure quantifying the price dispersion in the context of the US corporate bond market. The price Dispersion is estimated as follows:

$$\text{Price Dispersion}_t = \sqrt{\frac{1}{\sum_{j=1}^{N_t} Q_{j,t}} \sum_{j=1}^{N_t} \left(P_{j,t} - m_t\right)^2 \times Q_{j,t}} \tag{3}$$

where $P_{j,t}$ the trading is price of the trade j on day t for a bond; m_t is the average price of the bond on day t; and $Q_{j,t}$ is the trading volume of the trade j on day t.

3.1.3. Imputed Roundtrip Cost (IRC)

Feldhütter (2010) and Dick-Nielsen, Feldhütter, and Lando (2012) measure bid-ask spreads using Imputed Roundtrip Trades (IRT). Most of the data do not contain information about the buy and sell side in trades. IRTs are based on finding two trades that are close in time and likely to be a buy and a sell. These two trades are regarded as one IRT. If a number of trades with the same trade size take place on one day, and there are no other trades with the same size on that day, they define these trade as one IRT. For each IRT, we can calculate the bid-ask spread. Then we can calculate daily averaged bid-ask spread of all IRTs to obtain the imputed roundtrip cost (IRC)

$$IRC_t = \frac{1}{N_t} \sum_{j=1}^{N_t} \frac{P_{\max,j,t} - P_{\min,j,t}}{P_{\max,j,t}} \tag{4}$$

where N_t is the number of IRT on day t, $P_{j,\max}$ is the largest price in the j^{th} IRT, and $P_{j,\min}$ is the lowest price in the j^{th} IRT

3.1.4. Inter-quartile Range (IQR)

Finally, the inter-quartile range *(IQR)* is a liquidity measures used by Han and Zhou (2008) and Hewlege, Huang and Wang (2013). *IQR* is defined as the difference between the 75th percentile and 25th percentile of prices for one day normalized by the average price on that day. That is,

$$IRQ_t^i = \frac{P_t^{i,75th} - P_t^{i,25th}}{\overline{P_t^i}} \times 100 \quad (5)$$

This measure should be mainly affected by the bid-ask spread since price volatility is mostly a result of the bid-ask bounce when there is no information about fundamentals. Information about credit risk should lead to larger price movements, and this variation is more likely to be eliminated by using the 75th and 25th percentiles. In addition, IQR measures dispersion in statistics. Thus, IQR can also be interpreted as a new liquidity measure quantifying the price dispersion in the context of the US corporate bond market.

3.2 Sample Construction

After constructing the time series of firm-level bond illiquidity, we merge them with a bond issuance sample extracted from the FISD. We keep U.S. corporate bonds issued from 2002 to 2011. Unit deals, Yankee bonds, convertible, and medium-term-note are excluded. We also remove issues without covenants information. This screening procedure provides a sample of 12,732 bonds.

For each newly issued bond, we match it with the firm-level illiquidity, which is constructed using the issuer's existing bond trades. Given the sparse trading of bonds, the match may not always exist. We also remove observations that have missing information of bond characteristics and accounting information. The details of bond characteristics and accounting variables are discussed in later sections. The final dataset contains 2,380 new bond issuances.

3.3 Other Variables

Offering spread is the difference between bond offering yield and yield of duration-matched Treasury bonds. Based on the maturity of each newly issued bond, we obtain the matched risk-free yield using the constant maturity benchmark yields which are from DataStream and are for the following yearly maturities: 1/12, 1/4, 1/2, 1, 2, 3, 5, 7, 10, 20, 30. *Covenant index* is the sum of the firm's 22 covenant indicator variables, which are constructed using debt issue data from the Fixed Investment Securities Database (FISD). *Maturity* is the number of years remaining until a bond matures. In our regression analyses, we take the natural log transformation of offering spread, covenants index, and maturity because these variables are heavily skewed.

We add regression controls following the literature. In all regressions, we include the change of the spread between Baa-rated corporate bonds and 10-year Treasury bonds (CRSPRD) (Longstaff, Mithal, and Neis (2005), Dick-Nielsen, Feldhütter, and Lando (2012), Boyson, Stahel, and Stulz (2010)), the change in the Treasury-Eurodollar spread (TEDSPRD) (Gupta and Subrahmanyam (2000), Campbell and Taksler (2003), Taylor and Williams (2009), Boyson, Stahel, and Stulz (2010)); these two variables proxy for general market illiquidity shocks. In Table 1, we provide the definitions and data sources of all variables.

In the regression of offering spread, we control for leverage, firm size, stock return volatility, PPE ratio, profitability, whether a firm is in regulated industry, and coupon rate (Elton et al.

2001). We further control for the bond ratings that are argued to determine offering spread. In the regression of covenants, we include Tobin's Q as a proxy of growth opportunity, leverage, firm size, and stock return volatility, covenant index of the firm's previous bond issuance, and if a firm is in regulated industry. In the regression of maturity, we control for Tobin' Q, leverage ratio, firm size, stock return volatility, and term spread (yield spread between 10-year and 6-month treasury bonds). It is argued that tax concern affects the choice of debt maturity. We therefore control for net operating loss, investment tax credit, abnormal earnings and firm credit ratings.

