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Information and Liquidity of OTC Securities: Evidence from Public Registration of Rule 144A Bonds*

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Abstract

The Rule 144A private debt represents a significant and growing segment of the U.S. bond market. This paper examines the market liquidity effects of enhanced information disclosure induced by the public registration of 144A bonds. Using the regulatory version of TRACE data for the period 2002-2013, we find that following public registration of 144A bonds, dealer-specific effective bid-ask spreads narrow, especially for issues with higher ex-ante information asymmetry. Our results are consistent with existing theories that disclosure reduces information risk and thus improves market liquidity.

Keywords: Rule 144A bond, broker-dealers, public registration, liquidity, information disclosure

JEL Classifications: G12, G14

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1. Introduction

A wide range of corporate securities and derivatives are traded in the over-the-counter (OTC) market, where market-makers and investors search for trading counterparties and bargain over trade terms. Theories show that asymmetric information about issuer's financial conditions is one of the major factors contributing to search frictions and hence market illiquidity in underlying securities (e.g., Duffie 2012). In practice, lack of information can cause extreme illiquidity episodes leading to trading halts of specific securities, for example, when a firm stops filing periodic public reports. Trading conditions may also deteriorate sharply across the broader market when the information risk becomes too high, as evidenced during the 2008 financial crisis.

This article examines the liquidity effect on OTC securities of information disclosure in the context of the public registration of the Rule 144A corporate bonds. By comparing the transaction costs before and after a Rule 144A bond becomes a public-registered bond, we conduct a quantitative analysis on how the changes in information asymmetry impacts the trading liquidity in the market for Rule 144A bonds – an OTC market that has received a great deal of attention in recent years.

Adopted in 1990, the Rule 144A provides a safe harbor from the public registration requirements of the Securities Act (1933) for resales of restricted securities to "qualified institutional buyers" (QIBs), who generally are large financial institutions and other accredited investors.[1] A large fraction of 144A bond issues carry registration rights and are subsequently publicly registered.[2] Public registration requires all issuers to disclose their financial and operational conditions regularly following SEC security laws, while before public registration, issuers of 144A bonds have no obligation to disclose financial conditions to either the bond investors or regulators unless they are also issuing public equities or public bonds.

While there are significant changes in informational environment for market participants in 144A bonds, public registrations in general simply entail offers of new public bonds to exchange for the target Rule 144A bonds, where the terms of the new bonds such as coupon, maturity,

[1] Specifically, QIBs are the following financial entities: (1) an institution (e.g., an insurance company, investment company or pension plan) that owns or invests at least $100 million in securities of non-affiliates; (2) a bank or savings and loan (S&L) association that meets condition (1) and also has an audited net worth of at least $25 million; (3) a broker or dealer registered under the Exchange Act, acting for its own account or for that of QIBs that own and invest at least $10 million in securities of non-affiliates; or (4) an entity whose equity holders are all QIBs.

[2] Extant literature provides a wide range of estimates on the extent of exercises of these registration rights. Depending on the sample used, over 30 to 90 percent of the 144A bonds are publicly registered in the few months following issuance. See, e.g., Livingston and Zhou (2002), Huang and Ramirez (2010), and Craig (2012).

amount issued, and option features are mostly identical to those of the exchanged ones. As such, the 144A public registrations do not accompany changes in the issuer's fundamentals such as leverage, allowing us to better identify the liquidity impact from the changes in information set received by investors and market makers.

We find that liquidity generally improves following public registration of 144A bonds, with more significant impact for issues with higher ex-ante corporate information asymmetry. Our results show that on average, registration reduces the effective bid-ask spread Round-Trip Cost (RTC) – a dealer-specific liquidity measure estimated from transaction data – by 3.3 (5.0) basis points 100 (30) days around the registration, or about 12 (19) percent of its pre-registration level. Further decomposing trades according to transaction size, we find reduction of liquidity costs around registration appears more significant for large- and medium-sized transactions.

The decrease in liquidity cost could also come from more transparent post-trade information, as shown in empirical studies on TRACE dissemination for public bonds (Bessembinder, Maxwell, and Venkataraman, 2006). Allowing non-QIBs to trade post registration could also impact liquidity due to clientele effect. To separate the impact of issuer information disclosure from other drivers of liquidity, such as market transparency and clientele effect, we contrast the change in trading liquidity of 144A bonds that are more likely to experience changes in financial disclosure information environment due to registration with that of other 144A bonds. The hypothesis is that if the financial and operational information disclosure matters for trading liquidity, then the public registration effects should be stronger among issuers with greater corporate information risk pre-registration.

Two DID analyses are conducted for this hypothesis. Firstly, focusing on the 144A bonds experiencing public registrations, we contrast issues of firms with publicly-traded stocks with those of private firms. Because public firms file regularly, public registration of their 144A bonds has relatively less information content, when compared to 144A bond registrations of previously-private firms. In robustness checks, we expand the "public firm" definition to include firms with public bonds prior to the Rule 144A bond registration because those firms also files financial disclosure for the public bonds they offer. Secondly, we use three metrics from bond prospectus to measure ex-ante information asymmetry of an issue: total word count, count of uncertainty words, and file size, following the literature of SEC filing analysis (e.g., Li 2008, Loughran and McDonald 2013, Ertugrul et al. 2015). Suggested by the phenomenon of "information

obfuscation," where issuers tend to hide adverse information through lengthy filings (Bloomfield 2002), more lengthy files with more uncertainty words in post-registration bond prospectus are identified to be issues with higher degree of ex-ante information risk and are predicted to have larger liquidity change from registration. The results from both of these DID analysis show that the reduction in liquidity costs of trading the once Rule 144A bonds post registration is larger for firms with higher degree of information asymmetry. These findings provide evidence that enhanced corporate information disclosure associated with public registration improves the market liquidity of OTC securities.

Overall, this paper contributes to the finance literature examining the relationship between information asymmetry and liquidity cost in secondary market trading. Based on a comprehensive and unique transaction data set on Rule 144A bonds, we show that public disclosure reduces liquidity costs for OTC securities. Following public registration of the 144A bond, bid-ask spreads narrow, and more so for firms with higher ex-ante information asymmetry. We believe our paper is the first to identify such relationship between corporate information disclosure and liquidity cost in bond market. It also complements empirical studies on bond liquidity with detailed examination on Rule 144A bonds, which are often omitted in earlier bond market studies largely because the dissemination of 144A bonds is only recent.

The rest of the paper proceeds as follows. Section 2 provides institutional background on Rule 144A bonds, emphasizing on the information flow for these bonds around their public registration. Section 3 discusses our contributions to the literature. Section 4 describes our data, sample construction, and liquidity measures. Section 5 presents our main empirical results on the impact of registration to liquidity and trading activity. Section 6 provides additional robustness tests and other findings regarding trading activities. Section 7 concludes.

2. Information Disclosure of 144A Bonds Issuers

Since its inception, Rule 144A corporate bonds have quickly become an important source of corporate financing. For example, according to the Fixed Income Securities Database (FISD), between 1990 and 2013 (end of our sample period), Rule 144A bonds accounted for 20 percent of the total corporate bonds issued by U.S. firms, with the growth particularly strong since the recent

financial crisis.[3] Second, secondary market volumes of 144A bonds are also sizable, representing nearly 20 percent of the average trading volumes of all corporate bonds.[4]

Firms issue Rule 144A debt for a number of reasons. Huang and Ramirez (2010) argue that the speed of issuance by bypassing SEC registration has been the main driving force behind the growth in Rule 144A debt as a popular funding source. Speed of issuance is perhaps especially valuable for low credit quality firms as they are likely to have urgent financing needs. Another possible explanation is the lender specialization hypothesis: Private lenders (e.g., banks and QIBs) have advantages over public lenders in handling credit risk and information asymmetry because they have more skills and resources in the areas of information production, monitoring efficiency, and renegotiation in financial distress. As discussed in Bolton, Santos, and Scheinkman (2012), the disclosure exemption in the "dark" markets such as 144A bonds allows informed QIBs to exploit their information advantage and, as such, cream-skim most valuable assets away from the public.

Both of these incentives suggest information content is one of the key distinctions between Rule 144A bonds and public bond offerings. In contrast to public bond offerings, 144A bond issuers do not have any stand-alone mandatory requirement to disclose their financial conditions periodically in regular public filings. The only publicly available information investors could get come from the "Form D" filings that SEC requires 144A bond issuers to file within 15 days of the issuance. Form D is a brief notice that includes the names and addresses of the company's promoters, executive officers and directors, and some details about the offering such as offering amount, but contains little other information about the company. For example, issuers can report their total revenue as range value in Form D but they can also select "decline to disclose" or "Not Applicable". Except for total revenue range or total Net Asset Value range, there is virtually no financial information about the issuer to release in Form D.

In contrast, the U.S. Securities Act of 1933 requires that, before issuing public bonds, firms register with the SEC and provide a prospectus furnishing following information: (a) description of the company's properties and business; (b) description of the security to be offered for sale; (c)

[3] Specifically, out of the total $20.7 trillion of corporate debt issued during 1990-2013, $4.1 trillion was Rule 144A debt. Also, 144A bond issuance as a share of total U.S. corporate bond issuance rose from 23.40 percent during pre-crisis period (1999-2006) to 37.62 percent in post-crisis period (2010-2013).

[4] Dan Caplinger, "How Rule 144A Created a Shadow Financial Market," *Motley Fool*, July 3, 2015, https://www.fool.com/investing/brokerage/2015/07/03/how-rule-144a-created-a-shadow-financial-market.aspx.

Information about the management of the company; and (d) Financial statements certified by independent accountants for up to three years before the offering. Section 15(d) of the Exchange Act of 1934 further stipulates that issuers must provide supplementary and periodic information after the offering. Further disclosures and compliance are mandated based on several amendments since Regulation Fair Disclosure (Reg FD) in 2000, Sarbanes-Oxley (SOX) Act of 2002 and Dodd-Frank Act of 2010. Registration statements and prospectuses become public shortly after the company files them with the SEC. After registration and once the security is successfully offered to the public, the issuer is subject to periodic and non-periodic disclosure requirement, such as 10-Q (quarterly report), 10-K (annual report), and 8-K (material events). The SEC requirement on disclosure reduces the information asymmetry between issuers and outside investors not only through offering prospectus at the time of issuance, but more importantly, through the expectation of subsequent filings of periodic financial statements and material events of issuers.

Another informational difference in the market for 144A bonds versus public bonds is that prior to July 2014, Finance Industry Regulatory Authority (FINRA)'s transaction reporting system TRACE (Trade Reporting and Compliance Engine) has not phased in the dissemination of trading information on 144A bonds to general public.[5] That is to say, transaction information, such as trading volume and transaction price, was not available publicly to either investors or market makers for 144A bonds, in contrast to the more transparent OTC market for public corporate bonds. Our data ends in 2013 when the TRACE reporting change has not kicked in.

