Rainy Day Liquidity

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Abstract

Insurance companies collectively hold nearly one third of corporate bonds, making it critical to understand insurers' roles in the corporate bond market: do they provide or consume liquidity? We coin a new term "rainy day liquidity providers" for the role of insurance companies - with cash flow from core business activities, insurers may provide liquidity to the sell-side in times of market stress. Our empirical findings present strong support to rainy day liquidity provision hypothesis. First, based on widely used bond liquidity measures, we find that, on average, insurer corporate bond purchases improve bond liquidity while it is not the case for insurer bond sales. Second, breaking the sample down into bonds of different rating groups, maturity groups, crisis and non-crisis periods, we show that liquidity provision by insurers is much stronger in stressful conditions. Moreover, we present evidence that rainy day liquidity provision is not only limited to the bonds purchased by insurers - the liquidity of bonds with similar characteristics to the purchased (sold) bonds also increases during stressful periods. Finally, our findings show that insurer funding level, proxied by their net cash flow, strongly influences insurers' propensity to purchase bonds with low ratings and their ability to provide rainy-day liquidity, indicating that improvements in rainy-day market liquidity are directly linked to additional funding liquidity of the insurers.

JEL Codes: G11; G22

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1 Introduction

Illiquidity and illiquidity risk are major concerns to corporate bond investors, which become more severe in distressed market conditions. A predominant feature of the corporate bond market is about its major participants – insurance companies, holding almost one-third of corporate bonds. One would expect insurance companies to play a significant role in the formation of bid and offer prices. More impressively, as Warren Buffett stated in his annual letter to Berkshire Hathaway shareholders, "insurers receive premium upfront and pay claim later... This collect-now, pay-later model leaves us holding large sums – money we call 'float'. We get to invest this float for Berkshire's benefit". As such, would sufficient fund flow enable insurers to act as a liquidity provider in the bond market? Or, insurers, as suggested by the conventional wisdom, being passive buy-and-hold long-term investors, lock up bonds they have invested, lowering bond liquidity.

A main explanation of illiquidity recognized in the literature is the prevalence of information asymmetry in security markets; buyers of a stock may worry that potential sellers has private information that the company is losing money whereas sellers may be afraid that buyers have private information that the company is going to realize positive abnormal returns. The concern to trade with an informed counter-party reduces the liquidity of the security. The information asymmetry story, however, cannot directly apply to insurers' bond transactions since they may not be better informed than other sophisticated financial market participants, such as investment banks or hedge funds, who may deploy further resources to generate private signals about the security's fundamental value.

In this study, we aim to understand the role of insurer transactions in the corporate bond market. The corporate bond market is highly illiquid, and clearly a primary reason is that corporate bond investors are typically of buy-and-hold type, such as insurance companies and pension funds. We therefore expect that trading activities of insurance companies may reduce bond liquidity. Nevertheless, motivated by the fact that insurance companies' cash flow from the insurance business is largely independent of the macro economy, we conceive a conditional role of insurance companies, called the rainy day liquidity provision, that is, insurers provide liquidity to the bond investors when the market is at a distressed state. To motivate this idea, we start with a simple model based on **?**'s framework which suggests that bonds' (market) liquidity is strongly correlated with traders' capital constraints arising from time-varying margins. We consider an equilibrium model with an

intermediary who supplies liquidity to a customer with trading needs. The intermediary has access to margin accounts and face margin constraints set by the financiers. We derive the equilibrium illiquidity in this market and illustrate that an intermediary with relatively higher capital and lower margins in times of market stress can improve the liquidity of an underlying bond.

There are several important implications from the model. First, as the rainy-day liquidity provision is mainly on the buy-side, we expect asymmetric effects of buy- and sell-side transactions on bond illiquidity. Second, we consider several rainy-day conditions: financial crisis period, bonds with lower liquidity, and relatively lower rating. Under such conditions, corporate bonds face higher selling pressure, as investors exhibit "flight-to-quality" behavior. Therefore buy-side transactions by insurers can have dramatic improvements in liquidity. Third, in case insurers indeed act as a rainy-day liquidity provider, we expect to see the bond purchases of insurance companies not only affect the liquidity of bonds that insurers trade but also different bonds that are closely related to the bond that insurers trade.

We begin our empirical work by some explorative analysis on the relationship between insurer holding and bond liquidity. There is an interesting U-shape relationship between insurer holding and bond illiquidity. Specifically, irrespective of the illiquidity measures, bond illiquidity is lowest when insurers hold 30% par value of a bond. Moreover, bonds not held by any insurers have the lowest liquidity. It appears that when a bond's holding by insurance companies is relatively low, an increase in insurer holding improves liquidity, which is consistent with the conjecture on liquidity provision of insurance companies. Nevertheless, as long as insurer holding exceeds the threshold point, bond illiquidity increases in insurer holding, i.e., the "lock-up" effect becomes more applicable. Similarly, information asymmetry may play a role – if bond dealers believe that insurers are more informed about those bonds which they are addicted to, then dealers can increase bid-ask spread and make those bonds more illiquid.

Furthermore, we test the asymmetric effect of insurer buy and sell transactions on bond illiquidity. We find that insurers' bond purchases lower illiquidity whereas their aggregate sales increase illiquidity or have no effect on bond liquidity. To uncover the rainy day liquidity effect, we break down the sample into bonds of different ratings, liquidity, and different periods around the financial crisis. We find that liquidity provision by insurance companies is higher in stressful times. A one-standard deviation increase in insurers purchasing leads to approximate 3.5%, 0.8%, and

3.9% decrease in median *Roll*, *Amihud*, and *Highlow* respectively for the "Illiquid" bonds group, around 3.3%, 5.0%, and 2.5% decrease for the "Medium" bonds group, and around 12.0%, 19.1%, and 6.9% decrease for bonds during the financial crisis.

Next, we check the spillover effect, that is how the insurers' transactions on one bond affect the liquidity of different bonds with similar characteristics. To do so, we match bonds with the same ratings and similar maturity levels. When all bond-month observations are pooled together, the cross trading effects on illiquidity, both the buy and sell sides, are positive. Trading appears to reduce the liquidity of alternative bonds. However, when we examine the effects in rainy "days" (in crisis period, illiquid bonds, and low rating bonds), we find that the buy-side cross trading effect on illiquidity turns to be negative. This finding strengthens the argument on rainy day liquidity provision in the sense that insurer transactions not only improve the liquidity of the traded bonds, but also other bonds potentially appealing to insurers' portfolios.

The final set of analysis is to clearly identify the connection between insurers' cash flow and the rainy-day effect. A key premise of the rainy day effect hypothesis is that insurers provide liquidity to corporate bonds at distressed conditions. As noted in the literature,[2] insurance market is cyclical, suggesting insurers' cash flow fluctuate over time. Here, we use insurers' cash flow as a conditioning variable. We test if insurers purchase more of low quality bonds when they have more cash flow. Further, we study whether or not the rainy day effect is stronger when insurers have high cash flows, i.e., higher funding liquidity. Our findings render support to the conditional rainy day liquidity provision story – insurers purchase more bonds right above (or below) investment grades and junk bonds and the rainy day liquidity effect is stronger when their cash flow is high.

It should be noted that as though we model the rainy-day liquidity through the funding and market liquidity link, the resulting predictions can be broadly related to the search theory in over-the-counter (OTC) markets (**?**; **?**) and the inventory cost management of dealers (**?**). In terms of the consistency with the search models, insurance and dealers maintain a tight relationship which facilitate search, especially at harsh market conditions. Given that insurance companies look for bonds with certain characteristics (e.g., long-term, investment grade), the dealers may be more incentivized to facilitate trading in these types of bonds even under market stress as they are confident that they can sell these bonds to insurance companies with existing trading relationship.

[2]See **?**, **?** and **?** for discussions of insurance market features.

Alternatively, regarding inventory costs, the dealers would like to manage their inventories effectively to minimize the risk associated with time-varying fundamental values. When an investor buys a large number of bond shares for liquidity needs, dealers are forced to a net short position deviating from their preferred inventory positions. Dealers would be more aggressive in building long positions as they can potentially offload these to interested insurers.

The key contribution of the study is its evidence on the rainy day liquidity provision of insurance companies, which has not been documented in the literature. We show that insurance firms play a critical role in stabilizing the corporate bond market. The role of insurers on bond liquidity is quite different from other financial intermediaries, such as broker-dealers and hedge funds as insurers offer liquidity when it is really needed by the market. The theoretical model of **?** suggests that bonds' (market) liquidity is strongly correlated with traders' capital constraints arising from time-varying margins, i.e., the bond's funding liquidity. In their model, margins can lead to sudden liquidity dry-ups when speculators realize small losses. In this market equilibrium, liquidity provision becomes pro-cyclical. The counter-cyclical liquidity provision by insurers potentially broadens the significance of funding liquidity. Since insurers' portfolios have significant cash flows weakly correlated with the market, insurers assist in increasing liquidity in fragile markets. A good understanding of this mechanism is helpful to improve the trading of corporate bonds and other securities.

The rest of the paper is organized as follows. Section 2 reviews the related literature. Section 3 presents a model that leads to empirical predictions. Section 4 discusses the data and sample. Section 5 presents the empirical findings. Section 6 propose additional works. Section 7 concludes.

2 Literature Review

In a survey of market microstructure, **?** summarize two main competing theories for price formation: inventory (liquidity) and information (adverse selection) paradigm. In the inventory paradigm (see e.g., **?**), information does not play a critical role. Instead, dealers shy away from taking excessive positions and aim to control the arrival of trades by tilting their quotes. When they have large positive inventory, dealers decrease their bid quotes and ask quotes so as to reduce their inventory. Similarly, if they have large negative inventory, dealers increase their bid quotes and ask quotes so as to balance their inventory. In the information-based trading paradigm (see e.g., **?** and **?**),

an investor trades a large order due to his private information about the fundamental value of the asset and thus the market maker accounts for the information content of the order and set his quotes accordingly. In this framework, prices are formed according to the expectations of the value of the asset conditioned on the realized order flow and consequently buy (sell) orders imply higher (lower) valuation and increase (decrease) equilibrium prices.

Related to the inventory cost idea, **?** relate the (market) liquidity of an asset to traders' funding liquidity (i.e., the ease with which traders can obtain funding). Traders provide market liquidity, and their ability to provide funding liquidity depends on their funding. Alternatively, their funding liquidity is critically driven by assets' market liquidity. They show that, under harsh market conditions, market liquidity and funding liquidity are mutually reinforcing, leading to liquidity spirals.

In the over-the-counter market where transactions are thin, there are further frictions due to searching for a potential counter-party to trade. Furthermore, bilateral negotiations may take place before agreeing on a transaction price. Such frictions have led to the study of an alternative liquidity mechanism based on search and bargaining. These models build on the intuition that improving an investor's search alternatives forces marketmakers to give better prices. As a result, bid-ask spreads may be lower if investors can find each other more easily.

? study how intermediation and asset prices in OTC markets are affected by illiquidity associated with search and bargaining. In their model, bid-ask spreads are lower if investors can more easily find other investors or have easier access to multiple market makers. Further along, **?** provide a theory of dynamic asset pricing that directly treats search and bargaining in OTC markets (search then subsequently bargain). They show illiquidity discounts are higher when counterparties are harder to find, when sellers have less bargaining power, when the fraction of quality owners is smaller, or when risk aversion, volatility, or hedging demand is large.

? investigate execution quality issues in corporate bond trading. The essential finding is that insurance company entering a trade of similar size and on the same side for the same bond on the same day with the same dealer will receive a better price if it is a more active investor (active bond trader is holding more corporate bonds than the median corporate bond holding of all insurance companies). Less active investors pay higher execution costs in corporate bond market. Our paper differs from **?** in terms of research objectives. We study the active (positive) roles of insurance

companies and bond dealers in supplying liquidity, while they uncover cross-sectional differences in trading costs of insurance companies. Moreover, they use the NAIC transaction data, not TRACE, for bond price and trading information, thus their analysis is limited to the insurance sector. Also, they examine the effect of insurers' corporate bond holding on prices, while we test a rich set of insurer and bond characteristics. For example, we test the differential liquidity provision roles of insurance companies for bonds with different maturity and rating groups and examine the impact of different characteristics on liquidity provision.

? provide an equilibrium model of liquidity spirals in which market liquidity affects – and is affected by – traders' funding capital and margin constraints. The model implies that margins can increase with market illiquidity when financiers cannot distinguish fundamental shocks from liquidity shocks and fundamentals have time-varying volatility. These dynamics lead to sudden liquidity dry-ups and margin spirals. Speculators can scale back in providing liquidity in multiple securities simultaneously which results in commonality in liquidity. We use a simplified version of this model to generate testable hypotheses regarding the potential role of insurers in liquidity provision. We compute the equilibrium level of illiquidity in this market and the closed-form solution for illiquidity implies that an intermediary with relatively higher capital and lower margins in times of market stress can supply higher liquidity.

? explore the effect of electronic trading (MarketAxess) on bond pricing, with which investors can simultaneously search many bond dealers. It finds that electronic trading improves bond liquidity. It also documents that electronic trading and voice trading work for different types of bonds. They find that electronic trading costs are lower than voice trading but the characteristics of bonds traded via the electronic and voice mechanisms also differ, with bonds likely to be more liquid (e.g., bonds with larger issue sizes) trading more electronically. They propose a model of optimal venue selection and verify empirically that the voice market is chosen for orders with a higher likelihood of information leakage and higher search costs. Our paper complements this study by examining the role of the insurance companies in the corporate bond markets.

? explain the heterogeneity in network size of insurance companies. Insurers face the trade-off between repeated business and more intense dealer competitions. Larger insurers form more relations and receive better prices than small insurers. Our paper complements this study by focusing on the insurer's net effect on liquidity provision. We specifically illustrate that their liquidity

increasing activities are more pronounced during adverse market conditions.

3 A Model of Rainy Day Liquidity Provision

To motivate the rainy day effect, we introduce a simple version of the theoretical model presented in **?**. The economy only has a single risky asset, traded at time $t = 0, 1$. At time t=1, the security pays off v. We assume that the fundamental value of each stock is its conditional expected value of the final payoff $v_t = E_t[v]$. For simplicity, we assume that fundamental volatility has an ARCH structure: $v_{t+1} = v_t + \Delta v_{t+1} = v_t + \sigma_{t+1}\epsilon_{t+1}$, where ϵ_t is a white noise.

We consider three market participants. The first is a risk averse "customer", who trades the risky asset to optimize his portfolio. The second is a "speculator" who also trades this asset to optimize her portfolio. Different from the customer, the speculator has the ability to access a margin account from a "financier", the third party whose job is to finance the speculator's position.

The financier sets the margin, m_t, to limit his counterparty credit risk. m_t is m_t^+ if the specialist chooses to buy asset j and m_t^- if the specialist chooses to sell asset j. The margin is set to cover the position's π-value-at-risk (e.g., 1%).

Specifically, the margin on a long position m^+ is:

$$\pi = Pr(-\Delta p_{t+1} > m_t^+ | \mathscr{F}_t) \tag{1}$$

That is, m^+ is set such that price drops that exceed the amount of the margin only happen with a small probability π. The margin is larger for more volatile assets. The margin depends on financiers' information set $\mathscr{F}_t$.