4. Empirical Results

4.1 Summary Statistics

We compare the bond illiquidity of our matched sample with the entire sample of TRACE. Panel A of Table 2 presents the results. As shown in the table, the average Amihud ratio of our matched sample is 0.009, which is slightly lower than the average of Amihud of the entire TRACE sample, 0.013. The average of imputed roundtrip cost (IRC) of our matched sample is 0.003 while the average of TRACE sample is 0.004. The bond illiquidity of our sample is similar to TRACE sample but with lower standard deviations. Panel B of Table 2 compares the bond characteristics of our sample and the entire FISD sample. We find that our sample, relative to the full FISD sample, includes bonds with lower offering spread (2.39 vs. 2.95), more covenants (4.59 vs. 3.18), larger issue amount (644 vs. 504), and better credit ratings (9.62 vs. 11.43). Panel C reports the firm characteristics of our sample and entire CRSP/Compustat merged sample. It appears that our sample include larger firm (107 vs. 69), higher growth opportunity (1.86 vs. 1.74), higher leverage (0.31 v. 0.22), better abnormal earnings (2.50 vs. -6.19) and shorter-term asset maturity (7.22 vs. 14.33).

In Panel D of Table 2, we take a first look at the relation between bond illiquidity and the three terms of debt contracts. The Log (Amihud) is positively related to covenants with a coefficient of 0.015 but not statistical significant. The Log(Amihud) is positively related to offering spread with a coefficient of 0.015 at 1% significance. The correlation between Log(Amihud) and debt maturity is -0.038 at 10% significance. These preliminary results suggest that bond illiquidity increases borrowing cost and the use of covenants, but reduces debt maturity, in consistent with our conjectured hypotheses.

4.2 Causal Effect of Bond Illiquidity on Debt Contracts

We initiate our experiments using the implementation of TRACE as an exogenous shock to bond liquidity and examine the impact of incidence of TRACE on debt contracts. Prior literature documents that the implementation of TRACE increases the corporate bond market liquidity (e.g. Bessembinder et al. (2006); Edwards et al. (2007), and Goldstein et al. (2007)). We therefore expect that the exogenous shock of liquidity due to the implementation of TRACE will shift contractual terms of bond contract.

For each bond issue, we check whether there are transactions of the issuer's previous bonds reported in TRACE. We then create an indicator (D_ TRACE) that equals 1 if transactions of a firm's previous bonds were reported in TRACE, and 0 otherwise. To avoid the sample selection bias, we require firms issue bonds before TRACE in order to be included in the sample. Since bonds are included in TRACE through multiple phases[7], we obtain at each point of time a controlled group (i.e. firms whose bonds are not reported in TRACE) and a treated group (i.e., firms whose bonds are reported in TRACE). This difference-in-difference approach allows us to test whether the changes of bond contractual terms before and after the incidence in TRACE is

[7] See the detailed discussion on the multiple-stage adoption of TRACE in Bessembinder et al. (2006).

related to the improved bond liquidity sourced from the implementation of TRACE. We expect that the improved liquidity due to the incidence in TRACE will reduce cost of debt and use of covenants, but increase debt maturity.

We first use GMM estimation to jointly examine the liquidity effect on offering yield spread, covenants, and debt maturity. We also employ OLS regression to study the impact of liquidity on each term separately. Year fixed effects are included in all regressions. Industry fixed effects are controlled for in the GMM estimations while firm fixed effects are included in the OLS regressions.

Columns (1)-(3) of Table 3 provide the GMM estimations of simultaneous equations. The coefficient of D_TRACE is -0.05 but insignificant in the regression of offering spread, -0.29 with 1% significance in the regression of covenants, and 0.14 with 10% significance in the regression of maturity. These results suggest that the increased liquidity reduces the borrowing cost, and decreases the use of covenants, lengthens debt maturity. These findings are consistent with our expectations. Columns (4)-(6) presents the OLS regression of single equations. The results are consistent with those in simultaneous equations. The coefficient of D_TRACE is -0.01 but insignificant in the regression of offering spread, -0.18 with 1% significance in the regression of covenants, and 0.31 with 1% significance in the regression of maturity. The impact of liquidity on covenants and maturity are also economic significant. According the simultaneous equations, the incidence of TRACE reduces covenant index by 1.51 (about 25% from the sample median), and lengthen debt maturity by 1.5 years (about 15% from the sample median).

Estimates of other variables are in general consistent with our expectation. Larger firms have lower offering spread, and longer maturity. Firms with more growth opportunities tend to use shorter-term debt. Asset maturity appears to be positively related to debt maturity. As expected,

profitability reduces the borrowing cost of debt. Firms in regulated industry tend to use short-term debt. Callable bonds are more likely to include covenants and are associated with longer debt maturity. The use of covenants in a firm's previous bonds has a strong predictable power in the use of covenants in newly issued bonds. Coupon rate is an important determinant of offering yield spread.

Overall, the evidence presented here provides a clear picture that bond liquidity indeed has casual effect on debt contractual terms. We then turn to study the quantitative impact of bond illiquidity on debt contracts using illiquidity measure constructed from bond transactions.

4.3 Tests using Constructed Illiquidity Measures

In this subsection, we examine the impact of bond illiquidity on debt contract using a number of bond illiquidity proxies. Our main measure is Amihud Ratio (*Log(Amihud)*). In Table 4, we report the GMM estimation of simultaneous equations. We find that *Log(Amihud)* is positively related to offering spread with a coefficient of 7.93 and 1% significance, indicating that illiquidity increase the cost of debt. *Log(Amihud)* is positively related to covenant index with a coefficient of 18.28 at 1% significance, suggesting that illiquidity increase the use of convents. *Log(Amihud)* is negatively related to maturity with a coefficient of -10.52 at 1% significance level, showing that illiquidity reduce the debt maturity. These results support our hypotheses H1, H2 and H3, and are consistent to the results using TRACE dummy in Table 3. A firm with better liquidity is more likely to issue bonds with lower cost of debt, fewer covenants, and longer maturity.

