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The demand effect of yield-chasing retail investors: Evidence from the Chinese enterprise bond market[☆]

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ABSTRACT

Enterprise 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 yield to maturity, lower supply, and higher demand exposure to retail investors. Our results suggest that risky bonds can be priced significantly higher due to the demand of yield-chasing investors and a sudden negative demand shock can generate a sharp decrease in bond values. The demand and supply effects are stronger for bonds with higher duration due to the limited risk-sharing capacity of risk-averse arbitrageurs.

1. Introduction

An extensive literature suggests that corporate bond yield spreads contain substantial non-default risk components. For example, a number of papers suggest that liquidity is an important determinant of corporate bond prices.[1] More recently, researchers find that demand and supply effects also play an important role in determining bond prices. Vayanos and Vila (2009) develop a formal model with preferred-habitat investors and risk-averse arbitrageurs, and show that demand and supply affect the equilibrium bond prices under no-arbitrage conditions. D'Amico and King (2013), Greenwood and Vayanos (2014), and Fan et al. (2013) extend the model and provide supporting evidence of the supply effects in the government bond market. Lou et al. (2013) show that anticipated

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1 Chen et al. (2007), Li et al. (2009), Bao et al. (2011), Lin et al. (2011), and Acharya et al. (2013).

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and repeated supply shocks can have substantial effects on Treasury security prices. Hong et al. (2017) suggest that the interaction between supply and disagreement affects the slope of the yield curve.

While most of the existing literature focus on the supply effect in the government bond market, clean tests on the demand effect in the credit markets are rare. A few exceptions include Ivashina and Sun (2011) and Becker and Ivashina (2015), who show that investor demand can substantially affect the prices of corporate loans and corporate bonds. In particular, Becker and Ivashina (2015) find that insurance companies reach for yield due to principal–agent problem resulting from imperfect risk measurement. In this paper, we provide out-of-sample evidence that the demand effect on corporate bond prices and the behavior of ''reaching for yield'' are not unique phenomenons in the credit market of developed countries such as U.S., but also evident in large developing countries such as China. More importantly, our results suggest that the reaching-for-yield behavior can exist in the absence of principal–agent conflict. Other mechanisms, such as borrowing constraints as suggested by Frazzini and Pedersen (2014), may play an important role in generating such behavior.

Using a unique setup from the Chinese bond markets, we identify the demand effects of yield-chasing retail investors on corporate bond prices based on relative valuation. Chinese enterprise bonds, which are issued by state-controlled enterprises, are one of the largest sector of Chinese non-financial corporate bond market.[2] Enterprise bonds are simultaneously traded in two partially-separated markets, the exchange market and the interbank market. The exchange market is an active and important venue for trading non-financial corporate bonds in China. For example, corporate bonds issued by listed firms are exclusively traded in the exchange market; 30% of enterprise bonds are traded in the exchange 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 effect 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 12 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. More importantly, the price differences between the two markets exhibit substantial cross-sectional heterogeneity and are driven by the demand of retail investors. Retail investors trade and demand more of bonds that deliver higher yield to maturity. Using bond transaction data, we provide evidence that higher yield is associated with higher turnover, smaller average trade size, higher fraction of retail investor trading volume, and an increase in future order imbalance of retail investors. We show that the price difference is significantly higher for those bonds with higher demand of retail investors, such as bonds with higher yield 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 further show that the price differences persist over time due to limited arbitrage. Arbitrage within the exchange market is limited due to short-sale constraints and limited risk-sharing capacity of risk-averse arbitrageurs. Enterprise bonds cannot be sold short in the exchange market due to the lack of an active buyout repurchase agreement (repo) market. 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 is limited due to the slow transferring process of depository holdings and liquidity mismatch between the two markets.

We investigate two potential mechanisms in explaining the cross section of bond price differences, including the limits-to-arbitrage explanation and the liquidity premium explanation. The two explanations predict opposite signs of the coefficients on liquidity measures in the exchange market. According to the limits-to-arbitrage explanation, price differences should be lower when liquidity in the exchange market is higher because the high valuation of risky bonds in the exchange market is more easily to be arbitraged away. In contrast, the liquidity premium explanation suggests that bonds with higher liquidity in the exchange market should have higher price differences because they should earn lower expected returns. In order to identify the effect of liquidity in the exchange market while controlling for the effect of liquidity in the interbank market, we construct three relative liquidity measures by scaling liquidity in the exchange by liquidity in the interbank market. We find that the coefficients on the relative liquidity measures are significantly negative, which supports the limits-to-arbitrage explanation. It is worth noting that the two explanations are not mutually exclusive. While our results favor more of the limits-to-arbitrage explanation, the effect of liquidity premium may exist at the same time.

In addition, we 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. We also provide evidence based on bond transaction data that the order imbalance of retail investors decrease significantly for UC bonds during the crisis, which directly supports the demand effects of retail investors in the exchange market. Our results suggest that the high valuation of risky bonds in the exchange market could face sudden crash when there is a large negative demand shock to retail investors.

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. In a perfect market with no arbitrage opportunities, 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

[2] A fraction of enterprise bonds are issued by local-government backed investment units and may also be viewed as quasi-municipal bonds. Nevertheless, enterprise bonds are regulated as part of the non-financial corporate bond sector by the Chinese government.

investors through arbitrage across perfect substitutes. However, when assets are not perfectly substitutable and arbitrage is limited, demand and supply can affect asset prices. While the demand and supply effects have been investigated by a number of previous studies in the equity markets,[3] their impact on fixed income securities is less understood. Recent research in the fixed income markets suggests that government bond supply significantly impacts Treasury bond prices (Vayanos and Vila, 2009; D'Amico and King, 2013; Greenwood and Vayanos, 2014; Fan et al., 2013). And the interaction between Treasury supply and disagreement on inflation changes the slope of the yield curve (Hong et al., 2017). We add to this line of literature by identifying the demand effect of certain investors in the market on 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 up the prices of risky credit products in the presence of risk-averse arbitrageurs. Previous literature mainly relies on the principal–agent conflict to explain certain investors' behavior of reaching for yield.[4] 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. We suggest that investors may also reach for yield due to other reasons, such as borrowing constraints (Frazzini and Pedersen, 2014). Retail investors in China exhibit strong tendency to chase yield in the absence of principal–agent conflict. One potential explanation could be their limited access to leverage. Our findings can have general implications for the pricing of credit products in markets where large institutional investors (such as mutual funds and pension funds) face leverage constraints due to regulatory restrictions.

There are limited studies of relative pricing for municipal and corporate bonds. Hong and Warga (2000) 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). Green et al. (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 the 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 the relative overvaluation of risky bonds in the exchange market due to yield-chasing behavior of retail investors.

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

2. Institutional background

2.1. 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).[5]

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, which represented 35%, 2%, 39% and 19% of the total bond market, respectively, as of the end of 2013. The Internet Appendix provides the detailed description of each bond type. According to records from China Central Depository and Clearing Co. Ltd. (CCDC),[6] 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.[7] 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 later in 1997, which is an over-the-counter market designed for institutional investors, mainly 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. The exchange market remains an actively traded market with a large number of trades but relatively small trading volumes.[8] While the majority of Chinese Treasury securities are traded in the interbank market now, the exchange market continues to play an important role for trading corporate

[3] See, for example, Shleifer (1986), Harris and Gurel (1986), Pruitt and Wei (1989), Wurgler and Zhuravskaya (2002), and Greenwood (2005). There are limited studies in other markets, such as options (Garleanu et al., 2009), futures (de Roon et al., 2000), and mortgage-backed securities (Gabaix et al., 2007).