Similarly, the margin on the short position m^- is:

$$\pi = Pr(\Delta p_{t+1} > m_t^- | \mathscr{F}_t) \tag{2}$$

It means that price increases larger than the margin on a short position only happen with a small probability π.

Now we model the speculator's position. At time 0, the speculator has a cash holding of W_0 bonds and zero shares. Her wealth at time 1 is:

$$W_1 = W_0 + (p_1 - p_0)x_0 + \eta_1 \tag{3}$$

where x_0 is the number of shares purchased at time 0, and η_1 is a zero-mean random wealth shock to the speculator independent from other random variables. The speculator will provide liquidity to the customer's trading need. The speculator is risk-neutral and maximizes $\mathsf{E}[W_1]$ subject to the margin constraints:

$$x_t^+ m_t^+ + x_t^- m_t^- \leq W_t \tag{4}$$

Since there is only single risky asset, the risk-neutral speculator spends all of her wealth on this asset considering the dollar margins, m_t^+ and m_t^-, decided from the financier. At time 0, the speculator's position is:

$$x_0 = \begin{cases} \frac{W_0}{m_0^+} & \text{if } v_0 > p_0, \\ \frac{-W_0}{m_0^-} & \text{if } v_0 < p_0. \end{cases} \tag{5}$$

We finally look at the customer's portfolio. At time 0, the customer has a cash holding of W_0^c bonds and zero shares, and he finds out that he will experience an endowment shock of z at time $t = 0$, where z depends on economics condition at time 0. The customer is risk averse. He chooses the security position each period to maximize his expected exponential utility function $U(W_1^c) = -\exp^{-\gamma W_1^c}$ over final wealth. His wealth W_1^c, including the value of the endowment shock z, evolves as below.

$$W_1^c = W_0^c + (p_1 - p_0)(y_0 + z) \tag{6}$$

A customer's value function is denoted Γ. At time 0, the customer's problem is

$$\begin{aligned} \Gamma_0(W_0^c, p_0, v_0) &= \max_{y_0} -\mathsf{E}_0[e^{-\gamma W_1^c}] \\ &= \max_{y_0} -e^{-\gamma(\mathsf{E}_0[W_1^c] - \frac{\gamma}{2}\mathsf{Var}_0[W_1^c])} \end{aligned} \tag{7}$$

where $\mathsf{E}_0[W_1^c] = W_0^c + (\mathsf{E}_0[p_1] - p_0)(y_0 + z) = W_0^c + (v_0 - p_0)(y_0 + z)$, and $\mathsf{Var}_0[W_1^c] = (y_0 + z)^2 \mathsf{Var}_0[p_1] = (y_0 + z)^2 \sigma_1^2$. The solution for the customer's optimization is

$$y_0 = \frac{v_0 - p_0}{\gamma(\sigma_1)^2} - z \tag{8}$$

Given the the market clearance condition is $x_t + y_t = 0$, we obtain the following conditions:

$$\begin{aligned} \frac{W_0}{m_0^+} + \frac{v_0 - p_0}{\gamma(\sigma_1)^2} - z = 0 \quad \text{if } v_0 > p_0 \\ \frac{-W_0}{m_0^-} + \frac{v_0 - p_0}{\gamma(\sigma_1)^2} - z = 0 \quad \text{if } v_0 < p_0 \end{aligned} \tag{9}$$

Based on the above, a necessary condition for the existence of the market equilibrium is $W_0 \geq 0$. This is because when the condition does not hold, the speculator would have negative wealth. She would not be able to intermediate the financial market.

Moreover, when $v_0 > p_0$, the speculator would buy the risky asset. The market equilibrium exists when $z > \frac{v_0 - p_0}{\gamma(\sigma_1)^2}$ and $z > \frac{W_0}{m_0^+}$; both conditions suggest that the customer has a large number of shares available for selling.

Alternatively, when $v_0 < p_0$, the speculator would sell asset the risky asset while the customer would purchase it. We expect to see $z < \frac{v_0 - p_0}{\gamma(\sigma_1)^2} < 0$ and $z < \frac{-W_0}{m_0^-}$, which means that the customer realizes a negative shock in the risky asset.

When the market equilibrium exists, we have the following expression for the asset illiquidity, Λ_0, which captures the deviation of the price from the fundamental value.

$$\Lambda_0 \equiv |v_0 - p_0| = \begin{cases} \left(z - \frac{W_0}{m_0^+}\right)\gamma\sigma_1^2 & \text{if } v_0 > p_0, \\ \left(\frac{-W_0}{m_0^-} - z\right)\gamma\sigma_1^2 & \text{if } v_0 < p_0. \end{cases} \tag{10}$$

In the first case, given $z > \frac{W_0}{m_0^+}$, if the speculator has lower wealth or higher margins quoted from financiers, the market illiquidity Λ_0 would be high. Similarly, in the second case where $z < \frac{-W_0}{m_0^-}$, the market illiquidity becomes higher with higher margins and lower wealth level of the speculator.

For a normal speculator, it is more likely to get lower wealth and higher margin during the economic downturn which could increase the market illiquidity. For insurers who serve as an alternative speculator, their wealth and margin during crisis will not change too much because their cash flows are independent from the financial market. Therefore, insurers are market liquidity providers during rainy days.

3.1 Hypotheses

Based on the model, we have the following hypotheses:

Hypothesis 1 (Asymmetric trading effect): Insurers' buy-side transactions lower a bond's bid-ask spreads but their sell-side transactions would not lower the spreads.

Hypothesis 1 is based on the fact that insurers are more likely to provide liquidity at the buying side. As discussed in the introduction, it is mainly due to insurers' rich cash flow from the insurance business and their strong preference to purchase fixed income securities. Consequently, insurers are

the primary force to purchase in the secondary corporate bond markets.[3] Moreover, the extensive network with multiple dealers (see e.g., **?**) improves insurers' search ability.

Hypothesis 2 (Rainy day liquidity provision): Insurers are more likely to offer liquidity during adverse market conditions and on unpopular bonds among investors.

The primary motivation behind the second hypothesis is that the insurance business is largely uncorrelated with the general market conditions and they prefer to hold bonds with relatively long horizon. This improves insurers' ability to provide liquidity in economic downturns, and purchase poorly rated and illiquid bonds, i.e., rainy days and rainy bonds.

Hypothesis 3: (Cross bond liquidity spillover): Insurers' bond purchases (sales) could favorably influence the liquidity of matching bonds that are not purchased (sold) under rainy conditions.

We further consider the impact of insurers' bond transactions on liquidity of neighboring bonds under rainy conditions. It is likely that insurers' purchase of a bond reveals their preference of bonds of certain characteristics. As transactions are more sparse at unfavorable conditions (market- or security-wide), the signal effect becomes stronger at these conditions. As a result, we expect the purchase of a specific bond improves liquidity of other bonds with similar characteristics under adverse conditions and among unpopular bonds, i.e. among rainy days and rainy bonds.

4 Data

We use data from the National Association of Insurance Commissioners (NAIC), the Mergent Fixed Investment Securities Database (FISD), and the enhanced version of Trade Reporting and Compliance Engine (the "Enhanced TRACE") with filters in **?**. While the NAIC and FISD data go back to the 1990s, July 2002 is the starting point for the Enhanced TRACE dataset. Therefore, our sample period is from July 2002 to December 2014.

4.1 Data on Bond Characteristics

FISD has detailed information for corporate bonds, such as the issuer, coupon rate, par value, issuance date, maturity date, credit rating. There are 378,409 bonds in original FISD dataset. We only keep asset backed securities, convertible bonds, debentures, letter of credit backed bonds,

[3] Anecdotal evidence suggests that insurers typically cannot receive favorable allocations in the primary bond market. This makes them more actively engaged in the secondary market.

medium-term notes, papers, pass-through trusts, payment-in-kind bonds, strip bonds, zero-coupon bonds, insured debentures, and bank notes for US corporations. Bonds with missing data on key characteristics such as coupon rate, par value, credit ratings are excluded. We do not consider variable coupon rate bonds, denominated in a foreign currency bonds, or preferred securities. Bonds with less than one year maturity are also not considered because of high pricing errors according to **?**. We have 77,466 US corporate bonds in cleaned FISD dataset after those filters.

4.2 Liquidity Measures

Bonds illiquidity is obtained from TRACE. Following **?** and **?**, we clean Enhanced TRACE dataset by deleting known errors and double-counted interdealer transactions. We further use the median and the reversal filters from **?** following **?**. Following **?** and **?**, transactions with unreasonable prices and defaulted bond transactions are also excluded. In total, these filters remove roughly 38% of the raw transactions in TRACE. Months with no insurers trading information mean that there are no insurers trading during these periods.

Three widely used corporate bond illiquidity measures are applied in our paper – the **?** spread measure, the **?** illiquidity ratio, and the **?** *Highlow* proxy. Conceptually, *Roll* and *Highlow* measures are measures of bid-offer spread, whereas *Amihud* is a price impact measure. We only keep months with at least 6 valid trading days in order to compare all measures fairly, and to ensure robustness of the results. All illiquidity measures are winsorized at 1% and 99% level. We have the details on illiquidity measures in the Appendix.

Figure 1 depicts corporate bonds illiquidity measures over time. All reported numbers are weighted by bonds' aggregate par value. The trend for all three illiquidity measures are similar. Measures of illiquidity decreased from July 2002 to June 2007 during before-crisis period. During the credit crunch, they increased sharply and peaked around October 2008, and then significantly dropped to a relatively low level. The illiquidity surge in August 2011 could be attributed to the outburst of Eurozone debt crisis and S&P downgrade of US Treasury Bills rating from AAA to AA+ in that month.

4.3 Insurers' Corporate Bond Holdings and Transactions

State regulations require insurance companies to disclose their annual portfolio holdings and transactions on stocks, bonds and other securities. Such information is included in Schedule D filings of NAIC. For readers' information, we list the largest 15 insurer corporate bond buyers and sells based on the traded bond par values between 2000 to 2014 in Appendix. Except Continental Casualty Company, all other insurers are life insurance companies. Many largest buyers are also active sellers. We construct the sample in the following three steps. The path of sample construction is in Table 1.

First, we get insurer transaction level data from NAIC and merge with FISD. Additional data filters are utilized to ensure the procedure quality. We infer an insurer's year-end holdings by adding the net purchases during the entire year to the holdings at the beginning of the year. If for a given bond, an insurer's inferred year-end par value is below 90% or above 110% of the reported year-end par value, we exclude that year's observations on that bond by that insurer from the sample. If more than 10% of observations are excluded for an insurer during a given year for this reason, we exclude all observations in that year for the insurer. Moreover, we discard maturity, redemption, call, sinked fund, conversion from the sample. There are 952,706 insurer-bond purchases and 580,801 insurer-bond sales at the end of first step.

The second step is to obtain a sample of insurer holding and trading at the bond-insurer level in the monthly frequency. In order to complete this step, we infer insurers' monthly corporate bond holdings based on the reported year-end holdings and reported bond trades, a procedure similar to **?**. To obtain the par value of an insurer's holding on a bond in a specific month, we start with the par value of the insurer's holding of this bond at the beginning of the month, and then add the par value of the insurer's net purchases (buy minus sell) on this bond from the beginning of the month to the end of the month.[4] Finally, we exclude trades within 60 days after issuance and trades within 360 days to maturity focus on secondary market transactions as done in **?**. After merging insurer-bond monthly transaction data with illiquidity data from TRACE, there are 827,518 insurer-bond monthly purchases and 764,008 insurer-bond monthly sales at the end of second step.

While insurers' NAIC filing covers specific dates of each bond transaction, we aggregate daily transactions to estimate monthly holding and trading for each insurer. We use monthly data instead

[4]Note that the Schedule D data have bond holdings by both insurers and their holding companies.

of daily data for the following two reasons. First, insurers are low frequency traders. Over 96% of trading days will have no trading records from insurers if daily data were to be used, a problem making the regression at the daily frequency less reliable. In a sharp contrast, over 70% of monthly observations are non-zero. Second, daily liquidity measures are highly correlated, especially for the Roll measure because it is developed based on historical data, often using the information in the past months or quarters. On the other hand, if we opt to aggregate daily date in a quarterly frequency, such a trading measure is potentially contaminated by obsolete information.

Third, we aggregate across insurers to obtain a monthly holding and trading at the bond level. We only include bonds with positive par value, bond age, maturity, and available ratings. Finally, there are 487,601 observations for 195,010 bond purchases and 180,188 bond sales in our final sample.

4.4 Summary Statistics

Panel A of Table 2 provides summary statistics on the sample of plain-vanilla corporate bonds used in our analysis. Three illiquidity measures and turnover are calculated for each month. We assign number 1 to 22 to bond ratings based on their credit ratings, 22 for AAA rated bonds and 1 for D rated bonds. Bond remaining maturity and bond age are in years. Bond size is equal to the logarithm of outstanding shares. The distributions include the number of bond-month observations, 5th, 25th, 50th, 75th, 95th percentiles, as well as the mean, and standard deviation. We obtain each statistic in each month and then take the average over time. The means of the three illiquidity measures *Roll*, *Amihud*, and $Highlow$ are 1.99, 0.40, and 0.95 respectively. They are comparable with other studies (e.g., **?**). The standard deviations of these three measures are 1.73, 0.57 and 0.83, which indicate meaningful illiquidity dispersion.

Subsequently, in Panel B of Table 2 we report the correlation matrix of key variables. We compute the correlations in each month and then take the averages over time. Correlations among all three illiquidity measures are all positive, ranging from 0.39 to 0.55. The highest correlation is between *Roll* and *Amihud*, and the lowest is between *Amihud* and $Highlow$ measure. The reported correlations are again consistent with **?**. The correlations between turnover and all illiquidity measures are negative, which indicate higher circulation could increase liquidity. Further, bonds with better rating and larger size tend to have higher liquidity. Bonds with larger maturity, larger

bond age, and higher coupon rate, however, are more likely to have lower liquidity.

5 Main Results

5.1 A Preliminary Look at Insurers' Bond Holding and Transactions

Insurance companies are the major stakeholders of corporate bonds. In this section, we present a pilot analysis of insurer holding effect on bond illiquidity. The purpose is to see whether insurance holding could provide bond liquidity or consume bond liquidity. This helps us differentiate between the lock-up role of insurer holding versus liquidity provision. If the lock up explanation prevails, we would see that insurer holding is negatively correlated with bond liquidity. Nevertheless, the explorative analysis is not related to any of the proposed hypotheses, but it rather helps us understand the general univariate relationship between insurer holding and bond illiquidity.

We compute insurers' holding on bond i at time t, $H_{i,t}$, as:

$$H_{i,t} = \frac{\sum_j Holding_{i,j,t}}{Par_{i,t-1}} \tag{11}$$

where $\text{Holding}_{i,j,t}$ is the dollar amount of bond i held by insurer j at period t.