The interactions among the three terms of debt contracts are consistent with prior literature. The use of bond covenants reduces offering spreads; and long-term maturity increases offering

spreads, as shown in column (1). Bonds with longer maturity are more likely to include restrictive convents, as shown in column (2). Offering spread and covenants are both positively related to maturity as shown in column (3).

We further consider the economic significance. A decline of the Amihud Ratio by one standard deviation from the sample mean causes a decline of offering spread by 21 basis points, i.e. 7.16% of the average offering spread. As for the use of covenants, a decrease of one standard deviation of Amihud Ratio decreases the covenants index by 0.75. This decrease is about 16% of the average number of covenants. A reduction of one standard deviation of Amihud Ratio lengthens the debt maturity by 0.96 year, which is about 8.7 % of the average debt maturity. We therefore conclude that the economic impact of bond illiquidity on debt contract is important.

In order to address the potential endogeneity concerns of bond illiquidity, we use Two-stage least squares and instrument variables to redo our regressions of Table 4. The estimated results are presented in Table 5. In the first stage, we use firm-level bond trading volume, size-weighed bond trading volatility, and industry median of bond illiquidity excluding the firm of interest as instrument variables to estimate the Amihud Ratio. In the second stage, we employ the GMM estimation of the simultaneous equations using the estimated Amihud Ratio from the first stage. For the simplicity, only the results of second stage regressions are reported here. The results reported in Table 5 are consistent with prior results presented in Table 4.

4.4 Mechanism Behind the Liquidity Effect on Bond Contracts

In this subsection, we take efforts to identify the mechanism behind the causal effect of bond illiquidity. We examine the cross-sectional variations of the liquidity effect on bond contracts to study whether the effect is greater in those firms as predicted by the theories. As mentioned

above, the liquidity effect is related to several factors such as credit risk of firms, the degree of agency conflict within firm, the firm's dependence on external debt financing, information asymmetry of future credit prospectus of firms. We therefore generate proxies of these factors, and then create interaction terms between bond illiquidity and these factors. The empirical model is as follows:

$$\begin{aligned}
Offering_spread_{i,j,t} &= \alpha_1 + \beta_1 Illiqudity_{i,t} + \phi_1 Z_{i,t} + \mu_1 Illiqudity_{i,t} \times Z_{i,t} + \theta_1 Covenant_{i,t,j} \\
&\quad + \lambda_1 Maturity_{i,j,t} + \delta_1 Controls + \varepsilon_{i,j,t} \\
Covenant_{i,j,t} &= \alpha_2 + \beta_2 Illiqudity_{i,t} + \phi_2 Z_{i,t} + \mu_2 Illiqudity_{i,t} \times Z_{i,t} + \gamma_2 Offering_spread_{i,t,j} \\
&\quad + \lambda_2 Maturity_{i,j,t} + \delta_2 Controls + \varsigma_{i,j,t} \\
Maturity_{i,j,t} &= \alpha_3 + \beta_3 Illiqudity_{i,t} + \phi_3 Z_{i,t} + \mu_3 Illiqudity_{i,t} \times Z_{i,t} + \gamma_3 Offering_spread_{i,t,j} \\
&\quad + \theta_3 Covenant_{i,j,t} + \delta_3 Controls + \xi_{i,j,t}
\end{aligned} \tag{6}$$

where $Z_{i,t}$ is the proxy of credit risk, the degree of agency problem, or other factors. We are particularly interested at the coefficients of μ. If β and μ have same signs, then it indicates factor *Z* exaggerates the liquidity effect. In contrast, if β and μ have different signs, it suggests that factor Z reduces the liquidity effect.

We present the estimation results in Table 6. Panel A studies the interaction between illiquidity and high yield dummy, which is equals to 1 if a bond is rated below Baa, and 0 otherwise. As shown in the table, the interaction term carries negative but insignificant coefficients for offing spread (-0.32) and a significantly positive coefficient for covenant (21.14), and a negative coefficient for maturity (-11.90). This result suggests that the impact of liquidity is more pronounced for bonds with poor credit rating. The evidence presented here is consistent with both credit risk and agency-based arguments. Poor liquidity increases the credit risk and

exacerbates agency conflict, and in turn affects the debt contracts. Therefore, the effect of liquidity is concentrate on firms with higher default risk.

Panel B of Table 6 explores the interaction term between illiquidity and the proportion of short-term debt related to total assets. We find that the effect of illiquidity is stronger for firms with more short-term debt as evidenced by positive coefficients in regression of offering spread (0.15), and covenants (0.16) and a negative coefficient in regression of maturity (-0.14). This evidence is consistent with the argument of debt rollover channel. Firms with more short-term debt are more likely facing the rollover risk and are hence more exposed to the bond liquidity risk.

Panel C of Table 6 studies the interaction term between illiquidity and growth opportunity. We find that the liquidity effect is weaker for firm with higher Tobin's Q, as evidenced by the negative coefficients of the interaction term in the regression of offering spread (-2.3) and in regression of covenant (-5.04), and the positive coefficient in the regression of maturity (3.51). This evidence is consistent with the credit risk argument. Higher Tobin's Q indicates lower financial distress risk. Therefore, the liquidity impact is smaller for firms with lower default risk.

In unreported regressions, we interact bond illiquidity with free cash flow (a proxy of the degree of dependence on external financing) and with operation income volatility (a proxy of operation uncertainty). However, we do not find evidence that support the impact of illiquidity is related to these two channels. We therefore conclude that the impact of bond illiquidity on debt contract is mainly driven by the credit risk and agency-based channel.

4.5 Liquidity Effect on Various Types of Bond Covenants

In Table 7, we further examine the impact of liquidity on various types of covenants. We are particularly interested in the use of covenant because covenants have been long recognized as an effective method to monitor management behavior and provide bondholder protection. These tests aim to shed light on how liquidity affects the creditors' monitoring incentives.

