# The Demand Effect of Yield-Chasing Retail Investors: Evidence from the Chinese Corporate Bond Market*

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**Abstract**

Corporate bonds with higher demand of retail investors are traded at significantly higher prices in the exchange market than the same bonds traded by institutional investors in the interbank market in China. The price difference is higher for bonds with higher coupon rates, lower supply, and higher demand exposure to retail investors. Our results suggest that risky bonds can be significantly overvalued due to the demand of yield-chasing investors and a sudden demand shock can generate sharp decrease in bond values. The demand and supply effects are stronger for bonds with higher duration, consistent with limited arbitrage.



**Keywords:** Corporate bonds; Yield-chasing; Demand and supply effects; Limits to arbitrage; The law of one price

**JEL Classification:** G12, G14, G15

## 1 Introduction

Risky credit products are hard to value. An extensive literature suggests that corporate bond yield spreads contain substantial non-default risk components, such as the liquidity premium. More recently, researchers find that demand and supply effects also play an important role in determining bond prices. While existing studies mainly focus on the demand and supply effects on government bond prices, we explore how investor demand may impact corporate bond prices. In particular, we attempt to understand how the yield-chasing behavior of certain investors may potentially generate significant overvaluation of those risky bonds and how a sudden demand shock can lead to a sharp decrease in bond prices.

We use a unique setup from the Chinese bond markets to study demand effects of yield-chasing retail investors on corporate bond prices based on the relative valuation. Chinese enterprise bonds are simultaneously traded in two partially-separated markets, the exchange market and the interbank market. One of the major differences between the two markets is the type of participants. Retail investors are only allowed to trade in the exchange market but not the interbank market, while institutions can trade in both markets. Therefore, the bond prices in the exchange market are subject to the demand of retail investors while bond prices in the interbank market are not. By comparing the prices for exactly the same bond in the two markets, we cleanly identify the effect of retail investors' demand on corporate bond prices while fully controlling for fundamental information such as credit risk and any common shocks such as the demand of institutional investors.

Using data from 2009 to 2013, we find that in 14 out of 20 quarters, the average price of enterprise bonds in the exchange bond market is significantly higher than the average price of the same bonds traded in the interbank bond market. In addition, we discover that the time-varying average price difference between the two markets is mainly explained by trading activities in the exchange market. The result suggests that retail investors play an important role in driving the price difference between the two markets.

More importantly, the price differences between the two markets exhibit substantial cross-sectional heterogeneity. We find that the price differences are driven by the demand of retail investors. Retail investors demand more of bonds that deliver higher yield-to-maturity. The price difference is significantly higher for those bonds with higher demand of retail investors, such as bonds with higher coupon rates and higher demand exposure to retail investors.

Further, the price difference decreases with the supply of the bond itself as well as the supply of the bond's close substitutes due to the local supply effect along the term structure.

We find that the price difference persists due to limited arbitrage. Arbitrage within the exchange market is limited due to short-sale constraints and limited risk-sharing capacity of risk-averse arbitragers. Short-sale constraints make overvaluation more pervasive than undervaluation. The demand and supply effects are stronger for bonds with higher duration risk, consistent with limited arbitrage when arbitrageurs who specialize in the bond market are risk averse. Arbitrage across markets are limited due to the slow transferring process of depository holdings and liquidity mismatch between the two markets.

We further explore how a sudden decrease in retail investors' demand for those risky bonds may generate a sharp decrease in bond values in the exchange market. We use a special event, the urban construction investment (UC) bond crisis, which triggers an exogenous shock to retail investors' demand for enterprise bonds, especially for UC bonds. We find that the price difference between the two markets decreases significantly after the event and more so for UC bonds. Our results suggest that the overvaluation of risky bonds in the exchange market could face sudden crash when there is a large demand shock to retail investors.

One major alternative explanation for our findings is the liquidity premium. Does the price difference between the two markets simply reflect a liquidity premium? To address the liquidity explanation, we focus on the liquidity effect in the cross section of bond prices since a systematic difference between the exchange and the interbank market (which is difficult to quantify) cannot explain the cross-sectional pattern. We construct a number of commonly used liquidity measures, including the bid-ask spread, the Amihud illiquidity measure and the number of trades, and perform a comprehensive cross-sectional analysis. We have two major findings. First, various liquidity measures have limited power in explaining the cross section of price differences between the two markets. Second, the sign of the coefficients on the liquidity measures in the exchange market is opposite to what suggested by the liquidity premium explanation. As shown by Amihud and Mendelson (1986), assets with high liquidity should earn low expected returns and therefore have high prices. In contrast, we find that bonds with higher liquidity in the exchange market have significantly lower prices and therefore lower price differences between two markets. While our results cannot be explained by the liquidity premium hypothesis, they are consistent with the limits-to-arbitrage explanation. The overvaluation of risky bonds in the exchange market is more easily to be arbitraged away when liquidity is high.

Our paper contributes to several strands of the literature. First, our paper is closely linked to the recent study of the demand and supply effects on bond prices. While the demand and supply effects on equity prices have been investigated by a number of previous studies, their impact on fixed income securities is less understood. Recent research in fixed income markets suggests that government bond supply affects both US Treasury bond prices and corporate bond prices. We add to this line of literature by showing that the demand of certain investors in the market can also paly an important role in determining corporate bond prices.

Second, by analyzing the relative valuation of corporate bond prices, we shed light on market efficiency in the credit market. We show that the yield-chasing behavior of certain investors could potentially drive the prices of risky credit products well above their fundamental values in the presence of risk-averse arbitrageurs. Previous literature mainly relies on the agency-principle conflict to explain certain investors' behavior of reaching for yield. For example, Becker and Ivashina (2015) show that insurance companies reach for yield by investing in high yield assets conditional on the same credit ratings. Instead, we suggest that investors may also reach for yield due to other reasons, such as borrowing constraints in the similar spirit as Frazzini and Pedersen (2014). Retail investors have limited access to leverage in China and therefore exhibit strong tendency to chase yield. While our study mainly focuses on yield-chasing retail investors, the results could potentially be generalized to other types of investors who exhibit similar behavior. For example, mutual funds and pension funds may also reach for yield because they are constrained in leverage due to regulatory restrictions. Our findings therefore have important implications for other credit markets with large institutional investors.

Third, our findings provide new insight into bubble theories in asset pricing. While there is extensive literature discussing bubbles in the equity (or equity-like asset) market, the evidence in the credit market is limited. Different from equity, bonds have bounded upside payoff and finite maturity. The valuation of corporate bond prices therefore helps understand the implications of various bubble theories and their distinct predictions in the credit market.

One paper close to ours is Hong and Warga (2000), who compare transaction prices of corporate bonds in two markets in the US, the exchange market (NYSE) and the over-the-counter dealer market. However, they conclude that "We also found that transaction-based prices from the ABS (NYSE's Automated Bond System) and the dealer market are broadly in agreement with each other and with month-end bid quotations from dealers at Lehman Brothers..." (p. 44). In addition, they attempt to explain the squared price difference between the two markets and therefore do not provide answers to how and why the signed magnitude of the price difference changes across bonds.

There are also limited studies of relative pricing based on trade size for municipal and corporate bonds. Green, Hollifielda, and Schurhoff (2007) document that municipal bonds are traded at higher average prices for small trades than for large trades due to dealers' ability to discriminate between sophisticated and unsophisticated customers in an opaque decentralized broker-dealer market. Our study differs from theirs in that bond trading information in both the exchange and interbank markets are transparent in China. Trading prices are revealed by electronic trading platforms almost instantaneously to both retail and institutional investors and therefore information-based explanation cannot explain our results. Feldhutter (2012) suggests that the price difference between small trades and large trades measures selling pressure based on a search model and find supporting evidence in the corporate bond market. While Feldhutter (2012) focuses on temporary undervaluation of corporate bonds due to selling pressure, we identify overvaluation of risky bonds due to yield-chasing behavior of certain investors.

The remainder of the paper proceeds as follows. Section 2 surveys the related literature. Section 3 describes the institutional background of the Chinese bond markets. Section 4 develops our main hypothesis. Section 5 presents the data and describes the price difference of the same bonds between the two markets. Section 6 explores the mechanism and alternative explanations. Section 7 presents additional tests. Section 8 concludes the paper.

# 2 Literature Review

## 2.1 Demand and Supply Effects in Financial Markets

Assets with the same risk should be priced with the same expected returns by the market. Any price movement generated by changes in demand or supply could soon be eliminated by investors through arbitrage across perfect substitutes. However, when assets are not perfectly substitutable and arbitrage is limited, demand and supply could affect asset prices. The demand and supply effects on asset prices have been studied for various markets, including stocks (for example, Shleifer (1986), Harris and Gurel (1986), Pruitt and Wei (1989), Wurgler and Zhuravskaya (2002), and Greenwood (2005)), options (Garleanu, Pedersen, and Poteshman (2009)), futures (de Roon, Nijman, and Veld (2000)), and mortgage-backed securities (Gabaix, Krishnamurthy, and Vigneron (2007)).

Demand and supply effects have recently been shown to play an important role in the fixed income market as well. Vayanos and Vila (2009) develop a formal model with preferred-habitat investors and risk-averse arbitrageurs, and show that demand and supply shocks affect the equilibrium bond prices under no-arbitrage conditions. D'Amico and King (2013) and Greenwood and Vayanos (2014) extend the model and provide empirical evidence of the local supply effect and the duration effect, respectively, on the US government bond yields. Fan, Li, and Zhou (2013) show that the demand of both the preferred-habitat investors and arbitragers are important in explaining the Treasury bond yields in China. Ivashina and Sun (2011) show that there are significant price differences between institutional investors' tranches and banks' tranches of corporate syndicated loans with the same fundamentals, and the price differences increase with the demand pressure from institutional investors. We add to this line of literature by studying the demand and supply effects in the corporate bond market.

## 2.2 Reaching for Yield

"Reaching for yield" in the fixed income market generally refers to the behavior of investors or financial intermediaries' tendency to buy high-yield credit products. It is widely believed that such "yield-chasing" behavior has contributed to the credit risk accumulation before the 2008 financial crisis.

Why do investors reach for yield? One broad line of argument rests on the principle-agency conflict. Iannotta and Pennacchi (2012) suggest that banks have an incentive to invest more in risky assets when credit ratings cannot fully account for systematic risks due to the moral hazard problem between banks and governments. Guerrieri and Kondor (2012) argue that delegated portfolio managers tend to take on more crash risk due to career concerns when managers have heterogeneous information and the ultimate investors cannot properly assess risk. Supporting the view of agency conflicts, Becker and Ivashina (2015) provide empirical evidence that insurance companies who are subject to capital requirements take excessive risk by investing in high-yield corporate bonds given the same credit rating category.

Another potential explanation is based on portfolio constraints. For example, investors who face borrowing constraints overweight risky assets in their portfolios as suggested by Frazzini and Pedersen (2014). Retail investors could be significantly constrained due to limited access to leverage; mutual funds and pension funds cannot take on enough leverage due to regulatory restrictions. Different from Becker and Ivashina (2015) who focus on principle-agency conflicts in insurance companies, our paper explores retail investors' yield-chasing behavior that potentially originates from portfolio constraints.

## 2.3 Bubble Theories

Asset prices may exceed their fundamentals and therefore contain a "bubble" component due to various mechanisms. Blanchard and Watson (1983) suggest that a bubble can sustain when investors are homogeneous and rational in an infinite horizon setting as long as the bubble component grows at the same rate as the risk-free rate. Allen and Gorton (1993) show that in the presence of asymmetric information between investors and portfolio managers, asset prices may deviate from their fundamental value due to agency problems. Barberis and Huang (2008) develop a model along this line and suggest that assets with positive skewness are overvalued. In the presence of heterogeneous beliefs and short-sale constraints, asset prices may be upward biased because they unproportionately reflect the beliefs of optimistic investors (Miller, 1977; Chen, Hong, and Stein, 2002Harrison and Kreps, 1978; Scheinkman and Xiong, 2003). While these models successfully generate loud equity bubbles – high prices and large trading volumes, Hong and Sraer (2013) show that the debt bubbles, in contrast, can be quiet – high prices but small trading volumes. The finite maturity and bounded upside payoff of bonds enable us to distinguish the demand and supply explanation from a number of bubbles theories.

# 3 Institutional Background

## 3.1 The Chinese Bond Market

By the end of 2013, the Chinese domestic bond market was the world's third largest after the United States and Japan. It has been growing at 30% annually in recent years and the total market capitalization was close to 26 trillion yuan (4 trillion US dollars), which was much larger than the Shanghai equity market's 16 trillion yuan (2.5 trillion US dollars).[1]

There are four major bond categories available in the Chinese bond market: government bonds, central bank bills, financial institution bonds, and non-financial corporate bonds (the internet appendix provides a detailed description of each bond type), which represented 35%, 2%, 39% and 19% of the total bond market, respectively, as of the end of 2013. According to records from China Central Depository and Clearing Co. Ltd. (CCDC),[2] the current market participants of Chinese secondary bond markets include commercial banks, credit unions, insurance companies, security companies, mutual funds, Qualified Foreign Institutional Investors (QFII), non-financial institutions, retail investors and other market participants.

Currently there are two major partially separated secondary bond markets in China, the exchange bond market and the interbank bond market.[3] Secondary markets for trading bonds in China did not exist until the establishment of the Shanghai Stock Exchange in December 1990. The interbank bond market was introduced in 1997, which is an over-the-counter market designed for institutional investors, mainly the financial institutions, to trade. After a period of rapid growth, the interbank market has become the largest bond market in China in terms of depository holdings and trading volumes by the end of 2013, while the exchange market remains an actively traded market with a large number of trades but small trading volumes.[4]

[1]The conversion from Chinese yuan to US dollar is based on the foreign exchange rate of 6.25:1 at the end of 2013.

[2]Formerly, China Government Securities Depository Trust and Clearing Co. Ltd.

[3]There is also a bank counter market with insignificant trading volumes and therefore is not discussed here.

[4]Each sector of the Chinese bond market is the trustee of a certain proportion of the total bond outstanding, known as its depository holdings. The interbank market accounts for more than 90% of the total depository holdings and total trading volume.

Unlike most of the over-the-counter markets where information is opaque, price information in the Chinese interbank market is transparent to all investors. Transaction prices in both the exchange and the interbank markets are almost instantaneously revealed through electronic trading platforms and are available for both institutional and retail investors throughout the day.[5]

Trading bonds in the exchange market faces fewer restrictions and lower transaction costs than trading stocks in China. First, bonds can be bought and sold on the same day ("T+0" rule) while stocks are subject to the "T+1" rule (investors must hold a stock for at least one day before selling it). Second, bonds traded in the exchange market are exempt from the stamp tax paid to the government, which is 0.1% of the total proceeds for stocks. Third, while there is a 10% limit on the daily change in stock prices, there is literally no limit on the change in bond prices.

We summarize the differences between the exchange market and the interbank market in Panel A of Table 1. As explained earlier, one of the major differences between the two markets is the type of participants. All institutions (except for commercial banks, which can only trade in the interbank market) are allowed to trade in both the exchange market and the interbank market, while retail investors can only trade in the exchange market. In addition, there are a few other differences between the two markets, including the type of bonds traded, trading mechanism, the trustee, the supervising authority, and the structure of trading costs. The internet appendix discusses these differences across markets in more detail.