We conduct analysis regarding insurers' corporate bond holdings using sorted portfolios. All bonds in the sample are sorted into decile groups based on insurer holding in each month – corresponding to rank 1 through 10 portfolios. In our sample, bonds with insurers' holding less than 4 percent are in group 1, and the baseline for group 10 is around 60 percent. Bonds not held by any insurer in a month is placed in the rank 0 portfolio. For each sorted portfolio, we first compute the bond average illiquidity measure across insurers in each month, then take average of the cross sectional means over time. The relationship between insurer holding of corporate bonds and average illiquidity measures is depicted in Figure 2. Two panels respectively report the mean and median of bond illiquidity.

Based on the figure, it is quite visible that the there is a U-shaped relationship. Bonds not held by any insurers in a month actually have the lowest liquidity. The mean value of non-holding group's bond illiquidity for *Roll*, *Amihud*, and $Highlow$ is 2.63, 0.76, and 1.36 respectively, and the median value is 2.07, 0.44, and 1.07. Bonds tend to have lower illiquidity when insurers increase their trading participation. On the other hand, when insurers already hold a large portion of one bond, which is around 30% in average, more holding will decrease the bond's liquidity.

Our interpretation about the U-shaped relationship is as follows: when insurers are interested in some specific kind of bond, their participation could potentially increase those bond liquidities. However, insurers are buy-and-hold investors. When they hold a really large portion of one bond, its available amount on the market will be much lower. Insurer unwillingness to sell could discourage potential buyers and increase dealers' inventory cost, and such "lock-up" effect may make bonds more illiquid.

Figure 3 depicts the average insurer holding, insurer purchase, and sales over bond rating groups. The reported numbers are averaged across bonds in each month first then the cross sectional averages are averaged over time. We find that there is a sharp increase between BB+ rated bonds and BBB- rated bonds both for insurer bond holdings and bond purchasing. Insurers prefer to hold and purchase BBB rated bonds than high yield bonds and higher rated bonds. On the other hand, insurers sell large amount of low-rated bonds. One possible explanation is that insurers sell the downgraded bonds for regulatory reasons. These findings are also consistent with "reaching for yield" phenomenon documented in **?** which argue that insurers tend to invest on relatively higher yield bonds without violating their constraints.

Similar to Figure 3, Figure 4 describes insurers' holding and trading over various bond maturity groups. Bond maturities are rounded up to the nearest integer to form maturity groups. Bonds with maturities longer than 30 years are placed in maturity group > 30. 10 years and 30 years maturity bonds are apparently more favored by insurers. We could also tell that 5 year-, 15 year-, and 20 year-maturity bonds are also preferred by insurers.

5.2 Analysis Based on Insurance Trading

Now we move to the main analysis regarding insurance companies' bond transactions. Formally, we define insurer purchase and insurer sale of a bond as below:

$$B_{i,t} = \frac{\sum_j Buy_{i,j,t}}{Par_{i,t-1}} \tag{12}$$

$$S_{i,t} = \frac{\sum_j Sell_{i,j,t}}{Par_{i,t-1}}, \tag{13}$$

where $\text{Buy}_{i,j,t}$ is the dollar amount of bond i bought by insurer j at period t, $\text{Sell}_{i,j,t}$ is the dollar amount of bond i sold by insurer j at period t.

We run a panel regression model to test the impact of insurer purchases and sales on bond illiquidity controlling for bond illiquidity in previous month, bond characteristics and monthly time fixed-effects. The panel regression model has the following specification:

$$\mathrm{ILQ}_{i,t} = \alpha_0 + \alpha_1 \mathrm{ILQ}_{i,t-1} + \alpha_2 \mathrm{B}_{i,t-1} + \alpha_3 \mathrm{S}_{i,t-1} + \mathrm{Control}_{i,t} + \varepsilon_{i,t} \tag{14}$$

Illiquidity in last period, $\mathrm{ILQ}_{i,t-1}$, is controlled in Eq. (14) as a illiquidity change benchmark. Bond characteristics include bond coupon rate, bond age, bond size, bond maturity, bond rating dummy, putable bond dummy, exchangeable bond dummy, redeemable bond dummy, convertible bond dummy, credit enhancements bond dummy, senior bond dummy, and secured bond dummy. We compute two-way clustered standard errors along the time and bond dimensions.

Table 3 reports the results of panel regressions for insurer trading. Columns (1) through (3) present the baseline results from Eq. (14) in absence of any control variables, where bond illiquidity is based on the *Roll*, *Amihud*, and *Highlow* respectively. For all three illiquidity measures, insurer purchases could provide bond liquidity and insurer sales consume liquidity. All coefficients for insurer purchases and sales are significant at the 1% level. P-Values are for the null hypothesis that coefficients are the same between insurers purchase and insurers sell.

Columns (4) through (6) report the results from regressions specified in Eq. (14) with the full set of control variables. The coefficients for insurer purchasing and selling are similar to results in Column (1) through (3), but it's not as significant as baseline results when using *Amihud* as the illiquidity measure. The extremely low p-values support our Hypothesis 1 that the insurer buy-sell asymmetric effect on bond liquidity that insurer corporate bond purchases improve bond liquidity while it is not the case for insurer bond sales.

5.3 Rainy Day Effects

Because insurance companies' cash flow from the insurance business is largely independent of the macro economy, we break the sample down into bonds of different rating groups, maturity groups, crisis and non-crisis periods, and expect to show that liquidity provision by insurers is much stronger in stressful conditions. Panel A of Table 4 reports the results of panel regressions for Eq. (14) by different illiquidity groups. Sample bonds in the sample are broken down into five groups from liquid bonds group to illiquid bonds group. "Liquid" bond's liquidity is in the highest 20 percent

over all bonds liquidity in that month. "Illiquid" bond's liquidity is in the lowest 20 percent over all bonds liquidity in that month.

Asymmetric effect in buy versus sell transactions still exists in the regression results. Coefficients of insurer purchases are all negative when using *Roll* and *Highlow* as illiquidity measures across all five illiquidity groups. Furthermore, the coefficients get economically and statistically more significant from liquid group to illiquid group. For *Amihud* results, the coefficients of insurer purchases decrease from positive to negative from liquid group to illiquid group. "IML" is the coefficients difference between illiquid bond group and liquid bond group. The coefficient differences are -2.05 (t=-2.62), -0.19 (t=-0.64), and -1.01 (t=-2.45) for *Roll*, *Amihud*, and *Highlow* respectively, which generally support our conclusion that insurers are rainy day liquidity providers. A one-standard deviation increase in insurers purchasing leads to approximate 3.5%, 0.8%, and 3.9% decrease in median *Roll*, *Amihud*, and *Highlow* respectively for the "Illiquid" bonds group.

Panel B reports the results of panel regressions by different rating groups. All bonds in the sample are broken down into three groups: good, medium, and junk. "Good" bonds are bonds whose ratings are ranging from A- to AAA. "Medium" bonds are bonds whose ratings are ranging from BB to BBB+. "Junk" bonds are bonds whose ratings are below BB.

The coefficient of insurer purchases for "Medium" group bonds are -2.35 (t=-6.80), -0.34 (t=-3.86), and -0.77 (t=-5.28). Coefficients for "Junk" group bonds are also significant negative. For "Good" groups, however, the coefficient is 0.37 (t=0.96), 0.08 (t=0.76), and -0.10 (t=-0.70). The result implies that insurer purchasing does not strongly affect the liquidity of the bonds' with a rating of A- or more. "MMG" is the coefficients difference between medium rating group and good rating group. Again, differences of all three illiquidity measures are all significantly negative. A one-standard deviation increase in insurers purchasing leads to approximate 3.3%, 5.0%, and 2.5% decrease in median *Roll*, *Amihud*, and *Highlow* respectively for the "Medium" bonds group.

Panel C reports the results of panel regressions for insurer trading in different subsample period around the financial crisis. The sample is broken into the before-crisis period, crisis period, and the after-crisis period. The before-crisis period is from July 2002 to September 2007. The crisis period is from October 2007 to June 2009. The after-crisis period is from July 2009 to December 2014.

The coefficient for insurer purchasing during financial crisis is -8.49 (t=-5.93), -1.30 (t=-3.90), and -2.13 (t=-4.42), which is much more economically and statistically significant than coefficients

in other periods. Again, the coefficient differences are all significantly negative which support our argument that insurers are rainy day liquidity providers. A one-standard deviation increase in insurers purchasing leads to approximate 12.0%, 19.1%, and 6.9% decrease in median *Roll*, *Amihud*, and *Highlow* respectively during the financial crisis. Overall, Panel A to Panel C of Table 4 present a strong support to the rainy day liquidity provision hypothesis. All these regression results are consistent to our Hypothesis 2 that insurers are more likely to offer liquidity during adverse market conditions and on unpopular bonds among investors

Table 5 and 6 reports the results from regressions specified in Eq. (14) with using PC insurers and life insurers trading data respectively. We find life insurers perform more like rainy day liquidity providers than PC insurers. One explanation is life insurers are comparably larger and longer term investors than PC insurers, their cash flow from the insurance business is even more independent of the macro economy. Therefore, life insurers are more likely to perform as a white knight during rainy days.

5.4 Evidence on Cross-Bond Liquidity Spillover Effect

Prior studies present evidence on the commonality among stock liquidity – liquidity has been shown to covary strongly across securities (e.g., **?**). Motivated by this school of studies, we further examine how insurers' transactions on one bond affect the liquidity of different bonds with similar characteristics. There are two possible outcomes regarding the cross effect of insurer trading on bond illiquidity. One is the spillover effect (or called the contagion effect), under which insurers purchase of sample bond improves the liquidity of matching bonds. The other is the competition/substitution effect, under which insurers purchase of sample bond reduces the liquidity of matching bonds.

We run the following regression to test the cross-bond liquidity spillover effect:

$$\mathrm{ILQ}_{m,t} = \alpha_0 + \alpha_1 \mathrm{ILQ}_{m,t-1} + \alpha_2 \mathrm{B}_{s,t-1} + \alpha_3 \mathrm{S}_{s,t-1} + \mathrm{Control}_{m,t} + \varepsilon_{m,t} \tag{15}$$

where $ILQ_{m,t}$ is the current illiquidity of matching bond, $ILQ_{m,t-1}$ is the illiquidity of matching bond in previous month, $B_{s,t-1}$ and $S_{s,t-1}$ are the aggregate amounts of purchases and sales conducted by insurance companies on the sample bond in previous month, scaled by the bond's par value. A matching bond is defined as a bond with the same bond rating and the same maturity as a sample bond in that month. On average, each bond has 20 matching bonds in our final sample.

We pool all bond-month observations together and report the results for insurer trading on other bonds with matching characteristics in Table 7. Column 1 to Column 3 are the results without control variables. The coefficients for insurers' purchases and sales are all positive when using all three kinds of illiquidity measures. This implies that insurers trading appears to reduce liquidity of alternative bonds. After adding matching bond characteristics into our regression, the effect of insurer sample bond purchasing on matching bond liquidity is ambiguous according to Column 4 to Column 6: the coefficient for insurer's buy is 0.12 (t=1.91) when using *Roll* and 0.08 (t=3.33) when using $Highlow$, but the coefficient is -0.19 (t=-10.78) with using *Amihud* as the illiquidity measure. Therefore, we split our sample into groups and have a close scrutiny about the insurer trading effect on matching bonds during the rainy days.

First of all, we break bonds into three groups based on their illiquidity as we did Panel A of Table 4. Panel A of Table 8 reports the results of panel regressions for insurer trading on illiquidity of matching bonds within liquidity groups. When using *Roll* and $Highlow$ as illiquidity measures, the coefficients of insurer purchasing for illiquid bonds group are negative, and those of liquid bonds group are positive. As for *Amihud* results, the coefficients are all negative among all liquidity groups and getting more negative from liquidity group to illiquid group. This implies that insurers' purchasing of sample bonds have a significant contagion effect on their matching bonds if they are in "illiquid" group. The difference between the coefficients between illiquid and liquid bonds is -0.43 (t=-2.11), -0.06 (t=-1.01), and -0.21 (t=-2.04) respectively, which reflects the effect of insurer purchasing on illiquid bonds illiquidity is significantly higher than the effect on liquid bonds.

Panel B of Table 8 reports the results of panel regressions for insurer trading on matching bonds within rating groups. The coefficients of insurer purchasing is -0.21 (t=-2.66), -0.21 (t=-9.77), and -0.03 (t=-1.02) for "Medium" group bonds, which are lower than the coefficients for other rating groups. The differences in coefficients between "Medium" rating bonds and "good" rating bonds are -0.80 (t=-5.95), -0.03 (t=-1.00), and -0.24 (t=-4.42) respectively. This suggests that insurers' purchasing on sample bonds has a more significant contagion effect on matching bonds' liquidity of bonds with "Medium" ratings.

Finally, we split sample bonds into different subsample periods (before-, in, and after-financial crisis) as we did in Panel C of Table 4. In Panel C of Table 8, we present the empirical finding

for the regressions on the effect of insurer trading on liquidity changes of matching bonds for different subsample period. During the financial crisis, insurer purchases on sample bond could have contagion effect on the matching bonds' liquidity with the coefficients as -1.00 (t=-2.75), -0.47 (t=-3.96), and -0.29 (t=-2.05) respectively. This implies that insurers' bond purchasing can have a spillover effect on the liquidity of matching bonds, and the contagion effect prevails. As for before and after crisis periods, we observe that the competition effect from insurer purchasing is more dominant when using *Roll* and $Highlow$, and the contagion effect is lower using *Amihud*. The coefficients differences between crisis and before crisis are -1.02 (t=-2.70), -0.27 (t=-2.26), and -0.39 (t=-2.71) respectively, which suggests that insurer purchasing has higher contagion effect on the matching bonds during the financial crisis.

Taken together, when we examine the cross-bond liquidity effects for bonds with lower liquidity, lower rating, and during crisis period, we find that the buy-side cross trading effect on illiquidity turns out to be negative. This constitutes a strong evidence that rainy day liquidity provision is not only limited to the bonds purchased by insurers - the liquidity of bonds with similar characteristics to the purchased (sold) bonds also increases during stressful periods, which exactly supports our Hypothesis 3.

6 Further Analysis

We use insurer cash flow as an identification to assure the causality in terms of bond trading and liquidity adjustments. Table 9 reports insurers' cash flow and the rainy day liquidity provision by insurance companies. Panel A reports how insurers' cash flow affects their propensity to trade low-rating bonds. All bonds in the sample are broken down into good, medium, and junk groups as previous. We run the following regression:

$$\text{Purchase Propensity}_{r,j,t} = \alpha_0 + \alpha_1 \text{CF}_{j,t} + \text{Control}_{j,t} + \varepsilon_{j,t} \tag{16}$$

where purchase propensity is insurer j's propensity to purchase a bond of a specific rating category r in year t, which is the aggregate par value of bonds in that category bought in a year scaled by total par value of bonds purchased by the insurer. CF is insurer cash flows measured by the ratio of the sum of an insurers' operating, investment, and financing cash flows, to insurer's total asset. Controls include stock insurer dummy, dependent insurer dummy, and life insurer dummy.

Year fixed effect is included. The t-statistics reported in the parentheses are clustered by insurer standard errors.