[4] 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.

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

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

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

[8] Each sector of the Chinese bond market is the trustee of a certain proportion of the total bond outstanding, known as its depository holdings.

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
Number of bonds	849	991
Daily observations	125,754	72,005
Average non-zero trading days per bond per month	8.96	4.86
Average trading volume per bond per month (millions)	32.76	921.89
Average yield (%)	6.20	6.44
Average price	101.07	100.62
Average coupon (%)	6.50	6.56
Average year-to-maturity	5.78	5.14

bonds. Corporate bonds issued by listed firms can only be traded in the exchange market. And 30% depository holdings of enterprise bonds, which are issued by state-controlled and mainly unlisted enterprises, are held in the exchange market.

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.[9]

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 details.

2.2. 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 with 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.

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 was 236 billion yuan, and 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.

[9] 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.

2.3. 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 arbitrageurs 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. Short selling enterprise bonds is not feasible in the exchange market. Short selling a bond in China can only be achieved through buyout repos, which require the ownership of the bond to be transferred to the buyer and thus opens up a potential channel for short selling.[10] However, while buyout repos are allowed for all bonds traded in the interbank market, they are only allowed for 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.[11] In sum, the 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 the inefficient transfer of depository holdings.

3. 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. Any common shocks such as credit risk, interest rate risk, and institutional demand will be subtracted away when we investigate the price difference between the exchange and interbank markets. Thus the price difference between the two markets should be mainly determined by the demand of retail investor and bond supply in the exchange market.

Recent studies in the credit markets of developed countries suggest that investors "reach for yield". In other words, investor demand is positively related to bond yield. The difficulty of testing such "yield chasing" behavior lies in the fact that it is usually hard to separate fundamental effects from the yield-chasing effects in determining bond prices. Our setup, however, can solve this problem. We formally develop the hypothesis to test the "yield-chasing" behavior of retail investors in the exchange market as follows.

Hypothesis 1a. All else being equal, if retail investors reach for yield, the price difference between the two markets should increase with the yield of the bond.

Since bond supply is limited (determined at issuance and imperfectly correlated with total demand at issue), all else being equal, bonds with low supply should have higher equilibrium prices in the exchange market as stated in the next hypothesis.

Hypothesis 1b. All else being equal, the price difference between the two markets should decrease with the supply of the bond.

The total demand of a bond in the exchange market not only depends on bond yield but also relates to the demand intensity of retail investors. 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.

Hypothesis 1c. All else being equal, the price difference between the two markets should increase with the demand intensity of retail investors.

As discussed by Vayanos and Vila (2009), when arbitrageurs with moderate risk aversion are present in the market, arbitrage can happen across bonds and maturities. In this case, the demand (supply) shocks have two distinct effects: the local supply effect and the duration effect (Internet Appendix presents detailed discussions on the price difference between exchange and interbank markets in the presence of risk-averse arbitrageurs). The local supply effect is due to the arbitrage activities along the term structure and 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. The duration effect can be understood in the following sense. A demand (supply) shock to a bond with a high duration requires the arbitrageur 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 longer duration. We formalize these two effects in the following Hypotheses:

[10] There are two types of repo transactions in China. One is the so-called collateralized repo. Unlike the classical repos in the US, the ownership of the collateral does not transfer from the seller to the buyer during a collateralized repo transaction. The purpose of a collateralized repo is not to borrow or lend securities but to borrow and lend money. The other one is the so-called buyout repo, which is a US-style repo and requires the ownership of the collateral to be transferred from the seller to the buyer.

[11] 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.

Hypothesis 2a. All else being equal, 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 2b. The demand and supply effects should be stronger for bonds with longer 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. Short sale constraints in the exchange market and the duration effect help explain why risk-averse arbitrageurs in the exchange market cannot fully undo the demand effect of yield-chasing retail investors. However, they do not explain why institutional investors cannot arbitrage across markets.

If arbitrageurs 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 arbitrageurs. Arbitrageurs can only make a profit if they can trade a large amount quickly with small transaction costs and little price impact in both markets. If the arbitrageurs 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 can become a substantial limit to arbitrage and high valuation in the exchange market is hard to be arbitraged away when liquidity is low.

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 thus 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 limits-to-arbitrage explanation and the liquidity premium explanation generate opposite predictions on the relation between price differences and liquidity in the exchange market. In order to identify the effect of liquidity in the exchange market while controlling for the effect of liquidity in the interbank market, we define relative liquidity measures as liquidity in the exchange market scaled by liquidity in the interbank market. We distinguish the opposite predictions of the two alternative explanations in our Hypothesis 3.

Hypothesis 3. If the price difference is mainly driven by overvaluation in the exchange market and limits to arbitrage across markets, it should be higher when the relative liquidity in the exchange market is lower. If the price difference is mainly driven by liquidity premium, it should be higher when relative 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.

4. Data and bond prices across markets

4.1. 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.[12] 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 also 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 time, transaction price, bid and ask prices, trade size and trade direction (buy/sell identifier) for every trade. We also obtain limited access to intraday bond transaction data in the interbank market through WIND. WIND provides the time stamp and transaction price 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 of Chinese financial research data and their data have been widely used in published academic papers. The statistics about the overall Chinese bond market come directly from Chinabond, the official site of CCDC.

In Panel B of Table 1, we provide a preliminary comparison of the characteristics of enterprise bonds traded in the exchange and interbank markets using all daily trading observations with non-zero trading volume in the two markets. In this sample, we do not require that a bond has non-zero trading volume in both the exchange market and the interbank market on the same day, which means that the differences in bond characteristics can be driven by differences in bond fundamentals. The sample in the exchange market covers 849 bonds with 125,754 daily trading observations. The sample in the interbank market includes 991 bonds with 72,005 daily trading observations. All bonds are issued with the par value of 100 yuan. We calculate average monthly trading days/volume per

[12] 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).

bond by first summing up monthly trading days/volume for each bond and then take the average of all monthly observations. 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 smaller. We calculate average yield as the mean value of yield to maturity measured at the end of every trading day for all daily trading observations. Similarly, we calculate average price, coupon rate, and year to maturity by taking the mean value for all daily trading observations. The average yield is lower and the average price is higher in the exchange market than in the interbank market. All else being equal, lower yield in the exchange market can be due to higher bond prices in the exchange market or due to lower coupon rate of the bonds traded in the exchange market. We do observe that average bond price is higher in the exchange market than in the interbank market. We also observe that the average coupon rate is slightly lower in the exchange market, which partially contributes to the lower yield in the exchange market. 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. Panel A in Table 2 provides the descriptive 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. The 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.