## 3.2 Chinese Enterprise Bonds

Enterprise bonds are the only non-financial corporate bonds that can be traded in both the exchange market and the interbank market. They are issued by institutions affiliated to central government departments, enterprises solely funded by the state, state controlled enterprises and other large-sized state-owned entities. One special type of enterprise bonds is called the urban construction investment bond. UC bonds are issued by local government-backed investment units, a special local government financing vehicle. UC bonds are often viewed as quasi-municipal bonds.

[5]However, in the interbank market, trading volume for each trade is not revealed and only total daily trading volume is reported at the end of the day.

Enterprise bonds are one of the largest sectors of the non-financial corporate bond market. As of December 2013, the total outstanding amount of enterprise bonds was around 2.3 trillion yuan (0.4 trillion US dollars). The interbank depository holdings accounted for nearly 70% of outstanding enterprise bonds, while the exchange market accounted for about 30%. The monthly trading volume of enterprise bonds in the interbank market reached 236 billion yuan, and was about 8 billion yuan in the exchange market.

The issuance of enterprise bonds is strictly regulated by the National Development and Reform Commission. Enterprise bond issuance is subject to administrative approval for a quota. Therefore the supply of enterprise bonds is controlled by the government rather than driven by the market.

## 3.3 Limits to Arbitrage

Here we discuss several potential limits to arbitrage due to regulatory restrictions. Later on in the paper, we will discuss other types of limited arbitrage arising from the limited risk-sharing capacity of risk-averse arbitragers as an equilibrium outcome and liquidity issues.

First, the arbitrage for enterprise bonds is more limited in the exchange market than in the interbank market due to the lack of an active buyout repo (repurchase agreement) market. Buyout repos request the ownership of the bond to be transferred to the buyer and therefore opens up a potential channel for the short-sale mechanism. However, while buyout repos are allowed for all bonds traded in the interbank market, they only apply to Treasury bonds in the exchange market. Therefore, potential short-sales of enterprise bonds through repo transactions are only possible in the interbank market but not in the exchange market. Second, the arbitrage across markets may be limited due to the inefficient transfer of depository holdings. It in general takes three to five trading days to complete a transfer between the two markets, [6] In sum, arbitrage of enterprise bonds within the exchange market is more difficult due to the lack of short-sale mechanisms. Arbitrage across markets is feasible but limited due to inefficient transfer of depository holdings.

[6] According to the official rules imposed by the Minister of Finance, the transfer needs to be done within two trading days ("T+2") after the transfer application is submitted (it takes at most one day to transfer out and one day to transfer in the depository holdings). In addition, the bond can restart trading within one day after the transfer is completed.

# 4 Hypothesis Development

In this section, we develop hypotheses on two separate but closely related questions: First, what is the underlying mechanism generating the price difference between the exchange and the interbank markets? Second, when the price differences represent an obvious profitable investment opportunity, why is this "anomaly" not fully arbitraged away?

We start from the first question. The major difference between the exchange and interbank markets is the demand of retail investors, which only affects the bond prices in the exchange market but not those in the interbank market. In order to model the demand effect of retail investors, we assume that the equilibrium bond prices in the exchange market are solely determined by the demand of retail investors and limited bond supply. More importantly, retail investors reach for yield and their demand for a bond is proportional to its yield-to-maturity (retail investor demand equals demand intensity times yield-to maturity). In the interbank market, we assume that bond prices are determined by fundamentals, such as credit risk. While these assumptions seem extreme, their implications can be quite general for the price differences between the two markets. We could easily allow the bond prices in both markets to be affected by common shocks, such as credit risk, interest rate risk, and institutional demand. The results should be similar since any factor that affects both markets at the same time will be canceled out when we take the price difference.

In the Online Appendix, we first present a simple model without arbitragers (and therefore the markets for different bonds are completely segmented) and derive the equilibrium bond prices in both markets. Based on the price difference between the two markets, we have the following three hypotheses:

**Hypothesis 1a:** *The price difference between the two markets should increase with the coupon rate of the bond.*
**Hypothesis 1b:** *The price difference between the two markets should decrease with the supply of the bond.*
**Hypothesis 1c:** *The price difference between the two markets should increase with the demand intensity of retail investors.*

Hypothesis 1a is a direct consequence of the demand effect on the equilibrium price. Everything else being equal, bonds with high coupon rates have high yield-to-maturity and therefore high total demand in equilibrium, which leads to high equilibrium prices in the exchange market. It is worth mentioning that here we are interested in the effect of coupon rates rather than the effect of yield on price differences. This is because coupon rate is determined at issue and remain the same for the same bonds in both markets. Coupon rate is not correlated with bond prices at issuance since every bond is issued at par. Its subsequent effect on price differences between the two markets captures the demand effect of retail investors on the equilibrium bond prices in the exchange market. Since bond supply is limited (determined at issue and imperfectly correlated with total demand at issue), everything else being equal, bonds with low supply should have higher equilibrium prices in the exchange market as stated in Hypothesis 1b. The total demand of a bond in the exchange market not only depends on yield-to-maturity but also relates to the demand intensity of retail investors. Intuitively, demand intensity should have a positive effect on the equilibrium bond prices in the exchange market through the demand channel, which is our Hypothesis 1c. Demand intensity measures the bond exposure to retail investors. For example, bonds issued by firms located in places with more retail investors should have higher demand exposure. Demand intensity could also depend on bond maturity and credit risk. However, we do not directly model those effects here.

In the Online Appendix, we further consider a more general case with risk-averse arbitragers present in the exchange market. Arbitrageurs have moderate risk aversion and arbitrage can happen across bonds and maturities. As discussed by Vayanos and Vila (2009), the demand (supply) shocks have two distinct effects: the local supply effect and the duration effect. The local supply effect measures the relative impact of demand and supply factors across maturities. The duration effect, on the other hand, measures the magnitude of the demand and supply effects rather than their relative importance across maturities. We formalize these two effects in hypotheses 2a and 2b:

**Hypothesis 2a:** *The price difference of a bond between the two markets should decrease with the supply of its close substitutes due to the local supply effect.*

**Hypothesis 2a:** *The demand and supply effects should be stronger for bonds with higher duration.*

The local supply effect as stated in Hypothesis 2a is due to the arbitrage activities along the term structure. In the original Vayanos and Vila (2009) framework, there is no credit risk and bond close substitutes generally mean bonds with similar maturity. In order to take credit risk into consideration, we define a bond's close substitutes as all the other bonds with similar maturity and coupon rate (a proxy for credit risk at issuance). The rationale behind the choice is that by arbitraging across bonds with similar coupon rates, the arbitragers minimize their exposures to additional credit risk. The duration effect in Hypothesis 2b can be understood in the following sense. A demand (supply) shock to a bond with a high duration requires the arbitrager to bear more duration risk in their overall portfolio and in equilibrium it has a stronger impact on the bond returns expected by the arbitrageurs. Therefore, demand and supply factors should have a larger effect on the prices of bonds with higher duration.

The duration effect is closely related to our second question: why cannot arbitrage activities fully remove the demand effects on bond prices? Arbitrage can be performed in two ways: one is to arbitrage within the exchange market, for example, buying undervalued bonds and selling overvalued bonds; the other is to arbitrage across markets, for instance, buying bonds from the interbank market and selling them at higher prices in the exchange market. The duration effect helps explain why risk-averse arbitragers in the exchange market cannot fully undo the demand effect of yield-chasing retail investors. However, it does not explain why institutional investors cannot arbitrage across markets. If arbitragers can simultaneously buy and sell the same bonds in both markets, they take almost no duration or credit risk. But as we discussed earlier, trading across markets is not frictionless but faces several potential limits to arbitrage. Besides the time delay in transferring bonds across markets, liquidity could be another important concern for arbitragers. If the arbitragers buy a large amount of bonds in the interbank market, it may take them a prolonged time to sell the bonds in the exchange market where trading volume is relatively small, which exposes them to significant credit risk and interest rate risk. Illiquidity could become a substantial limit to arbitrage. We distinguish the limits-to-arbitrage explanation and the liquidity premium explanation in our last hypothesis:

**Hypothesis 3:** *If the price difference is due to overvaluation in the exchange market and limits to arbitrage across markets, it should be higher when liquidity in the exchange market is lower; If the price difference is entirely due to the liquidity premium, it should be higher when the liquidity in the exchange market is higher.*

It is worth mentioning that all our analyses focus on the price difference rather than the yield difference between the two markets. The reason is that price differences directly measure the returns of the trading strategy that buys bonds in the interbank market and sells the same bonds in the exchange market, while yield differences do not. The law of one price is maintained through arbitrage and the profits of the zero-investment trading strategy should be the most relevant measure of market efficiency.

# 5 Data and Bond Prices across Markets

## 5.1 Data

We obtain daily bond trading data in the exchange market from the GTA data company and daily bond trading data in the interbank market from WIND. [7] GTA (WIND) bond database provides daily bond closing prices, trading volumes, yields and other bond characteristics of all bonds traded in the exchange (interbank) markets. Daily bond closing prices correspond to the actual bond transaction prices of the last trade during the day in each market. Our sample covers all the bonds traded in both markets during 2009-2013.

We collect high-frequency intraday bond transaction data in the exchange market from GTA, covering the time period from 2009 to 2013. GTA high-frequency database contains intraday transaction data for all bonds traded in the exchange market. It provides detailed information on the transaction prices, bid and ask prices, and trade sizes for every trade. We also obtain limited access to intraday bond transaction data in the interbank market through WIND. WIND provides the time stamps and transaction prices for each trade in the interbank market but it does not provide information on trade size. And the intraday bond transaction data are only available from 2010 to 2013. GTA and WIND are major providers

[7]To ensure data quality, we cross-check the bond data in the exchange market from GTA with the data provided by the stock exchanges, and cross-check the bond data in the interbank market from WIND with the data provided by iFind (another commonly used Chinese data vender).

of Chinese data and their data have been widely used in published academic papers. The statistics about the overall Chinese bond market come directly from Chinabond, which is the official site of CCDC.

First, using all trading observations in the two markets, we provide a preliminary comparison of the characteristics of enterprise bonds traded in the exchange market and the interbank market (Panel B of Table 1). It is evident that enterprise bonds are traded more frequently in the exchange market than in the interbank market, but the average trading volume is much smaller. Moreover, the average yield-to-maturity is lower in the exchange market than in the interbank market, while the average price is higher in the exchange market. But we also observe that the average coupon is lower in the exchange market, suggesting that the lower yield-to-maturity may be partially due to the lower coupon of the bonds traded in the exchange rather than higher prices. Lastly, the average year-to-maturity is slightly higher in the exchange market.

In the final sample used in our empirical analysis, we further require that a bond has non-zero trading volume in both the exchange market and the interbank market on the same day, which enables us to identify the price difference of the same bond on the same day in order to fully control for bond fundamentals such as credit risk and interest rate risk. Our final sample covers 623 bonds with 15,751 observations from 2009 to 2013. Table 2 provides the summary statistics of bond characteristics. It is evident that after fully controlling for fundamentals, the average price difference between the exchange market and the interbank market is positive at 0.824 yuan (0.786% in terms of the difference in the natural logarithm of prices). Most enterprise bonds are medium-term bonds, with term year ranging from 5 to 10 years. A majority of the enterprise bonds have term year of 7 years. It is worth noting that the average year-to-issuance is 1.3 years. This is because since 2008, the total outstanding amount of enterprise bonds has grown quickly, and every year there are a large number of new bonds issued. During 2008-2013, the average growth rate of the outstanding enterprise bonds is close to 30%. Trade size in the exchange market is relatively small, with a mean of 0.640 million yuan and a median of only 0.037 million yuan. In contrast, the trade size in the interbank market reaches a mean of 98.627 million yuan and a median of 60 million yuan. The difference in the trade size between the two markets reflects the difference in the participants between the two markets: retail investors play a major role in the exchange market while only institutional investors trade in the interbank market.

## 5.2 The Price Difference between the Exchange Market and the Interbank Market

In this section, we present the average price difference of enterprise bonds between the exchange market and the interbank market across different subperiods.[8] Panel A of Table 3 shows the average price difference by year. The results suggest that the average price is always higher in the exchange market than in the interbank market on a yearly basis. The average price difference is 0.28 yuan in 2009 and reaches 1.19 yuan in 2013. A more detailed analysis of the price difference on a quarterly basis as shown in Panel B of Table 3 provides us with more insight into how the price difference between the two markets fluctuates over time. Among the 20 quarters in our sample period, 16 have positive average price difference (14 of them are statistically significant), while during the other four quarters the price difference is negative (three of them are statistically significant).

During the third and fourth quarters of 2009, the average price in the exchange market decreases to a level below that in the interbank market. This is potentially due to the fact that the Chinese economy was recovering from the financial crisis and the China central bank is expected to tighten the monetary policy, which, in turn, decreased the demand of retail investors for bonds in the exchange market. Moreover, the Chinese stock market kept rising significantly in 2009, which may also attract retail investors away from the bond market. Another significant drop in the price difference between the exchange market and the interbank market occurred in the third and fourth quarters of 2011. This large drop was triggered by the so-called UC bond crisis. In June 2011, it was revealed to the public that two UC bonds faced the risk of default. This was the first time ever in the history of the Chinese bond market that an enterprise bond might default, which generated a significant decrease in the demand for enterprise bonds. We discuss this event in detail later in Section 6.

[8]Treasury bonds are also traded in both the exchange market and the interbank market at the same time. However, the cross section of Treasury bonds is small. On average only less than 10 Treasury bonds are traded simultaneously in both markets every year. The average price difference between the exchange market and the interbank market for Treasury bonds is slightly negative but insignificant. The large supply of Treasury bonds could potentially decrease the price difference between the two markets. In addition, arbitrage is less limited for Treasury bonds. For example, short-sale of Treasury bonds in the exchange market can be done through buyout repos.

# 6 Mechanisms

Given the significant price difference between the exchange market and the interbank market, in this section, we attempt to identify the underlying mechanisms by investigating a large cross section of enterprise bonds that are traded in both markets at the same time. We first provide evidence supporting the demand effects of retail investors in the bond markets. We then explore alternative explanations and discuss their implications. Finally, we present time-series analysis, which sheds additional light on the time-varying price difference between the two markets.

## 6.1 Demand and Supply Effects in the Cross Section

### 6.1.1 Demand and Yield-to-Maturity

First of all, we provide evidence for the yield-chasing behavior of retail investors by showing that retail investors in the exchange market trade significantly more of the bonds with high yield-to-maturity. We report the regression analysis on the relation between turnover and bond yield in Table 4. We perform the following regression:

$$TURNOVER_{i,t} = a_0 + a_1 YTM_{i,t} + \boldsymbol{b}\boldsymbol{z_{i,t}} + \varepsilon_{i,t}. \tag{1}$$

where $TURNOVER_{i,t}$ is the natural logarithm of daily turnover in the exchange or interbank market; $YTM_{i,t}$ is the yield-to-maturity in the corresponding market; and $\boldsymbol{z_{i,t}}$ is a vector of control variables, including total bond outstanding, turnover in the other market, year-to-maturity, year-to-issuance, and daily price amplitude in each market. The daily price amplitude is defined as the daily highest price minus the daily lowest price scaled by the daily lowest price. The daily price amplitude can be viewed as a measure of daily bond price volatility. The coefficient on yield-to-maturity is significantly positive when the dependent variable is the turnover in the exchange market, suggesting a positive relation between exchange trading activities and the bond yield. The coefficient is close to 0.4, meaning that a one-standard-deviation increase in yield (which is 1) will increase turnover by $\sim$ 0.5 times ($e^{0.4\times 1} - 1 = 0.5$). In contrast, the coefficient on yield is insignificant or marginally negative when the dependent variable is turnover in the interbank market.