Hence, public registration of previously issued 144A debt significantly improves the information environment for the prospective investor, more so if the firm has no prior public equity or debt issues. It is noteworthy that a considerate portion of Rule 144A bond issuers are also public firms who have public listed stocks in equity market, or are "private firms" who have outstanding public bonds. These kinds of issuers are still requested by SEC law to have detailed financial disclosure through 10-Q or 10-K filings. Our sample includes these firms as well as pure "private" firms who only issue Rule 144A bonds. About 40% of the issuers in our sample are private firms without any publicly listed security prior to their registration of the Rule 144A bonds. We use such

[5] FINRA phased in public disseminations of public bonds (non-Rule 144A) on June 30, 2014, with imperfect data observed at least through 2015. Our data is based on regulatory version of TRACE data that covers most of 144A bond transactions before 2014.

distinction in financial disclosure to identify the impact of financial information disclosure on liquidity from other sources of liquidity mover, such as transaction information transparency, clientele base change, and market conditions that may change registration decision.

Of course, regulation requirements do not prevent bond issuers to voluntarily disclose more information to potential investors or market makers, but most of such information disclosure is on a bilateral base from issuers to initial purchasers of the bonds, hence invisible to the public or costly to obtain.[6] In lack of data, we cannot build our empirical study on the degree of such private information provision. Since our focus is on the market liquidity in the secondary market, the information provided to initial purchasers in the primary market is less relevant. If trading information, such as price and trading volume, of 144A bonds were transparent, investors might imply issuers' financial conditions from secondary market trading. However, prior to July 2014, transaction information is not disseminated to general public either, so such information transmission channel is also blocked and an opaque OTC market enforces the information asymmetry rising from less-regulated information disclosure.

3. Related Literature

From market microstructure theory, the market liquidity of traded securities reflects the risk of asymmetric information about the securities (e.g., Glosten and Milgram 1985, Diamond and Verrecchia 1991, among others). In particular, Diamond and Verrecchia (1991) predicts more corporate disclosure should in general reduce liquidity premium embedded in asset prices, although too little information asymmetry may discourage market making activities due to lack of profit. Duffie and Lando (2001) and Yu (2005) show that better corporate disclosure reduces yield spread and affects the observed term structure of yield spread.

However, previous empirical studies on the relationship between corporate disclosure and liquidity are almost all about OTC stock market, maybe due to data limitation. Studies such as Healy, Hutton, and Palepu (1999), Leuz and Verrecchia (2000), Easley, Hvidkjaer, and O'Hara (2002), Greenstone, Oyer, and Vissing-Jorgensen (2006), and Brüggemann, Kaul, Leuz, and Werner (2016) have found that market liquidity in the OTC stocks improve following mandatory

[6] SEC's regulation on 144A securities provide prospective buyers designated by current holders of the security "right to obtain" certain financial information from the issuer, but does not specify terms of such obligation. In practice, private issuers seldom respond information request from secondary market participants in a timely manner.

disclosure requirements because higher quality financial reporting and better disclosure can reduce information asymmetry.[7] White (2016), using a proprietary database of transaction-level OTC, shows that the typical OTC investment return is severely negative and that investor outcomes worsen for OTC stocks that have weaker disclosure-related eligibility requirements. Different market tiers of information disclosure are related to liquidity in both the OTC markets (Davis, Van Ness, and Van Ness 2016) and the Pink Sheet markets (Jiang, Petroni, and Wang 2016). Ang, Shatuber, and Tetlock (2013) find that there is an illiquidity premium among OTC stocks and that the premium is largest among stocks held predominantly by retail investors and those not disclosing financial information in the OTC stocks.

We believe our paper is the first empirical study to use transaction-level information in corporate bond market to provide evidence on how the issuer information disclosure affects market liquidity. The availability of detailed transaction data of public corporate bond OTC market through mandatory TRACE reporting facilitates empirical studies on bond liquidity, but the relationship between corporate information disclosure and market liquidity has not been the focus.

The relationship between post-trade transaction information and bond market liquidity has been investigated in studies such as Bessembinder, Maxwell, and Venkataraman (2006), Edwards, Harris, and Piwowar (2007), Goldstein and Hotchkiss (2007), and Goldstein, Hotchkiss, and Sirri (2007), where they all provide evidence that TRACE dissemination of transaction information results in lower transaction costs. In a very recent working paper, Jacobsen and Venkataraman (2018) uses TRACE reporting on 144A bonds and shows transaction costs decreases after July 2014 when TRACE starts to disseminate transaction information on 144A bonds as well. Similarly, Green, Hollifield, and Schurhoff (2007a and 2007b) and Green, Li, and Schurhoff (2011) find positive effects of trade dissemination on transaction information in the municipal bond market.

Given these rich evidences on the positive impact of market transparency on liquidity, we design our empirical study to focus instead on the impact of issuer financial information disclosure on liquidity. Employing DID analyses based on ex-ante information asymmetry in issuers' financial and operational facts, we are able to disentangle information disclosure impact from post-

[7] Greenstone, Oyer, and Vissing-Jorgensen (2006) analyze the effects of mandatory disclosure requirement using 1964 Securities Acts Amendments in U. S. equity markets and find the Amendments created $3.2 to $6.2 billion of value for shareholders of the OTC firms in their sample. Brüggemann, Kaul, Leuz, and Werner (2016) analyze a comprehensive sample of more than 10,000 U.S. OTC stocks and find that OTC stocks that are subject to stricter regulatory regimes and disclosure requirements have higher market quality (higher liquidity and lower crash risk).

trade transaction information disclosure, or in other words, market transparency impact. We provide the first empirical evidence in the corporate bond market that financial information disclosure enhances market liquidity.

Our paper also complements existing studies on 144A securities by focusing on the liquidity effects of information disclosure brought by public registration. Previous studies on 144A corporate bonds examine yield spreads and various aspects of the financing choice. Studies generally find that Rule 144A debt on average has higher yield than their public counterparts (e.g., Fenn 2000, Livingston and Zhou 2002, Chaplinsky and Ramchand 2004, and Huang, Kalimipalli, Nayak, and Ramchand 2017). Other studies on 144A bond market focus on the cost analysis of issuance and corporate finance choice between public and 144A bond issuance. These include the 144A debt issuance by foreign firms where 144A market is fast replacing the public debt market for high yield and non-rated international issues (e.g., Miller and Puthenpurackal 2002; Gao 2011), and the roles of corporate governance, market timing, industry strategy, and market competition in the decision of public vs. private debt or equity financing (e.g., Arena and Howe 2009; Barry, Mann, Mihov, and Rodríguez 2008; and Tang 2012). The empirical evidence is broadly consistent with the notion that costs associated with mandatory disclosure regulation have an economically significant impact on the financing choice between public and private financing.

The majority of the studies above conjecture that investors in 144A bonds generally require higher yield because of lower liquidity and higher degree of information opaqueness in the private debt market. Our paper is among the first to provide direct evidence on the liquidity effects in the 144A corporate bond market using transaction data. Hollifield, Neklyudov, and Spatt (2014) examine market liquidity using transaction data on 144A securitized (collateralized) securities, but their focus is the role of dealers in a network setting in liquidity provision. They find that central dealers receive relatively lower spreads than peripheral dealers, with the centrality discount stronger for 144A securitizations. Jacobsen and Venkataraman (2018) uses 144A bond data since 2013 and examines the liquidity impact of TRACE reporting change in 2014 for 144A bonds. In contrast to their data analysis, we compare the transaction costs around the event of public registration of each 144A bond, instead of the event of July 2014 TRACE reporting requirement change. In addition, our DID approach helps identify the information disclosure effects from other factors potentially associated with the changes in liquidity conditions.

4. Data and Sampling

4.1 Rule 144A Bonds in TRACE and FISD

We examine 144A bond issues that are subsequently registered as public bonds. We use Mergent's Fixed Income Securities Database (FISD) and the Trade Reporting and Compliance Engine (TRACE) to construct our initial sample. To start, we use FISD's 144A indicator to extract the corporate 144A bonds issued from 1990 (the inception of Rule 144A bonds) to 2013. We then examine 144A bond trading using transaction level data provided by the FINRA using the regulatory version of the TRACE data. Our TRACE data covers the period of July 2002 to February 2013, and contains corporate bond transactions for both publicly and non-publicly disseminated bonds; the latter include 144A bonds which were exclusively issued to QIBs.[8]

We follow Dick-Nielsen (2009) and Dick-Nielsen et al. (2012) to filter the raw TRACE data for cancelled trades, erroneous entries, reversals, duplicated reports, as well as trades with non-positive prices or non-positive volumes. We present the summary statistics of the final 144A TRACE data sample in Table I. Panel A of Table I lists the number of bond issues classified into 144A and non-144A categories using the 144A flag in the TRACE data. We observe that during the 2002 to 2013 sample period, 12 percent to 23 percent of bonds traded each year in the market are 144A bonds. In our entire secondary market trading sample of TRACE data, there are 26,716 unique issues, or 16 percent of all bonds, that are issued as 144A bonds. Panel A of Table I indicates that 144A bonds is a significant portion of the corporate bond universe in TRACE.

[Table I about here.]

We rely on FISD for bond characteristics. Intersecting FISD with TRACE bonds in Panel A of Table I based on issue CUSIP and restricting bond issuers to be corporations domiciling in U.S. leaves us with 11,443 Rule 144A bond issues from 3,528 issuers. Panel B of Table I lists the number of these bonds by their origination year. We observe that 144A bonds with reported trades in TRACE during 2002-2013 are mostly issued in the same period.

Panel C of Table I shows the primary market bond characteristics of the merged TRACE-FISD sample of Rule 144A bonds. While most bonds are non-convertible, non-puttable and non-

[8] This regulatory version of TRACE data is provided by FINRA to the Board of Governors of the Federal Reserve System under a data sharing agreement. The regulatory version of TRACE contains dealer ids which are necessary to construct our liquidity measures. To ensure accuracy, we double check the TRACE 144A bonds with those from FISD.

secured, more than half of the issues are callable. The average offering maturity of these bonds is 7.57 years, or medium- to long-term.

4.2 Public Registration of Ru1e 144A Bonds

Previous studies, such as Livingston and Zhou (2002) and Huang and Ramirez (2010), search company filings in EDGAR to identify subsequent registration of 144A bonds. We instead use a matching sample approach to identify 144A registration events. The information on the 144A registration rights clause or the exercise of the rights is not readily available. However, Rule 144A securities become registered mostly through an exchange offer in which the debtor issues registered public securities (with a new CUSIP) to tender for the 144A securities. The prospectus for the 144A issues typically states that the new bonds issued pursuant to such an offer will be substantially identical to the 144A bonds for which they may be exchanged in several attributes, such as coupon rate, maturity date, security (collateral), and restrictive covenants. Therefore, for every 144A bond in TRACE sample, we search the FISD database to identify a public bond that matches key characteristics of the 144A bond. We treat the matched bond as the corresponding registered bond and its issuance date as the registration date.

Specifically, our matching criteria are as follows: (i) the public bond is issued by the same borrower zero day to five years (inclusive) after the date of the 144A issuance, (ii) the difference in the dates of maturity of the two bonds is no greater than 30 days, (iii) the difference in the offering amount of the two bonds is no greater than 5 percent; (iv) the two bonds have the same coupon rate and same coupon type (fixed or variable),[9] (v) the two bonds have the same collateral condition (secured or not), and (vi) the two bonds have the same "straight" characteristic (straight bond or not, where straight bond is defined as non-convertible, non-puttable, and non-callable). From Panel C of Table I, we note that 10 percent of the 144A bonds are secured and 41 percent of the 144A bonds are straight.