We construct three liquidity measures from intraday trading data in the exchange market, including the bid–ask spread ($SPREAD\_EX$), daily Amihud illiquidity measure ($AMIHUD\_EX$), and daily number of trades ($NTRADE\_EX$). The average $SPREAD\_EX$, $AMIHUD\_EX$, and $NTRADE\_EX$ are 0.847 *yuan*, 1.195×10^{-5} $yuan^{-1}$ and 20.069, respectively. Since we do not have full information of intraday trading data for the interbank market, we construct two liquidity measures from daily trading data in the interbank market, including the monthly Amihud illiquidity measure ($AMIHUD\_IB$) and the monthly number of non-zero trading days ($NTRADE\_IB$). The average $AMIHUD\_IB$ and $NTRADE\_IB$ are 0.017×10^{-8} $yuan^{-1}$ and 8.268, respectively. In order to identify the unique effect of liquidity in the exchange market while controlling for the effect of liquidity in the interbank market, we also defined three relative liquidity measures by scaling liquidity in the exchange market by liquidity in the interbank market. The first relative liquidity measure, $RelativeLiq1$, is defined as the inverse of $\frac{SPREAD\_EX}{AMIHUD\_IB}$. Since data on bid–ask spreads in the interbank market is not available, we use the Amihud illiquidity measure in the interbank market as the denominator. The second relative liquidity measure, $RelativeLiq2$, is defined as the inverse of $\frac{AMIHUD\_EX}{AMIHUD\_IB}$. The third relative liquidity measure, $RelativeLiq3$, is defined as $\frac{NTRADE\_EX}{NTRADE\_IB}$.

Panel B in Table 2 reports the differences in several major bond characteristics between the exchange and interbank markets. The average price difference between the exchange and interbank markets is 0.824 with a *t*-statistic of 7.41. The difference in yield to maturity is −0.184 with a *t*-statistic of −7.54. The average bond duration is 0.013 higher in the exchange market than that in the interbank market with a *t*-statistic f 7.18. The difference in (the natural logarithm of) daily turnover and price amplitude between the exchange and interbank markets are −5.682 (*t*-statistic = −50.40) and 0.198 (*t*-statistic = 9.49), respectively. The difference in the trade size between the exchange and interbank markets is −97.987 with a *t*-statistic of −18.72, which 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.

4.2. 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.[13] 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 0.278 yuan in 2009 and reaches 1.193 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 (12 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

[13] 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-sales of Treasury bonds in the exchange market can be done through buyout repos.

Table 2
Summary statistics. This table (Panel A) 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 and interbank markets ($DPRICE^{EX-IB}$, in Chinese yuan), 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 natural logarithm of) total bond outstanding ($(ln)ISSUE$, in million yuan), term year ($TERMYEAR$), year-to-maturity ($YEARTOMATU$), year-to-issuance ($YEARTOISS$), turnover in the exchange market ($TURNOVER\_EX$, in million yuan), turnover in the interbank market ($TURNOVER\_IB$, in million yuan), modified duration in the exchange market ($DURATION\_EX$) and interbank market ($DURATION\_IB$), daily price amplitude in the exchange market ($HLPRICE\_EX$) and interbank market ($HLPRICE\_IB$), (the natural logarithm of) total bond outstanding of a bond's close substitutes ($(ln)ISSUE\_CLOSE$, in million yuan), (the natural logarithm of) total bond outstanding of a bond's far substitutes ($(ln)ISSUE\_FAR$, in million yuan), monthly Amihud illiquidity measure in the interbank market ($AMIHUD\_IB$), number of non-zero trading days within a month in the interbank market ($NTRADE\_IB$), daily Amihud illiquidity measure in the exchange market ($AMIHUD\_EX$), number of trades within a day in the exchange market ($NTRADE\_EX$), bid–ask spread in the exchange market ($SPREAD$), trade size in the exchange market ($TRADESIZE\_EX$, in million yuan) and the interbank market ($TRADESIZE\_IB$, in million yuan). Panel B reports the difference of several bond characteristics between the exchange and interbank markets and their corresponding t-statistics calculated from standard errors clustered at both the bond and time levels following Thompson (2011). See Appendix A for the detailed definition of variables. The sample period is from January 2009 to December 2013. Intraday data in the interbank market are only available from January 2010 to December 2013.

Panel A. Descriptive statistics

VAR	N	MEAN	STD	MIN	P25	MEDIAN	P75	MAX
$DPRICE^{EX-IB}$	15,751	0.824	2.515	−16.084	−0.379	0.803	2.133	27.671
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_EX	15,750	4.593	1.224	0.026	4.016	4.625	5.093	11.736
DURATION_IB	15,751	4.581	1.222	0.027	4.007	4.616	5.073	11.807
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 (in millions)	15,747	11.776	1.035	7.645	11.268	11.863	12.522	13.541
(ln)ISSUE_FAR (in 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_EX	14,558	0.847	1.259	0.001	0.129	0.355	0.957	6.880
TRADESIZE_EX (in millions)	15,743	0.640	2.673	0.001	0.011	0.037	0.163	35.482
TRADESIZE_IB (in millions)	14,010	98.627	97.342	5.000	35.000	60.000	120.000	500.000

Panel B. Difference between the exchange and interbank markets

	MEAN_EX	MEAN_IB	Diff(EX-IB)	t(EX-IB)
CPRICE	101.596	100.771	0.824	7.41
YTM	6.390	6.573	−0.184	−7.54
DURATION	4.593	4.581	0.013	7.18
(ln)TURNOVER	−8.273	−2.591	−5.682	−50.40
HLPRICE	0.517	0.319	0.198	9.49
TRADESIZE (in millions)	0.640	98.627	−97.987	−18.72

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 5.3.

5. Mechanisms

Given the significant price difference between the exchange and interbank markets, we aim 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 on the yield-chasing behavior of retail investors in the exchange market. We then identify the demand effects of retail investors on bond prices and investigate limits to arbitrage in the bond markets. Finally, we explore alternative explanations and discuss their implications.

Table 3
Average price difference between the exchange and the interbank market. This table reports the mean, standard deviation, minimum, median, and maximum of the price difference between the exchange and interbank bond markets 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}). The *t*-statistics of average price difference are reported based on standard errors clustered at both the bond and time levels following Thompson (2011).

Panel A. Price difference by year							
Year	N	MEAN	t(MEAN)	STD	MIN	MEDIAN	MAX
2009	1727	0.278	0.84	3.781	−14.140	0.042	27.671
2010	2877	0.496	1.93	2.277	−9.871	0.470	17.944
2011	2667	0.811	3.69	2.990	−16.084	1.026	18.782
2012	4205	0.906	6.99	2.055	−10.071	0.825	10.366
2013	4275	1.193	10.02	1.995	−11.420	1.067	14.522
Panel B. Price difference by quarter							
Quarter	N	MEAN	t(MEAN)	STD	MIN	MEDIAN	MAX
2009Q1	285	3.110	6.23	4.090	−5.292	2.392	23.280
2009Q2	475	1.512	3.75	3.477	−12.029	1.020	27.671
2009Q3	569	−1.285	−3.36	3.210	−14.140	−0.918	26.742
2009Q4	398	−0.988	−2.23	2.887	−11.162	−0.933	8.582
2010Q1	621	0.053	0.16	2.233	−9.871	0.222	5.690
2010Q2	683	0.397	1.46	2.047	−5.765	0.490	8.116
2010Q3	814	0.503	1.68	2.325	−7.550	0.341	17.944
2010Q4	759	0.938	3.26	2.378	−6.550	0.765	10.600
2011Q1	611	1.730	7.29	1.990	−5.771	1.511	8.800
2011Q2	779	2.614	9.73	2.028	−7.334	2.255	18.782
2011Q3	627	−0.169	−0.58	2.810	−16.084	−0.152	7.409
2011Q4	650	−1.268	−3.62	3.239	−14.667	−0.950	12.628
2012Q1	754	0.158	0.40	2.808	−10.071	0.370	10.230
2012Q2	1185	1.236	8.72	2.025	−6.418	0.828	10.366
2012Q3	899	0.633	4.04	1.884	−8.100	0.471	8.790
2012Q4	1367	1.213	9.64	1.490	−5.634	1.133	8.761
2013Q1	1759	1.441	11.70	1.672	−5.580	1.300	14.522
2013Q2	1297	1.560	13.21	1.732	−7.480	1.355	11.190
2013Q3	600	0.590	3.27	1.973	−11.420	0.555	6.540
2013Q4	619	0.306	1.02	2.812	−11.149	0.285	10.028