In sum, our analysis provides support for the yield-chasing behavior of retail investors in the exchange market: retail investors trade more when bond yields are higher. In contrast, institutional investors in the interbank market do not show a preference for high-yield bonds. Bonds with high yields suggest high credit risk and therefore may not seem particularly appealing to those sophisticated institutional investors.[9]

Yield measures the return of a bond if investors hold it to maturity. However, if retail investors behave as short-term speculators, they should care more about short-term returns than yield-to-maturity. Therefore the question is: do retail investors really chase yield-to-maturity or period-to-period short-term return? In order to address this issue, we add past month return into the regression of bond turnover in the exchange market. If retail investors chase short-term returns, they should trade more when past return is high and the effect of yield-to-maturity should be significantly weakened after we control for short-term returns. Our results suggest the opposite (the regression results are reported in online appendix Table IA.2). The coefficient on the past one-month return is negative, suggesting that investors in fact trade less when bonds experience high past short-term returns. In addition, after controlling for past returns, the effect of yield-to-maturity remains strong with the coefficient almost unchanged. We also control for past one-month return volatility in the regression. The coefficient on return volatility is also significantly negative, suggesting that retail investors are not chasing higher order return moments, such as volatilities, either.

Another potential question is: who are the actual buyers of the enterprise bonds in the exchange market? Do retail investors purchase bonds from institutional investors or vice versa? Due to the lack of information on each trading party, unfortunately we cannot provide clean identification of the buyers. Alternatively, we attempt to alleviate this concern by investigating the turnover of newly issued bonds with credit ratings below AAA. Due to government restrictions, bonds with credit rating below AAA can only be sold to "eligible investors" during initial public offering (IPO). Eligible investors refer to institutional investors and large individual investors with financial assets worth more than three million yuan. Therefore, during the early stage right after the IPO, most trading activities in the exchange market should happen when retail investors buy from

[9] A similar pattern is observed in the US over-the-counter corporate bond market, where high-yield bonds are traded much less than low-yield investment-grade bonds.

institutional investors. We perform the regression of turnover in the exchange market within the subsample of newly issued bonds with credit rating below AAA and report the results in the online appendix Table IA.3. Our results confirm that there is a strong positive relation between bond turnover and yield-to-maturity when retail investors buy from institutional investors most of the time.

Why do retail investors chase yield? Unlike certain institutional investors, retail investors do not face agency problems. Instead, they could face severe portfolio constraintssuch as leverage constraints. Retail investors have very limited access to leverage in China. Only large investors with more than 0.5 million yuan in their stock account can participate in margin trading with an initial margin of 50% (the percentage of the security prices that can be purchased on margin). Assets with embedded leverage such as options and futures are not available at the firm level. As suggested by previous studies such as Frazzini and Pedersen (2014), investors with leverage constraints will overweight risky (high beta) assets in their portfolio choices. Therefore, retail investors could exhibit strong preference for high-yield bonds in the corporate bond market potentially due to their constraints in taking on leverage.

#### 6.1.2 The Price Difference and the Demand and Supply Effects

In this subsection, we identify the demand and supply effects in the cross section using both univariate analysis and regression analysis. We provide evidence supporting our first three hypotheses. Hypothesis 1a suggests that the price difference between the two markets should be higher for bonds with high coupon rates because retail investors chase yield and therefore have higher demand for high coupon bonds.

Hypothesis 1b suggests that the price difference should be higher for bonds with less supply. We use total bond issuance as a measure of bond supply, which is determined by the government rather than driven by the market.[10] It is worth mentioning that while total bond issuance is relatively exogenous, bond supply in the exchange market is not because institutions can transfer bonds between the two markets. For example, institutions may transfer bonds from the interbank market to the exchange market if retail investors demand is high. However, using total bond outstanding rather than bond holdings in the exchange

[10]Due to data limitation, we only know the total bond outstanding but not its relative distribution across markets at the bond level.

market only *weakens*our results. Endogenous move of bond holdings narrows the price difference and makes the supply effect weaker. Therefore, our results provide a lower bond of the supply effect on bond prices.

Hypothesis 1c predicts that bonds with higher demand exposures to retail investors should have higher prices in the exchange market and therefore higher price differences between the two markets. We use two measures to proxy for individual investor demand exposure. Our first measure is a dummy variable, which equals one if the bond is issued by companies located in Shanghai city, and equals zero otherwise. Shanghai is not only the financial center of China, where the largest Chinese stock exchange, the Shanghai Stock Exchange, is located, but also the city with the largest urban population in China. According to the statistics provided by the Shanghai Stock Exchange, Shanghai is the city with the highest number of individual investor stock accounts. Therefore, bonds issued by companies in Shanghai are potentially highly exposed to retail investors due to, for example, information advantage or local bias. Our second measure is a dummy variable, which equals one if the bond is listed on the Shanghai Stock Exchange, and zero if it is listed on the Shenzhen Stock Exchange.[11] In terms of total market value, the Shanghai Stock Exchange is six times larger than the Shenzhen Stock Exchange. While retail investors with a personal stock account can trade securities listed on both exchanges, they likely pay more attention to bonds listed on the Shanghai Stock Exchange due to its large size and strong influence as are reflected in its more efficient information dissemination and news coverage.

Table 5 reports the univariate analysis of the price difference across subsamples. Panel A presents the average price difference in subsamples split by the coupon rate every year. We calculate both the equal-weighted and value-weighted (weighted by the total bond outstanding) price difference between the exchange market and the interbank market. It is evident that the price difference is significantly higher for bonds with higher coupon rates. The equal-weighted (value-weighted) price difference is only 0.166 (-0.015) yuan for the low coupon subsample, but increases to 1.678 (1.562) yuan for the high coupon sample. The difference in the equal-weighted (value-weighted) price difference between the high and low coupon subsamples is 1.513 (1.577) yuan, which is statistically significant at the 1% level. Panel B presents the average price difference in subsamples split by bond supply (measured

[11] Currently, there are two major stock exchanges in China, the Shanghai Stock Exchange and the Shenzhen Stock Exchange. An enterprise bond can only be listed on one of the two exchanges.

by total bond outstanding) every year. The results clearly suggest that the price difference is significantly higher for bonds with less supply. The equal-weighted (value-weighted) price difference is as large as 1.205 (1.194) yuan for the low supply subsample, but only 0.203 (0.157) yuan for the high supply subsample. The difference in the price difference between the high and low supply subsamples is -1.002 (-1.038) yuan, which is statistically significant at the 1% level. Panel C reports the price difference between two markets for bonds whose issuing company is located in Shanghai or in any other city. The equal-weighted (value-weighted) price difference of bonds located in Shanghai is 1.414 (2.242) yuan higher than that of bonds located outside Shanghai, and the difference is statistically significant at the 1% level. Finally, Panel D presents the price difference of bonds listed on Shanghai and Shenzhen Stock Exchanges. The equal-weighted (value-weighted) price difference of bonds listed on the Shanghai Stock Exchange is 0.414 (0.508) yuan higher than that of bonds listed on the Shenzhen Stock Exchange, and the difference is statistically significant at the 1% level.

We further investigate the relation between price difference and the demand and supply factors by performing the following regression:

$$\begin{aligned} DPRICE_{i,t} = & a_0 + a_1 COUPON_i + a_2 (ln) ISSUE_i + a_3 DUM\_SH_i + a_4 DUM\_SHEX_i \\ & + \boldsymbol{b z_{i,t}} + \varepsilon_{i,t}. \end{aligned} \quad (2)$$

where $DPRICE_{i,t}$ is the price difference between the exchange market and the interbank market for bond $i$ on day $t$, which is measured as the closing price in the exchange market ($P^{ex}$) minus the closing price in the interbank market ($P^{ib}$) or the natural logarithm of the ratio $P^{ex}/P^{ib}$; $COUPON_i$ is the coupon rate of bond $i$; $(ln)ISSUE_i$ is the (natural logarithm of) total bond outstanding for bond $i$; $DUM\_SH_i$ is a dummy variable, which equals 1 if the firm issuing bond $i$ is located in Shanghai and equals 0 otherwise; $DUM\_SHEX_i$ is a dummy variable, which equals 1 if bond $i$ is listed on the Shanghai Stock Exchange and equals 0 if listed on the Shenzhen Stock Exchange; and $\boldsymbol{z_{i,t}}$ is a vector of control variables.

The results are reported in Table 6. Consistent with Hypotheses 1a-1c, the regression coefficient on the coupon rate is significantly positive. The coefficient is close to 0.7, suggesting that a one-standard-deviation (1.07) increase in the coupon rate leads to a 0.7 yuan increase in the price difference between the two markets, which is economically significant. The coefficient on bond supply is significantly negative and ranges from -1.0 to -0.4. A one-standard-deviation (0.42) increase in the total bond outstanding therefore can generate a 0.2-0.4 yuan decrease in the price difference between the two markets. The coefficients on the Shanghai dummy and the Shanghai exchange dummy are all significantly positive. The average price difference of bonds issued by companies located in Shanghai is 1.5-3 yuan higher than that of any other bonds. The average price difference of bonds listed on the Shanghai Stock Exchange is 0.2-0.4 yuan higher than that of bonds listed on the Shenzhen Stock Exchange.

In Table 7, we further report regression results with additional control variables. In the first column, we include trading volume in each market. In the second column, we further include year-to-maturity, year-to-issuance, and price amplitude in each market. In the third column, we include two more dummy variables for the credit rating AA+ ($RATING\_AAP$) and AA ($RATING\_AA$).[12] Moreover, we include a dummy variable, which equals one if the bond is a UC bond and zero otherwise ($UC$). In the fourth column, we report the results by controlling for daily time fixed effects.

Trading volumes can be viewed as an imperfect measure of investor demand, and may also be closely related to liquidity. The results suggest that after controlling for factors directly related to retail investor demand and bond supply, trading volumes in general do not have significant coefficients in the cross-sectional regression of price difference. In the model of extended maturity, we show that bond maturity has a small but positive impact on bond prices in the exchange market (See the online appendix). We do find that year-to-maturity bears a positive coefficient with a small magnitude in the regression. But the coefficient becomes insignificant after controlling for daily fixed effects. It has been widely documented that on-the-run (newly issued) government bonds are traded at higher prices than off-the-run (previously issued) bonds maturing on similar dates in the US and other countries, suggesting that time-to-issuance could be a potential determinant of bond prices. We find that year-to-issuance has a positive coefficient in the regression, implying that the price difference between the exchange market and the interbank market becomes larger after bonds are issued for a longer time. Price amplitude can be viewed as a measure of daily price volatility. After controlling for daily fixed effects, price amplitude in the exchange market has a significant positive coefficient, suggesting that a high price in the exchange market

[12]Enterprise bonds only have three types of credit ratings, AAA, AA+, and AA.

is associated with a high price volatility. The coefficient on $RATING\_AA$ is significantly negative, which suggests that the price difference is lower for bonds with the lowest credit rating among all enterprise bonds. The coefficient on $UC$ is also negative, meaning that the price difference is lower for UC bonds. Taken together, after controlling for various additional variables, the demand and supply effects remain qualitatively the same.

#### 6.1.3 The Local Supply Effect

In the presence of risk-averse arbitrageurs, who can trade across bonds with different maturities, not only the supply of a bond itself but also the supply of its close substitutes may significantly affect its own price. In this section, we test the local supply effect as stated in Hypothesis 2a. We define the close substitutes of bond $i$ as all bonds whose coupon rate is within 1% of bond $i$'s coupon rate and whose year-to-maturity is within two years of bond $i$'s maturity. We also define a set of far substitutes of bond $i$ as all bonds whose coupon rate is within 1% of bond $i$'s coupon rate but whose year-to-maturity is between two and six years away from bond $i$'s maturity. As we discuss earlier, we define a bond's close substitutes as all other bonds with similar maturity and coupon rate in order to minimize both the duration risk and credit risk that arbitragers face.

Table 8 reports the regression results with the outstanding amount of close substitutes and the outstanding amount of far substitutes as additional explanatory variables. The dependent variable is the price difference between the two markets. In column 1, we include the supply and demand factors of the bond itself and the supply of its close and far substitutes. As predicted by Hypothesis 2a, the coefficient on the supply of close substitutes is significantly negative, suggesting that an increase in the supply of a bond's close substitutes corresponds to a decrease in the price of the bond itself. The coefficient is close to -0.3, suggesting that a one-standard-deviation (1.035) increase in the supply of a bond's close substitutes leads to a 0.3 decrease in the price difference of the bond between the two markets, which is economically significant. In addition, the coefficient on the supply of far substitutes is non-negative or insignificant, suggesting that only close substitutes with a similar coupon rate and similar maturity have significant impact on a bond's own price. We include additional explanatory variables in column 2 and daily time fixed effects in column 3, and the results remain qualitatively the same.

### 6.1.4 Duration Risk and Limits to Arbitrage

Demand and supply factors should have stronger effects on bonds with higher duration because arbitragers need to bear more duration risk in their portfolios due to demand shocks to those bonds. This result is formalized in Hypothesis 2b and we provide supporting evidence for this prediction.

We include the interaction term between demand and supply factors (including coupon rate, bond supply, Shanghai dummy, Shanghai exchange dummy, and the supply of close substitutes) with bond duration in the regression of price difference. The results are reported in Table 9. In column 1, we include only the demand and supply factors and their interactions with duration. In column 2, we include additional control variables similar to the ones used in the previous regressions, including trading volume, year-to-maturity, year-to-issuance, daily price amplitude, credit rating dummies, and UC dummy. In column 3, we also include daily time fixed effects.

In all specifications, the coefficient on the interaction term between coupon rate and duration is significantly positive, suggesting that the effect of coupon rate is stronger for higher duration bonds. The coefficient on the interaction term between bond supply and duration is significantly negative, suggesting that the negative effect of bond supply on bond prices is stronger for higher duration bonds. The coefficients on the interaction terms between demand exposure of retail investors (Shanghai dummy and Shanghai exchange dummy) and bond duration are significantly positive, suggesting that the positive effect of individual demand on bond prices is stronger for higher duration bonds. Finally, the coefficient on the interaction term between supply of close substitutes and duration is significantly negative, confirming that the local supply effect is also stronger for higher duration bonds.

In sum, as predicted by term structure models with preferred-habitat investors and risk-averse arbitragers, individual investor demand and bond supply have significant impacts on bond prices in the exchange market. The effects are stronger for bonds with high duration due to the limited risk-sharing capacity of risk-averse arbitrageurs.

## 6.2 Arbitrage across Markets and Liquidity

While arbitrage within the exchange market faces short-sales constraints and risks such as duration risk and credit risk, arbitrage across markets is less subject to these problems. If the same bond can be simultaneously and instantaneously bought in one market and sold in the other market, it seems to be a risk-free trading strategy to explore the price difference between the two markets. However, the reality is that markets are not frictionless and arbitrage across markets also faces several potential limits to arbitrage. First, transfer of bond holdings between markets is inefficient and subject to a time delay due to regulatory restrictions as we discuss in the previous section. Second and more importantly, liquidity can become an important concern when trading across markets. Arbitragers can only make a profit if they can trade a large amount quickly with small transaction costs and little price impact in both markets.