The matching process yields 2,749 bonds for the universe of 11,443 bonds in Panel B of Table I, i.e., about 25 percent of the 144A bonds in merged TRACE-FISD sample are subsequently registered. We, however, note that had we not intersected these bonds with TRACE, the

[9] We impose condition (iv) because maintaining the same coupon rate is one motivation for Rule 144A bonds to be registered. Livingston and Zhou (2002) document that for Rule 144A bonds with the registration-rights clause, a failure to register would, in most cases, result in an increase in the coupon rate. As such, issuers are motivated to register the bond to avoid the increase of coupon rate when a registration-rights clause exists.

registration rate would be higher at 31 percent for all the 144A bonds in FISD sample. These percentages are in line with 30 percent reported in Craig (2012) for the full sample of FISD and 40 percent of investment grade bonds reported in Livingston and Zhou (2002), who, unlike us, rely on Thompson SDC, EDGAR filings, and/or Bloomberg data to identify registration.[10] The number of bond registrations in our sample is insensitive to the matching dimensions of maturity and size differences.[11]

Panel A of Table II provides the characteristics of the registration. More than 99 percent of the matched pairs have exactly the same maturity, and more than 75 percent (90 percent) of the matched pairs have the same (less than 0.1 percent difference in) the offering amount. The slight differences in the offering amount in the right tail of the distribution may be due to early payment such as sinking fund. More than half the registrations take place within half a year of 144A issuance, and more than 95 percent of the registrations take place within a year. Even though we allow for five years to search for potential registration, these results indicate that the registration, if any, takes place quickly.

[Table II about here.]

We provide further validation of the registration events identified above by examining the EDGAR filings of the registered bonds. Specifically, we employ machine searching of bond prospectuses to ensure that the matched procedure that we used above indeed produces registered bonds of 144As. In registering a public bond for the 144A bond, the issuer makes an exchange offer. We note that the following four phrases appear frequently in the exchange-offer prospectuses in our reading of a number of bond prospectuses: "offer to exchange," "exchange offer," "exchange note," and "to exchange." We hence count the number of appearances of these phrases in bond prospectuses to verify that the pairs that we identified in Table II are indeed 144As and their exchange offers.

Out of the 2,749 matched bond pairs, we are able to download 1,150 prospectuses from the SEC's EDGAR website for those issues that we can calculate the bid-ask spread measure of round-trip cost (to be elaborated on in the next section). Panel B of Table II provides the summary

[10] Some authors report that for certain subsets of 144A bonds, the registration rate is much higher. For example, Huang and Ramirez (2000) document that the registration rate for all 144A convertible debt issues is about 88 percent for the sample period of 1996 to 2004. Note that in Panel C of Table I we identify that convertible debt issues only consist of 10 percent of all domestic 144A debt issues for our sample period.

[11] For example, if we relax the maturity difference of the two bonds to 15 (60) days and size difference to 0.025 (0.10), the matching process would yield 2,700 (2,878) pairs of bonds.

statistics of the above keywords in these prospectuses. The minimum number of occurrences of the aforementioned exchange-related phrases in a prospectus is four times. 98.2% (99.7%) of the prospectuses contains at least 50 (five) occurrences of these keywords, showing that our matching algorithm is effective in identifying 144A registrations. Out of the four key phrases, perhaps not surprisingly, "exchange offer" and "exchange note" make the most frequent appearance, each appearing on average 100 or more times in a prospectus. These results suggest that our filtering of 144A registration is highly effective in capturing the public registrations of 144A debt. We keep all of the matched pairs in our sample but note that our results are robust to excluding the registered issues whose prospectuses have fewer than 50 occurrences of the exchange-related phrases.

In untabulated results, we also investigate whether there is a change of registration activities after 2008 (inclusive), since that year witnesses not only the financial crisis, but also a regulatory reform on Rule 144A debt. Prior to 2008, non-affiliate QIBs (i.e., QIBs that are not in a relationship of control with the issuer) could freely trade 144As after a two-year holding period when the bond issuers met certain public-information disclosure requirement. After 2008, the SEC halved the holding period; as a result, a QIB could publicly trade any volume of a security acquired under Rule 144A after a six-month or one-year holding period respectively depending upon if it is affiliated or non-affiliated, provided that the issuer maintains adequate current public information. Such regulatory change may also affect how markets perceive implicit liquidity and other risks in 144A bonds. In our sample, post-2008 there are 2,887 offerings of 144A debt, out of which 855, or 29.6 percent, are subsequently registered. Hence, there is no discernible difference in the registration rate before and after 2008.

4.3 Liquidity Cost Measures

We are interested in the impact of information disclosure of bond issues on the liquidity cost of trading as these bonds are subsequently registered. Among the prevailing bond trading liquidity measures, we consider dealer round-trip liquidity measure following Goldstein et al. (2007). The dealer round-trip metric is based on transaction prices of opposite sides of trades matched by the same dealer and the same trading volume. This measure offers a direct estimate of trading spread charged by dealers. We construct a RTC measure of liquidity, as described below, and develop our main results of liquidity cost comparison based on this RTC measure.

For each bond in our sample, we use the dealer ID provided by FINRA and only dealer-to-

customer trades, and search for matched trading pairs within the same day from the same dealer with the same trading volume at the opposite trading sides. That is, for each trade in which a customer sells (buys) a bond to a dealer, we attempt to find a subsequent trade in which the same dealer sells (buys) the bond with the same amount to another customer within the same day. If we find such a pair, we estimate the bid-ask spread that the dealer charges to the customers as the difference between the pair of buy-sell prices.[12] Formally, we define this round-trip cost, for each pair of trades as

$$RTC = \frac{P_{ask} - P_{bid}}{100}$$

where P_{ask} (P_{bid}) is the ask (bid) price per \$100 par. We also define a normalized version of liquidity cost *RTC_pct* as $\frac{P_{ask}-P_{bid}}{(P_{ask}+P_{bid})/2}$. These round-trip cost measures are essentially the bid-ask spread charged by the same dealer implied from the buy and sell transactions intermediated by the specific dealer at a specific trading volume. Larger *RTC* indicates lower liquidity or, equivalently, larger transaction cost for trading the bond.

We take a simple average to aggregate the RTC measures by trading day, bond, and dealer. Daily *RTC* for each bond is then averaged across dealers and used as the sample liquidity measure. Clearly, the availability of *RTC* depends on whether there exist at least two opposite-side trades on the same bond with the same volume intermediated by the same dealer on the same day. Although in calculating *RTC*, we disregard all other trades, it is common practice in bond markets that dealers do cover the trades within a short-time period if they are pure market makers.[13]

Using *RTC* has advantages in our setting. For one thing, this liquidity measure is based on pairs of transactions with the same trading volume, hence immune from the impact on transaction costs from trading volume, a critique that some other liquidity measures, such as Amihud's price-impact measure, suffer from (see Schestag et al. 2016). In addition, *RTC* is less contaminated by intra-day price volatility, as dealers live on bid-ask spreads. Even although during volatile days, fundamental price movements may also affect *RTC*, but to a lesser degree as compared to other measures such as those based on price dispersion.

[12] In case there are multiple trades that match the original trade in terms of trading volume, trading parties (dealer), trading sides, and trading day, we select the trade with the closest transaction time.

[13] Roll's measure, requiring at least three trades on the same bond within the day, is another widely-used liquidity measure. In contrast, RTC requires two trades at minimum.

4.4 Sample Correlations

We use 100 trading days around registration as our primary event window. For the 2,487 matched registered bonds after 2002, we are able to calculate the round-trip-cost of 1,734 bond pairs, or more than two-thirds of the sample. Table III shows the correlations among the major variables used in the paper. The registration indicator variable, *post*, which takes the value of zero (one) for the transaction time before (post and including) registration, is negatively correlated with *RTC*. The table also reports that, consistent with conventional wisdom, *RTC* is negatively correlated with bond offering amount, firm size, and whether the issuing firm is a public firm or not, and is positively correlated with firm's leverage and stock return volatility.

[Table III about here.]

5. Empirical Analysis on 144A Bond Liquidity Around Registration

5.1 Univariate Analysis of Liquidity Change around Registration

We first examine *RTC* changes around registration. In the comparison of RTC liquidity measures, we take the mean values of *RTC* for each bond-pair, respectively, during specific window periods before and after the registration, and then average over the mean values of all bonds. This way, each bond has an equal weight regardless of its trading frequency. Panel A of Table IV offers the comparison of *RTC* pre- and post-registration. It shows that *RTC* decreases after registration regardless of event time window. From windows 30 to 100 days, the differences of *RTC* and *RTC_pct* pre- and post-registration are all significant, and the reduction of *RTC* ranges from 12 to 24 percent of the spread value, which is economically significant.

[Table IV about here.]

The last columns of Panel A of Table IV compare the trade size before and after the registration, and shows that the average trade size drops after registration. This prompts us to examine the change in *RTC* conditional on trade size. Based on trading volume and prevalent bond credit ratings, we partition transactions into three size groups: large, medium, and small. Transactions with par-value volume larger or equal to $5 million ($1 million) of an investment grade (high-yield or non-rated) bond belong to the "large" group; transactions with volume smaller than $100,000 belong to the "small" group; and the rest of the transactions are classified into the "medium" group. Within each size group, we re-calculate the *RTC* liquidity measures as we do for the full sample. Panel B of Table IV shows that large trades dominate the sample, accounting for

around two thirds of the trade observations. Noticeably, the large trade-size group has the largest reduction in *RTC* post-registration. The medium trade-size group also has a reduction in *RTC* but with a smaller magnitude. In the small trade-size group, *RTC* instead increases; however, we note that small trades account for less than 10 percent of the trades, and such increase disappears in later sections of multivariate regressions when prospectus-based information asymmetry measures are introduced.

5.2 Baseline Regressions of RTC

We test the robustness of univariate results using panel regressions that control for both bond cross-sectional characteristics variables and aggregate market variables. In examining the change of RTC following the public registration, we employ the following baseline regression specification based on the extant bond liquidity literature:

$$RTC_{i,t} = \alpha + \beta_0\, post_i + \beta_1\, (\text{issue-characteristics})_{i,t} + \beta_2\, (\text{firm-characteristics})_{i,t} + \beta_3\, (\text{aggregate variables})_{i,t} + \text{error}_{i,t} \quad (1)$$

for a given bond issue *i* at day *t*. The dependent variables are either of the two liquidity measures, i.e., *RTC* or *RTC_pct*, and β_1, β_2, and β_3 refer to regressions coefficients. Our main focus in Equation (1) is *post*, the registration indicator, that embodies overall transaction cost changes due to registration. Other regression covariates consist of issue-specific attributes (offering amount, time to registration, maturity, ratings, and callability dummy), issuer-specific characteristics (whether the firm is a public firm with listed stock or not, firm-size, leverage, idiosyncratic stock return volatility),[14] and aggregate bond market credit and liquidity risk factors (term-structure slope, default, funding liquidity, and VIX). We control for year fixed effects and clustering effects by issuer and employ heteroscedasticy adjustments in all regressions. Equation (1) is our baseline regression to evaluate the effects of registration.