Columns (1) through (3) in Panel A present the baseline results from Eq. (16) in absence of any control variables and Columns (4) through (6) have full set of control variables. The coefficients are -0.06 (t=-3.94), 0.05 (t=3.33), and 0.01 (t=2.15) for three rating groups, which means insurers tend to invest more in "Medium" and "Junk" rating bonds and less in "Good" rating bonds with more adequate cash flows.

Panel B of Table 9 reports the panel regressions on bond illiquidity when insurers' cash flow is interacted with bond purchases and sales of insurance companies as:

$$\mathrm{ILQ}_{i,t} = \alpha_0 + \alpha_1 \mathrm{ILQ}_{i,t-1} + \alpha_2 \mathrm{B}_{i,t-1} * \mathrm{ICF}_{t-1} + \alpha_3 \mathrm{S}_{i,t-1} * \mathrm{ICF}_{t-1} + \alpha_4 * \mathrm{ICF}_{t-1} + \mathrm{Control}_{i,t} + \varepsilon_{i,t} \quad (17)$$

Eq. (17) is set similarly to Eq. (14) but adding aggregate insurer cash flow, aggregate insurer cash flow (ICF) interacted with bond purchases and sales. *ICF* is the aggregate cash flow across all insurers. The coefficients of insurers purchase and ICF interacted term of "Medium" rating bonds groups are -1.49 (t=-3.92), -0.05 (t=-0.42), and -0.41(t=-2.17) when using *Roll*, *Amihud*, and *Highlow* respectively. This implies that insurers have higher rainy-day liquidity provision ability if they have higher net cash flows.

In sum, we find insurers' funding level, proxied by their net cash flow, strongly influences their propensity to purchase bonds with low ratings, and further affects their ability to provide rainy-day liquidity. This suggests that improvements in rainy-day market liquidity are directly linked to additional funding liquidity of the insurers.

7 Conclusion

In this study, we propose that insurers act as "rainy day liquidity providers" in the corporate bond market. We show that insurers' bond purchases may have a positive effect on bond liquidity but the same effect may not hold for insurers' sell transactions. Our empirical findings confirm this asymmetric effect of insurer transactions. Moreover, we show that insurers provide liquidity during rainy-day conditions, i.e., they offer more liquidity in the financial crisis period, for junk bonds, and to relatively longer-term maturity bonds. Finally, we present evidence that rainy day liquidity provision effect goes beyond bonds purchased by insurers – the liquidity of bonds with similar

characteristics as the purchased (sold) bonds also increases in rainy days.

These findings on rainy day liquidity provision by insurers are new to the literature. Since insurers are a major buy-and-hold player with potentially static strategies, their liquidity provision is quite different from those of the broker-dealers or hedge funds. Dealers typically provide liquidity according to their inventory levels and market making capital while hedge funds may trade with informative price signals. A clear understanding of the rainy day liquidity provision is helpful to improve trading of other securities.

A Appendix

A.1 Largest 15 Insurer Corporate Bond Buyers and Sellers

This lists the largest 15 insurer corporate bond buyers and sellers based on bond transaction par values. All data come from NAIC Schedule D files. The sample period is from 2000 to 2014.

Top 15 Buyers	Top 15 Sellers
Northwestern Mutual Life Insurance Company	Northwestern Mutual Life Insurance Company
Teachers Insurance & Annuity Association Of America	Prudential Insurance Company of America
Prudential Insurance Company Of America	Metropolitan Life Insurance Company
Metropolitan Life Insurance Company	PFL Life Insurance Company
American General Annuity Insurance Company	Teachers Insurance & Annuity Association of America
PFL Life Insurance Company	American General Annuity Insurance Company
Allianz Life Insurance Company of North America	American General Life Insurance Company
New York Life Insurance Company	Allstate Life Insurance Company
American General Life Insurance Company	Continental Casualty Company
Lincoln National Life Insurance Company	New York Life Insurance Company
Jackson National Life Insurance Company	Jackson National Life Insurance Company
Continental Casualty Company	American Life Insurance Company
New York Life Insurance & Annuity Company	Guardian Life Insurance Company of America
Allstate Life Insurance Company	Travelers Insurance Company life
Guardian Life Insurance Company Of America	Variable Annuity Life Insurance Company

A.2 Liquidity Measures

In this section, we briefly describe our monthly illiquidity measures. We follow **?** and **?** to get **?** measure, which captures the negative auto-covariance of trade price changes. Specially, we compute the monthly *Roll* measure as:

$$\text{Roll}_{j,m} = 2\sqrt{-cov(R_{j,t,m}, R_{j,t-1,m})} \tag{18}$$

where $R_{j,t,m}$ and $R_{j,t-1,m}$ are returns of two consecutive available trading days, and the covariance is computed for bond j in the same month m. *Roll* is set to be zero when the monthly covariance is positive.

Following **?**, we utilize bond returns and trading dollar volume to construct *Amihud* illiquidity ratio. Specially, the monthly Amihud measure is:

$$\text{Amihud}_{j,m} = \frac{1}{N}\sum_{t=1}^{N}\frac{R_{j,t}}{Q_{j,t}} \tag{19}$$

where N is the number of positive-volume trading days for bond j in a given month m. $R_{j,t}$ and $Q_{j,t}$ are the return and dollar trading volume for bond j when there is at least a trade in day t of month m. The return $R_{j,t}$ is calculated from daily closing prices on day t and its most recent trading day.

The third measure is the spread between the high and low daily transaction prices, following **?** and **?**. Corwin and Schultz (2012) propose that daily high prices correspond to buy orders and low prices are likely from sell orders. They utilize the $Highlow$ ratio on consecutive days to separate security's variance and the bid-ask spread. Because the variance component is proportional to time while the bid-ask spread should be constant, we follow them to construct $Highlow$ illiquidity measure as:

$$\text{Highlow} = \frac{2\cdot(e^{\alpha}-1)}{1+e^{\alpha}} \tag{20}$$

where

$$\alpha = \frac{\sqrt{2\cdot\beta}-\sqrt{\beta}}{3-2\cdot\sqrt{2}} - \sqrt{\frac{\gamma}{3-2\cdot\sqrt{2}}}, \tag{21}$$

$$\beta = \sum_{j=0}^{1}\left(log\left(\frac{H_{t+j}}{L_{t+j}}\right)\right)^2, \tag{22}$$

$$\gamma = \left(log\left(\frac{H_{t,t+1}}{L_{t,t+1}} \right) \right)^2 \tag{23}$$

H_t and L_t are the highest and lowest price on day t. We use the mean value of daily $Highlow$ values in a month to get a monthly $Highlow$ illiquidity measure for each bond.

Table 1: Sample Construction

Combining NAIC Schedule D, FISD, and TRACE Databases:

Panel A: Transaction Level Data

	Number of Purchase	Number of Sales
Keep bond transactions in NAIC Schedule D from 2002Q3 to 2014Q4, exclude matured, redeemed, called bond cases	3,401,354	2,910,422
Keep U.S. corporate bond transactions after merging with FISD	1,125,068	807,311
Utilize a less than 10% discrepancy filter using NAIC annual bond holding data to get cleaned insurer bond transaction data	952,796	580,801

Panel B: Monthly Insurer-Bond Level Data

	Number of Purchase	Number of Sales
Get monthly insurer-bond trading data from cleaned transaction data	919,177	555,691
Merge monthly insurer-bond transaction data with bond monthly illiquidity data generated from TRACE, leave zero if there is no insurers' trading	1,133,560	849,758
(none zero trading observations)	(702,882)	(407,409)
Keep bond tradings at least 60 days after bond IPO and at least 360 days before bond maturity	827,518	764,008
(none zero trading observations)	(451,336)	(373,136)

Panel C: Monthly Bond Level Data

	Number of Purchase	Number of Sales	Total Number of Obs.
Get monthly aggregated insurer bond trading data from cleaned monthly insurer-bond trading data	196,796	182,103	572,951
Keep bonds with positive par value, bond age, and remaining maturity	196,767	181,554	571,700
Keep bonds with at least one available rating from S&P, Moody's, and Fitch at that month	195,010	180,188	557,018
Delete negligible no insurer trading or holding observations	195,010	180,188	487,601

Table 2: Summary Statistics

Panel A of the table reports the cross sectional distributions of three illiquidity measures and other key variables for the entire sample. We restrict the sample to US plain-vanilla corporate bonds which have positive shares outstanding and non-missing credit ratings. The distributions characteristics include the number of bond-month observations, 5%, 25%, 75%, 95%, mean, median, and standard deviation. The reported characteristics include three illiquidity measures, bond monthly turnover, bond maturity (in years), bond age (in years), bond size (the nature logarithm of outstanding par value), coupon rate, bond ratings (the rating score of an AAA rated bond being 22 and that of a D rated bond is 1). Definitions of the illiquidity measures are provided in Appendix Section. We obtain each statistic in each month and then take the average over time. Panel B of the table reports the correlation matrix of key variables. We compute the correlations in each month and then take the averages over time. The sample period is from July 2002 to December 2014.

Panel A: Distributions

	N	P5	P25	Mean	Median	P75	P95	SD
Roll	448,746	0.01	0.79	1.99	1.56	2.72	5.49	1.73
Amihud	487,601	0.01	0.04	0.40	0.15	0.49	1.98	0.57
Highlow	487,601	0.15	0.37	0.95	0.68	1.26	2.69	0.83
Turnover	487,601	0.01	0.02	0.05	0.04	0.07	0.16	0.05
Maturity	487,601	1.65	3.62	8.90	6.13	9.39	27.41	8.27
Rating	487,601	6.47	11.45	13.92	14.26	16.84	19.35	4.04
Coupon	483,438	3.08	5.10	6.21	6.23	7.32	9.36	1.93
Bond Age	487,601	0.47	1.58	4.33	3.24	5.95	12.58	3.83
Bond Size	487,601	11.93	12.54	13.04	12.99	13.49	14.39	0.77

Panel B: Correlation

	Roll	Amihud	Highlow	Turnover	Maturity	Rating	Coupon	Bong Age	Bond Size
Roll	1.00								
Amihud	0.55	1.00							
Highlow	0.51	0.39	1.00						
Turnover	-0.10	-0.27	-0.09	1.00					
Maturity	0.25	0.20	0.26	0.02	1.00				
Rating	-0.13	-0.05	-0.14	-0.25	0.06	1.00			
Coupon	0.09	0.06	0.11	0.02	0.02	-0.5	1.00		
Bond Age	0.26	0.38	0.27	-0.27	0.06	0.05	0.22	1.00	
Bond Size	-0.21	-0.37	-0.17	0.09	-0.01	0.24	-0.17	-0.32	1.00

Table 3: Regression Analysis on Bond Illiquidity

This table reports the results of panel regressions for insurer trading. The dependent variable is one of the three bond illiquidity measures in current month: *Roll*, *Amihud*, and *Highlow*. The independent variables include the lagged illiquidity, lagged insurer buys, lagged insurer sales, bond coupon rate, bond age, bond size, bond maturity, bond rating dummy, putable bond dummy, exchangeable bond dummy, redeemable bond dummy, convertible bond dummy, credit enhancements bond dummy, senior bond dummy, and secured bond dummy. *Insurer Purchase* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. *Insurer Sell* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. Other variables are defined in Table 2. Lagged illiquidity, lagged insurer buys, and lagged insurer sales are measured in one month before the current. All other independent variables are measured in the beginning of current month. The monthly fixed effect is included. The t-statistics reported in the parentheses are based on two-way clustered (by time and by bond issuer) standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. p-Values are for the null hypothesis that coefficients are the same between insurers purchase and insurers sell.

	Roll	Amihud	Highlow	Roll	Amihud	Highlow
Illiquidity	0.40***	0.53***	0.64***	0.29***	0.41***	0.55***
	(36.04)	(47.86)	(75.55)	(34.47)	(37.15)	(65.39)
(1) Insurer Purchase	-1.53***	-0.20***	-0.47***	-1.15***	-0.12*	-0.42***
	(-5.01)	(-3.00)	(-4.41)	(-4.04)	(-1.88)	(-4.01)
(2) Insurer Sell	1.94***	0.59***	0.95***	0.98***	0.03	0.65***
	(6.23)	(6.41)	(7.58)	(3.32)	(0.34)	(5.20)
Coupon				-0.04***	-0.01***	-0.01***
				(-6.87)	(-6.10)	(-7.13)
Bond Age				0.06***	0.02***	0.02***
				(23.08)	(21.04)	(21.10)
Bond Size				-0.18***	-0.12***	-0.03***
				(-18.29)	(-30.69)	(-5.26)
Maturity				0.04***	0.01***	0.01***
				(22.57)	(16.13)	(19.75)
Putable				-0.35***	-0.08***	-0.15***
				(-5.35)	(-3.74)	(-7.15)
Exchangeable				0.03	0.07**	-0.08***
				(0.36)	(1.96)	(-2.64)
Redeemable				-0.14***	-0.03***	-0.04***
				(-6.58)	(-4.49)	(-5.63)
Convertible				-0.06	0.02	-0.12***
				(-0.95)	(0.96)	(-6.31)
Enhance				-0.21***	-0.02***	-0.09***
				(-12.69)	(-5.37)	(-13.32)
Senior				0.06**	0.04***	0.01
				(2.36)	(6.08)	(1.46)
Secured				-0.07***	0.01	-0.01
				(-2.81)	(1.46)	(-1.43)
Rating FE	No	No	No	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
SE cluster 1	Yes	Yes	Yes	Yes	Yes	Yes
SE cluster 2	Yes	Yes	Yes	Yes	Yes	Yes
p-Value: (1)=(2)	0.0000	0.0000	0.0000	0.0000	0.1517	0.0000
Adj R^2	0.27	0.34	0.48	0.33	0.40	0.51
N	432,715	434,352	434,391	432,715	434,352	434,391

Table 4: Regression Analysis on Bond Illiquidity: Rainy Day Effect

Panel A reports the results of panel regressions for insurer trading by illiquidity groups. Sample bonds in the sample are broken down into five groups from liquid bonds group to illiquid bonds group. "Liquid" bond's liquidity is in the highest 20 percent over all bonds liquidity in that month. "Illiquid" bond's liquidity is in the lowest 20 percent over all bonds liquidity in that month. Panel B reports the results of panel regressions for insurer trading by different rating groups. All bonds in the sample are broken down into three groups: good, medium, and junk. "Good" bonds are bonds whose ratings are ranging from A- to AAA. "Medium" bonds are bonds whose ratings are ranging from BB to BBB+. "Junk" bonds are bonds whose ratings are below BB. Panel C reports the results of panel regressions for insurer trading in different subsample period around the financial crisis. The sample is broken into the before-crisis period, crisis period, and the after-crisis period. The before-crisis period is from July 2002 to September 2007. The crisis period is from October 2007 to June 2009. The after-crisis period is from July 2009 to December 2014. The dependent variable is one of the three bond illiquidity measures in current month: *Roll*, *Amihud*, and *Highlow*. The independent variables include the lagged illiquidity, lagged insurer buys, lagged insurer sales, bond coupon rate, bond age, bond size, bond maturity, bond rating dummy, putable bond dummy, exchangeable bond dummy, redeemable bond dummy, convertible bond dummy, credit enhancements bond dummy, senior bond dummy, and secured bond dummy. *Insurer Purchase* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. *Insurer Sell* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. Other variables are defined in Table 2. Lagged illiquidity, lagged insurer buys, and lagged insurer sales are measured in one month before the current. All other independent variables are measured in the beginning of current month. "IML" is the coefficients difference between illiquid bond group and liquid bond group. "MMG" is the coefficients difference between medium rating group and good rating group. "CMB" is the coefficients difference between crisis period and before crisis period. The monthly fixed effect is included. The t-statistics reported in the parentheses are based on two-way clustered (by time and by bond issuer) standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: By Illiquidity