We studies four types of covenants: restriction on borrowing activities, restriction on merge and acquisition, restriction on stock issuance, and the protection at the event of default. We find that the impact of liquidity increases the use of covenants related to borrowing, M&A and default, which is consistent with prior findings. However, interestingly, illiquidity reduces the use of stock issuance covenants. This evidence is consistent with feedback effect theory that argues that effect of liquidity is related to firm's dependence on external financing. Poor liquidity indicates the difficulties to raise debt financing. Therefore, these firms are more likely to rely on equity financing, and hence are reluctant to include covenants restricting stock issuance. We also find that covenants of stock issuance increase offering spread, suggesting the covenants of stock issuance do not provide protection to debtholders. This last evidence is consistent with the findings in Mansi, Qi and Wald (2012) who find that stock issuance covenants increase bankruptcy probability of issuers.

4.6 Robustness Checks

We conduct a number of robustness checks. In Table 8, we consider alternative measures of bond illiquidity and these tests yield similar results as our baseline model. In all panels, we find that illiquidity significantly affects the cost of debt, the use of covenants, and debt maturity. In unreported regressions, we use OLS regression to study the impact of illiquidity on offering spread, covenant, and maturity, controlling for firm and year fixed effects. Our results are robust

to these additional tests. Taking together, we find that the liquidity effect on bond contracts is consistent with theoretical predictions. We conclude this effect is a causal impact, and is not driven by omitted variables, or potential endogeneity.

5. Conclusions

We investigate whether corporate bond liquidity in the secondary market affects the contracts of newly issued public bonds. We find that bond liquidity help reduce the borrowing cost of debt and the use of restrictive covenants, but increase the debt maturity. In addition, the liquidity effect is more pronounced for firms with higher credit risk, more rollover risk and higher degree of agency conflict between shareholders and bondholders. In sum, bond liquidity plays important role in shaping financial contracts. We therefore conclude that bond liquidity has causal effect on firm's external debt financing.

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Table 1: Variable Description

This table describes definitions and data sources of the variables.

Variable	Definition	Source
A. Proxy of bond liquidity		
Amihud Ratio	The ratio of absolute returns of two consecutive transactions to trading volume (in million $).	TRACE
Price Dispersion	The daily trading-size weighted average of the dispersion bond prices.	TRACE
Imputed Roundtrip Cost	The daily average of bid-ask spread of all imputed roundtrip trades.	TRACE
Inter-Quartile-Range	The difference between the 75th percentile and 25th percentile of prices for one day normalized by the average price on the day.	TRACE
Incidence in TRACE	An indicator equals to 1 if an issuer's bond(s) was traded in TRACE before time t, and 0 otherwise.	FISD, TRACE
B. Bond Characteristics		
Log (Offering Spread)	The log transformation of the difference between offering yield of a corporate bond and the yield to maturity on its duration equivalent Treasury bond.	FISD, DataStream
Log (Maturity)	The log transformation of a bond's maturity in years.	FISD
Log (Covenant)	The log of the covenant index which is the sum of the firm's 22 covenant indicator variables.	FISD
Coupon Rate	Coupon payment of a corporate bond.	FISD
Redeemable	A dummy variable equals to one if a bond is redeemable, and 0 otherwise.	
Bond ratings	S&P credit rating of bonds.	
C. Firm Characteristics		
Tobin's Q	The ratio of market value of total assets to the book value of assets, where the market value of assets is estimated as the book value of assets minus the book value of equity plus the market value of equity	Compustat
Leverage	The book value of total debt (long-term debt plus debt in current liabilities) divided by the market value of assets, where the market value of assets is estimated as the book value of assets minus the book value of equity plus the market value of equity.	Compustat
Firm Size	A firm's book value of total assets.	Compustat
Stock Return Volatility	The volatility of 1 year daily equity returns.	CRSP
PPE	The ratio of net property, plant, and equipment to the book value of total assets	Compustat

Profitability	The ratio of earnings before interest, taxes, depreciation, and amortization (EBITDA) to the book value of total assets.	Compustat
Investment Tax Credit Dummy	Dummy that equals to 1 if a firm has investment tax credit in the fiscal year, and 0 otherwise.	Compustat
Net Operating Loss Dummy	Dummy that equals to 1 if a firm has net operating loss in the fiscal year and 0 otherwise.	Compustat
Abnormal Earning	The difference between earnings per share in year t + 1 (excluding extraordinary items and discontinued operations and adjusted for any changes in shares outstanding) minus earnings per share in year t, divided by share price in year t.	Compustat
Firm Credit Rating Dummy	Dummy that equal to 1 if a firm has S&P rating on Compustat and 0 otherwise.	Compustat
Regulated Dummy	Dummy that equals to 1 if a firm is in regulated industries (SIC codes between 4900 and 4939), and 0 otherwise.	CRSP
Asset Maturity		
D. Other Controls		
CRSPRD	Change in Baa-10-year Constant Maturity Treasury credit spread.	DataStream
TEDSPRD	Change in the Treasury-Eurodollar spread.	DataStream
Term Spread	Yield spread between10-year and 6-month Treasury bonds.	DataStream

Table 2: Descriptive Statistics

This table presents the descriptive statistics of illiquidity proxies and other variables. Panel A presents the summary statistics of illiquidity proxies of our sample and compare them with the entire TRACE sample. Panel B report the statistics of bond features and compare our sample with the entire FISD sample. Panel C reports the statistics of firm characteristics and compare our sample with the merged sample of CRSP and Compustat, and market-wide variables. Panel D presents the correlations between Amihud, covenant index, offering spread, and maturity. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively.