Models (1) and (5) of Table V present the results for *RTC* and *RTC_pct*, respectively, using bond transactions 100-days around registration. They first confirm the correlation results reported earlier that RTC is negatively related to bond offering amount, firm size and credit rating, and positively related to stock return volatility, reflecting the conventional wisdom that higher-quality

[14] Fifty-six percent of the observations are from private firms and therefore will have missing values for issuer-specific characteristics. To preserve observations, private issuer characteristics are set to zero. Results are qualitatively the same otherwise.

issue or issuer has better liquidity. Consistent with Table IV, we note that *post* is negatively related to *RTC* and *RTC_pct*. After controlling for issue- and issuer-specific characteristics and the macro variables, the effect of *post* on *RTC* is economically significant. Registration of 144A debt reduces *RTC* by 0.02 (Model (1)), or about 8 percent of its pre-registration level. The coefficient estimate of *post* on *RTC_pct* in Model (5) is however not significant. In untabulated results we find that when we instead only control for the macro variables and issue- or issuer-characteristics, *post* is significantly and negatively related to *RTC_pct*. Thus, the insignificance of *post* on *RTC_pct* in Table V may be caused by potential multicollinearity. In sum, Models (1) and (5) of Table V shows that public registration on average improves liquidity.

[Table V about here.]

5.3 DID Analysis: The Impact of Information Asymmetry on Bond Liquidity

The results above show that there is a reduction of liquidity cost in trading after a 144A bond becomes publicly registered. We further investigate whether these changes are driven by information disclosure. To pin down the impact of corporate information disclosure to liquidity cost, we use a DID approach to identify the liquidity change caused by enhanced corporate information disclosure. We conduct two sets of DID analysis in this section. In our first DID test, we examine how registration affects the market liquidity of bonds for higher versus lower information asymmetry firms. The premise is that if the information disclosure matters for trading liquidity, then the public registration effects should be stronger among issuers with greater information risk pre-registration. Our hypothesis is that the *RTC* measure of bid-ask spread decreases more for firms with high information asymmetry pre-public registrations. In our second DID test, we examine the issue-level ex-ante information asymmetry so that the registration effect can be further attributed to the bond itself.

5.3.1 DID Results on Information Asymmetry: Public vs. Private Firms

As discussed, we first differentiate bonds issued by previously-public and private firms. Previously-public firms, via their SEC-mandated information disclosure, have less degree of information asymmetry to investors relative to private firms. Because public firms disclose regularly their financial and operational conditions, public registrations of their 144A bonds may have relatively less information content, compared to 144A registrations of private firms.

Our primary measure for the status of previously-public firm is whether the firm's stock is publicly listed pre-registration. Compared to a firm whose listed securities are only public bonds, regulatory disclosure of stock-listed firms is arguably much more extensively followed by investors and analysts. A large fraction of U.S. 144A bonds are issued by private firms. Earlier we showed that intersecting FISD with TRACE leaves us with 11,443 U.S. 144A bond issues from 3,528 issuers (Table I); a further intersection with Compustat reduces the universe to 3,835 issues from 1,573 issuers. In other words, only about 35 percent of 144A bonds are issued by previously-public firms that have listed stocks. In our registration sample of 2,487 matched bonds, 55 percent of bonds are issued by previously-public firms; these bonds in turn make up 39.5 percent of trades in our sample. In other words, in our regression sample of registered sample, about 60 percent of bond trades are from previously-private firms.

To examine whether information asymmetry is a channel for the effect of registration on liquidity, we focus on the interaction term of *post* times one of our information asymmetry measures. Models (2) and (6) of Table V present the results using *public*, our previously-public firm dummy, as the information asymmetry measure. We note that the interaction term, *post_x_public*, loads positively on liquidity measures of *RTC* and *RTC_pct*. Recall our earlier results that bond registration per se leads to reduction in RTC. Models (2) and (6) of Table V indicate that the reduction in *RTC* through bond registration is weaker (stronger) in public (private) issuers. The overall reduction in the bid-ask spread in the event of registration of *RTC* is moderated by public-issuer—in fact, the net reduction of *RTC* via *post* for public-issuers, which equals the sum of coefficients of *post* and *post_x_public*, is close to zero or slightly positive, suggesting that the reduction in *RTC* takes place mostly in private issuers. We note similar results for *RTC_pct*. Hence, Models (2) and (6) of Table V provide evidence for the role of information asymmetry via private firms as a channel for the effect of 144A registration on liquidity.

5.3.2 DID results on Information Asymmetry: Bond Prospectuses

In the previous section, the measure *public* captures the issuer-level of information asymmetry but not the granular issue level. The challenge of the latter lies in the fact that about half of the bonds are issued by private issuers. One way to learn about the issuer and issue by the private issuer is through bond prospectus. A growing literature examines how firms disclose the information in their financial reports such as 10-Ks and IPO prospectuses, and finds that firms tend

to hide adverse information through lengthy filings. Li (2008) finds that 10-K reports are harder to read when earnings are lower; and You and Zhang (2009) find that more complex 10-Ks have a delayed investor reaction to 10-K filings over the 12 months following the filing date. More recently, Ertugrul et al. (2015) investigate the impact of a firm's 10-K readability and ambiguous tone and find that firms with larger 10-K file size and higher proportion of uncertain words have worse bank loan contract terms and greater future stock price crash risk. In the equity IPO setting, Loughran and McDonald (2013) examine the tone of initial IPO prospectuses and find the uncertain language makes them more difficult for investors to precisely assimilate the value-relevant information. The literature generally suggests that disclosure documents that are longer or contain more uncertain words are more difficult to read and interpret. The inherent idea is "information obfuscation," where it is postulated that issuers tend to hide adverse information through lengthy filings (Bloomfield 2002).

Consistent with the above literature, we use the following three dimensions of prospectus to measure ex-ante information asymmetry of a public issue: the logarithm of the total number of word count of the prospectus (*log_wc*), the logarithm of the total number of "uncertainty" word count of the prospectus (*log_wc_unc*), and the logarithm of file size (*log_fsize*).[15] Based on the extant literature, larger values of these measures indicate higher degree of information asymmetry. These prospectus metrics allow us to differentiate, in an ex-ante sense, the level of information asymmetry among the bond issues. As discussed earlier, we downloaded 1,150 bond prospectuses (offering documents of the exchange bonds) for bonds that we can calculate *RTC*, and calculate these prospectus measures.

Models (3)-(4) and (7)-(8) of Table V present the information asymmetry results using *log_wc*. We first verify in Models (3) and (7) that *log_wc* is positively related to *RTC* and *RTC_pct*. That is, higher information asymmetry, as proxied by larger values of *log_wc*, induces larger bond bid-ask spreads. For our focus of interaction variable between *post* and *log_wc*, we note that it loads negatively on liquidity measures of *RTC* and *RTC_pct*. These results are consistent with those of *public*, in that they both indicate that bid-ask spread decreases more for high-information asymmetry issues. The coefficient estimates of the *post* and *log_wc* interaction term (*post_x_log_wc*) is about the same as those of *log_wc*, indicating that the information asymmetry

[15] The "uncertainty" word list is from Loughran and McDonald (2011). File size is in kilobytes. In measuring the file size, all prospectuses are converted to text file.

effect of registration is about the same as the main information asymmetry effect itself. Thus, the evidence suggests that the channel of information asymmetry is an important consideration in the reduction of bid-ask spread in Rule 144A bond registrations at the issue level. In sum, both DID tests support our hypothesis that information disclosure improves trading liquidity of private bonds.

6 Robustness Checks and Further Discussion

6.1 Endogeneity Consideration of Registration

Our sample so far relies on 144A bonds that are subsequently registered. However there is a possibility that bond registration may be an endogenous firm choice depending upon borrowing costs, issue amount, firm size, market liquidity and funding conditions. Endogeneity can, therefore, arise from self-selection, as more liquid firms may have a greater tendency to register. To control for potentially endogenous bond registration, we run a traditional two-stage Heckman's test. In the first stage, we utilize all domestic 144A bonds in FISD and run a probit regression of whether a bond is registered or not, based on bonds' primary-market characteristics, including issue- and issuer-characteristics and macro conditions. In the untabulated first-stage regression of registration, there are 10,548 Rule 144A issues from FISD, out of which 3,945 are registered. We observe that elements such as offering spread, offering size, callability, and public firms are positively related to the probability of registration, whereas elements such as idiosyncratic return volatility, macro default level, and liquidity are negatively related. These results are by and large consistent with going-public literature (e.g., Pagano, Panetta, and Zingales 1999).

We then calculate the inverse Mills ratio (IMR) from the first stage and include the IMR in the stage-two regressions of secondary-market liquidity measures of *RTC*. Table VI presents the results. We note that the IMR is negatively related to liquidity, suggesting that the higher the probability of registration, the lower an issue's bid-ask spread. Importantly, we note that the results of our main interest, *post_x_public* and *post_x_log_wc*, are almost identical to those of Table V, our main table. Thus, these results suggest that our conclusions are not driven by firms' potentially endogenous choice of registration.

[Table VI about here.]

6.2 Different Trade Sizes

We next examine how the post-public registration impact on liquidity is influenced by the size of the underlying trades. Post registration, as retail investors begin to trade 144A bonds, the average trading size drops. Table VII presents the results with different trade-size groups. We find that *post_x_public* remains significantly positive, and *post_x_log_wc* remains significantly negative for large and medium trade-size groups, but both become insignificant for small trade-size group. These results echo the patterns of *RTC* reduction in Table IV, where we found that the reduction in *RTC* is concentrated in large and medium trade-size groups, which nonetheless account for 90 percent of all trades.

[Table VII about here.]

6.3 Alternative Information Asymmetry Measures

We investigate the robustness with respect to alternative ex-ante information asymmetry measures. So far, we measured the public firm based on whether the issuer has a listed stock at the time of registration. We now expand the measure to include firms issuing public bonds as well. Specifically, a firm is instead defined as "public" if at the time of registration of the Rule 144A bond, it has a listed stock or an outstanding public bond issued at least two months before and maturing at least two months after the registration date. Earlier we reported that public-equity firms account for 39.5% of the trades in our sample; in contrast, public-equity or public-bond firms account for 53.1% of the trades. Results in Panel A of Table VIII show that *post_x_public* remains significantly positive for both *RTC* and *RTC_pct*; and such significance remains for large and median trade size groups.

[Table VIII about here.]

We also use the alternative prospectus measures of uncertainty word count and file size in the regressions of *RTC* and *RTC_pct*. Based on results in Panel B of Table VIII we find that both prospectus measures load positively, their interaction terms with *post* load negatively, and the coefficient estimates on the interaction terms are about the same magnitude as those of the counterpart prospectus measures. These results are highly consistent with those of *log_wc* and confirm the information asymmetry effect on liquidity during 144A registration.