In this section, we explore how liquidity is related to price differences in the cross section. If the price difference between the exchange and the interbank markets is due to overvaluation in the exchange market and illiquidity plays the role of limits to arbitrage, the price difference should decrease with liquidity in both markets because it is easy to perform arbitrage activities on liquid assets. Assets with different liquidity may also have different prices due to the liquidity premium. Investors require lower expected returns for assets with higher liquidity and more liquid assets should have higher prices. The liquidity premium argument suggests that the price difference should increase with liquidity in the exchange market but decrease with liquidity in the interbank market. Therefore, the two explanations have opposite predictions on the sign of liquidity in the exchange market. We formally state the predictions of these two alternative mechanisms in our Hypothesis 3.

We construct three liquidity measures from intraday trading data in the exchange market, including the bid-ask spread, the daily Amihud illiquidity measure, and the number of trades within a day. Since we do not have full information of intraday trading data for the interbank market, we construct two liquidity measures from daily trading data, including the monthly Amihud illiquidity measure and the number of trading days within a month. Liquidity is high when the bid-ask spread is low, the Amihud illiquidity measure is low, and the number of trades (or trading days) is large.

Table 10 reports the results from the price difference regression with various liquidity measures as explanatory variables. Columns 1-5 include each liquidity variable from both the exchange market and the interbank market. Column 6 includes all liquidity measures in the regression. On the one hand, the results suggest that bonds with higher liquidity in the exchange market have lower price differences. The coefficient is positive for the bid-ask spread and the Amihud illiquidity measure, and negative for the number of trades. The results are consistent with the explanation of overvaluation in the exchange market and illiquidity as limits to arbitrage. When liquidity is high, it is easier for arbitrageurs to trade in the exchange market and explore the profits from the price difference across two markets. Therefore, more liquid bonds should have lower prices in the exchange market. The results cannot be explained by the theory of liquidity premium, which suggests that assets with higher liquidity in the exchange market should have higher prices in the exchange market and therefore higher price differences.

On the other hand, the results suggest that bonds with higher liquidity in the interbank market have lower price differences. The coefficient is positive for the Amihud illiquidity measure and negative for the number of trading days. The results are potentially consistent with both explanations of overvaluation with limits to arbitrage and liquidity premium. Overvaluation with limits to arbitrage suggests that it is easier to arbitrage away the price difference when bonds have higher liquidity in the interbank market. The liquidity premium theory argues that bonds with high liquidity in the interbank market should have higher prices in the interbank market and therefore lower price differences. We cannot distinguish the two alternative explanations in this regard since they have the same prediction on the relation between price differences and bond liquidity in the interbank market.

When we include the demand and supply factors together with liquidity measures in the regression, our previous results on these factors remain unaffected. Taken together, we find that bonds with high liquidity in the exchange market have lower price differences, which is consistent with the explanation of limits to arbitrage across markets but not liquidity premium. The demand and supply effects remain strong after controlling for various liquidity measures.

Limits to arbitrage such as inefficient transfer and illiquidity are important for arbitrage activities across markets not only when arbitragers such as institutional investors have to transfer bonds across markets, but also when institutional investors hold bonds in both markets and transfer is not necessary. This is because such limits to arbitrage can potentially generate high costs of holding bonds in both markets simultaneously. For example, when there is a negative liquidity shock, institutional investors may not be able to quickly sell their bonds in large quantity in the exchange market and at the same time they cannot sell the bonds in the interbank market due to inefficient transfer between the two markets.

Therefore, limits to arbitrage not only constrain arbitragers' ability to transfer bonds across markets but also limit their capacity to hold bonds in both markets at the same time.

## 6.3 Event Study: The Urban Construction Bond Crisis

Urban construction investment bonds, a special type of enterprise bonds, are issued by local government-backed investment units and are often viewed as quasi-municipal bonds. In our sample, close to 80% of the enterprise bonds are UC bonds. While none of the enterprise bonds in China have ever defaulted before, two UV bond issuers were reported to face difficulty to repay their debt in June 2011. Such event triggered a sharp sell-off of all enterprise bonds, which is referred to as the "UC bond crisis". We use this event as an exogenous shock to the individual investor demand for enterprise bonds, especially for UC bonds. By investigating the price difference between the exchange market and the interbank market, we are able to perfectly control for fundamental information and only focus on the demand effect. Moreover, by comparing the change in price difference between UC and non-UC bonds during the crisis, we further identify the effect of demand shock specifically on UC bonds.

We define the before-event window as the six months before the event time (June 2011) from December 2010 to May 2011, and the after-event window as the six months after the event time from July 2011 to December 2011. Table 11 reports the results for the event study. Panel A reports the average price difference during the before-event and after-event windows for non-UC and UC bonds. It is evident that after the event, the price difference for both the Non-UC and UC bonds decreases significantly. For the non-UC bonds, the price difference is 1.991 yuan before the event, but decreases to 0.193 yuan after the event. The change in price difference, which is -1.798 with a $t$-statistic of -6.50, is significantly negative. For the UC bonds, the price difference is 2.026 yuan before the event, but decreases to -0.836 yuan after the event. The change in price difference, which is -2.863 with a $t$-statistic of -26.28, is again significantly negative. Moreover, the price difference decreases significantly more for the UC bonds: the difference in the change in price difference between UC and non-UC bonds is -1.065 yuan with a $t$-statistic of -3.58. We also plot the average monthly price difference before and after the event for UC and non-UC bonds in Figure 1. It is evident from the figure that the average price difference decreases significantly for both UC and non-UC bonds right after the event in June 2011. Moreover, the magnitude of the decrease is significantly higher for UC bonds.

Although we successfully control for bond fundamentals by taking the price difference between the two markets, the change in price difference may be due to the change in liquidity rather than the change in demand. We control for the liquidity effect by performing the following regression:

$$DPRICE_{i,t} = a_0 + a_1 event_t + a_2 event_t * UC_i + a_3 UC + \boldsymbol{b z_{i,t}} + \varepsilon_{i,t}. \quad (3)$$

where $event_t$ is a dummy variable that equals zero for before-event days and one for after-event days, and $\boldsymbol{z_{i,t}}$ represents a number of liquidity measures for bond $i$ at time $t$. The regression results are reported in Panel B of Table 11. The coefficient on *event* is significantly negative, suggesting that the price difference decreases significantly after the crisis. More importantly, the coefficient on the interaction term between *event* and $UC$ is also significantly negative, suggesting that price difference decreases significantly more for UC bonds than for non-UC bonds after the crisis. The results remain qualitatively the same after controlling for various liquidity measures. Only the liquidity measures in the exchange market have significant coefficients; however, they all have signs opposite to what is predicted by the liquidity premium theory but more consistent with limits to arbitrage. We perform placebo tests by assuming pseudo events on June 2012 and June 2013. The regression results are reported in online appendix Table IA.4. We do not observe any significant differences in the change of price differences between UC and non-UC bonds over the Pseudo events.

Taken together, the results in this section suggest that the 2011 UC bond crisis generated a negative demand shock to retail investors for enterprise bonds in the exchange market, which led to a significant decrease in the price difference between the exchange market and the interbank market. The demand shock effect was stronger for UC bonds and generated a more significant decrease in the price difference for those bonds. The results cannot be fully explained by the change in liquidity in the two markets.

## 6.4 Time-Series Analysis

In the previous sections, we focused on the cross-sectional determinants of the price difference between the exchange and interbank markets. In this section, we attempt to identify the factors that drive the time variation in the price difference between the two markets at the aggregate level. We perform the following time series regressions for the time period from 2009 to 2013:

$$ADPRICE_t = \alpha_0 + \alpha_1 AVOL\_EX_t + \alpha_2 AVOL\_IB_t + \gamma MACRO_t + \varepsilon_t, \quad (4)$$

$$ADPRICE_t = \alpha_0 + \alpha_1 AVOL\_EX_t + \alpha_2 AVOL\_IB_t + \gamma_1 LIQ\_EX_t + \gamma_2 LIQ\_IB_t + \varepsilon_t. \quad (5)$$

where the dependent variable $ADPRICE_t$ is the monthly average price difference between the exchange market and the interbank market. The explanatory variables include the monthly average trading volume in the exchange market ($AVOL\_EX_t$) and the interbank market ($AVOL\_IB_t$), macroeconomic variables ($MACRO_t$) including total supply of enterprise bonds ($SUPPLY\_ENT_t$), total supply of government bonds ($SUPPLY\_GOV_t$), equity market index return ($MARKET_t$), $SHIBOR$ one-month rate ($SHIBOR\_1M_t$, in %), annualized inflation rate ($CPI_t$, in %), liquidity measures in the exchange market ($LIQ\_EX_t$) including average bid-ask spread ($SPREAD_t$), amihud illiquidity measure ($AMIHUD\_EX_t$), and number of trades ($NTRADE\_EX_t$), and liquidity measures in the interbank market ($LIQ\_IB_t$) including amihud illiquidity measure ($AMIHUD\_IB_t$) and number of trading days ($NTRADE\_IB_t$).

We report the results in Table 12. Regression (4) (Panel A in Table 12) clearly suggests that the most important determinant of the average price difference is the average trading volume in the exchange market. The coefficient on the average trading volume in the exchange market is 0.574 with a $t$-statistic of 3.65. The average trading volume in the exchange market alone explains 35.6% of the time-series variation in the average price difference. Neither the trading volume in the interbank market nor other macroeconomic variables have significant coefficients and explanatory power in the time series regression. We plot the monthly average price difference and the average trading volume in each market in Figure 2(a). It is clear from the figure that the average price difference is highly positively correlated with the average trading volume in the exchange market, while its correlation with the trading volume in the interbank market is low.

In regression (5) (Panel B in Table 12), we add various liquidity measures in the exchange and interbank markets. The results suggest that liquidity in the exchange market has significant explanatory power for the average price difference between the two markets, while liquidity in the interbank has negligible explanatory power. Among all the liquidity measures, average bid-ask spread has the most robust coefficient and significant explanatory power. The coefficient on $SPREAD$ is significantly negative (-1.957 with t-statistic of -2.62 in univariate regression, and -2.697 with t-statistic of -3.24 in multivariate regression), suggesting that the price difference is high when liquidity in the exchange market is high. In Figure 3, we plot the monthly average of liquidity measures in the exchange market (Figure 3a) and the interbank market (Figure 3b), respectively. The average bid-ask spread and the amihud illiquidity measure in the exchange market are highly positively correlated, and their correlation with the average price difference is highly negative. Number of trades in the exchange market is less correlated with other liquidity measures and the average price difference. Liquidity measures in the interbank market, including amihud illiquidity measure and number of trading days, have very low correlation with the average price difference between the two markets. It is worth comparing our results in the time series with our previous results in the cross section. Our results suggest that liquidity in the exchange market does bear a significant positive premium at the aggregate level. However, liquidity premium cannot fully explain the heterogeneity of price differences in the cross section.

In sum, we provide strong evidence supporting the notion that trading activities in the exchange market play the most important role in determining the time-varying aggregate price difference between the two markets. Trading activities due to commercial banks and other institutions in the interbank market do not seem to have a significant correlation with the average price difference between the two markets. In addition, liquidity in the exchange market bears a significant positive premium at the aggregate level of the price difference between the two markets, while liquidity in the interbank market has negligible effects.

### 6.5 Portfolio Returns of Trading Strategies

Finally, we analyze portfolio returns of the trading strategy, which buys bonds in the interbank market and sells them in the exchange market. Due to the fact that the transfer of depository holdings between the two markets can take up to three trading days, we consider trading strategies with a time delay between the buying and selling dates from zero to three trading days. We calculate monthly portfolio returns by taking the average return of all trades within a month and report the results in Table 13.

The equal-weighted and value-weighted monthly portfolio returns for the full sample from 2009 to 2013 are 0.691% with a $t$-statistic of 4.28 and 0.540% with a $t$-statistic of 2.97, respectively. The equal-weighted (value-weighted) portfolio return has a Sharpe ratio of 0.35 (0.23). The portfolio return is even larger for bonds with higher coupon rates or lower supply. At the beginning of every month, we split all enterprise bonds into terciles based on their coupon rate or total issue value. We then calculate the average monthly return for each subsample. The equal-weighted (value-weighted) monthly portfolio return for the high coupon subsample is as high as 1.419 % (1.301%) with a $t$-statistic of 8.94 (7.58), and has a Sharpe ratio of 0.82 (0.72). Moreover, the equal-weighted (value-weighted) monthly portfolio return for the low supply subsample is as high as 1.176 % (1.208%) with a $t$-statistic of 6.33 (6.02), and has a Sharpe ratio of 0.69 (0.72)..

In addition, we report the average monthly portfolio returns for trading strategies requiring a time lag between the buying date in the interbank market and the selling date in the exchange market, with the time lag ranging from one to three trading days. The results show that the portfolio returns remain similar if we buy bonds in the interbank and sell them after one to three trading days in the exchange market, suggesting that the price difference between the two markets is relatively persistent.

Taken together, the potential trading strategies of buying bonds in the interbank market and selling them in the exchange market can generate substantial portfolio returns, reaching as much as 0.7% per month for the full sample. The profit is even higher for high coupon bonds (1.3% per month) and bonds with low issuance (1.3% per month).

The persistence of the profit is potentially related to the limited arbitrage across markets. The trading strategy may not be profitable if transaction cost is high. We investigate the transaction costs by looking at the bid-ask spread in the exchange market. In the internet appendix (Table IA.5), we show that the average bid-ask spread for the trading strategy is around 0.8 yuan, suggesting that the transaction costs could potentially subsume the profits associated with the unconditional trading strategy. However, the bid-ask spread is lower for bonds with higher coupon rates or lower supply, which in fact provide higher returns. The average bid-ask spread is $\sim$ 0.6 yuan for high coupon bonds and $\sim$ 0.7 yuan for low supply bonds. Therefore, the trading strategy still seems to be quite profitable for bonds with high coupon rates or low supply, which provides 0.6-0.8% monthly return after subtracting the bid-ask spread.

Besides transaction costs, there could potentially be other costs associated with the trading strategy. For example, arbitrageurs need to bear interest rate risk and credit risk if they cannot buy in the exchange and sell in the interbank instantaneously. While the price difference is persistent, the bond price itself could fluctuate over time. Arbitrageurs may experience significant losses before they could fully carry out the trading strategy. Not only does the transfer itself take time, it may also take arbitrageurs prolonged period to sell a large amount of bonds in the exchange market due to liquidity issues. The results we have shown in the previous sections that more liquid bonds have lower price differences provide consistent evidence for the argument that more liquid bonds face less limited arbitrage.

## 6.6 Discussion on Alternative Explanations

We explore a number of alternative explanations for the price difference between the two markets and conclude that none of them can fully explain our results. First, the higher prices in the exchange market cannot be explained by asymmetric information across the two markets. Compared with institutional investors in the interbank market, retail investors are more informationally disadvantaged and therefore require higher returns, which should lead to lower prices in the exchange market.

Second, distinct features of bonds also exclude alternative explanations based on a number of bubble theories. The finite maturity of bonds rules out the rational bubble in any infinite horizon setting. The capped upside payoff of bonds also excludes the explanation based on gambling motives and preference for positive skewness. Due to the fact that institutions can trade in both the exchange market and the interbank market, asymmetric information and agency conflict between investors and portfolio managers cannot explain the relatively high prices in the exchange market either.

Theories based on heterogeneous beliefs and short-sale constraints such as Hong and Sraer (2013) suggest that credit bubbles should be quiet, which means that high valuation of bonds is usually associated with low trading volume. This is because when investors are more optimistic about the bond value, the bond price is more closer to the value of a risk-free asset and has less upside potential. And therefore the bond has a smaller value of resale option and smaller trading volume. Our results in the time series suggest otherwise in the

Chinese bond market. The average price difference between the two markets tends to move together with trading volume: the higher the price difference, the higher the trading volume in the exchange market. Our results therefore suggest that the high bond prices in the China exchange market cannot be explained by a quiet bubble due to heterogeneous beliefs and short-sale constraints.