Panel A: Descriptive statistics of illiquidity proxies

	Final sample					TRACE sample				
	Mean	Std. Dev.	P25th	P50th	P75th	Mean	Std. Dev.	P25th	P50th	P75th
Amihud	0.009	0.009	0.003	0.006	0.012	0.013	0.019	0.002	0.006	0.015
Roundtrip (IRC)	0.003	0.003	0.002	0.003	0.004	0.004	0.005	0.001	0.003	0.005
Inter quartile range	0.405	0.333	0.188	0.317	0.501	0.375	0.914	0.141	0.255	0.435
Price dispersion	0.205	0.145	0.103	0.174	0.267	0.180	0.323	0.075	0.134	0.222

Panel B: Descriptive statistics of bond variables

	Final sample					FISD sample				
	Mean	Std. Dev.	P25th	P50th	P75th	Mean	Std. Dev.	P25th	P50th	P75th
Offering Spread	2.39	1.81	1.05	1.75	3.25	2.95	2.32	1.18	2.12	4.27
Maturity	11.03	7.82	5.33	10.00	10.08	11.10	8.35	6.99	10.01	10.06
Covenant index level	4.59	3.50	2.00	5.00	6.00	3.18	3.71	0.00	2.00	6.00
Offering Amount	644.11	539.75	300.00	500.00	750.00	504.31	477.24	250.00	350.00	600.00
Bond Rating	9.62	4.14	7.00	9.00	13.00	11.43	4.79	8.00	11.00	15.00

Panel C: Descriptive statistics of firm-level and market-wide variables

	Final sample					CRSP/Compustat sample				
	Mean	Std. Dev.	P25th	P50th	P75th	Mean	Std. Dev.	P25th	P50th	P75th
Firm Size	107.00	310.00	5.68	18.10	49.70	68.60	236.00	3.33	10.70	33.80
Tobin's Q	1.86	1.06	1.13	1.49	2.18	1.74	4.17	1.09	1.41	2.07
Profitability	0.09	0.08	0.05	0.09	0.13	0.09	0.08	0.05	0.08	0.12
Leverage	0.31	0.17	0.19	0.28	0.41	0.22	0.38	0.02	0.16	0.33
PPE	0.30	0.27	0.08	0.22	0.52	0.22	0.25	0.03	0.12	0.34
Stock Return Volatility	0.03	0.03	0.02	0.03	0.04	0.04	0.03	0.02	0.03	0.05
Abnormal earning	2.50	86.61	-2.55	1.54	10.61	-6.19	626.70	-0.75	0.12	1.46
Asset maturity	7.22	5.78	3.25	5.11	8.87	14.33	445.32	1.91	3.30	6.27
Proportion of firm-years with										
Firm Credit Rating dummy	0.94	n/a	n/a	n/a	n/a	0.72	n/a	n/a	n/a	n/a
Investment Tax Credit	0.04	n/a	n/a	n/a	n/a	0.01	n/a	n/a	n/a	n/a
Net Operating Loss	0.39	n/a	n/a	n/a	n/a	0.38	n/a	n/a	n/a	n/a
Proportion of regulated firm-years	0.13	n/a	n/a	n/a	n/a	0.13	n/a	n/a	n/a	n/a
TEDSPRD	-0.01	0.36	-0.12	0.00	0.11					
CRSPRD	0.00	0.16	-0.09	-0.02	0.09					
Term Spread	1.89	1.29	0.59	2.27	2.98					

Panel D: Correlations between Amihud, Covenant index, offering spread, and time to maturity. (We may not want to show this table)

	Log(Amihud)	Log(covenants)	Offering spread	Log(Maturity)
Log(Amihud)	1			
Log(covenants)	0.015	1		
Offering spread	0.34***	-0.188***	1	
Log(maturity)	-0.038*	0.070***	-0.048**	1

Table 3: Causal Effect of Bond Liquidity on Debt Contracts

This table reports the impact of TRACE implementation (i.e. exogenous shock to bond liquidity) on offering spread, covenant index, and maturity. A dummy variable *D_TRACE* is used to capture the incidence in TRACE as the exogenous shock to bond liquidity. Columns (1)-(3) present GMM estimation of simultaneous equations. Columns (4) – (6) report OLS estimation of single equations. All variables are defined in Table 1. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively.

	Simultaneous Equations			OLS Single Equation		
	Log(Offering Spread)	Log(Covenant Index)	Log(Maturity)	Log(Offering Spread)	Log(Covenant Index)	Log(Maturity)
	(1)	(2)	(3)	(4)	(5)	(6)
D_TRACE	-0.05	-0.29***	0.14*	-0.01	-0.18**	0.31***
	(-1.03)	(-2.87)	(1.8)	(-0.27)	(-2.16)	(3.48)
Log(Offering Spread)		-0.56***	0.39***			
		(-8.53)	(8.72)			
Log (Maturity)	0.23**	0.91***				
	(2.57)	(12.96)				
Log (Covenant)	-0.11***		0.41***			
	(-3.22)		(9.65)			
Leverage	0.06	-0.29	-0.09	0.25	0.44*	-0.44***
	(0.89)	(-1.64)	(-0.77)	(1.47)	(1.71)	(-3.31)
Firm Size	-0.08***	0.01	0.06***	-0.08**	0.28***	0.15***
	(-7.65)	(0.45)	(3.44)	(-2.29)	(5.24)	(8.13)
Tobin's Q		0.03	-0.03**		0.15***	-0.15***
		(1.52)	(-2.39)		(5.68)	(-5.81)
Stock Return Volatility	0.22	-1.22	0.42	-0.72	-0.82	-0.16
	(0.51)	(-1.25)	(-0.61)	(-1.01)	(-0.77)	(-0.22)
PPE	-0.03			-0.3		
	(-0.67)			(-1.41)		
Asset maturity			0.005**			0.01***
			(2.2)			(3.64)
Profitability	-1.19***			-0.80**		
	(-5.92)			(-2.50)		
Abnormal earning			0.0001			0.0005
			(0.43)			(1.32)
Regulated	0.34***	0.51***	-0.49***	0.43	-1.80**	-1.46**