6.4 Alternative Event Windows

We further employ alternative event windows. As suggested in Table IV, we find that

trades occurring closely around registration dates are scant. For example, using 10 days around registration date we are able to identify only 42 pairs of Rule 144A-registered bond for our entire sample period; widening this estimation window to 100 days increases the number of bond pairs to 1,734, or 40 times more bonds. In untabulated results, we find that trading frequency ramps up to exhibit a hump shape with the peak at around 50 days after registration. Since there is no "real" issuance of a new bond, it may take time for public investors to become aware of the exchanged, registered bond. To test whether the information asymmetry effect is robust to this trending-up of trades, we consider alternative estimation windows that exclude 10, 20, 30, or 50 days around registration from our base window of [-100, 100] days. Panel A of Table IX confirms that both *post_x_public* and *post_x_log_wc* retain the same significance for these alternative estimation windows.

[Table IX about here.]

6.5 Year 2008 SEC Regulatory Change

We next examine how a potential structural break in year 2008 can impact the post-registration effect. Prior to 2008, non-affiliate (affiliate) QIBs could freely trade 144As after a two- (one-) year holding period when the bond issuers met mandated information disclosure requirements. After 2008, the SEC halved the holding period requirement. In addition, for QIBs that are non-affiliates of the issuer, the volume restrictions for resale are removed. As a result, after the 2008 amendment, a non-affiliate (or affiliate) QIB could publicly trade any volume of a security acquired under Rule 144A after a six-month (one-year) holding period, subject only to the restriction that the issuer maintains adequate current public information.

We use a dummy variable for the adoption of the new reform time of February 29, 2008, and interact the dummy variable with *post_x_public* and *post_x_log_wc*, respectively, to form a triple interaction variable. Panel B of Table IX shows that the significance of *post_x_public* and *post_x_log_wc* on *RTC* and *RTC_pct* remain intact. The triple interaction term of *post_x_public* and post-2008 dummy is insignificant. And while the triple interaction term of *post_x_log_wc* and post-2008 dummy is significantly negative, as expected, the magnitude of its coefficient estimate is just about one-tenth of that of *post_x_log_wc* itself. Overall, the results suggest that the 2008 reform has no or only weak effect on the impact of information asymmetry on liquidity in private debt registrations.

In untabulated results, we further examine the impact of QIBs potentially trading with non-QIBs after two- or one-year vintage for 144A bonds. We first note that very few registrations take place outside this window—earlier Table II shows that the 99th (90th) percentile of registration distance is 1.89 (0.96) years. We drop the few observations with pre-registration trading vintage of greater than either one or two years, and find our results to be robust.

6.6 Alternative Liquidity Measures and Clientele Effect

Our RTC spread measures are constrained by the availability of same-dealer trades. Such restriction significantly reduces the sample size. We provide a further discussion of three alternate measures of liquidity that are not subjective to this constraint: (i) the logarithm of total dollar trading volume (*total_trd_vol*); (ii) Amihud's (2002) price impact measure (*Amihud*), defined in our context as the percentage change in bond price between two consecutive trades divided by the dollar trading volume of the first transaction; and (iii) Roll's (1984) measure (*Roll*), estimated as the square root of negative covariance (zero) of consecutive bond returns when the covariance is negative (positive). Total dollar trading volume positively measures liquidity, whereas *Amihud* and *Roll* measure illiquidity.[16]

Panel A of Table X presents the results for the full sample of bond trades for the 100-day window around the registration date. Models (1) and (4) in Panel A show the effect of registration as reflected in the trading volume measure of *total_trd_vol*. The dollar value of trading experiences a drop after registration. Earlier in Table IV, we documented that there is a decrease in trade size post registration. This is possibly due to the change of investor base post registration. Pre-registration traders of 144As consist largely of QIBs (for short-vintage 144As, the only traders are QIBs), who are large institutional investors. In contrast, post registration, the investor base is expanded to include all public investors. Retail and non-QIB investors are likely to trade in smaller amounts and less frequently than do QIBs. While our *RTC* measures of liquidity only consider the round-trip trades between dealers and customers, retail and non-QIB investors are to likely account for a significant part of customers in the post- versus pre-registration periods. Since registration is an anticipated event, some institutional traders may have reasons to trade 144A bonds ahead of

[16] We also tested other liquidity measures such as difference of average bid and ask prices as in Hong and Warga (2000), effective half spreads as in Bessembinder and Venkataraman (2010), and intraday price range as in Han and Zhou (2014). These all yield similar results, which are available upon requests.

registration more actively. The entrance of retail investors post registration will likely cause lower trading activity as they tend to behave more like "buy-and-hold" investors than QIBs. Retail investors may also interpret public information less efficiently than QIBs (e.g., Kandel and Pearson 1995, Han and Zhou 2014). The change of the investor base, post registration, may therefore lead to a clientele effect on our results. The negative coefficient of *post* on *total_trd_vol* in Table X is consistent with the above conjecture that the introduction of retail and non-QIB customers post registration results in smaller and less frequent trades, or a clientele change. As well, the result of subdued trading size and volume is consistent with Goldstein, Hotchkiss, and Sirri (2007), who find that enhanced transparency is not associated with greater trading volume.

[Table X about here.]

Consistent with *total_trd_vol*, we observe that *post* has a negative coefficient estimate on both *Amihud* and *Roll*, indicating that *Amihud* and *Roll* both increase post-registration. Although this may suggest that liquidity deteriorates per se post registration, we find that the result is driven by the dominator of trade size in *Amihud* and by less frequent trades in *Roll*. Post-registration, the decrease in trade size leads to higher values of *Amihud*, since size serves as the denominator of *Amihud*. Therefore, higher Amihud illiquidity measure could simply arise from change in investor base. Additionally, there are fewer trades by the buy-and-hold retail investors post registration, resulting in a more negative covariance between consecutive returns (therefore a larger value of *Roll*).

Importantly, we observe that the interaction term *post_x_public* has a significantly negative coefficient on *total_trd_vol* and a significantly positive coefficient on *Amihud* and *Roll* (Models (1)-(3)). This is consistent with our findings that liquidity improvement post registration is higher for private debt issuers that have higher ex-ante information asymmetry. For example, the positive sign of *post_x_public* on *Amihud* is the same as on *RTC*. Similarly supporting our findings, the sign of *post_x_log_wc* on *total_trd_vol* is positively significant and the signs of *post_x_log_wc* on *Amihud* and *Roll* are negatively significant. Overall, Panel A of Table X indicates that our findings that more information asymmetric bonds enjoy higher liquidity improvement post registration extend to traditional liquidity measures.

The results in Panel A of Table X include all observations—including the sample where RTC can be measured. These non-missing *RTC* trades, being those by dealers, tend to be large, and are thus less subject to the clientele effect of changing investor base. In Panel B of Table X

we constrain the sample to only observations with missing-*RTC* trades. In this last sample, the clientele effect is arguably more acute, and it is possible that our findings may not survive. Contrary to this, we find that the signs of *post_x_public* and *post_x_log_wc* on *total_trd_vol*, *Amihud* and *Roll* remain the same as those in Panel A. Thus, the results on traditional liquidity measures are not driven by the clientele effect.

7. Conclusions

In this paper, we utilize a detailed transaction level data on Rule 144A bonds to examine the liquidity change following registration, focusing on the link between information asymmetry and bond trading liquidity.

We use broker-dealers' round-trip-cost (RTC) to measure the underlying liquidity of the 144A bond market. We find that the registration of Rule 144A bonds leads to decreasing trading costs, especially for 144A issues with higher ex-ante information asymmetry. Specifically, our results show that on average registration reduces RTC by about 12 percent of its pre-registration level in 100 days around the registration. More importantly, we find that the reduction of RTC is larger for 144A issues with higher ex-ante information asymmetry. These results are based on two difference-in-difference approaches, by contrasting registered bonds between public and private firms, and between high and low ex-ante information asymmetry issues as embodied in bond offering prospectuses. We also conduct several robustness tests such as incorporating possible endogeneity of registration, subsamples by trade size, alternative liquidity and asymmetric information measures, alternative event windows, and the effects of year 2008 SEC reform. Overall, our findings suggest information disclosure contributes to lower transaction costs and better liquidity of corporate bond trading in the OTC markets.

In addition, enhanced market transparency from TRACE dissemination seems to have positive effects on decreasing liquidity costs as well, while clientele base change following public registration of 144A bonds could be associated with lower trading volume, smaller transaction size, and perhaps higher liquidity costs for bonds with little information asymmetry change post registration. Most of the liquidity improvement effects are found in the large- and medium-sized trades. Hence, despite the change in clientele base and the reduction of trading size post registration, we continue to observe information asymmetry driving liquidity.

Our paper contributes to policy debate on the externalities of financial disclosure in the

OTC markets. Monnet and Quintin (2017) suggest that mandated disclosures on dark trading platforms could exacerbate average underpricing in primary asset markets and reduce welfare. Extant literature, on the other hand, also show, mostly on the equity side, that disclosure in OTC markets could provide benefits such as reduction in cost of capital, increased liquidity, restraining the shadow financial sector, and lowering crash risk (e.g., Greenstone et al. 2006, Brüggemann et al. 2016). Our results imply, in the context of OTC private debt market, that corporate disclosure improves information environment by lowering information asymmetry and improving underlying liquidity.

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Appendix A. Variable Definitions

This table describes all the variables used in the paper.

Liquidity and related measures (Source: TRACE)	
RTC	Round-trip cost of trading, a proxy for effective bid-ask spread, calculated as the daily mean price difference between buy and sell dealer-customer trades, while price is measured as $100 at par.
RTC_pct	Round-trip cost of trading as a percentage of the midpoint of the buy and sell.
Amihud	Percentage change in bond price between two consecutive trades divided by the dollar trading volume (in million $) of the first transaction. A price impact measure of liquidity.
Roll	Roll measure of liquidity cost, i.e., effective bid-ask spread constructed following Roll (1984), equals two times the square root of minus the covariance between consecutive returns from price changes.
total_trd_vol	The logarithm of dollar volume of the trade (in thousand $).
Issue-specific characteristics (Source: FISD; EDGAR)	
post	A dummy variable that equals one for the post-registration period and zero otherwise
public	A dummy variable that equals one if the bond is issued by a firm with a public equity (or by a firm with a public equity or public bond in robustness check), and zero otherwise.
post_x_public	The interaction term of *post* times *public*.
log_wc	The logarithm of the number of words in the bond offering prospectus.
log_wc_unc	The logarithm of the number of uncertain words in the bond offering prospectus.
log_fsize	The logarithm of the file size of the bond offering prospectus.
post_x_log_wc	The interaction variable of *post* times *log_wc*.
offer_amt	Offering amount of the bond, in millions. In regressions, the variable is transformed into logarithm.
reg_time	The time distance between the 144A bond issuance date and its subsequent registration date (in years).
maturity	Maturity of the bond, in years, either on bond issuance date or on transaction date.
callable	A dummy variable that equals one if the bond is callable.
convertible	A dummy variable that equals one if the bond is convertible.
puttable	A dummy variable that equals one if the bond is puttable.
straight bond	A bond that is non-convertible, non-puttable, and non-callable.
secured	A dummy variable that equals one if the bond is secured by collateral.
BB	An indicator variable if the bond's credit rating is BB+, BB, and BB- on the transaction date. Credit ratings by Moody's, Standard and Poor's, and Fitch are used and averaged.