	ILQ measure: *Roll*						ILQ measure: *Amihud*						ILQ measure: *Highlow*					
	Liquid	2	3	4	Illiquid	IML	Liquid	2	3	4	Illiquid	IML	Liquid	2	3	4	Illiquid	IML
Illiquidity	-0.68***	0.43***	0.34***	0.31***	0.21***		2.04***	1.11***	0.55***	0.40***	0.28***		0.57***	0.52***	0.47***	0.49***	0.47***	
	(-16.92)	(10.55)	(5.97)	(9.51)	(20.34)		(10.16)	(11.63)	(8.16)	(11.28)	(20.43)		(23.56)	(10.48)	(8.61)	(14.72)	(28.21)	
Insurer Purchase	-0.46	-0.48	-1.30***	-1.06*	-2.51***	-2.05***	0.14**	0.23**	0.00	-0.11	-0.05	-0.19	-0.19*	-0.39**	-0.36**	-0.37*	-1.20***	-1.01**
	(-1.26)	(-1.18)	(-3.36)	(-1.84)	(-3.37)	(-2.62)	(2.08)	(2.24)	(0.01)	(-0.54)	(-0.20)	(-0.64)	(-1.68)	(-2.32)	(-2.04)	(-1.96)	(-3.03)	(-2.45)
Insurer Sell	0.83	0.23	1.28***	0.91*	0.51	-0.32	0.45**	0.52***	0.38**	0.18	-0.47**	-0.92***	-0.02	0.05	0.44**	0.72**	1.07***	1.09***
	(1.12)	(0.48)	(2.59)	(1.76)	(0.87)	(-0.33)	(2.42)	(3.68)	(2.32)	(1.00)	(-2.00)	(-2.86)	(-0.12)	(0.24)	(2.15)	(2.53)	(4.13)	(3.48)
Coupon	-0.03***	-0.02***	-0.04***	-0.05***	-0.08***		-0.00***	-0.00	0.00	-0.01**	-0.03***		0.00	-0.01***	-0.02***	-0.02***	-0.02**	
	(-4.32)	(-3.91)	(-7.06)	(-7.01)	(-5.57)		(-3.02)	(-0.03)	(0.22)	(-2.08)	(-5.30)		(0.44)	(-5.22)	(-8.60)	(-7.11)	(-2.53)	
Bond Age	0.09***	0.05***	0.05***	0.05***	0.05***		0.01***	0.01***	0.01***	0.02***	0.02***		0.02***	0.02***	0.02***	0.02***	0.02***	
	(21.07)	(16.06)	(17.39)	(16.93)	(15.22)		(13.20)	(10.26)	(14.14)	(16.86)	(15.17)		(14.84)	(17.25)	(17.72)	(16.64)	(11.58)	
Bond Size	-0.22***	-0.15***	-0.14***	-0.15***	-0.17***		-0.06***	-0.08***	-0.12***	-0.16***	-0.19***		-0.09***	-0.09***	-0.07***	-0.04***	0.08***	
	(-19.12)	(-16.18)	(-13.18)	(-12.18)	(-7.83)		(-22.72)	(-24.01)	(-22.65)	(-25.56)	(-18.03)		(-28.46)	(-24.12)	(-12.40)	(-4.78)	(6.03)	
Maturity	0.04***	0.04***	0.03***	0.04***	0.03***		0.00***	0.00***	0.01***	0.01***	0.01***		0.01***	0.01***	0.01***	0.01***	0.01***	
	(20.50)	(18.71)	(20.23)	(20.98)	(13.12)		(9.35)	(9.92)	(12.13)	(16.35)	(10.01)		(19.54)	(20.76)	(22.12)	(20.03)	(9.67)	
Adj R^2	0.27	0.22	0.23	0.23	0.23		0.08	0.11	0.15	0.22	0.33		0.25	0.27	0.28	0.30	0.33	
N	85,805	89,079	88,723	87,043	82,065		90,076	91,008	89,525	86,443	77,300		88,486	89,565	89,116	86,624	80,600	

Panel B: By Rating

	ILQ measure: *Roll*				ILQ measure: *Amihud*				ILQ measure: *Highlow*			
	Good	Medium	Junk	MMG	Good	Medium	Junk	MMG	Good	Medium	Junk	MMG
Illiquidity	0.26***	0.27***	0.29***		0.35***	0.39***	0.46***		0.52***	0.54***	0.57***	
	(26.90)	(35.75)	(24.27)		(32.26)	(32.64)	(27.05)		(55.09)	(42.76)	(51.14)	
Insurer Purchase	0.37	-2.35***	-2.74**	-2.71***	0.08	-0.34***	-0.81***	-0.43***	-0.10	-0.77***	-0.74**	-0.67***
	(0.96)	(-6.80)	(-2.43)	(-6.04)	(0.76)	(-3.86)	(-4.10)	(-3.00)	(-0.70)	(-5.28)	(-2.48)	(-3.55)
Insurer Sell	-0.12	0.77**	2.13***	0.89*	-0.15	0.02	0.03	0.17	0.15	0.67***	1.02***	0.52**
	(-0.28)	(2.00)	(2.96)	(1.74)	(-1.13)	(0.15)	(0.14)	(0.89)	(0.79)	(4.02)	(3.32)	(2.42)
Coupon	-0.04***	-0.03***	-0.08***		-0.01***	-0.01***	-0.02***		-0.02***	-0.01***	-0.02***	
	(-3.37)	(-4.11)	(-7.52)		(-2.74)	(-3.86)	(-7.28)		(-5.25)	(-4.21)	(-6.29)	
Bond Age	0.06***	0.04***	0.07***		0.02***	0.02***	0.02***		0.02***	0.02***	0.02***	
	(14.35)	(14.66)	(13.13)		(12.67)	(15.82)	(12.43)		(15.60)	(13.15)	(12.63)	
Bond Size	-0.14***	-0.25***	-0.20***		-0.13***	-0.14***	-0.10***		-0.02***	-0.05***	-0.02**	
	(-10.57)	(-16.89)	(-8.87)		(-21.50)	(-25.69)	(-15.02)		(-2.95)	(-5.22)	(-2.39)	
Maturity	0.04***	0.03***	0.02***		0.01***	0.01***	0.01***		0.02***	0.01***	0.01***	
	(19.57)	(17.30)	(7.11)		(15.34)	(11.03)	(4.92)		(18.66)	(15.10)	(5.43)	
Adj R^2	0.37	0.32	0.30		0.40	0.38	0.42		0.53	0.48	0.51	
N	177,002	164,516	91,197		177,322	165,144	91,886		177,324	165,175	91,892	

Panel C: Around the Financial Crisis

	ILQ measure: *Roll*				ILQ measure: *Amihud*				ILQ measure: *Highlow*			
	Before Crisis	Crisis	After Crisis	CMB	Before Crisis	Crisis	After Crisis	CMB	Before Crisis	Crisis	After Crisis	CMB
Illiquidity	0.30***	0.21***	0.30***		0.36***	0.40***	0.40***		0.58***	0.44***	0.56***	
	(41.35)	(12.15)	(44.19)		(39.10)	(16.77)	(46.98)		(60.23)	(31.75)	(62.52)	
Insurer Purchase	-0.84**	-8.49***	-0.25	-7.65***	-0.10	-1.30***	-0.06	-1.20***	-0.43***	-2.13***	-0.06	-1.70***
	(-2.38)	(-5.93)	(-0.73)	(-5.29)	(-1.28)	(-3.90)	(-0.77)	(-3.59)	(-3.31)	(-4.42)	(-0.42)	(-3.49)
Insurer Sell	1.60***	-1.23	0.38	-2.83***	0.09	-0.08	-0.18*	-0.17	0.90***	-0.55	0.40**	-1.45***
	(3.87)	(-1.33)	(1.09)	(-2.84)	(0.79)	(-0.17)	(-1.76)	(-0.36)	(5.69)	(-1.16)	(2.40)	(-2.98)
Coupon	-0.06***	-0.16***	-0.01**		-0.02***	-0.05***	-0.00**		-0.02***	-0.06***	-0.00**	
	(-6.92)	(-12.36)	(-2.14)		(-4.78)	(-6.70)	(-2.03)		(-7.12)	(-11.82)	(-2.35)	
Bond Age	0.08***	0.06***	0.04***		0.03***	0.04***	0.02***		0.03***	0.03***	0.01***	
	(17.26)	(12.69)	(19.27)		(18.70)	(13.36)	(19.64)		(16.35)	(16.24)	(16.18)	
Bond Size	-0.15***	-0.21***	-0.20***		-0.13***	-0.18***	-0.12***		-0.03***	0.02	-0.05***	
	(-11.30)	(-6.95)	(-20.64)		(-25.02)	(-11.93)	(-26.11)		(-2.97)	(1.20)	(-10.10)	
Maturity	0.04***	0.06***	0.03***		0.01***	0.02***	0.01***		0.01***	0.02***	0.01***	
	(22.75)	(19.91)	(17.41)		(17.86)	(12.59)	(12.35)		(18.54)	(18.79)	(15.63)	
Adj R^2	0.30	0.22	0.35		0.35	0.38	0.43		0.51	0.39	0.52	
N	162,050	50,453	220,212		162,868	50,837	220,647		162,873	50,855	220,663	

Table 5: Rainy Day Effect of PC Insurers

This table only use property and casualty insurers data. Panel A reports the results of panel regressions for insurer trading by illiquidity groups. Sample bonds in the sample are broken down into five groups from liquid bonds group to illiquid bonds group. "Liquid" bond's liquidity is in the highest 20 percent over all bonds liquidity in that month. "Illiquid" bond's liquidity is in the lowest 20 percent over all bonds liquidity in that month. Panel B reports the results of panel regressions for insurer trading by different rating groups. All bonds in the sample are broken down into three groups: good, medium, and junk. "Good" bonds are bonds whose ratings are ranging from A- to AAA. "Medium" bonds are bonds whose ratings are ranging from BB to BBB+. "Junk" bonds are bonds whose ratings are below BB. Panel C reports the results of panel regressions for insurer trading in different subsample period around the financial crisis. The sample is broken into the before-crisis period, crisis period, and the after-crisis period. The before-crisis period is from July 2002 to September 2007. The crisis period is from October 2007 to June 2009. The after-crisis period is from July 2009 to December 2014. The dependent variable is one of the three bond illiquidity measures in current month: *Roll*, *Amihud*, and *Highlow*. The independent variables include the lagged illiquidity, lagged insurer buys, lagged insurer sales, bond coupon rate, bond age, bond size, bond maturity, bond rating dummy, putable bond dummy, exchangeable bond dummy, redeemable bond dummy, convertible bond dummy, credit enhancements bond dummy, senior bond dummy, and secured bond dummy. *Insurer Purchase* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. *Insurer Sell* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. Other variables are defined in Table 2. Lagged illiquidity, lagged insurer buys, and lagged insurer sales are measured in one month before the current. All other independent variables are measured in the beginning of current month. "IML" is the coefficients difference between illiquid bond group and liquid bond group. "MMG" is the coefficients difference between medium rating group and good rating group. "CMB" is the coefficients difference between crisis period and before crisis period. The monthly fixed effect is included. The t-statistics reported in the parentheses are based on two-way clustered (by time and by bond issuer) standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: By Illiquidity

	ILQ measure: *Roll*						ILQ measure: *Amihud*						ILQ measure: *Highlow*					
	Liquid	2	3	4	Illiquid	IML	Liquid	2	3	4	Illiquid	IML	Liquid	2	3	4	Illiquid	IML
Illiquidity	-0.62***	0.43***	0.34***	0.30***	0.21***		1.92***	1.06***	0.51***	0.39***	0.26***		0.58***	0.52***	0.47***	0.48***	0.50***	
	(-14.03)	(9.61)	(5.75)	(8.10)	(18.36)		(10.30)	(12.24)	(7.36)	(10.48)	(17.21)		(23.91)	(9.67)	(7.95)	(14.21)	(25.35)	
Insurer Purchase	-0.86	-0.78	-0.99	-2.86*	-3.55	-2.69	-0.01	0.26	0.15	-1.03**	-0.80	-0.78	-0.19	-0.68	-0.53	-0.57	-0.93	-0.74
	(-0.83)	(-0.88)	(-0.93)	(-1.94)	(-1.56)	(-1.04)	(-0.07)	(1.08)	(0.38)	(-2.02)	(-1.06)	(-1.01)	(-0.55)	(-1.45)	(-0.97)	(-1.21)	(-1.02)	(-0.77)
Insurer Sell	-0.26	2.44**	0.86	3.20**	5.21**	5.47**	0.60*	0.92**	0.51	0.45	-0.36	-0.95	-0.60*	0.46	0.92	1.08**	1.18	1.78**
	(-0.17)	(2.09)	(0.62)	(1.98)	(2.39)	(2.14)	(1.75)	(2.16)	(1.08)	(0.76)	(-0.39)	(-0.96)	(-1.80)	(0.84)	(1.22)	(2.01)	(1.33)	(1.99)
Coupon	-0.03***	-0.02***	-0.04***	-0.05***	-0.08***		-0.00***	0.00	-0.00	-0.01**	-0.03***		0.00	-0.01***	-0.02***	-0.02***	-0.01**	
	(-3.82)	(-3.90)	(-6.37)	(-6.78)	(-5.32)		(-3.13)	(0.15)	(-0.09)	(-2.19)	(-5.24)		(0.99)	(-4.56)	(-7.99)	(-7.00)	(-2.09)	
Bond Age	0.08***	0.05***	0.05***	0.05***	0.05***		0.01***	0.01***	0.01***	0.02***	0.02***		0.02***	0.02***	0.02***	0.02***	0.02***	
	(18.55)	(15.39)	(16.01)	(15.37)	(13.67)		(11.88)	(9.41)	(13.30)	(15.30)	(14.04)		(13.32)	(15.44)	(16.11)	(14.87)	(9.99)	
Bond Size	-0.19***	-0.14***	-0.13***	-0.15***	-0.16***		-0.05***	-0.08***	-0.12***	-0.16***	-0.19***		-0.09***	-0.09***	-0.06***	-0.02**	0.13***	
	(-16.19)	(-14.04)	(-12.23)	(-11.45)	(-6.37)		(-20.84)	(-24.28)	(-22.87)	(-23.65)	(-15.73)		(-26.66)	(-22.92)	(-10.52)	(-2.36)	(8.61)	
Maturity	0.04***	0.04***	0.04***	0.04***	0.03***		0.00***	0.00***	0.01***	0.01***	0.01***		0.01***	0.01***	0.01***	0.02***	0.01***	
	(18.90)	(17.97)	(20.71)	(21.18)	(13.22)		(9.15)	(10.45)	(12.32)	(15.75)	(11.13)		(17.12)	(18.53)	(21.40)	(19.10)	(9.38)	
Adj R^2	0.26	0.23	0.23	0.23	0.23		0.08	0.11	0.14	0.21	0.32		0.25	0.27	0.28	0.30	0.35	
N	75,410	81,323	80,315	76,758	65,725		81,616	82,806	80,715	75,331	60,168		80,100	80,754	79,438	75,527	64,839	