5.1. Demand and supply effects in the cross section

5.1.1. 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 higher yield to maturity. We perform the following regressions:

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

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, which can be viewed as a measure of daily bond price volatility. Definitions of all variables are detailed in Appendix A. Standard errors are clustered at both the bond and time levels following Thompson (2011).

We report the above regression analysis in Panel A of Table 4. The coefficient on yield to maturity is significantly positive when the dependent variable is turnover in the exchange market, suggesting a positive relation between exchange trading activities and bond yield. The coefficient is close to 0.4, meaning that a one-standard-deviation increase in yield (which is ~1) will increase turnover in the exchange market by ~50% ($e^{0.4\times 1} - 1 = 0.5$). In contrast, the coefficient on yield is insignificant or negative when the dependent variable is turnover in the interbank market.

Bond 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. 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 returns into the regression of bond turnover in the exchange market. If retail investors chase short-term returns, they should trade more when past returns are high and the effect of yield to maturity should be significantly weakened after controlling for short-term returns. Our results suggest the opposite and are reported in the Internet Appendix. The coefficient on past one-month returns is negative, suggesting that investors in fact trade less when bonds experience higher 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

Table 4
Trading activities and yield to maturity in the two markets. This table reports results of regressions that relate trading activities of retail investors to bond yield to maturity. Panel A reports the results from the following regression of turnover on yield to maturity:

$$TURNOVER_{i,t} = a_0 + a_1 YTM_{i,t} + \mathbf{b}\mathbf{z}_{i,t} + \varepsilon_{i,t},$$

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 $\mathbf{z}_{i,t}$ 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. Based on transaction data with buy/sell identifiers in the exchange market, we further use trading volume arising from small trades to investigate the relation between retail investor trading behavior and bond yield. Panel B reports the results from the following regressions:

$$TradeSize_{i,t} = a_0 + a_1 YTM_{i,t} + \mathbf{b}\mathbf{z}_{i,t} + \varepsilon_{i,t},$$
$$RetailTrade_{i,t} = a_0 + a_1 YTM_{i,t} + \mathbf{b}\mathbf{z}_{i,t} + \varepsilon_{i,t},$$
$$\Delta RetailOIB_{i,(t,t+1)} = a_0 + a_1 YTM_{i,t} + \mathbf{b}\mathbf{z}_{i,t} + \varepsilon_{i,t},$$

where $TradeSize_{i,t}$ is daily average trade size, which is defined as the daily trading volume divided by daily number of trades in the exchange market. $RetailTrade_{i,t}$ is the fraction of retail trading volume, which is defined as the retail trading volume divided by total trading volume in the exchange market. A trade is classified as a retail trade if its transaction value is below 100,000 yuan. $\Delta RetailOIB_{i,(t,t+1)}$ represents future change in retail order imbalance. Retail order imbalance is defined as (buy-initiated retail trading volume - sell-initiated retail trading volume)/ the sum of buy-initiated and sell-initiated retail trading volume in the exchange market. Retail order imbalance measures the demand pressure of retail investors. In all regressions reported in Panel B, we control for contemporaneous daily bond returns (RET). The corresponding t-statistics calculated from standard errors clustered at both the bond and time levels following Thompson (2011) are reported in parentheses.

Panel A. Turnover and yield to maturity

	Turnover in exchange			Turnover in interbank		
YTM_EX	0.403	0.284	0.773			
	(5.75)	(3.83)	(5.35)			
YTM_IB				−0.015	−0.121	−0.085
				(−0.38)	(−3.35)	(−1.79)
(ln)ISSUE		−0.854	−0.692		−0.736	−0.780
		(−3.96)	(−3.31)		(−7.08)	(−7.66)
(ln)TURNOVER_EX					−0.023	−0.021
					(−3.34)	(−3.22)
(ln)TURNOVER_IB		−0.176	−0.165			
		(−3.37)	(−3.19)			
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
		(−0.92)	(1.46)		(−1.49)	(−0.31)
HLPRICE_EX		−0.044	0.064		0.015	0.010
		(−1.49)	(1.89)		(1.17)	(0.89)
HLPRICE_IB		0.119	0.050		0.364	0.367
		(3.04)	(1.28)		(16.46)	(17.38)
Intercept	−10.846	−4.482		−2.495	3.310	
	(−24.64)	(−2.66)		(−9.55)	(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

Panel B. Retail trading and yield to maturity

	$TradeSize$	$RetailTrade$	$\Delta RetailOIB$
YTM_EX	−0.793	0.159	0.033
	(−10.32)	(13.68)	(3.83)
(ln)ISSUE	0.835	−0.124	0.019
	(6.54)	(−5.95)	(2.12)
(ln)TURNOVER_EX	0.313	−0.071	−0.003
	(16.69)	(−38.87)	(−1.18)
YEARTOMATU	−0.002	0.005	−0.002
	(−0.07)	(0.84)	(−0.86)
YEARTOISS	−0.357	0.061	0.010
	(−7.17)	(7.43)	(2.05)
HLPRICE_EX	−0.189	0.041	0.032
	(−10.19)	(16.04)	(3.45)
RET	−0.113	0.009	−0.099
	(−4.09)	(3.84)	(−7.75)
Adjusted R-Squared	0.172	0.505	0.016
Observations	15,494	15,494	14,911
Daily Fixed Effect	Yes	Yes	Yes

cannot provide a clean identification of the buyers. 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 offerings (IPO). Eligible investors refer to institutional investors and large investors with financial assets worth more than three million yuan. Therefore, right after the IPO, most trading activities in the exchange market should happen when retail investors buy from institutional or large investors. In this case, large trading volume in the exchange market is more likely to reflect large demand of retail investors. We perform the regression of turnover in the exchange market for the subsample of IPO bonds with credit rating below AAA and for the subsample of non-IPO bonds/IPO bonds with credit rating equal or above AAA, respectively. The results are reported in Internet Appendix. We find that the coefficient on yield to maturity is significant for both subsamples but the magnitude is larger for the subsample of IPO bonds with credit rating below AAA. While our results do not provide direct evidence on a causal relation between retail investor demand and bond turnover, they at least suggest that the positive relation between bond turnover and yield to maturity is stronger when retail investors buy from institutional or large investors most of the time.