B	An indicator variable if the bond's credit rating is B+, B, and B- on the transaction date. Credit ratings by Moody's, Standard and Poor's, and Fitch are used and averaged.
CCC_n_below	An indicator variable if the bond's credit rating is CCC+ and below on the transaction date. Credit ratings by Moody's, Standard and Poor's, and Fitch are used and averaged.
post2008	An indicator variable that equals to one if the bond transaction time is after Feb. 29, 2008, and zero otherwise.
post_x_post2008	The interaction term of *post* times *post2008*.
post_x_public_x_post2008	The interaction term of *post_x_public* times *post2008*.
post_x_log_wc_x_post2008	The interaction term of *post_x_log_wc* times *post2008*.
Registered	A dummy variable for a 144A bond that is subsequently registered.
IMR	Inverse Mills Ratio from bond's registration regression.

Issuer-specific characteristics (Sources: COMPUSTAT,CRSP)

firm_size	Logarithm of the issuing firm's market capitalization of the previous three months, obtained as the product of stock price and shares outstanding.
ltdebt_ratio	Ratio of long-term debt to total book value of assets of the previous fiscal year.
iv	Idiosyncratic return volatility, computed as standard deviation of residuals from the application of Fama-French 3-factor model on six months of monthly stock returns preceding the transaction date.

Aggregate risk variables (Source: Datastream)

term	Term-structure factor, obtained as 10-year swap rate minus 2-year swap rate.
def	Default factor, obtained as Moody's BAA yield minus 10-year swap rate.
ted	Aggregate liquidity factor, obtained as 30-day LIBOR rate minus 3-month Treasury-Bill rate.
vix	Equity market volatility factor, obtained as VIX index.

Table I: Domestic Rule 144A Bond Issues in TRACE and FISD

This table reports the number of 144A issues based on (a) secondary market trades from TRACE (Panel A), and (b) primary market issuances from FISD (Panel B). Panel C presents the bond offering characteristics from the intersection of TRACE and FISD databases.

Panel A: 144A Bonds in TRACE

Year	Total Issues	144A Issues	% of 144A issues
2002	32,543	4,152	12.8%
2003	40,697	6,225	15.3%
2004	43,428	8,076	18.6%
2005	47,423	9,073	19.1%
2006	62,512	11,376	18.2%
2007	69,934	12,969	18.5%
2008	59,657	12,031	20.2%
2009	55,611	11,085	19.9%
2010	56,606	11,075	19.6%
2011	60,368	11,003	18.2%
2012	74,985	17,410	23.2%
2013	52,035	10,653	20.5%
Total unique issues	166,672	26,716	16.0%

Panel B: TRACE 144A Issues by Issuing Year in FISD

Period	144A issues	# of issuers
1990-1994	107	52
1995-1999	596	410
2000-2004	3,867	1,577
2005-2009	4,846	1,429
2010-Feb., 2013	2,027	1,201
Total (unique)	11,443	3,528

Panel C: Characteristics of TRACE-FISD 144A Bonds (11,443 issues)

	Mean	Std Dev	Minimum	Maximum
Convertible	0.10	0.31	0	1
Puttable	0.05	0.21	0	1
Callable	0.55	0.50	0	1
Straight bond	0.41	0.49	0	1
Secured	0.10	0.30	0	1
Maturity (years)	7.57	7.62	0.06	100.10

Table II: Searching for Registration of Rule 144A Corporate Bonds

Panel A reports the distribution of a number of differences between the Rule 144A issue and a subsequent public issue from the same issuer treated as a registered issue that satisfies our registration criteria. In Panel A, offering size difference is defined as the offering amount of the 144A bond minus the offering amount of the matched registered bond, divided by the offering amount of the 144A bond. In Panel B, we download 1,150 prospectuses of registered bonds from Panel A for which we can calculate the round-trip-cost liquidity measure, and perform a searching for the "exchange"-related key phrases in each prospectus.

Panel A: Public Registration of Rule 144A Bonds

	N	min	p1	q1	median	q3	p90	p99	max
Maturity difference (years)	2,749	-0.08	0	0	0	0	0	0	0.07
Offering size difference	2,749	0	0	0	0	0	0.07%	3.13%	5.00%
Registration distance (years)	2,749	0	0.06	0.28	0.44	0.64	0.96	1.89	4.98

Panel B: Count of Key Phrase Occurrences in Each Public Bond Prospectus (1,150 Prospectuses)

Key phrase	mean	min.	q1	median	q3	max	std
"offer to exchange"	2.52	0	1	2	3	48	3.16
"exchange note"	99.75	0	2	98	170	663	106.22
"to exchange"	10.71	0	8	10	13	61	5.08
"exchange offer"	137.38	0	122	138	153	391	34.09
Total "exchange"-related phrases	250.35	4	156	228	329	1,075	122.15

Table III: Variable Correlations

This table shows the correlations of major variables for 144A bond sample used in the paper. See Appendix A for variable definitions.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
(1)	*RTC*	1																				
(2)	*RTC_pct*	0.97	1																			
(3)	*post*	-0.04	-0.02	1																		
(4)	*log_wc*	0.05	0.06	-0.01	1																	
(5)	*log_wc_unc*	0.04	0.05	-0.01	0.97	1																
(6)	*log_fsize*	0.04	0.04	-0.01	0.80	0.77	1															
(7)	*offer_amt*	-0.17	-0.14	0.04	0.12	0.13	0.09	1														
(8)	*reg_time*	0.06	0.08	0.00	0.17	0.16	0.13	0.19	1													
(9)	*maturity*	-0.06	-0.03	-0.02	-0.25	-0.23	-0.23	0.06	-0.04	1												
(10)	*callable*	0.09	0.08	-0.01	0.14	0.10	0.14	-0.10	-0.02	0.10	1											
(11)	*BB*	-0.05	-0.05	0.00	-0.08	-0.07	-0.12	0.17	0.04	0.02	-0.28	1										
(12)	*B*	-0.04	-0.04	0.04	-0.04	-0.05	-0.02	0.16	0.01	0.01	-0.06	-0.01	1									
(13)	*CCC_n_below*	0.08	0.08	-0.03	0.14	0.16	0.13	-0.25	-0.02	-0.04	0.22	-0.64	-0.59	1								
(14)	*public*	-0.04	-0.04	0.00	-0.49	-0.45	-0.49	-0.11	-0.14	0.16	-0.20	0.10	0.00	-0.07	1							
(15)	*firm_size*	-0.23	-0.22	0.05	-0.34	-0.33	-0.22	0.64	0.07	0.17	-0.26	0.36	0.14	-0.46		1						
(16)	*ltdebt_ratio*	0.05	0.04	0.03	0.25	0.22	0.22	-0.02	0.03	-0.11	0.12	-0.15	-0.08	0.20	-0.23	-0.29	1					
(17)	*iv*	0.17	0.23	-0.03	0.09	0.08	0.01	-0.08	0.10	-0.02	0.16	-0.17	0.00	0.19	0.00	-0.43	0.18	1				
(18)	*term*	0.10	0.09	-0.07	-0.06	-0.06	-0.13	-0.08	-0.03	-0.06	0.10	-0.08	0.06	0.02	0.02	-0.22	0.14	0.31	1			
(19)	*def*	0.13	0.16	0.03	0.07	0.08	0.04	0.15	0.17	-0.09	0.09	-0.04	0.09	-0.02	-0.03	-0.11	0.03	0.37	0.60	1		
(20)	*ted*	-0.03	0.00	0.08	0.17	0.17	0.19	0.19	0.06	0.04	-0.08	0.02	0.01	-0.01	-0.01	0.15	-0.06	-0.09	-0.36	-0.05	1	
(21)	*vix*	0.12	0.16	0.03	0.10	0.10	0.06	0.18	0.14	-0.04	0.05	-0.01	0.09	-0.04	-0.02	-0.04	-0.01	0.28	0.36	0.79	0.23	1

Table IV: RTC Measures around Registration

A 144A issue and its exchange issue must appear both before and after registration to be included in the comparison. In the comparison, for each bond-pair, we take the mean values of the RTC liquidity measures, respectively, before and after the registration, and then average over the mean values of all bonds to arrive at the number reported in the table. In Panel B, we partition the transactions into three size groups: Large, Medium, and Small, according to their trading volume and bond credit ratings. Transactions with volume larger or equal to $5 million ($1 million) at par value for an investment grade (high-yield or non-rated) bond belong to the "Large" group; transactions with volume smaller than $100,000 belong to the "Small" group; and the rest of the transactions are classified into the "Medium" group. After the partition, within each size group, we re-calculate the *RTC* liquidity measures as we do for the full sample. ***, **, and * indicate significance at 1, 5, and 10 percent levels, respectively.

Panel A: *RTC* and Trade Size around Registration

Trading days around registration	# of bond pairs	*RTC*			*RTC_pct* (%)			Trade Size (in $1,000s)		
		Before	After	Diff.	Before	After	Diff.	Before	After	Diff.
10	42	0.224	0.164	-0.060*	0.233	0.166	-0.067*	17,367.2	15,692.7	-1,674.5
20	172	0.195	0.175	-0.020	0.203	0.184	-0.019	13,317.5	10,754.9	-2,562.7*
30	604	0.264	0.214	-0.050***	0.276	0.222	-0.053***	10,234.8	9,391.6	-843.1
50	1,280	0.271	0.233	-0.038***	0.280	0.241	-0.039***	10,644.7	8,715.9	-1,928.8***
100	1,734	0.267	0.235	-0.033***	0.276	0.243	-0.034***	14,221.0	8,485.8	-5,735.2***

Panel B: *RTC* Comparison by Size Group (100 days around registration)

Trade size Group	# of obs.	# of bond pairs	*RTC*			*RTC_pct* (%)		
			Before	After	Diff.	Before	After	Diff.
Large	23,541	1,518	0.287	0.261	-0.026***	0.298	0.271	-0.028***
Medium	9,875	1,106	0.225	0.207	-0.018*	0.230	0.212	-0.018*
Small	2,629	327	0.234	0.294	0.060**	0.235	0.296	0.062**