	(5.39)	(5.36)	(-5.67)	(1.09)	(-2.37)	(-2.53)
Firm Credit Rating	-0.07	-0.16	0.16	0.2	-2.01***	0.14
	(-1.35)	(-0.99)	(1.61)	(0.62)	(-4.31)	(0.26)
Redeemable	-0.08	0.17*	0.14*	0.19***	0.32***	0.29***
	(1.65)	(1.94)	(1.91)	(5.27)	(5.99)	(5.24)
Investment tax credit			0.04			0.23
			(0.97)			(1.12)
Net operating loss			0.03			0.15***
			(1.65)			(2.76)
Lag covenant		0.27***			0.24***	
		(9.89)			(10.23)	
Coupon Rate	0.19***			0.20***		
	(10.15)			(20.46)		
Term Spread			-0.10***			0.03
			(-6.53)			(1.19)
CRSPRD	0.36***	0.47***	-0.14	0.57***	0.11	-0.03
	(6.00)	(3.90)	(-1.46)	(9.20)	(1.12)	(-0.33)
TEDSPRD	-0.07***	-0.03	-0.02	-0.08***	-0.04	-0.07
	(-3.48)	(-0.59)	(-0.52)	(-3.03)	(-1.11)	(-1.76)
Constant	0.66***	0.49	0.17	1.43***	1.14	3.38***
	(3.28)	(1.30)	(0.62)	(2.78)	(1.44)	(5.30)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	No	No	No
Firm Fixed Effect	No	No	No	Yes	Yes	Yes
Bond Rating Fixed	Yes	No	No	Yes	Yes	Yes
Observations	2,395	2,395	2,395	2,395	2,395	2,395

Table 4: GMM Estimation of the Liquidity Effect on Bond Contracts

This table reports the GMM estimation of the liquidity effect on terms of debt contracts. The dependent variables are log of offering spread, log transformation of covenants index, and log transformation of debt maturity, respectively. The illiquidity is proxied by log(Amihud). Other independent variables are defined in Table 1. In all regressions, we control for industry and year fixed effect. In the regression of offering yield spread, we further control for dummies of bond ratings. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively.

	Log(Offering Spread)	Log(Covenant Index)	Log(Maturity)
	(1)	(2)	(3)
Log(Amihud)	7.93***	18.28***	-10.52***
	(4.68)	(6.02)	(-4.79)
Log(Offering Spread)		-0.90***	0.59***
		(-13.25)	(14.45)
Log (Maturity)	0.35***	1.09***	
	(2.58)	(14.79)	
Log (Covenant)	-0.11***		0.32***
	(-3.53)		(7.77)
Leverage	0.34***	0.15	-0.43***
	(3.83)	(0.76)	(-3.58)
Firm Size	-0.10***	-0.14***	0.16***
	(-6.01)	(-5.17)	(8.78)
Tobin's Q		-0.04	0.07***
		(-1.84)	(5.15)
Stock Return Volatility	0.31	-0.54	-0.46
	(0.66)	(-0.54)	(-0.69)
PPE	-0.12***		
	(-2.87)		
Asset maturity			0.01***
			(3.37)
Profitability	-0.72***		
	(-3.92)		
Abnormal earning			0.0001
			(1.33)
Regulated	0.13**	0.29**	-0.19**
	(2.23)	(2.37)	(-2.02)
Firm Credit Rating Dummy	0.44	0.01	-0.11*
	(-0.13)	(0.12)	(-1.71)
Redeemable	0.02	-0.07	0.30***
	(0.20)	(-0.47)	(3.09)
Investment tax credit			-0.02
			(-0.54)
Net operating loss			-0.01
			(-1.06)
Lag covenant		0.31***	
		(9.00)	
Coupon Rate	0.21***		
	(6.42)		
CRSPRD	0.42***	0.65***	-0.41***
	(5.70)	(4.19)	(-3.74)
TEDSPRD	-0.02	-0.02	-0.03
	(-0.79)	(-0.31)	(-0.69)

Term Spread			-0.09***
			(-5.62)
Constant	-0.10	0.86**	-0.32
	(-0.57)	(2.33)	(-1.26)
Industry fixed effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
Bond Rating Fixed Effect	Yes	No	No
Observations	2,380	2,380	2,380

Table 5: Liquidity Effect on Bond Contracts using Instrumental Variable

This table reports two-stage least squares results on the estimation of the liquidity effect on offering spread, covenant index, and debt maturity of newly issued bonds. The first stage estimation of firm level bond liquidity is as follow:

$$Log\ Amihud = \alpha_1 + \beta_1 Bond\ Trading\ Information + \theta_1\ Firm\ Information + \lambda_1 Market\ Conditions$$
$$+ Credit\ Rating\ dummy + Year\ dummy + Industry\ dummy + \varepsilon_{i,j,t}$$

where Bond Trading Information includes firm-level bond trading volume and size-weighted bond trading volatility; Firm Information controls for firm size, firm leverage, capital expenditure, abnormal earnings, firm credit rating dummies, asset maturity, and equity volatility; Market conditions include term slope of treasury bonds, shocks in market level credit risk, and shocks in Euro-dollar and treasury spread.