In order to better distinguish retail investor demand from institutional investor demand, we further utilize transaction data with buy/sell identifiers in the exchange market. Following previous literature (for example, Hvidkjaer (2006) and Hvidkjaer (2008)), We use trading volume arising from small trades to investigate the relation between retail investor trading behavior and bond yield. We perform the following three regressions:

$$TradeSize_{i,t} = a_0 + a_1 YTM_{i,t} + \boldsymbol{b}\boldsymbol{z}_{\boldsymbol{i},\boldsymbol{t}} + \varepsilon_{i,t}, \tag{2}$$

$$RetailTrade_{i,t} = a_0 + a_1 YTM_{i,t} + \boldsymbol{b}\boldsymbol{z}_{\boldsymbol{i},\boldsymbol{t}} + \varepsilon_{i,t}, \tag{3}$$

$$\Delta RetailOIB_{i,(t,t+1)} = a_0 + a_1 YTM_{i,t} + \boldsymbol{b}\boldsymbol{z}_{\boldsymbol{i},\boldsymbol{t}} + \varepsilon_{i,t}, \tag{4}$$

where $TradeSize_{i,t}$ is daily average trade size, which is defined as the daily trading volume divided by daily number of trades in the exchange market.[14] $RetailTrade_{i,t}$ is the fraction of retail trading volume, which is defined as the retail trading volume divided by total trading volume in the exchange market. A trade is classified as a retail trade if its transaction value is below 100,000 yuan. Our results remain qualitatively similar if we vary the cutoff point from 50,000 to 500,000 yuan. $\Delta RetailOIB_{i,(t,t+1)}$ represents future change in retail order imbalance.[15] Retail order imbalance is defined as (buy-initiated retail trading volume - sell-initiated retail trading volume)/ the sum of buy-initiated and sell-initiated retail trading volume in the exchange market. Retail order imbalance measures the demand pressure of retail investors. In all regressions, we control for contemporaneous daily bond returns.

The results are reported in Panel B of Table 4. The coefficient on yield to maturity is significantly negative in the regression of $TradeSize$, suggesting that higher yield is associated with smaller trade size. The coefficient on yield to maturity is significantly positive in the regression of $RetailTrade$, suggesting that higher yield is associated with larger fraction of retail trading volume. Both regressions suggest that retail investors prefer high yield bonds and trade more on them. In all the above analysis, trading activities are non-directional. Thus we construct $\Delta RetailOIB$ to capture the change in demand pressure from retail investors. The coefficient on yield to maturity is significantly positive in the regression of $\Delta RetailOIB$, suggesting that higher yield is associated with higher retail order imbalance in the future. This result more directly supports the hypothesis that high yield bonds experience high demand from retail investors.

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 strong preference for high-yield bonds.[16] Furthermore, using transaction data with buy/sell identifiers in the exchange market, we find that higher yields are associated with smaller trade size, larger fraction of retail trading volume, and larger increase in future retail order imbalance.

Why do retail investors chase yield? Unlike certain institutional investors, retail investors do not face agency problems. Instead, they could face severe portfolio constraints, such as leverage constraints. Retail investors have very limited access to leverage in China. Only large investors with more than 500,000 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.

5.1.2. 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. We use total bond issuance as a measure of bond supply, which is determined by the government rather than driven by the market.[17] 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 the demand of retail investors is high. However, 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.

We use two measures to proxy for retail investor demand exposure. The first measure is whether the bond is issued by companies located in Shanghai city. 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

[14] If high yield bonds tend to have small amount of bond outstanding, the relation between trade size and yield to maturity may be driven by the differences in bond outstanding. In order to check the robustness of our results, we scale trade size by the amount of bond outstanding and the results remain qualitatively similar.

[15] We use future change in order imbalance instead of contemporaneous order imbalance as the dependent variable to avoid any mechanical relation between order imbalance and concurrent bond price (and thus yield) movements.

[16] 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.

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

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, which is measured as the closing price in the exchange market minus the closing price in the interbank market, in subsamples split by yield to maturity, total bond outstanding, Shanghai dummy (DUM_SH, a dummy variable that equals 1 if the issuing firm is located in Shanghai and zero otherwise), and Shanghai exchange dummy (DUM_SHEX, 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. The corresponding t-statistics calculated from standard errors clustered at both the bond and time levels following Thompson (2011) are reported in parentheses.

Panel A. Yield to maturity					
	N	MEAN (ew)	t-stat	MEAN (vw)	t-stat
Low	5200	0.327	2.65	0.214	1.39
Medium	5356	0.892	6.19	0.748	4.27
High	5195	1.251	6.53	1.094	5.17
(High–Low)		0.924	4.16	0.880	3.42
Panel B. Issue					
	N	MEAN (ew)	t-stat	MEAN (vw)	t-stat
Low	6801	1.205	8.51	1.194	8.37
Medium	4728	0.831	5.08	0.820	5.02
High	4222	0.203	0.85	0.157	0.68
(High–Low)		−1.002	−3.67	−1.038	−3.89
Panel C. DUM_SH					
	N	MEAN (ew)	t-stat	MEAN (vw)	t-stat
0	15,631	0.813	7.29	0.625	4.86
1	120	2.227	3.11	2.867	3.18
(1-0)		1.414	2.38	2.242	2.76
Panel D. DUM_SHEX					
	N	MEAN (ew)	t-stat	MEAN (vw)	t-stat
0	3016	0.490	2.80	0.233	1.85
1	12,735	0.903	7.63	0.741	5.35
(1-0)		0.414	2.43	0.508	2.68

Shanghai Stock Exchange, Shanghai is the city with the highest number of retail 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 whether the bond is listed on the Shanghai Stock Exchange. In terms of total market value, the Shanghai Stock Exchange is six times larger than the Shenzhen Stock Exchange. Retail investors with a personal stock account can trade securities listed on both exchanges. However, they are likely to pay more attention to bonds listed on the Shanghai Stock Exchange due to its large size and strong influence as reflected in its more efficient information dissemination and broader 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 yield to maturity every year.[18] We calculate both the equal-weighted and value-weighted (weighted by the total bond outstanding) price differences between the exchange and interbank markets. It is evident that the price difference is significantly higher for bonds with higher yield to maturity. The equal-weighted (value-weighted) price difference is only 0.327 (0.214) yuan for the low yield subsample, but increases to 1.251 (1.094) yuan for the high yield sample. The difference in the equal-weighted (value-weighted) price difference between the high and low yield subsamples is 0.924 (0.880) yuan, which is statistically significant at the 1% level. This result is consistent our Hypothesis 1a, which suggests that all else being equal, the price difference between the exchange and interbank markets should be higher for bonds with high yield to maturity because retail investors chase yield and therefore have higher demand for high yield bonds.

Panel B presents the average price difference in subsamples split by bond supply (measured 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. The results support our Hypothesis 1b, which suggests that all else being equal, the price difference should be higher for bonds with less supply.

Panels C and D test Hypothesis 1c. Panel C reports the price difference 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 5%(1%) level. Panel D presents the price difference of bonds listed on Shanghai or Shenzhen Stock Exchange. 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 5%(1%) level.

[18] Yield to maturity is calculated from the average bond price in the exchange and interbank markets.