Table V: Effects of Registration on *RTC* and the Roles of Information Asymmetry

This table reports the results of regressions involving secondary market trades of U.S. 144A bonds 100 days around registration. The depend variable is *RTC* or *RTC_pct*. Explanatory variables include indicator variable *post* (a dummy variable that equals one for the post-registration period and zero otherwise); *public* (a dummy variable if the issuer is a public firm and zero otherwise); *post_x_public*, an interaction variable of *post* and *public*; *log_wc* (logarithm of total word count of the bond offering prospectus); and *post_x_log_wc*, an interaction variable of *post* and *log_wc*. To preserve the number of observations, issuer characteristics of *firm_size*, *ltdebt_ratio*, and *iv* are replaced with zero when missing. All other variables are defined in Appendix A. All regressions include controls for year-specific fixed effects and issuer-specific cluster effects, and adjustments for heteroskedasticity. Values of *t*-statistics are reported in parentheses. ***, **, and * indicate significance at 1, 5, and 10 percent levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	RTC	*RTC*	*RTC*	*RTC*	*RTC_pct*	*RTC_pct*	*RTC_pct*	*RTC_pct*
post	-0.02***	-0.03***	-0.02***	0.31***	-0.01	-0.02**	-0.01	0.37***
	(-2.77)	(-3.90)	(-3.13)	(2.61)	(-1.18)	(-2.48)	(-1.63)	(2.69)
post_x_public		0.03**				0.03**		
		(2.44)				(2.28)		
log_wc			0.02**	0.03***			0.02**	0.04***
			(2.43)	(3.38)			(2.36)	(3.34)
post_x_log_wc				-0.03***				-0.03***
				(-2.78)				(-2.78)
offer_amt	-0.07***	-0.07***	-0.07***	-0.07***	-0.07***	-0.07***	-0.08***	-0.08***
	(-11.15)	(-11.19)	(-10.54)	(-10.54)	(-8.53)	(-8.58)	(-8.67)	(-8.69)
reg_time	0.06***	0.06***	0.09***	0.09***	0.09***	0.09***	0.14***	0.14***
	(4.62)	(4.65)	(5.71)	(5.74)	(4.76)	(4.78)	(6.21)	(6.23)
maturity	-0.00***	-0.00***	-0.00	-0.00	-0.00	-0.00	0.00	0.00
	(-3.07)	(-3.08)	(-0.39)	(-0.44)	(-0.69)	(-0.69)	(1.21)	(1.18)
callable	0.07***	0.07***	0.05	0.05	0.06***	0.06***	0.05	0.05
	(3.43)	(3.45)	(1.34)	(1.35)	(2.98)	(3.01)	(1.31)	(1.31)
BB	0.10***	0.10***	0.14**	0.14**	0.10**	0.10**	0.11*	0.11*
	(2.74)	(2.76)	(2.31)	(2.37)	(2.48)	(2.49)	(1.78)	(1.79)
B	0.01	0.01	-0.01	-0.01	-0.01	-0.01	-0.05	-0.05
	(0.22)	(0.31)	(-0.59)	(-0.30)	(-0.29)	(-0.22)	(-1.07)	(-0.90)
CCC_n_below	0.06***	0.06***	0.05*	0.05**	0.07***	0.07***	0.05*	0.06**
	(4.40)	(4.42)	(1.84)	(2.05)	(3.34)	(3.36)	(1.95)	(2.19)
public	0.04	0.02	0.11**	0.11**	0.01	-0.00	0.08	0.07
	(0.73)	(0.51)	(2.17)	(2.18)	(0.13)	(-0.05)	(1.15)	(1.16)
firm_size	-0.01**	-0.01**	-0.02***	-0.02***	-0.01**	-0.01**	-0.02**	-0.02***
	(-2.29)	(-2.35)	(-2.88)	(-2.91)	(-2.28)	(-2.34)	(-2.58)	(-2.60)
ltdebt_ratio	-0.04*	-0.04*	-0.04	-0.04*	-0.06**	-0.06**	-0.06**	-0.06**
	(-1.87)	(-1.88)	(-1.64)	(-1.68)	(-2.25)	(-2.27)	(-2.03)	(-2.07)
iv	2.30***	2.31***	0.66	0.67	4.37***	4.38***	2.80**	2.82**
	(2.96)	(3.01)	(0.90)	(0.93)	(3.04)	(3.08)	(2.19)	(2.23)
term	0.01	0.01	0.02**	0.02**	0.01	0.01	0.02*	0.02*
	(1.47)	(1.44)	(2.28)	(2.31)	(0.72)	(0.69)	(1.86)	(1.87)
def	0.02***	0.02***	0.02*	0.02**	0.05***	0.05***	0.04***	0.04***
	(2.88)	(2.97)	(1.89)	(2.21)	(4.30)	(4.35)	(3.31)	(3.54)
ted	0.00	0.00	0.00	-0.00	-0.01	-0.01	-0.01	-0.02
	(0.22)	(0.17)	(0.09)	(-0.06)	(-0.62)	(-0.67)	(-0.78)	(-0.96)
vix	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	(6.09)	(6.14)	(4.93)	(4.97)	(6.65)	(6.69)	(5.45)	(5.48)
Constant	0.85***	0.85***	0.70***	0.56***	0.75***	0.76***	0.59***	0.42**
	(9.72)	(9.83)	(5.34)	(3.89)	(6.44)	(6.55)	(3.40)	(2.28)
Observations	29,171	29,171	19,044	19,044	29,171	29,171	19,044	19,044
Adjusted R-squared	0.081	0.082	0.075	0.075	0.093	0.094	0.097	0.097

TABLE VI: Endogeneity Consideration of Registration

This table presents a Heckman two-stage regression, where the first stage's dependent variable is registration, and the second stage's dependent variable is *RTC* or *RTC_pct*. In the first stage, *registered* (a dummy variable equal 1 for a 144A bond that is subsequently registered and 0 otherwise) is regressed on bonds' primary-market characteristics, where we utilize all of the primary market 144A bonds from FISD. In the second stage, the estimated inverse Mills ratio (*IMR*) from the first stage is included in secondary-market regressions that are otherwise identical to Table V. The second-stage regressions include controls for year-specific fixed effects and issuer-specific cluster effects, and adjustments for heteroskedasticity. Values of *t*-statistics are reported in parentheses. ***, **, and * indicate significance at 1, 5, and 10 percent levels, respectively.

	(1)	(2)	(3)	(4)	(5)
	Heckman Stage-1	Heckman Stage-2			
	Registered	*RTC*	*RTC_pct*	*RTC*	*RTC_pct*
post		-0.03***	-0.02**	0.31**	0.38***
		(-3.92)	(-2.43)	(2.56)	(2.68)
post_x_public		0.03**	0.03**		
		(2.55)	(2.38)		
log_wc				0.03***	0.04***
				(3.14)	(3.16)
post_x_log_wc				-0.03***	-0.03***
				(-2.73)	(-2.78)
IMR		-0.10***	-0.09***	-0.08***	-0.07**
		(-5.09)	(-4.03)	(-3.60)	(-2.40)
offering_spread	0.07***				
	(9.65)				
reg_time		0.06***	0.09***	0.09***	0.14***
		(4.72)	(4.85)	(5.60)	(6.15)
offer_amt	0.28***	-0.08***	-0.08***	-0.08***	-0.08***
	(14.85)	(-11.70)	(-8.68)	(-10.84)	(-8.68)
maturity	-0.002	-0.00**	-0.00	0.00	0.00
	(-0.82)	(-2.54)	(-0.28)	(0.15)	(1.42)
callable	1.27***	-0.04	-0.04	-0.03	-0.02
	(26.08)	(-1.31)	(-1.05)	(-0.63)	(-0.35)
BB	0.46***	0.10***	0.11***	0.13**	0.10
	(8.98)	(2.82)	(2.67)	(2.17)	(1.62)
B	0.37***	0.01	-0.01	-0.01	-0.04
	(7.73)	(0.29)	(-0.35)	(-0.19)	(-0.83)
CCC_n_below	-0.03	0.04**	0.05**	0.03	0.03
	(-0.46)	(2.50)	(2.50)	(0.85)	(1.08)
public	1.42***	-0.03	-0.06	0.05	0.03
	(7.83)	(-0.65)	(-0.86)	(0.93)	(0.37)
firm_size	-0.06***	-0.01	-0.01*	-0.01**	-0.01**
	(-3.31)	(-1.57)	(-1.72)	(-2.20)	(-2.11)
ltdebt_ratio	0.29***	-0.05**	-0.08***	-0.04*	-0.06**
	(3.61)	(-2.32)	(-2.62)	(-1.73)	(-2.11)
iv	-17.26***	2.67***	4.79***	1.11	3.23**
	(-6.60)	(3.28)	(3.20)	(1.50)	(2.55)
term	0.20***	0.01	0.00	0.01	0.01
	(7.74)	(0.84)	(0.38)	(1.64)	(1.41)
def	-0.74***	0.02***	0.05***	0.02**	0.04***
	(-22.47)	(2.79)	(4.01)	(2.08)	(3.39)
ted	-0.24***	0.00	-0.01	0.00	-0.01
	(-3.40)	(0.04)	(-0.76)	(0.10)	(-0.85)
vix	0.06***	0.00***	0.00***	0.00***	0.00***
	(18.75)	(5.68)	(6.32)	(4.65)	(5.23)
Constant	-5.32***	1.22***	1.09***	0.89***	0.69***
	(-22.40)	(10.01)	(6.94)	(4.92)	(2.92)
Observations	10,548	28,441	28,441	18,782	18,782
Likelihood Ratio/Adjusted	4,554.70	0.087	0.098	0.078	0.099

Table VII: The Roles of Information Asymmetry across Different Trade Size Groups

This table reports the regression results across different trade-size groups. The dependent variable is *RTC*. Values of *t*-statistics are reported in parentheses. ***, **, and * indicate significance at 1, 5, and 10 percent levels, respectively.

	Trade-size Group					
	Large		Medium		Small	
	(1)	(2)	(3)	(4)	(5)	(6)
post	-0.03***	0.22	-0.01	0.44**	0.11**	-0.31
	(-3.29)	(1.42)	(-1.52)	(2.43)	(2.29)	(-0.42)
post_x_public	0.03**		0.03*		0.03	
	(2.05)		(1.92)		(0.50)	
log_wc		0.03***		0.02*		-0.00
		(2.68)		(1.81)		(-0.02)
post_x_log_wc		-0.02*		-0.04**		0.04
		(-1.68)		(-2.50)		(0.58)
offer_amt	-0.06***	-0.07***	-0.07***	-0.09***	0.02	-0.01
	(-10.06)	(-9.57)	(-9.55)	(-8.61)	(0.67)	(-0.36)
reg_time	0.07***	0.09***	0.03*	0.08***	0.11	0.19
	(4.88)	(5.07)	(1.84)	(3.60)	(1.25)	(1.36)
maturity	-0.00***	-0.00	-0.00	0.00	-0.01***	-0.00
	(-3.01)	(-0.64)	(-0.20)	(0.45)	(-2.97)	(-0.91)
callable	0.08***	0.07*	0.03	0.03	-0.02	-0.06
	(4.14)	(1.72)	(1.03)	(0.41)	(-0.35)	(-0.80)
BB	0.11***	0.17***	0.06	0.10	-0.15	0.22
	(2.59)	(2.75)	(1.45)	(1.13)	(-1.36)	(1.33)
B	0.03	0.01	0.01	0.01	-0.12	-0.11
	(0.70)	(0.24)	(0.35)	(0.34)	(-0.92)	(-0.67)
CCC_n_below	0.08***	0.08**	0.03*	0.02	0.16	0.13
	(4.43)	(2.28)	(1.92)	(0.69)	(1.56)	(0.93)
public	0.05	0.13**	-0.05	0.02	-0.37**	-0.07
	(0.84)	(2.07)	(-0.86)	(0.31)	(-2.08)	(-0.37)
firm_size	-0.01**	-0.02**	-0.00	-0.01	0.03	0.01
	(-2.19)	(-2.52)	(-0.88)	(-0.97)	(1.30)	(0.26)
ltdebt_ratio	-0.05*	-0.04	-0.06*	-0.06*	-0.04	-0.10
	(-1.91)	(-1.61)	(-1.96)	(-1.75)	(-0.36)	(-1.03)
iv	1.67*	0.15	3.88***	1.89**	10.75**	3.17
	(1.95)	(0.17)	(3.83)	(2.09)	(2.16)	(0.93)
term	0.01	0.01*	0.00	0.02*	-0.07*	-0.05
	(1.37)	(1.68)	(0.45)	(1.75)	(-1.69)	(-0.90)
def	0.02**	0.02**	0.04***	0.04***	0.08	0.03
	(2.52)	(2.00)	(3.01)	(2.77)	(1.49)	(0.69)
ted	0.01	0.02	-0.02	-0.03*	-0.04	-0.10**
	(0.71)	(0.89)	(-1.55)	(-1.77)	(-0.98)	(-2.06)
vix	0.00***	0.00***	0.00**	0.00	-0.00	0.00
	(4.50)	(4.28)	(2.01)	(1.23)	(-0.65)	(0.27)
Constant	0.78***	0.49***	0.97***	0.87***	-0.10	0.30
	(8.59)	(2.88)	(8.51)	(4.32)	(-0.27)	(0.47)
Observations	20,219	13,417	8,725	5,451	2,366	1,573
Adjusted R-squared	0.086	0.078	0.081	0.083	0.074	0.056