Panel B: By Rating

	ILQ measure: *Roll*				ILQ measure: *Amihud*				ILQ measure: *Highlow*			
	Good	Medium	Junk	MMG	Good	Medium	Junk	MMG	Good	Medium	Junk	MMG
Illiquidity	0.26***	0.28***	0.30***		0.34***	0.38***	0.46***		0.52***	0.56***	0.59***	
	(26.11)	(32.44)	(24.59)		(27.70)	(28.61)	(23.38)		(51.42)	(39.56)	(46.79)	
Insurer Purchase	-0.65	-3.04***	-2.66	-2.40**	-0.23	-0.48*	-1.44*	-0.25	0.19	-0.78**	-0.24	-0.97**
	(-0.84)	(-2.94)	(-1.13)	(-2.16)	(-1.02)	(-1.82)	(-1.78)	(-0.77)	(0.51)	(-2.24)	(-0.22)	(-2.12)
Insurer Sell	1.03	3.66***	2.73	2.63	-0.43	0.51	1.14	0.94*	-0.57	1.87***	1.54	2.44***
	(0.78)	(3.13)	(1.07)	(1.57)	(-1.46)	(1.23)	(1.60)	(1.80)	(-1.41)	(3.34)	(1.60)	(3.44)
Coupon	-0.03***	-0.03***	-0.09***		-0.01**	-0.01***	-0.02***		-0.02***	-0.01***	-0.02***	
	(-2.78)	(-3.94)	(-8.15)		(-2.05)	(-3.71)	(-7.12)		(-5.02)	(-3.81)	(-6.93)	
Bond Age	0.05***	0.04***	0.07***		0.02***	0.02***	0.02***		0.02***	0.01***	0.02***	
	(13.85)	(12.73)	(12.05)		(11.46)	(14.06)	(10.67)		(14.68)	(11.35)	(11.54)	
Bond Size	-0.13***	-0.23***	-0.18***		-0.12***	-0.14***	-0.10***		-0.01	-0.04***	-0.01	
	(-11.08)	(-14.14)	(-7.45)		(-22.94)	(-23.59)	(-13.59)		(-1.51)	(-3.37)	(-1.33)	
Maturity	0.05***	0.04***	0.02***		0.01***	0.01***	0.01***		0.02***	0.01***	0.01***	
	(22.91)	(17.22)	(6.60)		(16.63)	(10.86)	(4.52)		(20.50)	(13.68)	(4.79)	
Adj R^2	0.37	0.32	0.30		0.38	0.36	0.41		0.54	0.49	0.52	
N	160,619	142,468	76,444		160,855	142,894	76,887		160,860	142,906	76,892	

Panel C: Around the Financial Crisis

	ILQ measure: *Roll*				ILQ measure: *Amihud*				ILQ measure: *Highlow*			
	Before Crisis	Crisis	After Crisis	CMB	Before Crisis	Crisis	After Crisis	CMB	Before Crisis	Crisis	After Crisis	CMB
Illiquidity	0.30***	0.21***	0.31***		0.34***	0.39***	0.38***		0.59***	0.44***	0.58***	
	(42.52)	(12.16)	(43.40)		(35.85)	(15.63)	(43.31)		(58.28)	(32.96)	(55.17)	
Insurer Purchase	-1.50*	-11.03***	-0.15	-9.53**	-0.51**	-1.29	0.02	-0.77	-0.44	-2.85**	0.43	-2.40*
	(-1.66)	(-2.88)	(-0.18)	(-2.47)	(-2.08)	(-1.18)	(0.10)	(-0.70)	(-1.07)	(-2.26)	(1.25)	(-1.85)
Insurer Sell	4.50***	2.59	-2.72***	-1.91	0.45*	1.54	-0.97***	1.09	1.34***	-0.21	-0.13	-1.56
	(4.34)	(1.12)	(-2.75)	(-0.77)	(1.90)	(1.33)	(-2.72)	(0.94)	(2.88)	(-0.20)	(-0.38)	(-1.38)
Coupon	-0.06***	-0.18***	-0.01*		-0.01***	-0.06***	-0.00		-0.02***	-0.06***	-0.00*	
	(-7.12)	(-9.95)	(-1.67)		(-4.27)	(-6.84)	(-1.57)		(-8.13)	(-11.79)	(-1.84)	
Bond Age	0.07***	0.06***	0.04***		0.03***	0.04***	0.02***		0.03***	0.03***	0.01***	
	(17.01)	(12.18)	(16.50)		(17.76)	(12.01)	(17.25)		(16.71)	(14.52)	(13.49)	
Bond Size	-0.13***	-0.19***	-0.19***		-0.12***	-0.17***	-0.11***		-0.01	0.04**	-0.04***	
	(-9.64)	(-6.34)	(-18.47)		(-24.99)	(-10.75)	(-25.87)		(-1.20)	(2.30)	(-8.01)	
Maturity	0.04***	0.06***	0.03***		0.01***	0.02***	0.01***		0.01***	0.02***	0.01***	
	(22.17)	(18.58)	(16.83)		(17.01)	(12.51)	(12.10)		(16.25)	(17.61)	(14.90)	
Adj R^2	0.29	0.23	0.36		0.32	0.38	0.40		0.51	0.40	0.53	
N	144,693	46,289	188,549		145,217	46,572	188,847		145,220	46,582	188,856	

Table 6: Rainy Day Effect of Life Insurers

This table only use life insurers data. Panel A reports the results of panel regressions for insurer trading by illiquidity groups. Sample bonds in the sample are broken down into five groups from liquid bonds group to illiquid bonds group. "Liquid" bond's liquidity is in the highest 20 percent over all bonds liquidity in that month. "Illiquid" bond's liquidity is in the lowest 20 percent over all bonds liquidity in that month. Panel B reports the results of panel regressions for insurer trading by different rating groups. All bonds in the sample are broken down into three groups: good, medium, and junk. "Good" bonds are bonds whose ratings are ranging from A- to AAA. "Medium" bonds are bonds whose ratings are ranging from BB to BBB+. "Junk" bonds are bonds whose ratings are below BB. Panel C reports the results of panel regressions for insurer trading in different subsample period around the financial crisis. The sample is broken into the before-crisis period, crisis period, and the after-crisis period. The before-crisis period is from July 2002 to September 2007. The crisis period is from October 2007 to June 2009. The after-crisis period is from July 2009 to December 2014. The dependent variable is one of the three bond illiquidity measures in current month: *Roll*, *Amihud*, and *Highlow*. The independent variables include the lagged illiquidity, lagged insurer buys, lagged insurer sales, bond coupon rate, bond age, bond size, bond maturity, bond rating dummy, putable bond dummy, exchangeable bond dummy, redeemable bond dummy, convertible bond dummy, credit enhancements bond dummy, senior bond dummy, and secured bond dummy. *Insurer Purchase* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. *Insurer Sell* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. Other variables are defined in Table 2. Lagged illiquidity, lagged insurer buys, and lagged insurer sales are measured in one month before the current. All other independent variables are measured in the beginning of current month. "IML" is the coefficients difference between illiquid bond group and liquid bond group. "MMG" is the coefficients difference between medium rating group and good rating group. "CMB" is the coefficients difference between crisis period and before crisis period. The monthly fixed effect is included. The t-statistics reported in the parentheses are based on two-way clustered (by time and by bond issuer) standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: By Illiquidity

	ILQ measure: *Roll*						ILQ measure: *Amihud*						ILQ measure: *Highlow*					
	Liquid	2	3	4	Illiquid	IML	Liquid	2	3	4	Illiquid	IML	Liquid	2	3	4	Illiquid	IML
Illiquidity	-0.69***	0.44***	0.34***	0.30***	0.21***		2.01***	1.09***	0.53***	0.40***	0.27***		0.56***	0.52***	0.47***	0.50***	0.48***	
	(-16.18)	(10.97)	(5.85)	(9.16)	(20.04)		(9.87)	(10.52)	(7.84)	(11.17)	(19.21)		(22.03)	(9.88)	(8.39)	(14.45)	(26.94)	
Insurer Purchase	-0.49	-0.49	-1.53***	-1.25**	-2.60***	-2.11**	0.16*	0.23**	-0.01	-0.12	-0.04	-0.19	-0.22*	-0.40**	-0.37*	-0.42**	-1.37***	-1.15***
	(-1.14)	(-1.08)	(-3.59)	(-2.20)	(-3.22)	(-2.42)	(1.86)	(1.96)	(-0.04)	(-0.54)	(-0.14)	(-0.63)	(-1.71)	(-2.25)	(-1.82)	(-1.99)	(-3.27)	(-2.62)
Insurer Sell	0.81	0.11	1.45***	0.62	-0.18	-0.99	0.35**	0.37**	0.44**	0.21	-0.45*	-0.80**	0.01	0.02	0.39	0.75**	1.09***	1.08***
	(1.02)	(0.19)	(2.61)	(1.19)	(-0.28)	(-0.96)	(2.38)	(2.32)	(2.49)	(1.10)	(-1.69)	(-2.51)	(0.05)	(0.09)	(1.59)	(2.28)	(3.72)	(3.01)
Coupon	-0.04***	-0.02***	-0.04***	-0.05***	-0.10***		-0.00***	-0.00	0.00	-0.01**	-0.03***		0.00	-0.01***	-0.02***	-0.03***	-0.02***	
	(-4.78)	(-4.13)	(-6.81)	(-7.01)	(-6.35)		(-3.00)	(-0.15)	(0.06)	(-2.26)	(-5.56)		(0.27)	(-5.04)	(-8.29)	(-7.82)	(-3.40)	
Bond Age	0.09***	0.05***	0.05***	0.05***	0.05***		0.01***	0.01***	0.01***	0.02***	0.02***		0.02***	0.02***	0.02***	0.02***	0.02***	
	(20.36)	(15.81)	(16.74)	(16.63)	(15.04)		(12.89)	(10.17)	(13.86)	(17.54)	(14.71)		(14.18)	(16.56)	(17.33)	(16.49)	(11.62)	
Bond Size	-0.23***	-0.17***	-0.14***	-0.16***	-0.17***		-0.06***	-0.09***	-0.12***	-0.17***	-0.19***		-0.10***	-0.10***	-0.07***	-0.03***	0.10***	
	(-20.00)	(-16.30)	(-13.29)	(-11.90)	(-7.62)		(-23.44)	(-23.92)	(-22.28)	(-24.72)	(-17.49)		(-27.18)	(-23.90)	(-12.35)	(-4.38)	(6.57)	
Maturity	0.04***	0.04***	0.03***	0.04***	0.03***		0.00***	0.00***	0.01***	0.01***	0.01***		0.01***	0.01***	0.01***	0.01***	0.01***	
	(19.91)	(18.31)	(19.83)	(21.10)	(13.43)		(9.01)	(9.66)	(12.17)	(16.11)	(10.30)		(18.73)	(20.23)	(21.90)	(20.17)	(9.54)	
Adj R^2	0.26	0.22	0.23	0.23	0.23		0.08	0.11	0.15	0.22	0.33		0.25	0.27	0.28	0.30	0.34	
N	78,205	82,864	83,773	82,603	76,723		83,816	85,369	84,014	80,892	71,477		80,414	83,726	83,961	81,981	75,519	

Panel B: By Rating

	ILQ measure: *Roll*				ILQ measure: *Amihud*				ILQ measure: *Highlow*			
	Good	Medium	Junk	MMG	Good	Medium	Junk	MMG	Good	Medium	Junk	MMG
Illiquidity	0.26***	0.27***	0.29***		0.36***	0.38***	0.46***		0.52***	0.54***	0.58***	
	(26.75)	(36.03)	(22.67)		(32.04)	(31.88)	(25.68)		(53.55)	(41.87)	(48.02)	
Insurer Purchase	0.36	-2.60***	-2.49*	-2.95***	0.13	-0.40***	-0.79***	-0.52***	-0.14	-0.85***	-0.78**	-0.71***
	(0.91)	(-7.76)	(-1.85)	(-6.36)	(1.00)	(-4.54)	(-3.22)	(-3.44)	(-0.86)	(-5.76)	(-2.54)	(-3.36)
Insurer Sell	-0.33	0.49	2.21***	0.82	-0.16	-0.01	-0.13	0.14	0.25	0.57***	1.13***	0.31
	(-0.74)	(1.18)	(2.82)	(1.59)	(-1.14)	(-0.10)	(-0.43)	(0.80)	(1.06)	(3.13)	(3.21)	(1.29)
Coupon	-0.05***	-0.03***	-0.09***		-0.01**	-0.01***	-0.02***		-0.02***	-0.01***	-0.03***	
	(-3.34)	(-4.26)	(-8.45)		(-2.49)	(-3.80)	(-7.63)		(-5.38)	(-4.44)	(-7.39)	
Bond Age	0.06***	0.05***	0.07***		0.02***	0.02***	0.02***		0.02***	0.02***	0.02***	
	(13.30)	(14.71)	(12.69)		(11.62)	(15.83)	(12.37)		(14.91)	(13.14)	(11.81)	
Bond Size	-0.14***	-0.26***	-0.20***		-0.13***	-0.15***	-0.10***		-0.02**	-0.05***	-0.02*	
	(-10.26)	(-16.84)	(-8.31)		(-20.90)	(-25.65)	(-14.65)		(-2.29)	(-4.97)	(-1.81)	
Maturity	0.04***	0.03***	0.02***		0.01***	0.01***	0.01***		0.02***	0.01***	0.01***	
	(19.11)	(18.67)	(6.76)		(14.97)	(11.42)	(4.73)		(18.25)	(15.51)	(5.12)	
Adj R^2	0.36	0.31	0.30		0.40	0.38	0.43		0.53	0.48	0.51	
N	165,432	157,349	81,387		165,709	157,911	81,948		165,712	157,936	81,953	