# 7 Additional Tests

## 7.1 Further Evidence on the Impact of Buying Pressure

Trading volume is not a perfect proxy for demand since it contains both buy-initiated and sell-initiated trades. In this section, we directly test the impact of buying pressure on bond prices. Buying pressure can be viewed as a temporary demand shock, which varies over time.

We obtain information on whether a trade is buy-initiated or sell-initiated from the exchange.[13] We define demand pressure by calculating the ratio of buy-initiated trading volume to total trading volume (including both buy-initiated and sell-initiated trades), denoted by $BSRATIO$. We report the regression results with $BSRATIO$ as an additional explanatory variable in the internet appendix (Table IA.6). The results based on various model specifications show that the coefficient on $BSRATIO$ is always significantly positive, which suggests that buying pressure in the exchange market has a direct positive impact on bond prices.

## 7.2 Transaction Prices Matched on Time Stamps

One concern about calculating the price difference using the last transaction price in each market is whether the transactions in both markets have the same (or very close) time stamps. If the time stamps of the last transaction in the two markets are systematically different, the price difference may reflect differences in information across the two markets.

In order to minimize the time-stamp effect, we match the time stamp of the last transaction in the interbank market with the closest trade in the exchange market.[14] Due

[13] We also classify trades based on midprice (the average of the ask and bid prices) and the results remain similar.

[14] We choose to match the last transaction in the interbank market with the closest trade in the exchange

to data limitation, our time-stamp matched sample is confined to the time period from January 2010 to December 2013. We report the summary statistics of the matched sample in the online appendix (Panel A in Table IA.7). It is evident that the average time-stamp matched bond price (101.627) is very close to the average non-matched price (101.702) in the exchange market. And the average difference in time stamp between the two markets is only -3.532 minutes, assuring that there is no systematic difference in our matched sample. We replicate our main analysis in regression (2) for the time-stamp matched sample and report the results in the online appendix (Panel B in Table IA.7). All our previous results remain similar, suggesting that the price differences are not driven by the time-stamp difference between the exchange and interbank markets.

# 8 Conclusion

Investors who have limited access to leverage reach for yield by overweighing high-yield bonds in their investment portfolio. Risky credit products that deliver high yields therefore could potentially be overvalued due to the high demand of those investors. In this paper, we cleanly identify the demand effect of yield-chasing retail investors on corporate bond prices using a unique setup in China.

Chinese enterprise bonds are traded in two markets simultaneously, the exchange market and the interbank market. However, while institutions can trade in both markets, retail investors can only trade in the exchange market. This unique feature enables us to identify the demand effect of retail investors based on the relative valuation, which help fully control for fundamental information such as credit risk and any common shocks to both markets such as demand of institutional investors. We provide evidence that retail investors trade high-yield bonds significantly more than low-yield bonds, consistent with the idea that retail investors chase yield. Further more, we show that the price difference increases with proxies for individual investor demand, such as coupon rate and demand exposure to retail investors, but decreases with bond supply. The price difference also decreases with the supply of a bond's close substitutes as predicted by the local supply effect in the term structure.

market rather than to match the last transaction in the exchange market with the closest trade in the interbank market because bonds are traded much more frequently in the exchange market than in the interbank market.

We provide additional evidence that the higher bond prices in the exchange market persists due to potential limited arbitrage. Arbitrage within the exchange market cannot fully reverse the demand effect of yield-chasing retail investors due to both short-sale constraints and the limited risk-sharing capacity of risk-averse arbitragers who specialize in the bond market. Short-sale constraints make overvaluation more prevalent than undervaluation in the exchange market. Arbitrage along the term structure is limited due to the additional duration risk risk-averse arbitragers need to take on and therefore the demand and supply effects are stronger for bonds with high duration. Arbitrage across markets can be limited due to slow transferring process and liquidity mismatch between the two markets. We show that bonds with higher liquidity in the exchange market have lower price differences, which is consistent with the limited arbitrage explanation rather than the liquidity premium explanation.

Overall, our results suggest that the price differences between the exchange and the interbank markets are better explained by the demand effect of yield-chasing retail investors and limited arbitrage in the cross section of enterprise bonds. Our results cannot be explained by the liquidity premium and asymmetric information. The distinct natures of bonds such as finite maturity and bounded upside payoff also exclude a number of alternative explanations based on various bubble theories.

In a broader context, our findings have general implications for a variety of policy issues, such as regulations on financial intermediaries' risk taking practices and the large-scale open market operations conducted by central banks. Our results suggest that proper regulations preventing investors from chasing yield could potentially lower the risk of overvaluation in the risky credit market. Future research is need to fully understand the motivation for the yield-chasing behavior. Not only agency conflicts but also portfolio constraints may induce investors to chase for yield, which can have significant consequences for the credit market. In addition, governments could potentially affect corporate bond prices through the demand and supply channel. In the more specific context of the Chinese bond market, our results suggest that the partial segmentation of bond markets generates higher costs for retail investors who want to invest in the corporate bond market. A better integrated and developed financial market environment can potentially benefit Chinese investors, especially the retail investors.

# Appendix A Definition of Variables

***DPRICE and DLPRICE*** The price difference of the same bond traded in the exchange market and the interbank market, defined as the closing price in the exchange market ($P^{ex}$) minus the closing price in the interbank market ($P^{ib}$), $DPRICE$; or the natural logarithm of the ratio $P^{ex}/P^{ib}$, $DLPRICE$.

***CPRICE_EX*** The closing price in the exchange market (in Chinese Yuan).

***CPRICE_IB*** The closing price in the interbank market (in Chinese Yuan).

***YTM_EX*** Yield-to-maturity (in %) calculated from the closing price in the exchange market given by the following formula:

$$PV_t = \frac{C}{(1+y)^{\frac{d}{365}}} + \frac{C}{(1+y)^{\frac{d}{365}+1}} + ... + \frac{C+F}{(1+y)^{\frac{d}{365}+n-1}}, \tag{6}$$

where $PV_t$ is the full price (clean price + accrued interest) of the bond on day $t$, $C$ is the coupon paid annually, $y$ is yield-to-maturity, $n$ is the remaining number of coupon payments, $d$ is the number of days from day $t$ to the next coupon payment day, and $F$ is the face value of the bond.

***YTM_IB*** Yield-to-maturity (in %) calculated from the closing price in the interbank market.

***COUPON*** Coupon rate at issuance (in %). We only consider fixed coupon bonds in all our analyses.

***ISSUE*** Total outstanding at issuance (in million yuan).

***TERMYEAR*** Term year of the bond (in years).

***YEARTOMATU*** Year to maturity (in years).

***YEARTOISS*** Year to issuance (in years).

***VOL_EX*** Natural logarithm of trading volume in the exchange market (in million yuan).

***VOL_IB*** Natural logarithm of trading volume in the interbank market (in million yuan).

***DURATION*** Modified duration of the bond, which measures the percentage change in bond price for a one-percentage change in bond yield, given by

$$Duration_t = \frac{\sum_{i=1}^{n} \frac{\tau_i CF_i}{(1+y)^{\tau_i+1}}}{\sum_{i=1}^{n} \frac{CF_i}{(1+y)^{\tau_i}}}, \tag{7}$$

where $n$ is the number of cash flows the bond will receive from time $t$ to maturity, $CF_i$ is the $ith$ cash flow, $\tau_i$ is the number of years between time $t$ and time of the $ith$ cash flow, and $y$ is yield-to-maturity.

***CONVEXITY*** Convexity of the bond, given by

$$Convexity_t = \frac{\sum_{i=1}^{n} \frac{\tau_i(\tau_i+1) CF_i}{(1+y)^{\tau_i+2}}}{\sum_{i=1}^{n} \frac{CF_i}{(1+y)^{\tau_i}}}, \tag{8}$$

where $n$ is the number of cash flows the bond will receive from time $t$ to maturity, $CF_i$ is the $ith$ cash flow, $\tau_i$ is the number of years between time $t$ and time of the $ith$ cash flow, and $y$ is yield-to-maturity.

***HLPRICE_EX*** Daily price amplitude in the exchange market, defined as the difference between the daily highest and lowest prices scaled by the lowest price in the exchange market.

***HLPRICE_IB*** Daily price amplitude in the interbank market, defined as the difference between the daily highest and lowest prices scaled by the lowest price in the interbank market.

***MARKET*** Chinese equity market index return (in %).

***SHIBOR*** One-month Shanghai interbank offered rate ($SHIBOR$) (in %).

***CPI*** Annualized inflation rate (in %).

***Dum_SH*** A dummy variable, which equals 1 if the bond is issued by a firm located in Shanghai and equals 0 otherwise.

***Dum_SHEX*** A dummy variable, which equals 1 if a bond is listed on the Shanghai Stock Exchange and equals 0 if listed on the Shenzhen Stock Exchange.

***RATING_AAP*** A dummy variable, which equals one if the bond is rated as AA+ and equals zero otherwise.

***RATING_AA*** A dummy variable, which equals one if the bond is rated as AA and equals zero otherwise.

***UC*** A dummy variable, which equals one if the bond is an urban construction investment bond and equals zero otherwise. A UC bond is a special type of enterprise bond, which is issued by local government-backed investment units. UC bonds are often viewed as quasi-municipal bonds.

***ISSUE_CLOSE*** Natural logarithm of total bond outstanding (in million yuan) of a bond's close substitutes. The close substitutes of bond $i$ are defined as the bonds that have coupon rates within 1% and remaining maturity within two years of bond $i$.

***ISSUE_FAR*** Natural logarithm of total bond outstanding (in million yuan) of a bond's far substitutes. The far substitutes of bond $i$ are defined as the bonds that have coupon rates within 1% and remaining maturity within three to six years of bond $i$.

***BSRATIO*** The buy-initiated trading volume divided by total trading volume within a day.

***SPREAD*** The average bid-ask spread within a day. The bid-ask spread is defined as the difference between the lowest ask price and the highest bid price.

***AMIHUD_EX*** Amihud illiquidity measure calculated from intraday trading data within a day in the exchange market.

$$Amihud_t = \frac{1}{N_t} \sum_{j=1}^{N_t} \frac{|r_j|}{v_j}, \tag{9}$$

where $r_j$ and $v_j$ are the return (in %) and trading volume (in thousand yuan) of trade $j$ on day $t$, respectively, and $N_t$ is the number of trades on day $t$.

***NTR_EX*** Number of trades within a day in the exchange market.

***AMIHUD_IB*** Amihud illiquidity measure calculated from daily trading data within a month in the interbank market.

$$Amihud_t = \frac{1}{N_t} \sum_{j=1}^{N_t} \frac{|r_j|}{v_j}, \tag{10}$$

where $r_j$ and $v_j$ are the return (in %) and trading volume (in million yuan) of day $j$ in month $t$, respectively, and $N_t$ is the number of trading days in month $t$.

***NTR_IB*** Number of trading days within a month in the interbank market.

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**Table 1. Institutional Background**

This table provides institutional information about the exchange bond market and the interbank bond market in China (Panel A). Panel B reports the statistics of all enterprise bonds traded in both markets.

**Panel A. The exchange bond market and the interbank bond market**

| | Exchange Market | Interbank Market |
|---|---|---|
| Types of Investors | Individuals and institutions (excluding commercial banks) | Institutions |
| Types of Bonds traded | Government bonds, enterprise bonds, listed corporate bonds and convertible bonds | Government bonds, central bank bills, financial institution bonds, and nonfinancial corporate bonds (excluding listed corporate bonds and convertible bonds) |
| Trading mechanism | Order driven | Quote driven |
| Trustee | Exchange | China Central Depository and Clearing Co., Ltd |
| Supervisory institution | China Securities Regulatory Commission | People's Bank of China |
| Trading costs | 0.0001% registration fee + (max) 0.1% brokerage fee | 0.00025% registration fee + 100 yuan fixed cost |

**Panel B. Statistics of enterprise bonds traded in both markets**

| | Exchange Market | Interbank Market |
|---|---|---|
| Average trading days per bond per month | 8.96 | 4.86 |
| Average trading volume per bond per month (millions) | 32.76 | 921.89 |
| Average yield (%) | 5.92 | 6.44 |
| Average price | 101.04 | 100.41 |
| Average coupon (%) | 6.21 | 6.51 |
| Average year-to-maturity | 5.60 | 4.88 |

## Table 2. Summary Statistics

This table reports the number, mean, standard deviation, minimum, 25th percentile, median, 75th percentile, and maximum of bond characteristics, including the difference in bond price between the exchange market and the interbank market (*DPRICE*, in Chinese yuan), the difference in natural logarithm of bond price between the exchange market and the interbank market (*DLPRICE*, in %), the closing clean price in the exchange market (*CPRICE_EX*) and the interbank market (*CPRICE_IB*), the yield-to-maturity in the exchange market (*CYIELD_EX*) and the interbank market (*CYIELD_IB*), the annually-paid coupon rate (*COUPON*, in %), the total bond outstanding (*ISSUE*, in million yuan), term year (*TERMYEAR*), year-to-maturity (*YEARTOMATU*), year-to-issuance (*YEARTOISS*), trading volume in the exchange market (*VOL_EX*, in million yuan), trading volume in the interbank market (*VOL_IB*, in million yuan), modified duration (*DURATION*), convexity (*CONVEXITY*), daily price amplitude in the exchange market (*HLPRICE_EX*) and the interbank market (*HLPRICE_IB*), monthly Amihud illiquidity measure in the interbank market (*AMIHUD_IB*), number of trading days within a month in the interbank market (*NTR_IB*), daily Amihud illiquidity measure in the exchange market (*AMIHUD_EX*), number of trades within a day in the exchange market (*NTR_EX*), bid-ask spread in the exchange market (*SPREAD*), the daily buy-initiated trading volume scaled by total trading volume (*BSRATIO*), trade size in the exchange market (*TRADESIZE_EX*, in million yuan) and the interbank market (*TRADESIZE_IB*, in million yuan). See Appendix A for the detailed definition of variables. Daily bond transaction price and trading data are available from January, 2009 to December, 2013. Intraday data in the exchange market are available from January, 2009 to December, 2011.