The second stage is a GMM estimation of the simultaneous equations of offering yield spread, covenants, and maturity. The estimation results of the second stage are reported below. In all regressions, we control for industry and year fixed effects. In the regression of offering yield spread, we further control for dummies of bond ratings. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively.

	Log(Offering Spread)	Log(Covenant Index)	Log(Maturity)
	(1)	(2)	(3)
Estimated log(Amihud)	4.25***	9.67***	-7.05***
	(3.28)	(2.75)	(-2.95)
Log(Offering Spread)		-0.83***	0.58***
		(-12.43)	(13.76)
Log (Maturity)	0.08	1.09***	
	(0.70)	(14.62)	
Log (Covenant)	-0.08**		0.37**
	(-2.56)		(8.10)
Leverage	0.24***	0.20	-0.44***
	(3.02)	(0.92)	(-3.31)
Firm Size	-0.06***	-0.13***	0.15***
	(-4.50)	(-4.82)	(8.13)
Tobin's Q		-0.03	0.06***
		(-1.23)	(3.81)
Stock Return Volatility	-0.24	-1.35	-0.16
	(-0.59)	(-1.32)	(-0.22)
PPE	-0.10**		
	(-2.14)		
Asset maturity			0.01***
			(3.64)
Profitability	-0.29		
	(-1.65)		
Abnormal earning			0.0002*
			(1.71)
Regulated	0.04	0.14	-0.04
	(0.88)	(1.05)	(-0.96)
Firm Credit Rating Dummy	0.18	0.10	-0.07*
	(1.40)	(0.90)	(-1.93)
Redeemable	-0.02	-0.05	0.26**
	(-0.20)	(-0.32)	(2.48)
Investment tax credit			-0.01
			(-0.14)
Net operating loss			-0.01

			(-0.61)
Lag covenant		0.28***	
		(7.72)	
Coupon Rate	0.20***		
	(5.22)		
CRSPRD	0.53***	0.83***	-0.54***
	(5.82)	(5.22)	(-4.62)
TEDSPRD	-0.01	-0.03	-0.03
	(-0.41)	(-0.49)	(-0.62)
Term Spread			-0.08***
			(-4.50)
Constant	-0.22	0.38*	-0.35
	(-1.42)	(1.99)	(-1.28)
Industry fixed effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
Bond Rating Fixed Effect	Yes	No	No
Observations	2,380	2,380	2,380

Table 6: Mechanism behind Causal Effect of Bond Liquidity

This table reports the GMM estimation of the liquidity effect on terms of debt contracts. The dependent variables are log transformations of offering spread, debt maturity and covenants index. The illiquidity is proxied by Log(Amihud). Panel A studies Log*(Amihud)*x*HighYieldDumm),* the interaction between bond illiquidity and a high yield dummy. Panel B examines *Log(Amihud)*x*Short-termDebt*., the interaction between bond illiquidity and the ratio of short-term debt over book value of firm asset, where short-term debt is defined as debt maturing within three yearsPanel C examines *Log(Amihud)*x*Tobin's Q*, the interaction between bond illiquidity and growth opportunity proxied by Tobin's Q, All variables are defined in Table 1. We control for firm characteristics and industry and year fixed effect in all regressions. In the regression of offering yield spread, we further control for dummies of bond ratings.

Panel A. The impact of high yield dummy on the effect of bond illiquidity

	Log (Offering Spread)	Log(Covenant Index)	Log(Maturity)
	(1)	(2)	(3)
Log(Amihud)	8.45***	14.73***	-9.18***
	(4.63)	(4.31)	(-3.39)
Log(Amihud) x High Yield Dummy	-0.32	21.14***	-11.90**
	(-0.08)	(2.74)	(-2.45)
High Yield	0.27	0.20*	-0.40***
	(5.47)	(1.86)	(-6.13)
Log (Offering Spread)		-0.90***	0.72***
		(-9.89)	(15.66)
Log (Maturity)	0.34*	0.96***	
	(1.75)	(8.80)	
Log (Covenant)	-0.07**		0.21***
	(-2.01)		(4.62)
Other Controls	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
Bond Rating Fixed Effect	Yes	No	No
Observations	2,380	2,380	2,380

Panel B. The impact of short-term debt on the effect of bond illiquidity

	Log (Offering Spread)	Log(Covenant Index)	Log(Maturity)
	(1)	(2)	(3)
Log(Amihud)	7.69***	16.98***	-9.63***
	(3.67)	(5.67)	(-4.11)
Log(Amihud) x Short-term debt	0.15***	0.16***	-0.14***
	(4.79)	(3.17)	(-3.98)
Short debt	-0.05	-0.01	0.10
	(-0.73)	(-0.07)	(1.01)
Log (Offering Spread)		-0.78***	0.55***
		(-11.17)	(13.20)
Log (Maturity)	0.31	0.94***	
	(1.33)	(11.81)	
Log (Covenant)	-0.08**		0.28***
	(-2.09)		(6.03)
Other Controls	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes

Year Fixed Effect	Yes	Yes	Yes
Bond Rating Fixed Effect	Yes	No	No
Observations	2,380	2,380	2,380