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

$$DPRICE_{i,t}^{EX-IB} = a_0 + a_1 YTM_i + a_2(ln)ISSUE_i + a_3 DUM\_SH_i + a_4 DUM\_SHEX_i + \boldsymbol{b}\boldsymbol{z}_{i,t} + \varepsilon_{i,t}. \quad (5)$$

where $DPRICE_{i,t}^{EX-IB}$ 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}).[19] YTM_i is the yield to maturity 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 one if the firm issuing bond i is located in Shanghai and zero otherwise. DUM_SHEX_i is a dummy variable, which equals one if bond i is listed on the Shanghai Stock Exchange and zero if listed on the Shenzhen Stock Exchange. $\boldsymbol{z}_{i,t}$ is a vector of control variables, including coupon rate, year-to-maturity, year-to-issuance, price amplitude in each market, and dummy variables for the credit rating AA+ ($RATING\_AAP$) and AA ($RATING\_AA$).[20] and a dummy variable for the UC bond (UC), which equals one if the bond is a UC bond and zero otherwise.

The regression results are reported in Table 6. After controlling for various bond characteristics and time fixed effects, the regression coefficient on the yield to maturity remains significantly positive. In column 5, the coefficient on YTM is 1.030, suggesting that one percentage point increase in yield to maturity leads to a 1.030 yuan increase in the price difference between the two markets, which is both statistically and economically significant. The coefficient on bond supply is significantly negative and equals −0.242, which means a one-standard-deviation (0.42) increase in total bond outstanding can generate a 0.10 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 2.644 yuan higher than that of any other bonds. The average price difference of bonds listed on the Shanghai Stock Exchange is 0.542 yuan higher than that of bonds listed on the Shenzhen Stock Exchange.

In all regressions, we control for a number of bond characteristics. The coefficient on coupon rate is positive in most specifications, but its magnitude and significance drops substantially when yield to maturity is included in the regression. One potential explanation for the positive coefficient on coupon rate might be that some investors illusionally think that high coupon rate represents high yield on the bond although this effect is weakened when bond yield is taken into account. Year-to-maturity bears a positive coefficient but the magnitude is relatively small. 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 after controlling for time fixed effects, 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. Price amplitude in the exchange market has a significant positive coefficient, suggesting that a high price in the exchange market is associated with a high price volatility. Taken together, after controlling for various additional variables, the demand and supply effects remain robust.

5.1.3. 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 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 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 arbitrageurs face.

Table 7 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 exchange and interbank markets. In column 1, we include the supply and demand factors of the bond itself and the supply of its close 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 −0.472, suggesting that a one-standard-deviation (1.035) increase in the supply of a bond's close substitutes leads to a 0.489 decrease in the price difference of the bond between the two markets. In column 2, we further include the supply of a bond's far substitutes. As expected, the coefficient on the supply of far substitutes is insignificant, suggesting that only close substitutes but not far substitutes have significant impact on a bond's own price. In column 3, We include additional explanatory variables and the results remain qualitatively the same.

5.1.4. Duration risk and limits to arbitrage

As stated in Hypothesis 2b, demand and supply factors should have stronger effects on bonds with longer duration because arbitrageurs need to bear more duration risk in their portfolios due to demand shocks to those bonds. We include the interaction term between demand and supply factors (including yield to maturity, bond supply, Shanghai dummy, Shanghai exchange dummy,

[19] The results remain qualitatively similar when we define $DPRICE_{i,t}^{EX-IB}$ as the natural logarithm of the ratio P^{ex}/P^{ib}.

[20] Enterprise bonds only have three major types of credit ratings, AAA, AA+, and AA. There are only a few ratings below AA, which are combined into $RATING\_AA$.

Table 6
Regression analysis of the price difference between the exchange and interbank markets. This table reports the results from the following regression:

$$DPRICE^{EX-IB}_{i,t} = a_0 + a_1 YTM_i + a_2 (ln) ISSUE_i + a_3 DUM\_SH_i + a_4 DUM\_SHEX_i + \boldsymbol{b z}_{i,t} + \varepsilon_{i,t},$$

where $DPRICE^{EX-IB}_{i,t}$ is the price difference between the exchange and interbank markets for bond i on day t; YTM_i is the yield to maturity 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, including coupon rate, year-to-maturity, year-to-issuance, daily price amplitude in each market, credit rating dummies, and an urban construction investment bond dummy (UC). See Appendix A for the detailed definition of variables. The corresponding t-statistics calculated from standard errors clustered at both the bond and time levels following Thompson (2011) are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)
YTM	1.018				1.030
	(3.25)				(3.13)
(ln)ISSUE		−0.487			−0.242
		(−3.40)			(−2.10)
Dum_SH			2.692		2.644
			(3.44)		(3.40)
Dum_SHEX				0.509	0.542
				(2.93)	(3.17)
COUPON	0.316	0.798	0.868	0.858	0.340
	(1.72)	(7.31)	(7.84)	(7.89)	(1.92)
YEARTOMATU	−0.118	−0.006	−0.027	−0.024	−0.107
	(−1.94)	(−0.12)	(−0.56)	(−0.50)	(−1.90)
YEARTOISS	0.148	0.079	0.048	0.141	0.257
	(1.65)	(0.98)	(0.57)	(1.75)	(3.21)
HLPRICE_EX	0.164	0.139	0.138	0.131	0.160
	(5.04)	(4.54)	(4.53)	(4.32)	(5.00)
HLPRICE_IB	−0.047	−0.034	−0.042	−0.047	−0.039
	(−1.07)	(−0.72)	(−0.88)	(−0.98)	(−0.87)
RATING_AAP	−0.270	−0.258	−0.076	0.041	−0.028
	(−0.64)	(−0.71)	(−0.21)	(0.11)	(−0.07)
RATING_AA	−0.662	−0.625	−0.395	−0.281	−0.474
	(−1.55)	(−1.73)	(−1.09)	(−0.76)	(−1.15)
Dum_UC	−0.229	−0.144	−0.122	−0.165	−0.234
	(−0.84)	(−0.58)	(−0.50)	(−0.70)	(−0.91)
Adjusted R-Squared	0.314	0.295	0.298	0.295	0.329
Observations	15,503	15,503	15,503	15,503	15,503
Daily fixed effect	Yes	Yes	Yes	Yes	Yes

and the supply of close substitutes) with bond duration in the regression of the price difference to test this hypothesis. The results are reported in Table 8. 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 those used in the previous regressions, including coupon rate, trading volume, year-to-maturity, year-to-issuance, daily price amplitude, credit rating dummies, and UC dummy.

In both specifications, the coefficient on the interaction term between yield to maturity and duration is significantly positive, suggesting that the effect of bond yield is stronger for longer duration bonds. The coefficient on the interaction term between bond own supply and duration is not quite significant but the coefficient on the interaction term between the supply of close substitutes and duration is significantly negative, suggesting that the local supply effect is stronger for longer 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 retail investor demand exposure on bond prices is stronger for longer duration bonds. In sum, as predicted by term structure models with preferred-habitat investors and risk-averse arbitrageurs, retail investor demand and bond supply have significant impacts on bond prices in the exchange market. The effects are stronger for bonds with longer duration due to the limited risk-sharing capacity of risk-averse arbitrageurs.