| VAR | N | MEAN | STD | MIN | P25 | MEDIAN | P75 | MAX |
|---|---|---|---|---|---|---|---|---|
| *DPRICE* | 15,751 | 0.824 | 2.515 | -16.084 | -0.379 | 0.803 | 2.133 | 27.671 |
| *DLPRICE* | 15,751 | 0.786 | 2.529 | -17.596 | -0.373 | 0.794 | 2.096 | 28.918 |
| *CPRICE_EX* | 15,751 | 101.596 | 4.098 | 80.250 | 99.600 | 102.000 | 104.200 | 120.000 |
| *CPRICE_IB* | 15,751 | 100.771 | 3.317 | 79.854 | 99.140 | 100.827 | 102.919 | 115.349 |
| *YTM_EX* | 15,751 | 6.390 | 0.968 | -1.337 | 5.801 | 6.462 | 6.966 | 11.367 |
| *YTM_IB* | 15,751 | 6.573 | 0.982 | 1.732 | 5.962 | 6.707 | 7.235 | 12.473 |
| *COUPON* | 15,751 | 6.767 | 1.069 | 3.020 | 6.050 | 6.950 | 7.480 | 8.900 |
| *(ln)ISSUE (millions)* | 15,751 | 7.150 | 0.419 | 6.109 | 6.908 | 7.090 | 7.438 | 8.517 |
| *TERMYEAR* | 15,751 | 7.214 | 1.681 | 3.000 | 7.000 | 7.000 | 7.000 | 20.000 |
| *YEARTOISS* | 15,751 | 1.264 | 1.067 | 0.027 | 0.463 | 0.967 | 1.718 | 10.126 |
| *YEARTOMATU* | 15,751 | 5.950 | 1.849 | 0.027 | 5.033 | 5.978 | 6.674 | 17.337 |
| *(ln)TURNOVER_EX* | 15,751 | -8.273 | 2.831 | -14.509 | -10.373 | -7.985 | -5.991 | -2.933 |
| *(ln)TURNOVER_IB* | 15,751 | -2.591 | 1.094 | -5.561 | -3.322 | -2.532 | -1.781 | -0.237 |
| *DURATION* | 15,708 | 4.591 | 1.225 | 0.026 | 4.014 | 4.624 | 5.091 | 11.728 |
| *CONVEXITY* | 15,708 | 30.056 | 16.377 | 0.025 | 21.714 | 28.503 | 34.267 | 182.702 |
| *HLPRICE_EX* | 15,503 | 0.517 | 0.939 | 0.000 | 0.000 | 0.200 | 0.570 | 7.790 |
| *HLPRICE_IB* | 15,751 | 0.319 | 0.785 | 0.000 | 0.000 | 0.007 | 0.069 | 7.398 |
| *(ln)ISSUE_CLOSE (millions)* | 15,747 | 11.776 | 1.035 | 7.645 | 11.268 | 11.863 | 12.522 | 13.541 |
| *(ln)ISSUE_FAR (millions)* | 15,749 | 11.195 | 1.043 | 8.434 | 10.383 | 11.168 | 11.980 | 13.668 |
| *AMIHUD_IB* | 15,748 | 0.017 | 0.026 | 0.000 | 0.003 | 0.008 | 0.019 | 0.262 |
| *NTRADE_IB* | 15,751 | 8.268 | 5.804 | 1.000 | 4.000 | 7.000 | 12.000 | 23.000 |
| *AMIHUD_EX* | 14,558 | 1.195 | 3.623 | 0.000 | 0.012 | 0.070 | 0.460 | 31.584 |
| *NTRADE_EX* | 15,743 | 20.069 | 38.616 | 1.000 | 2.000 | 6.000 | 19.000 | 360.000 |
| *SPREAD* | 14,558 | 0.847 | 1.259 | 0.001 | 0.129 | 0.355 | 0.957 | 6.880 |
| *BSRATIO* | 14,550 | 0.531 | 0.365 | 0.000 | 0.191 | 0.526 | 0.923 | 1.000 |
| *TRADESIZE_EX (millions)* | 15,743 | 0.640 | 2.673 | 0.001 | 0.011 | 0.037 | 0.163 | 35.482 |
| *TRADESIZE_IB (millions)* | 14,010 | 98.627 | 97.342 | 5.000 | 35.000 | 60.000 | 120.000 | 500.000 |

## Table 3. Average Price Difference between the Exchange and the Interbank Market

This table reports the average price difference between the exchange bond market and the interbank bond market by year (Panel A) and by quarter (Panel B). The price difference is measured as the closing price in the exchange ($P^{ex}$) minus the closing price in the interbank market ($P^{ib}$) or the natural logarithm of the ratio $P^{ex}/P^{ib}$.

**Panel A. Average price difference by year**

| | | $P^{ex} - P^{ib}$ | | | | | $\ln(P^{ex}/P^{ib})$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | N | MEAN | STDERR | MAX | MEDIAN | MIN | MEAN | STDERR | MAX | MEDIAN | MIN |
| 2009 | 1,727 | 0.278 | 0.091 | 27.671 | 0.042 | -14.140 | 0.262 | 0.093 | 28.918 | 0.044 | -15.253 |
| 2010 | 2,877 | 0.496 | 0.042 | 17.944 | 0.470 | -9.871 | 0.460 | 0.041 | 16.202 | 0.469 | -10.352 |
| 2011 | 2,667 | 0.811 | 0.058 | 18.782 | 1.026 | -16.084 | 0.757 | 0.059 | 18.003 | 1.031 | -17.596 |
| 2012 | 4,205 | 0.906 | 0.032 | 10.366 | 0.825 | -10.071 | 0.880 | 0.032 | 10.355 | 0.819 | -10.419 |
| 2013 | 4,275 | 1.193 | 0.031 | 14.522 | 1.067 | -11.420 | 1.144 | 0.030 | 12.899 | 1.038 | -12.400 |

**Panel B. Average price difference by quarter**

| | | $P^{ex} - P^{ib}$ | | | | | $\ln(P^{ex}/P^{ib})$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Quarter | N | MEAN | STDERR | MAX | MEDIAN | MIN | MEAN | STDERR | MAX | MEDIAN | MIN |
| 2009Q1 | 285 | 3.110 | 0.242 | 23.280 | 2.392 | -5.292 | 3.105 | 0.249 | 24.579 | 2.260 | -4.918 |
| 2009Q2 | 475 | 1.512 | 0.160 | 27.671 | 1.020 | -12.029 | 1.515 | 0.160 | 28.918 | 0.978 | -11.014 |
| 2009Q3 | 569 | -1.285 | 0.135 | 26.742 | -0.918 | -14.140 | -1.300 | 0.138 | 28.230 | -0.900 | -15.253 |
| 2009Q4 | 398 | -0.988 | 0.145 | 8.582 | -0.933 | -11.162 | -1.036 | 0.149 | 8.630 | -0.920 | -11.877 |
| 2010Q1 | 621 | 0.053 | 0.090 | 5.690 | 0.222 | -9.871 | 0.026 | 0.090 | 5.523 | 0.220 | -10.352 |
| 2010Q2 | 683 | 0.397 | 0.078 | 8.116 | 0.490 | -5.765 | 0.365 | 0.077 | 8.079 | 0.480 | -5.578 |
| 2010Q3 | 814 | 0.503 | 0.081 | 17.944 | 0.341 | -7.550 | 0.462 | 0.077 | 16.202 | 0.332 | -7.247 |
| 2010Q4 | 759 | 0.938 | 0.086 | 10.600 | 0.765 | -6.550 | 0.900 | 0.084 | 10.697 | 0.764 | -7.227 |
| 2011Q1 | 611 | 1.730 | 0.081 | 8.800 | 1.511 | -5.771 | 1.709 | 0.080 | 8.452 | 1.504 | -5.959 |
| 2011Q2 | 779 | 2.614 | 0.073 | 18.782 | 2.255 | -7.334 | 2.580 | 0.071 | 18.003 | 2.241 | -7.644 |
| 2011Q3 | 627 | -0.169 | 0.112 | 7.409 | -0.152 | -16.084 | -0.220 | 0.117 | 7.435 | -0.149 | -17.596 |
| 2011Q4 | 650 | -1.268 | 0.127 | 12.628 | -0.950 | -14.667 | -1.381 | 0.135 | 12.974 | -1.001 | -15.861 |
| 2012Q1 | 754 | 0.158 | 0.102 | 10.230 | 0.370 | -10.071 | 0.124 | 0.107 | 10.355 | 0.377 | -10.419 |
| 2012Q2 | 1,185 | 1.236 | 0.059 | 10.366 | 0.828 | -6.418 | 1.223 | 0.058 | 9.738 | 0.819 | -6.438 |
| 2012Q3 | 899 | 0.633 | 0.063 | 8.790 | 0.471 | -8.100 | 0.607 | 0.062 | 8.330 | 0.467 | -8.722 |
| 2012Q4 | 1,367 | 1.213 | 0.040 | 8.761 | 1.133 | -5.634 | 1.179 | 0.040 | 8.339 | 1.133 | -5.374 |
| 2013Q1 | 1,759 | 1.441 | 0.040 | 14.522 | 1.300 | -5.580 | 1.391 | 0.038 | 12.899 | 1.263 | -5.323 |
| 2013Q2 | 1,297 | 1.560 | 0.048 | 11.190 | 1.355 | -7.480 | 1.497 | 0.046 | 10.477 | 1.311 | -7.119 |
| 2013Q3 | 600 | 0.590 | 0.081 | 6.540 | 0.555 | -11.420 | 0.555 | 0.081 | 6.102 | 0.528 | -12.142 |
| 2013Q4 | 619 | 0.306 | 0.113 | 10.028 | 0.285 | -11.149 | 0.269 | 0.115 | 9.778 | 0.285 | -12.400 |

**Table 4. Trading activities and Yield-to-Maturity in the Two Markets**

This table reports the results from the following regression:

$$TURNOVER_{i,t} = a_0 + a_1 YTM_{i,t} + \boldsymbol{b}\boldsymbol{z_{i,t}} + \varepsilon_{i,t},$$

where $TURNOVER_{i,t}$ is the natural logarithm of turnover in the exchange or interbank market; $YTM_{i,t}$ is the yield-to-maturity of bond $i$ on day $t$; and $\boldsymbol{z_{i,t}}$ is a vector of control variables, including total bond outstanding, turnover in the other market, year-to-maturity, year-to-issuance, and daily price amplitude in each market. The corresponding $t$-statistics based on robust standard errors are reported in parentheses.

| | Turnover in exchange | | | Turnover in interbank | | |
|---|---|---|---|---|---|---|
| *YTM_EX* | 0.403 | 0.284 | 0.773 | | | |
| | (5.78) | (3.86) | (5.43) | | | |
| *YTM_IB* | | | | -0.015 | -0.121 | -0.085 |
| | | | | (-0.38) | (-3.36) | (-1.79) |
| *(ln)ISSUE* | | -0.854 | -0.692 | | -0.736 | -0.780 |
| | | (-3.96) | (-3.33) | | (-7.09) | (-7.69) |
| *(ln)TURNOVER_EX* | | | | | -0.023 | -0.021 |
| | | | | | (-3.34) | (-3.25) |
| *(ln)TURNOVER_IB* | | -0.176 | -0.165 | | | |
| | | (-3.37) | (-3.22) | | | |
| *YEARTOMATU* | | 0.018 | -0.023 | | -0.015 | -0.015 |
| | | (0.31) | (-0.42) | | (-0.70) | (-0.73) |
| *YEARTOISS* | | -0.073 | 0.121 | | -0.052 | -0.012 |
| | | (-0.93) | (1.47) | | (-1.50) | (-0.32) |
| *HLPRICE_EX* | | -0.044 | 0.064 | | 0.015 | 0.010 |
| | | (-1.48) | (1.98) | | (1.19) | (0.91) |
| *HLPRICE_IB* | | 0.119 | 0.050 | | 0.364 | 0.367 |
| | | (3.03) | (1.32) | | (17.16) | (18.40) |
| *Intercept* | -10.846 | -4.482 | | -2.495 | 3.310 | |
| | (-24.85) | (-2.66) | | (-9.57) | (3.81) | |
| Adjusted R-Squared | 0.019 | 0.036 | 0.077 | 0.000 | 0.142 | 0.199 |
| Observations | 15,751 | 15,503 | 15,503 | 15,751 | 15,503 | 15,503 |
| Daily Fixed Effect | No | No | Yes | No | No | Yes |

**Table 5. Univariate Analysis of the Price Difference of the Same Bond Traded in the Exchange Market and the Interbank Market**

This table reports the average price difference ($DPRICE$), which is measured as the closing price in the exchange market ($P^{ex}$) minus the closing price in the interbank market ($P^{ib}$), in subsamples split by coupon rate ($COUPON$), total bond outstanding ($ISSUE$), Shanghai dummy ($DUM\_SH_i$, a dummy variable that equals 1 if the issuing firm is located in Shanghai and zero otherwise), and Shanghai exchange dummy ($DUM\_SHEX_i$, a dummy variable that equals 1 if the bond is listed on the Shanghai exchange and zero if the bond is listed on the Shenzhen exchange). We report both equal-weighted and value-weighted (weighted by total bond outstanding) price differences between the two markets.

| **Panel A. Coupon rate** | | | | | |
|---|---|---|---|---|---|
| | N | MEAN (ew) | t | MEAN (vw) | t |
| Low | 5,401 | 0.166 | 5.18 | -0.015 | -0.45 |
| Medium | 5,333 | 0.688 | 22.26 | 0.643 | 20.88 |
| High | 5,017 | 1.678 | 44.02 | 1.562 | 40.62 |
| (High-Low) | | 1.513 | 30.41 | 1.577 | 30.97 |
| **Panel B. Issue** | | | | | |
| | N | MEAN (ew) | t | MEAN (vw) | t |
| Low | 6,801 | 1.205 | 42.22 | 1.194 | 42.04 |
| Medium | 4,728 | 0.831 | 22.75 | 0.820 | 22.28 |
| High | 4,222 | 0.203 | 4.99 | 0.157 | 3.90 |
| (High-Low) | | -1.002 | -20.16 | -1.038 | -21.08 |
| **Panel C. SH dum** | | | | | |
| | N | MEAN (ew) | t | MEAN (vw) | t |
| 0 | 15,631 | 0.813 | 40.80 | 0.625 | 31.00 |
| 1 | 120 | 2.227 | 5.59 | 2.867 | 6.23 |
| (1-0) | | 1.414 | 3.54 | 2.242 | 4.87 |
| **Panel D. SH_EX dum** | | | | | |
| | N | MEAN (ew) | t | MEAN (vw) | t |
| 0 | 3,016 | 0.490 | 9.96 | 0.233 | 4.77 |
| 1 | 12,735 | 0.903 | 41.40 | 0.741 | 33.31 |
| (1-0) | | 0.414 | 7.69 | 0.508 | 9.45 |

**Table 6. Regression Analysis of the Price Difference between the Exchange and Interbank Markets**

This table reports the results from the following regression:

$$DPRICE_{i,t} = a_0 + a_1 COUPON_i + a_2 (ln) ISSUE_i + a_3 DUM\_SH_i + a_4 DUM\_SHEX_i + + \boldsymbol{b z_{i,t}} + \varepsilon_{i,t},$$

where $DPRICE_{i,t}$ is the price difference between the exchange market and the interbank market for bond $i$ on day $t$, which is measured as the closing price in the exchange ($P^{ex}$) market minus the closing price in the interbank market ($P^{ib}$) or the natural logarithm of the ratio $P^{ex}/P^{ib}$; $COUPON_i$ is the coupon rate of bond $i$; $(ln)ISSUE_i$ is the (natural logarithm of) total bond outstanding for bond $i$; $DUM\_SH_i$ is a dummy variable, which equals 1 if the firm issuing bond $i$ is located in Shanghai and equals 0 otherwise; $DUM\_SHEX_i$ is a dummy variable, which equals 1 if bond $i$ is listed on the Shanghai exchange and equals 0 if listed on the Shenzhen exchange; and $\boldsymbol{z_{i,t}}$ is a vector of control variables. The corresponding $t$-statistics based on robust standard errors are reported in parentheses.