Panel C. The impact of growth opportunity on the effect of bond illiquidity

	Log (Offering Spread)	Log(Covenant Index)	Log(Maturity)
	(1)	(2)	(3)
Log(Amihud)	16.21***	29.62***	-18.62***
	(3.51)	(5.56)	(-4.86)
Log(Amihud) x Tobin's Q	-2.30	-5.04**	3.51**
	(-1.40)	(-2.45)	(2.28)
Tobin's Q	-0.06***	-0.02	0.06**
	(-2.65)	(-0.59)	(2.58)
Log (Offering Spread)		-0.90***	0.60***
		(-13.13)	(14.54)
Log (Maturity)	0.77***	1.11***	
	(4.43)	(15.05)	
Log (Covenant)	-0.18***		0.32***
	(-4.50)		(7.60)
Other Controls	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
Bond Rating Fixed Effect	Yes	No	No
Observations	2,380	2,380	2,380

Table 7: GMM Estimation of the Liquidity Effect on the Use of Various Types of Covenants, Offering Spread and Maturity

This table reports the GMM estimation of the liquidity effect on terms of debt contracts. We decompose overall covenants index into several sub-indices. The dependent variables are offering spread, and natural log transformation of debt maturity and sub-covenants index (Borrowing index, Antitakeover Index, Stock index, and Default index). In columns (1) – (3), covenant index is referred to sub-index of borrowing covenants. In columns (4) – (6), the covenant index is replaced by sub-index of antitakeover covenants. In columns (7) – (9), we replace covenant index with sub-index of stock issuance covenants. In columns (10) – (12), covenant index is referred to sub-index of default related covenants. The illiquidity is proxied by log of Amihud. Other independent variables are defined in Table 1. In all regressions, we control for firm characteristics and industry and year fixed effect. In the regression of offering yield spread, we further control for dummies of bond ratings. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively.

	Borrowing Restrictive Covenants			Antitakeover Restrictive Covenants		
	Log(Offering Spread)	Log(Covenant Index)	Log(Maturity)	Log(Offering Spread)	Log(Covenant Index)	Log(Maturity)
	(1)	(2)	(3)	(4)	(5)	(6)
Log(Amihud)	8.17***	15.06***	-10.44***	6.99***	8.15***	-10.53***
	(4.65)	(5.85)	(-4.74)	(4.27)	(5.12)	(-4.62)
Log(Offering Spread)		-0.71***	0.57***		-0.42***	0.61***
		(-13.77)	(14.40)		(-12.27)	(14.36)
Log (Maturity)	0.40***	0.91***		0.26*	0.58***	
	(2.97)	(15.29)		(1.77)	(16.71)	
Log (Covenant)	-0.18***		0.39***	-0.21***		0.95***
	(-4.67)		(7.91)	(-3.01)		(11.37)
	Stock Issuance Covenants			Default Related Covenants		
	Log(Offering Spread)	Log(Covenant Index)	Log(Maturity)	Log(Offering Spread)	Log(Covenant Index)	Log(Maturity)
	(7)	(8)	(9)	(10)	(11)	(12)
Log(Amihud)	6.84***	-1.97***	-12.30***	4.00**	6.08***	-11.02***
	(4.65)	(-4.47)	(-4.89)	(2.38)	(5.67)	(-4.92)
Log(Offering Spread)		0.11***	0.69***		-0.26***	0.61***
		(9.98)	(13.13)		(-10.59)	(13.20)
Log (Maturity)	0.15	-0.14***		-0.01	0.29***	
	(1.05)	(-14.65)		(-0.08)	(10.30)	
Log (Covenant)	0.80***		-4.36***	0.40***		1.03***
	(2.90)		(-11.73)	(3.64)		(6.52)

Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Bond Rating Fixed Effect	Yes	No	No	Yes	No	No
Observations	2,380	2,380	2,380	2,380	2,380	2,380

Table 8: Robustness Check Using Alternative Measures of Bond Illiquidity

This table reports the GMM estimation of the liquidity effect on terms of debt contract. The dependent variables are offering spread, and natural log transformation of debt maturity, and covenant index. The illiquidity is proxied by Price dispersion (PD) in Panel A; Imputed Roundtrip cost (IRC) in Panel B, and Inter quartile range (IQR) in Panel C. All variables are defined in Table 1. In all regressions, we control for firm characteristics and industry and year fixed effect. In the regression of offering spread, we further control for dummies of bond ratings. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively.

Panel A: Price dispersion (PD)

	Log(Offering Spread)	Log(Covenant Index)	Log(Maturity)
	(1)	(2)	(3)
PD	0.92***	1.41***	-1.02***
	(8.22)	(6.18)	(-6.73)
Log(Offering Spread)		-0.95***	0.63***
		(-13.24)	(14.58)
Log (Maturity)	0.41***	1.12***	
	(3.15)	(15.03)	
Log (Covenant)	-0.12***		0.33***
	(-4.02)		(7.97)

Panel B: Roundtrip cost (IRC)

	Log(Offering Spread)	Log(Covenant Index)	Log(Maturity)
	(1)	(2)	(3)
IRC	38.31***	70.06***	-51.33***
	(6.16)	(6.27)	(-6.78)
Log(Offering Spread)		-0.96***	0.64***
		(-13.37)	(15.03)
Log (Maturity)	0.44***	1.13***	
	(3.26)	(14.88)	
Log (Covenant)	-0.13***		0.33***
	(-4.21)		(7.96)

Panel C: Inter quartile range (IQR)

	Log(Offering Spread)	Log(Covenant Index)	Log(Maturity)
	(1)	(2)	(3)
IQR	0.39***	0.67***	-0.44***
	(6.49)	(6.45)	(-6.41)
Log(Offering Spread)		-0.93***	0.61***
		(-13.27)	(14.46)
Log (Maturity)	0.45***	1.11***	
	(3.33)	(15.21)	
Log (Covenant)	-0.13***		0.33***
	(-4.04)		(7.94)
Other Controls	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
Bond Rating Fixed Effect	Yes	No	No
Observations	2,380	2,380	2,380