5.2. Arbitrage across markets and liquidity

Limits to arbitrage prevents the price difference between the exchange and interbank markets to be arbitraged away. Arbitrage within the exchange market faces short-sale constraints and risks such as duration risk and credit risk. Arbitrage across markets also faces several potential limits to arbitrage. As discussed earlier, liquidity is an important concern for arbitrage across markets. In this section, we explore how liquidity is related to price differences in the cross section and test the predictions from two alternative mechanisms, overvaluation with limits to arbitrage and liquidity premium, as stated in our Hypothesis 3.

We construct three liquidity measures from intraday trading data in the exchange market, including the bid–ask spread ($SPREAD\_EX$), daily Amihud illiquidity measure ($AMIHUD\_EX$), and daily number of trades ($NTRADE\_EX$). And we construct two liquidity measures from daily trading data in the interbank market, including the monthly Amihud illiquidity measure ($AMIHUD\_IB$) and the monthly number of non-zero trading days ($NTRADE\_IB$). Liquidity is high when the bid–ask spread is low, when the Amihud illiquidity measure is low, and when the number of trades (or non-zero trading days) is large.

Table 7
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 and interbank markets. The close substitutes of bond i are defined as the bonds that have coupon rates within 1% and maturity within two years of bond i. The far substitutes of bond i are defined as the bonds that have coupon rates within 1% but maturity within three to six years of bond i. The corresponding t-statistics calculated from standard errors clustered at both the bond and time levels following Thompson (2011) are reported in parentheses.

	(1)	(2)	(3)
YTM	0.821	0.816	1.207
	(5.62)	(4.17)	(3.69)
(ln)ISSUE	−0.281	−0.279	−0.244
	(−1.28)	(−1.32)	(−1.15)
Dum_SH	2.931	2.936	2.914
	(4.00)	(4.03)	(3.70)
Dum_SHEX	0.460	0.459	0.620
	(1.78)	(1.81)	(2.45)
(ln)ISSUE_CLOSE	−0.472	−0.472	−0.453
	(−4.81)	(−4.82)	(−3.66)
(ln)ISSUE_FAR		−0.005	0.073
		(−0.05)	(0.58)
COUPON			(0.06)
			(0.25)
YEARTOMATU			−0.163
			(−2.93)
YEARTOISS			0.108
			(1.31)
HLPRICE_EX			0.162
			(5.00)
HLPRICE_IB			−0.038
			(−0.84)
RATING_AAP			−0.197
			(−0.51)
RATING_AA			−0.624
			(−1.66)
Dum_UC			−0.286
			(−1.14)
Adjusted R-Squared	0.317	0.316	0.342
Observations	15,747	15,745	15,497
Daily Fixed Effect	Yes	Yes	Yes

As discussed earlier, overvaluation with limits-to-arbitrage and liquidity premium explanations have opposite predictions on the effect of bond liquidity in the exchange market but have the same prediction on the effect of bond liquidity in the interbank market. In order to identify the unique effect of liquidity in the exchange market while controlling for the effect of liquidity in the interbank market, we defined three relative liquidity measures by scaling liquidity in the exchange market by liquidity in the interbank market. $RelativeLiq1$ is defined as the inverse of $\frac{SPREAD\_EX}{AMIHUD\_IB}$, $RelativeLiq2$ is defined as the inverse of $\frac{AMIHUD\_EX}{AMIHUD\_IB}$, and $RelativeLiq3$ is defined as $\frac{NTRADE\_EX}{NTRADE\_IB}$. Higher relative liquidity measures mean higher liquidity in the exchange market relative to that in the interbank market.

Table 9 reports the regression of price difference on three relative liquidity measures. Columns 1–3 include each relative liquidity measure and various control variables in the regression. Column 4 includes all three relative liquidity measures in the regression. The results show that the coefficient is negative for all three relative liquidity measures, which is 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 the 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.

5.3. 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 enterprise bonds in China had ever defaulted before, two UC bond issuers were reported to face difficulty to repay their debt in June 2011. Such an 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 retail 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 shocks specifically on UC bonds.

Table 8
The duration effect. 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 and interbank markets. Modified duration measures the percentage change in bond price for a one-percentage change in bond yield. The corresponding t-statistics calculated from standard errors clustered at both the bond and time levels following Thompson (2011) are reported in parentheses.

	(1)	(2)
YTM	0.612	0.594
	(6.66)	(4.60)
(ln)ISSUE	−0.272	−0.198
	(−1.41)	(−0.97)
Dum_SH	0.362	0.289
	(0.63)	(0.49)
Dum_SHEX	−0.419	−0.113
	(−2.62)	(−0.67)
(ln)ISSUE_CLOSE	−0.141	−0.193
	(−2.12)	(−2.33)
*YTM*Duration*	0.085	0.142
	(3.75)	(5.97)
*(ln)ISSUE*Duration*	0.035	−0.011
	(0.79)	(−0.23)
*Dum_SH*Duration*	0.533	0.521
	(3.81)	(3.70)
*Dum_SHEX*Duration*	0.205	0.156
	(5.37)	(3.99)
*(ln)ISSUE_CLOSE*Duration*	−0.048	−0.021
	(−3.59)	(−2.32)
Duration	−0.549	−0.830
	(−1.22)	(−1.72)
Adjusted R-Squared	0.326	0.345
Observations	15,704	15,457
Controls	No	Yes
Daily Fixed Effect	Yes	Yes

Table 9
The effect of relative liquidity. This table reports the results from the regression of price difference on three relative liquidity measures. The dependent variable is the price difference between the exchange market and the interbank market. $RelativeLiq1$ is defined as the inverse of $\frac{SPREAD\_EX}{AMIHUD\_IB}$. $RelativeLiq2$ is defined as the inverse of $\frac{AMIHUD\_EX}{AMIHUD\_IB}$. $RelativeLiq3$ is defined as $\frac{NTRADE\_EX}{NTRADE\_IB}$. The corresponding t-statistics calculated from standard errors clustered at both the bond and time levels following Thompson (2011) are reported in parentheses.

	(1)	(2)	(3)	(4)
RelativeLiq1	−0.439			−0.076
	(−2.67)			(−0.55)
RelativeLiq2		−0.008		−0.008
		(−5.93)		(−6.32)
RelativeLiq3			−0.028	−0.028
			(−4.00)	(−4.64)
YTM	1.483	1.488	1.323	1.635
	(6.59)	(6.37)	(6.16)	(6.90)
(ln)ISSUE	−0.217	−0.246	−0.275	−0.268
	(−0.97)	(−1.07)	(−1.29)	(−1.16)
Dum_SH	3.139	3.046	2.951	3.051
	(3.68)	(3.65)	(3.92)	(3.75)
Dum_SHEX	0.604	0.623	0.544	0.545
	(2.42)	(2.41)	(2.27)	(2.25)
(ln)ISSUE_CLOSE	−0.453	−0.458	−0.478	−0.470
	(−4.45)	(−4.39)	(−4.87)	(−4.58)
Adjusted R-Squared	0.391	0.398	0.352	0.408
Observations	14,415	13,417	15,491	13,417
Controls	Yes	Yes	Yes	Yes
Daily Fixed Effect	Yes	Yes	Yes	Yes

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. We plot the average monthly price difference before and after the event for UC and non-UC bonds in Fig. 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.