| | $P_{ex} - P_{ib}$ | | | | | $ln(P_{ex}/P_{ib})$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *COUPON* | 0.703 | | | | 0.702 | 0.684 | | | | 0.682 |
| | (29.05) | | | | (29.77) | (27.74) | | | | (28.55) |
| *(ln)ISSUE* | | -0.974 | | | -0.335 | | -0.975 | | | -0.355 |
| | | (-19.19) | | | (-6.83) | | (-18.93) | | | (-7.13) |
| *Dum_SH* | | | 1.414 | | 3.125 | | | 1.563 | | 3.230 |
| | | | (3.25) | | (6.98) | | | (3.40) | | (6.85) |
| *Dum_SHEX* | | | | 0.414 | 0.195 | | | | 0.390 | 0.174 |
| | | | | (7.41) | (3.49) | | | | (6.94) | (3.09) |
| *Intercept* | -3.934 | 7.788 | 0.813 | 0.490 | -1.707 | -3.840 | 7.755 | 0.774 | 0.471 | -1.458 |
| | (-22.89) | (21.49) | (22.87) | (8.50) | (-4.14) | (-21.79) | (21.14) | (21.63) | (8.13) | (-3.50) |
| Adjusted R-Squared | 0.089 | 0.026 | 0.002 | 0.004 | 0.105 | 0.084 | 0.026 | 0.003 | 0.004 | 0.100 |
| Observations | 15,751 | 15,751 | 15,751 | 15,751 | 15,751 | 15,751 | 15,751 | 15,751 | 15,751 | 15,751 |

**Table 7. Robustness**

This table reports the results from the regression of price difference with additional control variables, including trading volume in each market ($VOL\_EX$ and $VOL\_IB$), year-to-maturity ($YEARTOMATU$), year-to-issuance ($YEARTOISS$), daily price amplitude in each market ($HLPRICE\_EX$ and $HLPRICE\_IB$), credit rating dummies ($RATING\_AAP$ and $RATING\_AA$), urban construction investment bond dummy ($UC$) and daily fixed effects that capture time-varying aggregate market conditions. See Appendix A for the detailed definition of variables. The corresponding $t$-statistics based on robust standard errors are reported in parentheses.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *COUPON* | 0.705 | 0.708 | 0.748 | 0.851 |
| | (30.73) | (28.58) | (29.06) | (31.16) |
| *(ln)ISSUE* | -0.308 | -0.358 | -0.435 | -0.485 |
| | (-6.16) | (-6.88) | (-8.28) | (-9.36) |
| *Dum_SH* | 3.138 | 3.162 | 3.125 | 2.343 |
| | (7.02) | (7.01) | (6.92) | (6.42) |
| *Dum_SHEX* | 0.195 | 0.233 | 0.223 | 0.473 |
| | (3.51) | (3.62) | (3.32) | (8.04) |
| *(ln)TURNOVER_EX* | 0.004 | 0.004 | 0.005 | -0.022 |
| | (0.46) | (0.47) | (0.59) | (-2.77) |
| *(ln)TURNOVER_IB* | 0.034 | 0.018 | 0.013 | -0.043 |
| | (1.77) | (0.88) | (0.66) | (-2.29) |
| *YEARTOMATU* | | 0.026 | 0.013 | -0.007 |
| | | (1.73) | (0.88) | (-0.45) |
| *YEARTOISS* | | 0.068 | 0.048 | 0.157 |
| | | (2.40) | (1.68) | (5.76) |
| *HLPRICE_EX* | | -0.072 | -0.073 | 0.135 |
| | | (-2.04) | (-2.09) | (4.96) |
| *HLPRICE_IB* | | 0.085 | 0.079 | -0.018 |
| | | (2.24) | (2.09) | (-0.49) |
| *RATING_AAP* | | | -0.026 | 0.014 |
| | | | (-0.29) | (0.17) |
| *RATING_AA* | | | -0.361 | -0.368 |
| | | | (-4.04) | (-4.49) |
| *Dum_UC* | | | -0.072 | -0.162 |
| | | | (-1.14) | (-2.51) |
| *Intercept* | -1.809 | -1.777 | -1.108 | |
| | (-4.38) | (-4.21) | (-2.54) | |
| Adjusted R-Squared | 0.105 | 0.107 | 0.111 | 0.307 |
| Observations | 15,751 | 15,503 | 15,503 | 15,503 |
| Daily Fixed Effect | No | No | No | Yes |

**Table 8. The Local Supply Effect**

This table reports the results from the regression of price difference with the supply of bond close substitutes and far substitutes as additional explanatory variables. The dependent variable is the bond price difference between the exchange market and the interbank market. The close substitutes of bond $i$ are defined as the bonds that have coupon rates within 1% and remaining maturities within two years of bond $i$. The far substitutes of bond $i$ are defined as the bonds that have coupon rates within 1% but remaining maturities within three to six years of bond $i$. The corresponding $t$-statistics based on robust standard errors are reported in parentheses.

| | (1) | (2) | (3) |
|---|---|---|---|
| *COUPON* | 0.748 | 0.779 | 0.670 |
| | (22.42) | (22.96) | (13.01) |
| *(ln)ISSUE* | -0.407 | -0.495 | -0.519 |
| | (-8.30) | (-9.59) | (-10.22) |
| *Dum_SH* | 3.178 | 3.184 | 2.517 |
| | (7.15) | (7.00) | (6.86) |
| *Dum_SHEX* | 0.432 | 0.455 | 0.518 |
| | (8.37) | (7.75) | (8.99) |
| *(ln)ISSUE_CLOSE* | -0.325 | -0.328 | -0.323 |
| | (-12.73) | (-12.18) | (-8.01) |
| *(ln)ISSUE_FAR* | 0.170 | 0.148 | 0.002 |
| | (5.42) | (4.58) | (0.04) |
| *(ln)TURNOVER_EX* | | 0.003 | -0.023 |
| | | (0.39) | (-2.82) |
| *(ln)TURNOVER_IB* | | -0.017 | -0.053 |
| | | (-0.84) | (-2.83) |
| *YEARTOMATU* | | -0.020 | -0.031 |
| | | (-1.28) | (-2.05) |
| *YEARTOISS* | | 0.011 | 0.044 |
| | | (0.39) | (1.39) |
| *HLPRICE_EX* | | -0.077 | 0.134 |
| | | (-2.19) | (4.93) |
| *HLPRICE_IB* | | 0.078 | -0.013 |
| | | (2.03) | (-0.35) |
| *RATING_AAP* | | -0.054 | -0.105 |
| | | (-0.57) | (-1.27) |
| *RATING_AA* | | -0.359 | -0.471 |
| | | (-4.01) | (-5.84) |
| *Dum_UC* | | -0.139 | -0.187 |
| | | (-2.20) | (-2.90) |
| *Intercept* | 0.219 | 1.347 | 3.551 |
| | (0.28) | (1.73) | (2.85) |
| Adjusted R-Squared | 0.119 | 0.123 | 0.313 |
| Observations | 15,745 | 15,497 | 15,497 |
| Daily Fixed Effect | No | No | Yes |

**Table 9. The Effect of Limits to Arbitrage**

This table reports the results from the regression of price difference with interaction terms between demand (and supply) factors and bond modified duration. The dependent variable is the bond price difference between the exchange market and the interbank market. Modified duration measures the percentage change in bond price for a one-percentage change in bond yield. The corresponding $t$-statistics based on robust standard errors are reported in parentheses.

| | (1) | (2) | (3) |
|---|---|---|---|
| *COUPON* | 0.508 | 0.444 | 0.597 |
| | (5.60) | (4.74) | (6.36) |
| *(ln)ISSUE* | 0.132 | 0.143 | 0.017 |
| | (0.66) | (0.70) | (0.08) |
| *Dum_SH* | -0.174 | -0.288 | 0.273 |
| | (-0.35) | (-0.56) | (0.47) |
| *Dum_SHEX* | -0.771 | -0.508 | -0.350 |
| | (-5.04) | (-3.30) | (-2.16) |
| *(ln)ISSUE_CLOSE* | 0.100 | -0.008 | 0.155 |
| | (1.49) | (-0.11) | (2.29) |
| *COUPON*Duration* | 0.095 | 0.110 | 0.112 |
| | (5.55) | (6.40) | (7.30) |
| *(ln)ISSUE*Duration* | -0.109 | -0.142 | -0.113 |
| | (-2.47) | (-3.13) | (-2.56) |
| *Dum_SH*Duration* | 0.691 | 0.716 | 0.456 |
| | (4.44) | (4.49) | (3.08) |
| *Dum_SHEX*Duration* | 0.254 | 0.207 | 0.184 |
| | (6.94) | (5.82) | (4.71) |
| *(ln)ISSUE_CLOSE*Duration* | -0.078 | -0.056 | -0.097 |
| | (-5.17) | (-3.36) | (-5.79) |
| *Duration* | 1.325 | 1.226 | 1.655 |
| | (2.78) | (2.52) | (3.39) |
| *Intercept* | -4.294 | -2.843 | |
| | (-2.06) | (-1.36) | |
| Adjusted R-Squared | 0.125 | 0.131 | 0.319 |
| Observations | 15,704 | 15,457 | 15,457 |
| Controls | No | Yes | Yes |
| Daily Fixed Effect | No | No | Yes |

**Table 10. The Effect of Liquidity**

This table reports the results from the regression of price difference with various liquidity measures, including bid-ask spread ($SPREAD$), daily Amihud illiquidity measure ($AMIHUD\_EX$), and number of trades within a day ($NTR\_EX$) in the exchange market, and monthly Amihud illiquidity measure ($AMIHUD\_IB$) and number of trading days within a month ($NTR\_IB$) in the interbank market. The dependent variable is the price difference between the exchange market and the interbank market. The corresponding $t$-statistics based on robust standard errors are reported in parentheses.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| *SPREAD* | 0.079 | | | | | 0.066 | 0.124 | 0.163 | 0.243 |
| | (4.43) | | | | | (3.54) | (6.64) | (8.50) | (11.30) |
| *AMIHUD_EX* | | 0.007 | | | | -0.008 | 0.002 | 0.042 | 0.041 |
| | | (1.11) | | | | (-1.18) | (0.32) | (5.11) | (5.00) |
| *NTRADE_EX* | | | -0.003 | | | -0.003 | -0.005 | -0.008 | -0.006 |
| | | | (-2.69) | | | (-2.90) | (-5.39) | (-6.82) | (-6.22) |
| *AMIHUD_IB* | | | | 7.875 | | 8.842 | 5.027 | 5.451 | 5.593 |
| | | | | (5.18) | | (5.36) | (3.07) | (3.01) | (3.11) |
| *NTRADE_IB* | | | | | -0.011 | -0.002 | -0.011 | -0.014 | -0.029 |
| | | | | | (-2.76) | (-0.51) | (-2.60) | (-3.20) | (-7.13) |
| *COUPON* | | | | | | | 0.695 | 0.751 | 0.806 |
| | | | | | | | (26.18) | (27.24) | (26.96) |
| *(ln)ISSUE* | | | | | | | -0.402 | -0.411 | -0.423 |
| | | | | | | | (-7.83) | (-6.79) | (-7.11) |
| *Dum_SH* | | | | | | | 3.169 | 3.173 | 2.375 |
| | | | | | | | (7.21) | (7.04) | (5.75) |
| *Dum_SHEX* | | | | | | | 0.309 | 0.266 | 0.346 |
| | | | | | | | (6.21) | (4.76) | (6.30) |
| *(ln)ISSUE_CLOSE* | | | | | | | -0.353 | -0.364 | -0.303 |
| | | | | | | | (-11.66) | (-12.35) | (-8.80) |
| *Intercept* | 0.746 | 0.804 | 0.881 | 0.694 | 0.919 | 0.704 | 2.858 | 4.119 | |
| | (16.67) | (20.43) | (24.88) | (16.80) | (18.50) | (10.33) | (4.85) | (6.62) | |
| Adjusted R-Squared | 0.001 | 0.000 | 0.002 | 0.006 | 0.001 | 0.011 | 0.140 | 0.154 | 0.372 |
| Observations | 14,558 | 14,558 | 15,743 | 15,748 | 15,751 | 14,557 | 14,553 | 14,415 | 14,415 |
| Controls | No | No | No | No | No | No | No | Yes | Yes |
| Daily Fixed Effect | No | No | No | No | No | No | No | No | Yes |

**Table 11. Event Study**

This table reports the event study based on the urban construction investment bond crisis in June 2011. The average price difference (Panel A) before and after the event are reported for the UC and non-UC bonds. The before-event period is defined as the six months before the crisis from December 2010 to May 2011, and the after-event period is defined as the six month after the crisis from July 2011 to December 2011. Panel B reports the results from the following regression:

$$DPRICE_{i,t} = a_0 + a_1 event_t + a_2 event_t * UC_i + a_3 UC_i + \boldsymbol{b z_{i,t}} + \varepsilon_{i,t},$$

where $event_t$ is a dummy variable that equals zero for the before-event days and one for after-event days, $UC_i$ is a dummy variable that equals one if bond $i$ is a UC bond and zero otherwise, and $\boldsymbol{z_{i,t}}$ represents a number of liquidity measures for bond $i$ at time $t$. The corresponding $t$-statistics based on robust standard errors are reported in parentheses.

**Panel A. Price difference in univariate analysis**

| | Before | After | Diff |
|---|---|---|---|
| *Non-UC Bonds* | 1.991 | 0.193 | -1.798 |
| | (11.82) | (0.88) | (-6.50) |
| Observations | 186 | 134 | |
| *UC bonds* | 2.026 | -0.836 | -2.863 |
| | (35.16) | (-9.05) | (-26.28) |
| Observations | 1211 | 1143 | |
| Diff-in-Diff | | | -1.065 |
| | | | (-3.58) |

**Panel B. Price difference in regression analysis**

| *Event* | *UC* | *Event*UC* | *SPREAD* | *AMIHUD_EX* | *NTR_EX* | *AMIHUD_IB* | *NTR_IB* | *Adj.R²* | *Obs.* |
|---|---|---|---|---|---|---|---|---|---|
| -1.800 | 0.039 | -1.069 | | | | | | 0.225 | 2689 |
| (-6.55) | (0.27) | (-3.69) | | | | | | | |
| -2.350 | -0.017 | -0.656 | 0.248 | 0.263 | -0.011 | -2.915 | -0.002 | 0.304 | 2568 |
| (-8.93) | (-0.11) | (-2.48) | (5.06) | (2.32) | (-3.93) | (-0.90) | (-0.24) | | |

**Table 12. Time Series Analysis**

This table reports the results from the following time series regression:

$$ADPRICE_t = \alpha_0 + \alpha_1 AVOL\_EX_t + \alpha_2 AVOL\_IB_t + \gamma MACRO_t + \varepsilon_t,$$
$$ADPRICE_t = \alpha_0 + \alpha_1 AVOL\_EX_t + \alpha_2 AVOL\_IB_t + \gamma_1 LIQ\_EX_t + \gamma_2 LIQ\_IB_t + \varepsilon_t.$$

where the dependent variable $ADPRICE_t$ is the monthly average price difference between the exchange market and the interbank market. The explanatory variables include the monthly average trading volume in the exchange market ($AVOL\_EX_t$) and the interbank market ($AVOL\_IB_t$), macroeconomic variables ($MACRO_t$) including total supply of enterprise bonds ($SUPPLY\_ENT_t$), total supply of government bonds ($SUPPLY\_GOV_t$), equity market index return ($MARKET_t$), $SHIBOR$ one-month rate ($SHIBOR\_1M_t$, in %), annualized inflation rate ($CPI_t$, in %), liquidity measures in the exchange market ($LIQ\_EX_t$) including average bid-ask spread ($SPREAD_t$), amihud illiquidity measure ($AMIHUD\_EX_t$), and number of trades ($NTRADE\_EX_t$), and liquidity measures in the interbank market ($LIQ\_IB_t$) including amihud illiquidity measure ($AMIHUD\_IB_t$) and number of trading days ($NTRADE\_IB_t$). The corresponding $t$-statistics calculated from Newey and West (1987) robust standard errors are reported in parentheses.