Table VIII: Alternative Ex-Ante Information Asymmetry Measures

Panel A reports the results of regressions using the existence of either public equity or public bond as the measure for "public". Panel B reports the results for alternative prospectus measures. All control variables are omitted for brevity. Values of *t*-statistics are reported in parentheses. ***, **, and * indicate significance at 1, 5, and 10 percent levels, respectively.

Panel A: Alternative Measure of *"public"*

Using the existence of public bond or equity status prior to 144A registration to define "*public*"

	Full Sample		*RTC*		
	RTC	*RTC_pct*	Large trades	Median trades	Small trades
	(1)	(2)	(3)	(4)	(5)
public	0.03	0.00	0.05	-0.04	-0.36**
	(0.61)	(0.05)	(0.93)	(-0.78)	(-2.04)
post	-0.03***	-0.02**	-0.03***	-0.02	0.11*
	(-3.55)	(-1.98)	(-3.06)	(-1.62)	(1.91)
post_x_public	0.02**	0.02*	0.02*	0.03**	0.01
	(2.22)	(1.76)	(1.80)	(1.99)	(0.16)

Panel B: Alternative Prospectus Measures

	log_wc_unc (uncertainty word count) as prospectus measure		*log_fsize* (file size) as prospectus measure	
	RTC	*RTC*	*RTC_pct*	*RTC_pct*
	(1)	(2)	(3)	(4)
Prospectus Measure	0.03***	0.02***	0.03***	0.02***
	(3.30)	(3.22)	(3.11)	(2.81)
post	0.21**	0.25***	0.25***	0.31***
	(2.54)	(2.88)	(2.69)	(2.85)
post × Prospectus Measure	-0.03***	-0.02***	-0.03***	-0.02***
	(-2.79)	(-3.15)	(-2.84)	(-3.00)

Table IX: Alternative Event Windows and the 2008 Reform

Panel A reports the results of regressions of those in Table V but using alternative estimation windows that exclude 10, 20, 30, or 50 days around registration. In Panel B, regressions of those in Table V are performed, except that we add an additional variable *post2008* (an indicator variable that equals to one if the bond transaction time is after Feb. 29, 2008, and zero otherwise), and its interactions with *post* (*post_x_post2008*), *post_x_public* (*post_x_public_x_post2008*), and *post_x_log_wc* (*post_x_log_wc_x_post2008*). All control variables are omitted for brevity. Values of *t*-statistics are reported in parentheses. ***, **, and * indicate significance at 1, 5, and 10 percent levels, respectively.

Panel A: Alternative Estimation Windows

	Days around registration removed							
	[-10, 10]		[-20, 20]		[-30, 30]		[-50, 50]	
	RTC	*RTC*	*RTC*	*RTC*	*RTC*	*RTC*	*RTC*	*RTC*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
post	-0.02***	0.31**	-0.02***	0.36***	-0.02**	0.35***	-0.02*	0.44**
	(-3.38)	(2.50)	(-3.10)	(2.87)	(-2.43)	(2.65)	(-1.94)	(2.54)
post_x_public	0.03**		0.03**		0.03**		0.03**	
	(2.33)		(2.35)		(2.18)		(2.24)	
log_wc		0.03***		0.04***		0.03***		0.03***
		(3.29)		(3.54)		(3.17)		(2.81)
post_x_log_wc		-0.03***		-0.03***		-0.03***		-0.04***
		(-2.66)		(-3.00)		(-2.74)		(-2.60)
Observations	27,571	18,032	25,549	16,750	22,839	14,887	16,182	10,248
Adjusted R-squared	0.082	0.076	0.083	0.079	0.082	0.078	0.083	0.081

Panel B: The Effect of the 2008 Reform

	RTC	*RTC_pct*	*RTC*	*RTC_pct*
	(1)	(2)	(3)	(4)
post	-0.03***	-0.02**	0.28**	0.34**
	(-3.91)	(-2.50)	(2.33)	(2.44)
post_x_public	0.04***	0.04***		
	(2.84)	(2.76)		
post_x_public_x_post2008	-0.03	-0.04		
	(-1.46)	(-1.55)		
log_wc			0.03***	0.04***
			(3.31)	(3.27)
post_x_log_wc			-0.03**	-0.03**
			(-2.37)	(-2.42)
post_x_log_wc_x_post2008			-0.004***	-0.004***
			(-3.60)	(-3.48)

TABLE X: Effects of Registration on Other Liquidity and Trading Variables

The dependent variables consist of the logarithm of the total dollar volume of the trade (*total_trd_vol*), Amihud measure (*Amihud*), and Roll's measure (*Roll*). In Panel A, all trades are included; in Panel B, trades for which we can calculated *RTC* are excluded. The control variables in Panel B, same as those in Panel A, are omitted for brevity. All regressions include controls for year-specific fixed effects and issuer-specific cluster effects, and adjustments for heteroskedasticity. Values of *t*-statistics are reported in parentheses. ***, **, and * indicate significance at 1, 5, and 10 percent levels, respectively.

Panel A: Full Sample (the sample with both non-missing and missing-*RTC* observations)						
	(1)	(2)	(3)	(4)	(5)	(6)
	total_trd_vol	*Amihud*	*Roll*	*total_trd_vol*	*Amihud*	*Roll*
post	-0.48***	0.08***	0.36***	-1.71***	0.42***	2.09***
	(-16.88)	(10.23)	(9.26)	(-3.45)	(2.77)	(3.16)
post_x_public	-0.13***	0.06***	0.24***			
	(-3.28)	(3.89)	(4.04)			
log_wc				-0.06	0.00	0.05
				(-1.56)	(0.88)	(1.59)
post_x_log_wc				0.11**	-0.03**	-0.14**
				(2.49)	(-2.08)	(-2.45)
offer_amt	0.78***	0.00	-0.10***	0.78***	-0.00	-0.13***
	(29.04)	(0.02)	(-3.61)	(25.69)	(-0.28)	(-4.31)
reg_time	-0.37***	0.00	0.19***	-0.29***	0.01	0.28***
	(-7.79)	(0.39)	(3.14)	(-4.66)	(0.71)	(3.72)
maturity	0.01***	0.00	0.01***	0.01	-0.00	0.02***
	(3.90)	(0.40)	(3.47)	(1.22)	(-1.15)	(3.21)
callable	-0.28***	-0.01	-0.03	-0.06	0.01	-0.01
	(-2.78)	(-0.94)	(-0.37)	(-0.52)	(0.85)	(-0.05)
BB	0.35***	-0.05	-0.08	0.08	-0.04	0.35
	(2.79)	(-1.32)	(-0.70)	(0.50)	(-1.08)	(1.40)
B	0.29**	-0.00	-0.10	0.05	0.00	0.10
	(2.26)	(-0.00)	(-0.49)	(0.22)	(0.14)	(0.67)
CCC_n_below	0.53***	-0.03	0.05	0.46***	-0.01	0.29***
	(5.04)	(-0.76)	(0.68)	(3.59)	(-0.42)	(2.90)
public	-0.23	-0.05	-0.20	-0.40**	0.03	-0.08
	(-1.39)	(-1.13)	(-0.83)	(-1.98)	(0.63)	(-0.31)
firm_size	0.00	0.01	-0.00	0.01	0.00	0.01
	(0.10)	(1.26)	(-0.20)	(0.34)	(0.09)	(0.22)
ltdebt_ratio	0.14	-0.02	-0.22*	0.14	-0.03	-0.23
	(1.54)	(-1.06)	(-1.94)	(1.49)	(-0.81)	(-1.62)
iv	10.33***	0.56	13.29**	11.65***	-0.37	9.63*
	(4.32)	(1.09)	(2.38)	(3.79)	(-0.65)	(1.84)
term	0.03	-0.02***	-0.02	0.04	-0.02*	0.00
	(0.96)	(-2.73)	(-0.87)	(1.05)	(-1.88)	(0.03)
def	-0.05	0.01	0.10**	-0.01	0.01	0.10**
	(-1.35)	(1.34)	(2.15)	(-0.30)	(1.35)	(2.00)
ted	-0.01	-0.02*	-0.05	0.04	-0.05***	-0.09
	(-0.18)	(-1.95)	(-1.25)	(0.74)	(-4.92)	(-1.51)
vix	-0.01***	0.00	0.02***	-0.01***	0.00	0.02***
	(-2.98)	(1.12)	(6.28)	(-2.89)	(1.08)	(4.78)
Constant	-2.21***	0.05	1.30***	-1.65***	-0.02	0.80
	(-5.97)	(0.64)	(3.18)	(-2.81)	(-0.18)	(1.64)
Observations	154,184	86,406	31,831	86,390	51,193	19,256
Adjusted R-squared	0.114	0.073	0.131	0.105	0.064	0.134

Panel B: Sample with missing-*RTC* observations only

	(1)	(2)	(3)	(4)	(5)	(6)
	total_trd_vol	*Amihud*	*Roll*	*total_trd_vol*	*Amihud*	*Roll*
post	-0.48***	0.10***	0.45***	-2.02***	0.41**	1.89***
	(-16.48)	(10.84)	(10.00)	(-3.92)	(2.49)	(2.76)
post_x_public	-0.15***	0.06***	0.24***			
	(-3.64)	(3.84)	(3.69)			
log_wc				-0.10**	0.00	0.03
				(-2.50)	(0.52)	(0.93)
post_x_log_wc				0.14***	-0.02*	-0.12*
				(3.00)	(-1.70)	(-1.94)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	125,266	58,056	18,517	67,510	32,668	10,478
Adjusted R-squared	0.105	0.084	0.139	0.100	0.076	0.148