Panel C: Around the Financial Crisis

	ILQ measure: *Roll*				ILQ measure: *Amihud*				ILQ measure: *Highlow*			
	Before Crisis	Crisis	After Crisis	CMB	Before Crisis	Crisis	After Crisis	CMB	Before Crisis	Crisis	After Crisis	CMB
Illiquidity	0.29***	0.20***	0.30***		0.35***	0.39***	0.39***		0.58***	0.44***	0.56***	
	(39.36)	(12.45)	(43.09)		(38.34)	(17.00)	(45.60)		(60.26)	(32.12)	(61.42)	
Insurer Purchase	-0.80**	-8.59***	-0.62*	-7.78***	-0.04	-1.64***	-0.15*	-1.60***	-0.38***	-2.20***	-0.24*	-1.82***
	(-2.29)	(-5.30)	(-1.79)	(-4.79)	(-0.52)	(-4.02)	(-1.89)	(-3.94)	(-2.74)	(-4.18)	(-1.68)	(-3.42)
Insurer Sell	1.41***	-2.24*	0.51	-3.65***	0.06	-0.33	-0.16	-0.38	0.89***	-0.57	0.44**	-1.46***
	(3.15)	(-1.78)	(1.31)	(-2.78)	(0.43)	(-0.58)	(-1.55)	(-0.67)	(4.46)	(-1.11)	(2.21)	(-2.70)
Coupon	-0.07***	-0.18***	-0.02***		-0.02***	-0.05***	-0.00**		-0.02***	-0.06***	-0.01***	
	(-6.75)	(-13.22)	(-3.10)		(-4.57)	(-6.65)	(-2.48)		(-7.25)	(-11.75)	(-3.44)	
Bond Age	0.08***	0.06***	0.04***		0.03***	0.04***	0.02***		0.03***	0.03***	0.01***	
	(16.76)	(12.61)	(19.35)		(18.63)	(13.26)	(19.54)		(15.90)	(16.28)	(16.04)	
Bond Size	-0.15***	-0.21***	-0.21***		-0.13***	-0.18***	-0.12***		-0.02**	0.03*	-0.05***	
	(-11.20)	(-6.58)	(-20.69)		(-24.86)	(-11.70)	(-26.47)		(-2.44)	(1.66)	(-9.82)	
Maturity	0.04***	0.06***	0.03***		0.01***	0.02***	0.01***		0.01***	0.02***	0.01***	
	(22.45)	(18.85)	(17.77)		(17.65)	(12.51)	(12.28)		(18.13)	(18.37)	(15.60)	
Adj R^2	0.30	0.22	0.35		0.35	0.38	0.43		0.51	0.39	0.51	
N	152,523	48,256	203,389		153,224	48,598	203,746		153,227	48,611	203,763	

Table 7: Regression Analysis on Matching Bond Illiquidity

This table reports the results of panel regressions for insurer trading on matching bonds. A matching bond is defined as a bond with the same bond rating and the same maturity as a sample bond in that month. The dependent variable is one of the three matching bonds' illiquidity measures: *Roll*, *Amihud*, and *Highlow*. The independent variables include the lagged illiquidity of matching bond, lagged insurer buys of sample bond, lagged insurer sales of sample bond, bond coupon rate, bond age, bond size, bond maturity, bond rating dummy. *Insurer Purchase* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. *Insurer Sell* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. Other variables are defined in Table 2. Lagged illiquidity, lagged insurer buys, and lagged insurer sales are measured in one month before the current. All other independent variables are measured in the beginning of current month. The monthly fixed effect is included. The t-statistics reported in the parentheses are clustered by bond issuer standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	Roll	Amihud	Highlow	Roll	Amihud	Highlow
Illiquidity	0.37***	0.47***	0.61***	0.33***	0.45***	0.58***
	(28.47)	(31.28)	(47.86)	(31.58)	(34.97)	(49.48)
Insurer Purchase	1.87***	0.12***	0.65***	0.12*	-0.19***	0.08***
	(21.91)	(6.78)	(20.60)	(1.91)	(-10.78)	(3.33)
Insurer Sell	0.35***	0.09***	0.15***	-0.02	-0.05***	0.04
	(4.86)	(4.85)	(5.34)	(-0.33)	(-2.77)	(1.47)
Coupon				-0.00***	-0.00***	-0.00***
				(-4.80)	(-9.69)	(-3.67)
Bond Age				0.01***	0.00***	0.00***
				(9.00)	(14.60)	(8.50)
Bond Size				-0.01***	-0.00***	-0.00
				(-4.29)	(-7.90)	(-1.56)
Maturity				0.03***	0.01***	0.01***
				(56.51)	(32.13)	(51.67)
Rating FE	No	No	No	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
SE cluster	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.27	0.27	0.48	0.30	0.28	0.49
N	8,472,403	8,494,823	8,495,634	8,472,403	8,494,823	8,495,634

Table 8: Regression Analysis on Matching Bond Illiquidity: Spillover Effect

This table reports the results of panel regressions for insurer trading on matching bonds. A matching bond is defined as a bond with the same bond rating and the same maturity as a sample bond in that month. Panel A reports the results of panel regressions for insurer trading by illiquidity groups. Sample bonds in the sample are broken down into five groups from liquid bonds group to illiquid bonds group. "Liquid" bond's liquidity is in the highest 20 percent over all bonds liquidity in that month. "Illiquid" bond's liquidity is in the lowest 20 percent over all bonds liquidity in that month. Panel B reports the results of panel regressions for insurer trading by different rating groups. All bonds in the sample are broken down into three groups: good, medium, and junk. "Good" bonds are bonds whose ratings are ranging from A- to AAA. "Medium" bonds are bonds whose ratings are ranging from BB to BBB+. "Junk" bonds are bonds whose ratings are below BB. Panel C reports the results of panel regressions for insurer trading in different subsample period around the financial crisis. The sample is broken into the before-crisis period, crisis period, and the after-crisis period. The before-crisis period is from July 2002 to September 2007. The crisis period is from October 2007 to June 2009. The after-crisis period is from July 2009 to December 2014.The dependent variable is one of the three matching bonds' illiquidity measures: *Roll*, *Amihud*, and *Highlow*. The independent variables include the lagged illiquidity of matching bond, lagged insurer buys of sample bond, lagged insurer sales of sample bond, bond coupon rate, bond age, bond size, bond maturity, bond rating dummy. *Insurer Purchase* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. *Insurer Sell* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. Other variables are defined in Table 2. Lagged illiquidity, lagged insurer buys, and lagged insurer sales are measured in one month before the current. All other independent variables are measured in the beginning of current month. "IML" is the coefficients difference between illiquid bond group and liquid bond group. "MMG" is the coefficients difference between medium rating group and good rating group. "CMB" is the coefficients difference between crisis period and before crisis period. The monthly fixed effect is included. The t-statistics reported in the parentheses are clustered by bond issuer standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: By Illiquidity

	ILQ measure: *Roll*						ILQ measure: *Amihud*						ILQ measure: *Highlow*					
	Liquid	2	3	4	Illiquid	IML	Liquid	2	3	4	Illiquid	IML	Liquid	2	3	4	Illiquid	IML
Illiquidity	0.33***	0.32***	0.32***	0.32***	0.33***		0.45***	0.44***	0.44***	0.44***	0.48***		0.58***	0.57***	0.57***	0.58***	0.59***	
	(18.36)	(19.76)	(20.08)	(18.25)	(14.34)		(20.88)	(22.85)	(22.71)	(21.48)	(17.28)		(30.41)	(33.62)	(33.03)	(32.60)	(25.98)	
Insurer Purchase	0.42***	0.26**	0.02	0.05	-0.01	-0.43**	-0.10***	-0.05	-0.11***	-0.13***	-0.16***	-0.06	0.18***	0.16***	0.13**	0.06	-0.04	-0.21**
	(4.06)	(2.14)	(0.16)	(0.33)	(-0.03)	(-2.11)	(-4.19)	(-1.58)	(-2.88)	(-3.04)	(-3.10)	(-1.01)	(4.37)	(3.17)	(2.55)	(1.13)	(-0.37)	(-2.04)
Insurer Sell	0.13	0.07	0.18	-0.00	-0.48***	-0.61***	0.04	0.01	-0.01	0.00	-0.05	-0.09	0.08*	0.16***	0.07	-0.01	-0.09	-0.17**
	(1.10)	(0.54)	(1.54)	(-0.03)	(-3.28)	(-3.21)	(0.96)	(0.15)	(-0.28)	(0.10)	(-1.19)	(-1.54)	(1.65)	(3.13)	(1.50)	(-0.27)	(-1.31)	(-2.02)
Coupon	0.00***	0.00**	-0.01***	-0.01***	-0.02***		-0.00***	-0.00***	-0.00***	-0.00***	-0.00**		0.00***	0.00	-0.00***	-0.00***	-0.00***	
	(3.00)	(2.57)	(-4.31)	(-9.16)	(-4.52)		(-4.10)	(-6.12)	(-7.34)	(-8.00)	(-2.42)		(7.22)	(0.63)	(-3.93)	(-6.55)	(-2.75)	
Bond Age	0.00**	-0.00***	-0.00	0.00***	0.01***		0.00***	0.00***	0.00***	0.00***	0.00***		-0.00***	-0.00***	-0.00***	0.00***	0.00***	
	(2.18)	(-5.69)	(-1.58)	(4.50)	(8.47)		(4.64)	(4.84)	(8.99)	(10.93)	(7.21)		(-5.80)	(-6.07)	(-2.68)	(2.84)	(7.80)	
Bond Size	-0.02***	-0.01***	0.00	0.01***	0.01		0.00**	0.00***	0.00**	-0.00	-0.00		-0.01***	-0.00	0.00	0.00***	0.00	
	(-6.06)	(-2.74)	(1.62)	(2.89)	(0.92)		(2.34)	(3.26)	(2.04)	(-0.06)	(-0.19)		(-5.41)	(-0.96)	(0.96)	(2.65)	(1.08)	
Maturity	0.03***	0.03***	0.03***	0.03***	0.03***		0.00***	0.00***	0.00***	0.01***	0.01***		0.01***	0.01***	0.01***	0.01***	0.01***	
	(52.05)	(47.69)	(45.82)	(41.87)	(32.29)		(14.49)	(18.64)	(24.33)	(26.23)	(24.03)		(40.38)	(41.50)	(43.14)	(39.23)	(26.96)	
Adj R^2	0.31	0.30	0.28	0.27	0.28		0.26	0.25	0.26	0.28	0.33		0.50	0.48	0.47	0.47	0.49	
N	1,829,746	2,098,071	1,918,874	1,589,618	1,023,367		1,793,890	1,955,794	1,921,041	1,703,767	1,119,640		2,078,615	1,939,797	1,849,582	1,582,668	1,044,702	

Panel B: By Rating

	ILQ measure: *Roll*				ILQ measure: *Amihud*				ILQ measure: *Highlow*			
	Good	Medium	Junk	MMG	Good	Medium	Junk	MMG	Good	Medium	Junk	MMG
Illiquidity	0.30***	0.31***	0.37***		0.43***	0.44***	0.49***		0.54***	0.58***	0.64***	
	(18.99)	(21.24)	(15.56)		(19.51)	(25.63)	(18.01)		(31.33)	(31.90)	(31.82)	
Insurer Purchase	0.59***	-0.21***	-0.11	-0.80***	-0.18***	-0.21***	-0.08	-0.03	0.21***	-0.03	0.02	-0.24***
	(5.40)	(-2.66)	(-0.40)	(-5.95)	(-6.53)	(-9.77)	(-1.00)	(-1.00)	(4.66)	(-1.02)	(0.22)	(-4.42)
Insurer Sell	0.21**	-0.19**	-0.45**	-0.40***	0.02	-0.06**	-0.09	-0.08**	0.10***	-0.07**	-0.07	-0.17***
	(2.41)	(-2.31)	(-1.98)	(-3.34)	(0.57)	(-2.42)	(-1.38)	(-2.05)	(2.58)	(-2.25)	(-0.82)	(-3.42)
Coupon	0.00	-0.01***	-0.02***		-0.00***	-0.00***	-0.00***		-0.00	-0.00***	-0.01***	
	(0.53)	(-5.18)	(-8.49)		(-4.63)	(-9.67)	(-7.23)		(-0.31)	(-3.73)	(-8.11)	
Bond Age	0.00**	0.01***	0.02***		0.00***	0.00***	0.01***		0.00***	0.00***	0.01***	
	(2.08)	(6.23)	(8.99)		(7.42)	(13.42)	(7.94)		(2.58)	(5.80)	(8.39)	
Bond Size	-0.01**	-0.02***	0.00		-0.00***	-0.00***	-0.00		-0.00	-0.00***	0.00	
	(-2.01)	(-4.07)	(0.74)		(-3.73)	(-3.82)	(-0.05)		(-1.51)	(-3.29)	(0.79)	
Maturity	0.04***	0.03***	0.00*		0.01***	0.00***	-0.00		0.01***	0.01***	0.00	
	(42.65)	(36.89)	(1.88)		(28.59)	(18.60)	(-1.35)		(39.56)	(33.57)	(0.87)	
Adj R^2	0.34	0.28	0.23		0.27	0.27	0.31		0.52	0.46	0.48	
N	4,217,918	3,256,538	997,947		4,222,816	3,266,993	1,005,014		4,222,888	3,267,699	1,005,047	

Panel C: Around the Financial Crisis

	ILQ measure: *Roll*				ILQ measure: *Amihud*				ILQ measure: *Highlow*			
	Before Crisis	Crisis	After Crisis	CMB	Before Crisis	Crisis	After Crisis	CMB	Before Crisis	Crisis	After Crisis	CMB
Illiquidity	0.33***	0.26***	0.35***		0.43***	0.44***	0.47***		0.60***	0.48***	0.61***	
	(19.06)	(12.07)	(29.51)		(21.83)	(18.43)	(33.68)		(26.86)	(23.56)	(53.72)	
Insurer Purchase	0.01	-1.00***	0.39***	-1.02***	-0.19***	-0.47***	-0.15***	-0.27**	0.11***	-0.29**	0.09***	-0.39***
	(0.15)	(-2.75)	(5.14)	(-2.70)	(-7.25)	(-3.96)	(-8.22)	(-2.26)	(2.75)	(-2.05)	(3.03)	(-2.71)
Insurer Sell	0.12	-0.80***	0.10	-0.92***	-0.02	-0.19**	-0.00	-0.17**	0.04	-0.27***	0.05**	-0.32***
	(1.37)	(-2.96)	(1.41)	(-3.27)	(-0.76)	(-2.49)	(-0.15)	(-2.09)	(1.27)	(-2.64)	(1.99)	(-2.93)
Coupon	-0.02***	-0.02***	0.00***		-0.01***	-0.01***	-0.00***		-0.01***	-0.01***	0.00***	
	(-9.35)	(-3.95)	(3.31)		(-8.85)	(-4.83)	(-3.84)		(-8.39)	(-3.93)	(3.53)	
Bond Age	0.01***	0.00***	0.00***		0.00***	0.00***	0.00***		0.00***	0.00***	0.00*	
	(10.46)	(2.94)	(3.47)		(10.80)	(6.73)	(12.26)		(10.89)	(3.33)	(1.79)	
Bond Size	0.01*	-0.01	-0.01***		-0.00*	-0.00	-0.00***		0.00**	-0.00	-0.00***	
	(1.83)	(-1.11)	(-3.07)		(-1.84)	(-0.76)	(-5.18)		(2.22)	(-0.38)	(-2.58)	
Maturity	0.04***	0.04***	0.03***		0.01***	0.01***	0.00***		0.01***	0.02***	0.01***	
	(34.11)	(29.02)	(50.05)		(23.64)	(17.21)	(27.40)		(31.22)	(31.96)	(45.27)	
Adj R^2	0.24	0.18	0.29		0.22	0.27	0.28		0.47	0.35	0.49	
N	2,661,694	747,062	5,063,647		2,671,492	751,952	5,071,379		2,671,567	752,386	5,071,681	