**Panel A.**

| *Intercept* | *AVOL_EX* | *AVOL_IB* | *(ln)SUPPLY_ENT* | *(ln)SUPPLY_GOV* | *SHIBOR_IM* | *MARKET* | *CPI* | Adj.R2 |
|---|---|---|---|---|---|---|---|---|
| -1.519 | 0.574 | | | | | | | 0.356 |
| (-2.09) | (3.65) | | | | | | | |
| 1.230 | | -0.003 | | | | | | 0.001 |
| (1.89) | | (-0.71) | | | | | | |
| 2.773 | | | -0.114 | | | | | -0.012 |
| (0.35) | | | (-0.27) | | | | | |
| 0.602 | | | | 0.004 | | | | -0.017 |
| (0.08) | | | | (0.01) | | | | |
| 0.784 | | | | | -0.026 | | | -0.016 |
| (0.95) | | | | | (-0.14) | | | |
| 0.669 | | | | | | 0.032 | | 0.015 |
| (2.29) | | | | | | (1.30) | | |
| 0.720 | | | | | | | -0.013 | -0.017 |
| (1.24) | | | | | | | (-0.08) | |
| -0.342 | 0.591 | -0.003 | 0.000 | 0.000 | 0.011 | 0.013 | 0.125 | 0.399 |
| (-0.24) | (3.83) | (-0.67) | (-1.66) | (1.53) | (0.08) | (0.71) | (1.34) | |

**Panel B.**

| *Intercept* | *AVOL_EX* | *AVOL_IB* | *SPREAD* | *AMIHUD_EX* | *NTRADE_EX* | *AMIHUD_IB* | *NTRADE_IB* | Adj.R2 |
|---|---|---|---|---|---|---|---|---|
| -1.519 | 0.574 | | | | | | | 0.356 |
| (-2.09) | (3.65) | | | | | | | |
| 1.230 | | -0.003 | | | | | | 0.001 |
| (1.89) | | (-0.71) | | | | | | |
| 2.345 | | | -1.957 | | | | | 0.224 |
| (3.38) | | | (-2.62) | | | | | |
| 1.782 | | | | -0.859 | | | | 0.266 |
| (3.99) | | | | (-2.97) | | | | |
| 0.347 | | | | | 0.015 | | | 0.002 |
| (0.54) | | | | | (0.51) | | | |
| 0.239 | | | | | | 26.788 | | 0.005 |
| (0.31) | | | | | | (0.64) | | |
| 0.419 | | | | | | | 0.034 | -0.014 |
| (0.63) | | | | | | | (0.43) | |
| 1.241 | 0.352 | -0.006 | -2.697 | 0.205 | -0.021 | 40.579 | 0.124 | 0.478 |
| (1.08) | (2.20) | (-1.36) | (-3.24) | (0.48) | (-1.10) | (1.57) | (1.66) | |
| 6.814 | 0.367 | -0.004 | -0.002 | -0.332 | 0.096 | 0.007 | 0.036 | 0.487 |
| (0.91) | (3.28) | (-0.96) | (-0.95) | (-0.50) | (0.74) | (0.42) | (0.43) | |

**Table 13. Portfolio Returns of Trading Strategies**

This table reports the average monthly portfolio returns (in %) of trading strategies, which buy bonds in the interbank market and sell them in the exchange market with a time lag between 0-3 trading days. The equal-weighted and value-weighted monthly portfolio returns are reported for the full sample and subsamples split by coupon rate and bond outstanding. Enterprise bonds are split into terciles based on their coupon rate (or outstanding) at the beginning of each month. The sample period is from 2009 to 2013. The corresponding $t$-statistics based on Newey and West (1987) standard errors are reported in parentheses. Sharpe ratios (sr) are also reported for portfolio returns.

| | | **0 day** | | **1 day** | | **2 days** | | **3 days** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **R (EW)** | **R (VW)** | **R (EW)** | **R (VW)** | **R (EW)** | **R (VW)** | **R (EW)** | **R (VW)** |
| Full Sample | | 0.691 | 0.540 | 0.718 | 0.570 | 0.699 | 0.545 | 0.697 | 0.529 |
| | t | (4.28) | (2.97) | (4.37) | (3.04) | (4.39) | (3.11) | (4.27) | (2.89) |
| | sr | 0.35 | 0.23 | 0.37 | 0.26 | 0.36 | 0.25 | 0.35 | 0.23 |
| Low Coupon | | 0.062 | -0.061 | 0.084 | -0.031 | 0.020 | -0.090 | 0.006 | -0.125 |
| | t | (0.27) | (-0.23) | (0.37) | (-0.12) | (0.09) | (-0.37) | (0.02) | (-0.46) |
| | sr | -0.11 | -0.19 | -0.10 | -0.18 | -0.16 | -0.25 | -0.15 | -0.23 |
| Medium Coupon | | 0.427 | 0.386 | 0.493 | 0.458 | 0.476 | 0.449 | 0.456 | 0.416 |
| | t | (2.29) | (2.14) | (2.44) | (2.38) | (2.29) | (2.26) | (2.21) | (2.02) |
| | sr | 0.16 | 0.13 | 0.21 | 0.19 | 0.20 | 0.18 | 0.18 | 0.15 |
| High Coupon | | 1.419 | 1.301 | 1.431 | 1.328 | 1.434 | 1.320 | 1.449 | 1.333 |
| | t | (8.94) | (7.58) | (8.57) | (7.36) | (8.50) | (7.36) | (8.51) | (7.41) |
| | sr | 0.82 | 0.72 | 0.82 | 0.73 | 0.81 | 0.72 | 0.82 | 0.72 |
| Low Issue | | 1.176 | 1.208 | 1.157 | 1.187 | 1.126 | 1.160 | 1.182 | 1.228 |
| | t | (6.33) | (6.02) | (7.25) | (6.98) | (6.89) | (6.67) | (7.43) | (7.17) |
| | sr | 0.69 | 0.72 | 0.69 | 0.72 | 0.64 | 0.68 | 0.68 | 0.72 |
| Medium Issue | | 0.666 | 0.664 | 0.729 | 0.727 | 0.717 | 0.715 | 0.721 | 0.719 |
| | t | (2.29) | (2.29) | (2.37) | (2.37) | (2.37) | (2.37) | (2.48) | (2.48) |
| | sr | 0.25 | 0.25 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 |
| High Issue | | 0.422 | 0.331 | 0.434 | 0.352 | 0.416 | 0.325 | 0.385 | 0.288 |
| | t | (2.13) | (1.58) | (2.10) | (1.60) | (2.25) | (1.64) | (1.90) | (1.33) |
| | sr | 0.14 | 0.07 | 0.14 | 0.09 | 0.14 | 0.07 | 0.11 | 0.04 |

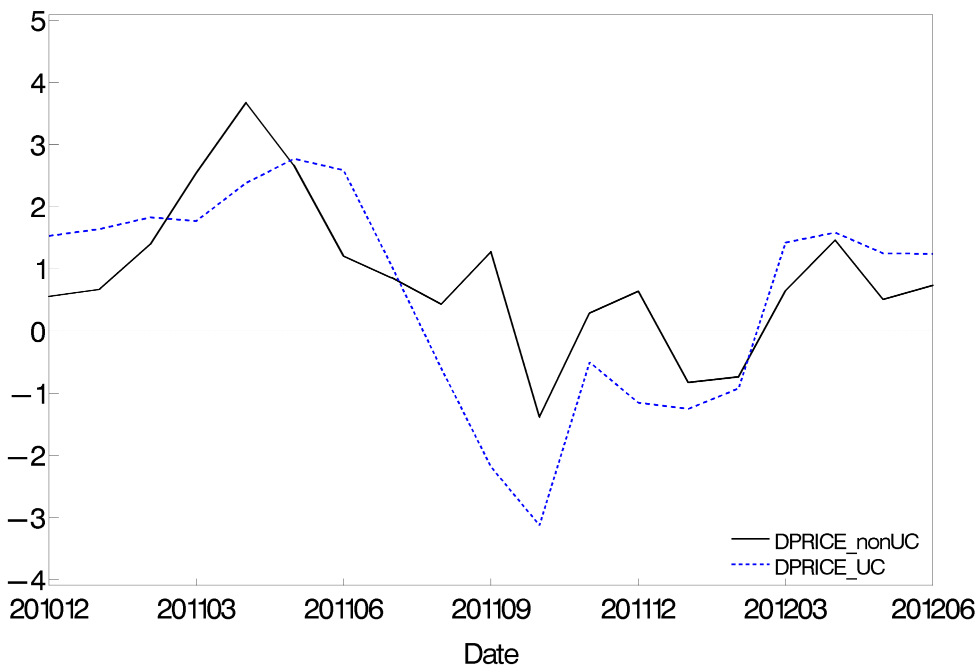


**Figure 1. Average price difference before and after the urban construction bond crisis for UC and non-UC bonds**

This figure plots the monthly average price difference between the exchange market and the interbank market for UC and non-UC bonds. The urban construction bond crisis broke out in June 2011.

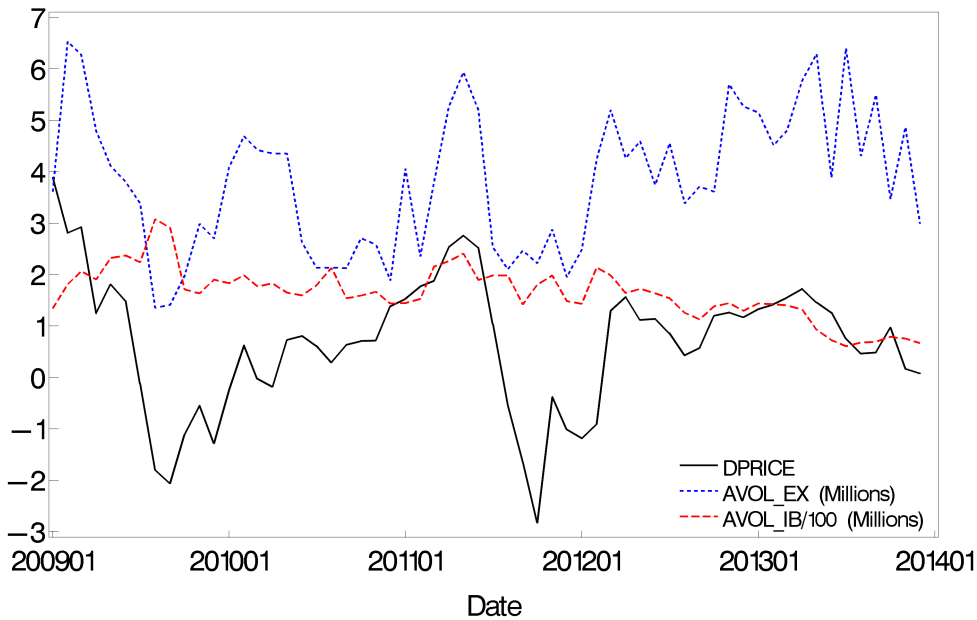


**Figure 2. Time series of average price difference, trading volume, and bond outstanding**
This figure plots the monthly average price difference ($ADPRICE_t$), average trading volume in the exchange market and the interbank market ($AVOL\_EX_t$ and $AVOL\_IB_t$), and average bond outstanding ($AISSUE_t$) from 2009 to 2013.

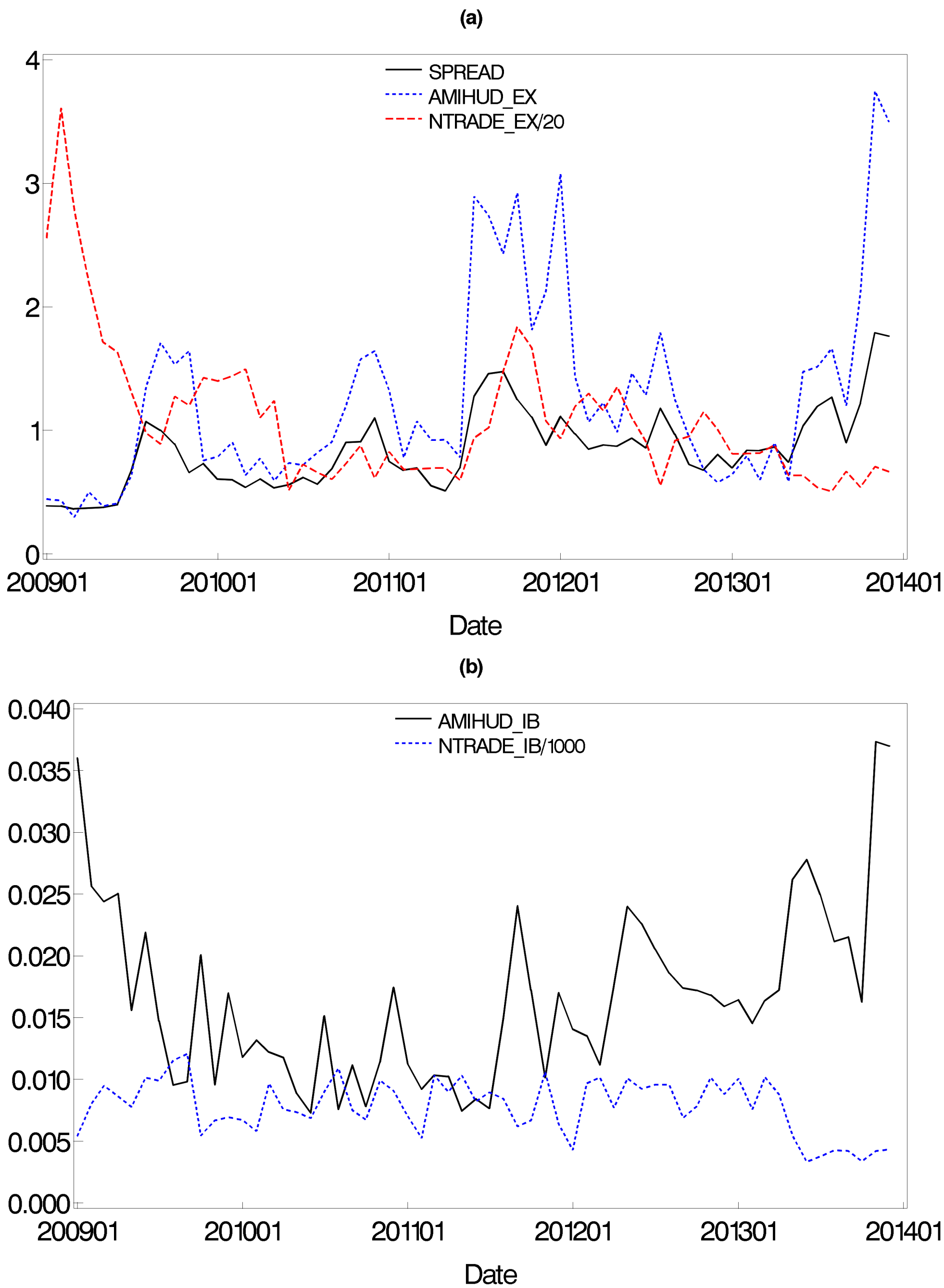


**Figure 3. Time series of liquidity measures in the exchange and interbank markets**
This figure plots the monthly average of liquidity measures (a) in the exchange market, including bid-ask spread ($SPREAD$), amihud illiquidity measure ($AMIHUD\_EX$), and number of trades ($NTRADE\_EX$), and (b) in the interbank market, including amihud illiquidity measure ($AMIHUD\_IB$) and number of trading days ($NTRADE\_IB$).