Table 9: Insurance Company Cash Flow and Rainy Day Liquidity Provision

This table reports insurers' cash flow and the rainy day liquidity provision by insurance companies. Panel A reports how insurers' cash flow affects their propensity to trade low-rating bonds. All bonds in the sample are broken down into three groups: good, medium, and junk. "Good" bonds are bonds whose ratings are ranging from A- to AAA. "Medium" bonds are bonds whose ratings are ranging from BB to BBB+. "Junk" bonds are bonds whose ratings are below BB. The dependent variable is insurer's propensity to purchase a bond of a specific rating category, which is the aggregate par value of bonds in that category bought in a year scaled by total par value of bonds purchased by the insurer. The independent variables include insurer cash flows, stock insurer dummy, dependent insurer dummy, and life insurer dummy. Insurer's cash flow is measured by the ratio of the sum of an insurers' operating, investment, and financing cash flows, to insurer's total asset. The year fixed effect is included. The t-statistics reported in the parentheses are clustered by insurer standard errors. Panel B reports the panel regressions on bond illiquidity when insurers' cash flow is interacted with bond purchases and sales of insurance companies. The dependent variable is one of the three bond illiquidity measures in current month: *Roll*, *Amihud*, and *Highlow*. The independent variables include the lagged illiquidity, lagged insurer buys, lagged insurer sales, aggregate insurer cash flow, aggregate insurer cash flow (ICF) interacted with bond purchases and sales, bond coupon rate, bond age, bond size, bond maturity, bond rating dummy, putable bond dummy, exchangeable bond dummy, redeemable bond dummy, convertible bond dummy, credit enhancements bond dummy, senior bond dummy, and secured bond dummy. *Cash flow* is the aggregate cash flow across all insurers. *Insurer Purchase* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. *Insurer Sell* is the aggregate par value purchased by all insurance companies in the sample scaled by the par value of a bond. Other variables are defined in Table 2. Lagged illiquidity, lagged insurer buys, and lagged insurer sales are measured in one month before the current. All other independent variables are measured in the beginning of current month. The monthly fixed effect is included. The t-statistics reported in the parentheses are based on two-way clustered (by time and by bond issuer) standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Insurers Bond Purchases and Cash Flow

	Good	Medium	Junk	Good	Medium	Junk
Insurer Cash Flow	-0.06***	0.05***	0.01**	-0.06***	0.05***	0.01**
	(-3.56)	(2.97)	(2.17)	(-3.94)	(3.33)	(2.15)
Stock				-2.42***	1.92**	0.50
				(-2.59)	(2.36)	(1.52)
Group				-5.56***	4.51***	1.06***
				(-6.62)	(6.10)	(3.69)
Life				-13.65***	13.06***	0.59**
				(-17.26)	(18.70)	(2.07)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
SE cluster	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.03	0.03	0.00	0.08	0.09	0.01
N	30,272	30,272	30,272	29,618	29,618	29,618

Panel B: Insurers Cash Flow and Rainy Day Effects

	ILQ measure: *Roll*			ILQ measure: *Amihud*			ILQ measure: *Highlow*		
	Good	Medium	Junk	Good	Medium	Junk	Good	Medium	Junk
Illiquidity	0.26***	0.27***	0.29***	0.35***	0.39***	0.46***	0.52***	0.54***	0.57***
	(26.90)	(35.73)	(24.28)	(32.26)	(32.64)	(27.05)	(55.09)	(42.73)	(51.12)
Insurer Purchase	0.46	-1.91***	-2.78***	0.03	-0.33***	-0.77***	-0.11	-0.65***	-0.64**
	(1.10)	(-5.88)	(-2.86)	(0.27)	(-3.79)	(-3.48)	(-0.70)	(-4.59)	(-2.11)
Insurer Purchase * ICF	-0.22	-1.49***	0.10	0.13	-0.05	-0.14	0.02	-0.41**	-0.29
	(-0.47)	(-3.92)	(0.06)	(1.05)	(-0.42)	(-0.54)	(0.09)	(-2.17)	(-0.68)
Insurer Sell	-0.08	0.80**	1.77**	-0.10	-0.07	-0.07	0.24	0.75***	1.20***
	(-0.21)	(2.15)	(2.03)	(-0.68)	(-0.60)	(-0.24)	(1.28)	(4.60)	(3.99)
Insurer Sell * ICF	-0.10	-0.06	0.63	-0.17	0.27	0.20	-0.28	-0.26	-0.31
	(-0.17)	(-0.11)	(0.68)	(-1.08)	(1.28)	(0.83)	(-1.09)	(-1.14)	(-0.75)
ICF	0.11***	-1.16***	0.12***	0.07***	-0.08***	-0.04***	0.13***	-0.31***	0.03
	(11.21)	(-9.17)	(2.75)	(5.91)	(-3.70)	(-2.71)	(13.08)	(-5.42)	(1.53)
Coupon	-0.04***	-0.03***	-0.08***	-0.01***	-0.01***	-0.02***	-0.02***	-0.01***	-0.02***
	(-3.37)	(-4.08)	(-7.52)	(-2.74)	(-3.87)	(-7.28)	(-5.25)	(-4.17)	(-6.29)
Bond Age	0.06***	0.04***	0.07***	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***
	(14.35)	(14.66)	(13.14)	(12.67)	(15.82)	(12.45)	(15.60)	(13.15)	(12.64)
Bond Size	-0.14***	-0.25***	-0.20***	-0.13***	-0.14***	-0.10***	-0.02***	-0.05***	-0.02**
	(-10.55)	(-16.87)	(-8.87)	(-21.48)	(-25.70)	(-15.01)	(-2.94)	(-5.22)	(-2.39)
Maturity	0.04***	0.03***	0.02***	0.01***	0.01***	0.01***	0.02***	0.01***	0.01***
	(19.57)	(17.30)	(7.11)	(15.35)	(11.03)	(4.91)	(18.66)	(15.10)	(5.43)
Adj R^2	0.37	0.32	0.30	0.40	0.38	0.42	0.53	0.48	0.51
N	177,002	164,516	91,197	177,322	165,144	91,886	177,324	165,175	91,892

Figure 1. Bond Illiquidity over Time

The figure depicts corporate bonds illiquidity measures over time. The illiquidity measures are i) the *Roll* measure, ii) the *Amihud* measure, and iii) the *Highlow* measure. The reported numbers are weighted by bonds' aggregate par value.

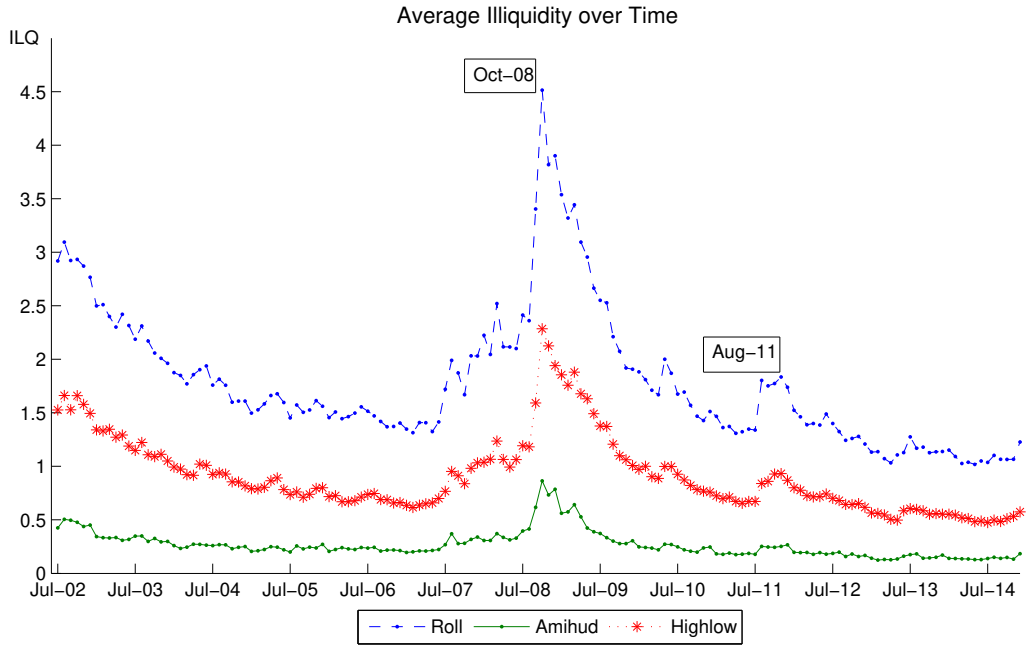

Figure 2. Relation between Insurer Holding and Bond Illiquidity

The figure depicts the relationship between insurer holding of corporate bonds and average illiquidity measures (ILQ) across decile groups sorted by insurer holding. Insurer holding is the fraction of par value of a bond held by insurers at the end of each month. The illiquidity measures are i) the *Roll* measure, ii) the *Amihud* measure, and iii) the *Highlow* measure. Two panels respectively report the mean (Panel A) and median (Panel B) of bond illiquidity. The distribution points (mean or median) are obtained for each month first then they are averaged over time.

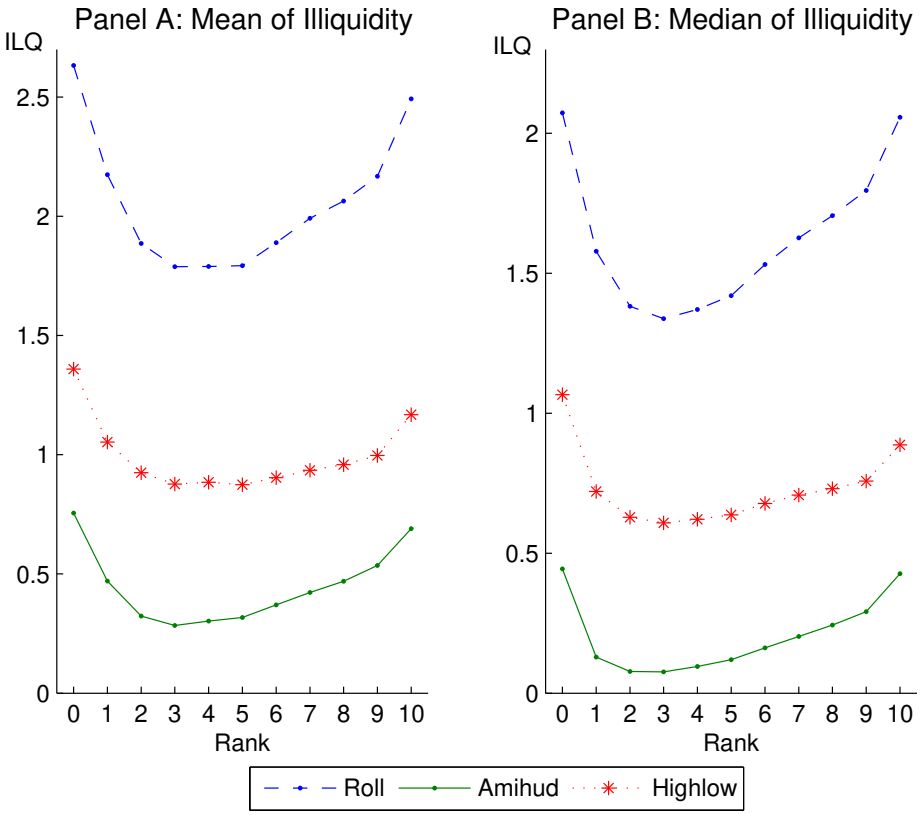

Figure 3. Insurer Transactions across Bond Ratings

The figure depicts the average insurer holding, insurer purchase, and sales over bond rating groups. Insurer holding is the fraction of par value of a bond held by insurers at the end of each month. Insurer purchase is the fraction of par value of a bond purchased by insurers at the end of each month. Insurer sales is the fraction of par value of a bond sold by insurers at the end of each month. The averages are weighted by bonds' aggregate par value. The reported numbers are averages across bonds in each month first then the cross sectional averages are averaged over time.

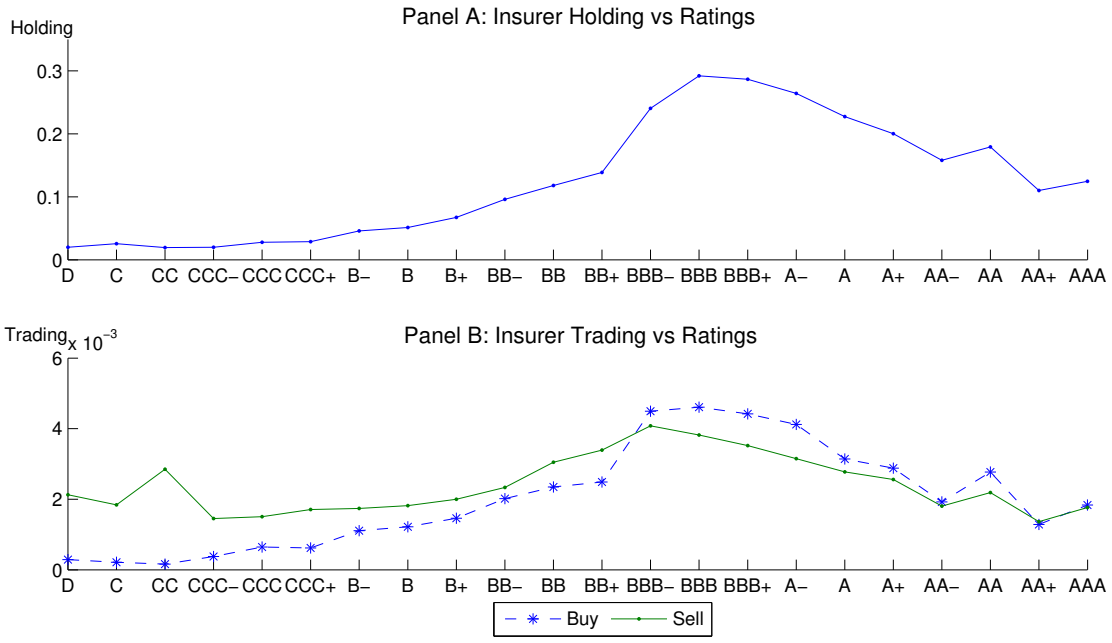

Figure 4. Insurer Transactions across Bond Maturities

The figure depicts the average insurer holding, insurer purchase, and sales over bond maturity groups. Bond maturities are rounded up to the nearest integers to form maturity groups. Bonds with maturities longer than 30 years are placed in maturity group 31. Insurer holding is the fraction of par value of a bond held by insurers at the end of each month. Insurer purchase is the fraction of par value of a bond purchased by insurers at the end of each month. Insurer sales is the fraction of par value of a bond sold by insurers at the end of each month. The averages are weighted by bonds' aggregate par value. The reported numbers are averages across bonds in each month first then the cross sectional averages are averaged over time.