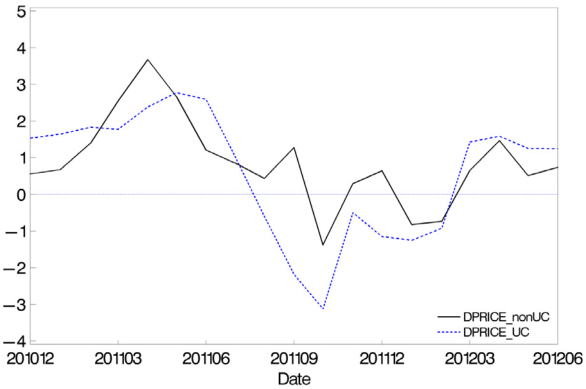

Fig. 1. Average price difference between the exchange and interbank markets before and after the urban construction bond crisis for UC and non-UC bonds. This figure plots the monthly average price difference between the exchange and interbank markets for UC and non-UC bonds during December 2010 and June 2012. The urban construction bond crisis broke out in June 2011.

Table 10
Event study: The urban construction bond crisis. This table reports the event study based on the urban construction investment bond crisis in June 2011. 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 A reports the results from the following regression of price difference between the exchange and interbank markets:

$$DPRICE_{i,t}^{EX-IB} = a_0 + a_1 Event_t + a_2 Event_t * UC_i + a_3 UC_i + \mathbf{b}\mathbf{z}_{i,t} + \varepsilon_{i,t},$$

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 $\mathbf{z}_{i,t}$ represents a number of relative liquidity measures for bond i at time t. Panel B reports the results from the following regression of retail order imbalance:

$$Retail\ OIB_{i,t} = a_0 + a_1 Event_t + a_2 Event_t * UC_i + a_3 UC_i + \mathbf{b}\mathbf{z}_{i,t} + \varepsilon_{i,t},$$

where $RetailOIB_{i,t}$ is defined as (buy-initiated retail trading volume - sell-initiated retail trading volume)/ the sum of buy-initiated and sell-initiated retail trading volume in the exchange market. The corresponding t-statistics calculated from standard errors clustered at both the bond and time levels following Thompson (2011) are reported in parentheses.

Panel A. Price difference								
Model	*Event*	*UC*	*Event*UC*	*RelativeLiq1*	*RelativeLiq2*	*RelativeLiq3*	*Adj.R*^{2}	*Obs.*
(1)	−1.800	0.039	−1.068				0.225	2,689
	(−3.21)	(0.04)	(−2.71)					
(2)	−2.228	0.019	−0.629	0.271	−0.005	−0.054	0.286	2,426
	(−3.59)	(0.02)	(−2.44)	(0.79)	(−1.57)	(−3.20)		
Panel B. Retail order imbalance								
Model	*Event*	*UC*	*Event*UC*	*RelativeLiq1*	*RelativeLiq2*	*RelativeLiq3*	*Adj.R*^{2}	*Obs.*
(1)	−0.055	−0.057	−0.126				0.002	2,689
	(−0.86)	(−0.56)	(−2.41)					
(2)	−0.064	−0.046	−0.119	−0.045	−0.003	−0.004	0.008	2,426
	(−1.20)	(−0.47)	(−2.51)	(−0.76)	(−2.94)	(−2.87)		

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 therefore control for the liquidity effect by performing the following regression:

$$DPRICE_{i,t}^{EX-IB} = a_0 + a_1 Event_t + a_2 Event_t * UC_i + a_3 UC_i + \mathbf{b}\mathbf{z}_{i,t} + \varepsilon_{i,t}. \quad (6)$$

where $Event_t$ is a dummy variable that equals zero for before-event days and one for after-event days, and $\mathbf{z}_{i,t}$ represents three relative liquidity measures for bond i at time t. The regression results are reported in Panel A of Table 10. The coefficient on the interaction term between $Event$ and UC is 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 relative liquidity measures. We perform placebo tests by assuming pseudo events on June 2012 and June 2013. The regression results are reported in the Internet Appendix. We do not observe any significant differences in the change of price differences between UC and non-UC bonds over the pseudo events.

In order to understand how the demand of retail investors change during the crisis, we further investigate the order imbalance of retail investors derived from transaction data with buy/sell identifiers in the following regression:

$$RetailOIB_{i,t} = a_0 + a_1 Event_t + a_2 Event_t * UC_i + a_3 UC_i + \mathbf{b}\mathbf{z}_{i,t} + \varepsilon_{i,t}. \quad (7)$$

The results are reported in Panel B of Table 10. It is evident that the coefficient on the interaction term between $Event$ and UC is significantly negative in all specifications, suggesting that order imbalance of retail investors decreases significantly more for UC bonds than for non-UC bonds after the crisis. The results provide evidence that the decrease in the demand of retail investors during the crisis can be an important factor that drives down the price difference between the exchange and interbank markets.

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 and interbank markets. The demand shock effect was stronger for UC bonds and generated a more significant decrease in the price difference for those bonds. The results remain qualitatively similar after controlling for changes in relative liquidity.

6. Additional tests and discussions on alternative explanations

6.1. 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.[21] Due 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 Internet Appendix. 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 min, assuring that there is no systematic difference in our matched sample. We replicate our main analysis in regression (5) for the time-stamp matched sample and report the results in the Internet Appendix. 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.

6.2. 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 (Chan et al., 2008). 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 (Blanchard and Watson, 1983). The capped upside payoff of bonds also excludes the explanation based on gambling motives and preference for positive skewness (Barberis and Huang, 2008). 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 (Allen and Gorton, 1993).

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; Harrison and Kreps, 1978; Chen et al., 2002; 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, are quiet – high prices but small trading volumes. 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 cross section suggest otherwise in the Chinese bond market. High yield bonds are not only associated with high prices but also high turnovers 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. Conclusion

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 the exchange and interbank markets simultaneously. 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 relative valuation, which helps 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 and demand high-yield bonds significantly more than low-yield bonds, consistent with the idea that retail investors chase yield. Furthermore, we show that the price difference increases with proxies for retail investor demand, such as yield to maturity 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.

[21] We choose to match the last transaction in the interbank market with the closest trade in the exchange 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 further evidence that the higher bond prices in the exchange market persist due to potential limited arbitrage. Arbitrage within the exchange market cannot fully eliminate the demand effect of yield-chasing retail investors due to both short-sale constraints and the limited risk-sharing capacity of risk-averse arbitrageurs 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 that risk-averse arbitrageurs need to take on and therefore the demand and supply effects are stronger for bonds with longer duration. Arbitrage across markets is limited due to slow transferring process and liquidity mismatch between the two markets. We show that bonds with higher relative liquidity in the exchange market have lower price differences, which is consistent with the limited arbitrage explanation but not 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 or asymmetric information. The distinct natures of bonds such as finite maturity and bounded upside payoffs 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 reach for yield, which can have significant consequences for the credit market. In addition, governments can 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

$\boldsymbol{DPRICE^{EX-IB}}$ The price difference of the same bond traded in the exchange and interbank markets, defined as the closing price in the exchange market (P^{ex}) minus the closing price in the interbank market (P^{ib}).

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:

$$PV_t = \frac{C}{(1+y)^{\frac{d}{365}}} + \frac{C}{(1+y)^{\frac{d}{365}+1}} + \cdots + \frac{C+F}{(1+y)^{\frac{d}{365}+n-1}}, \tag{8}$$

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.

YTM Yield to maturity (in %) calculated from the average closing price in the exchange and interbank markets.

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

(ln)ISSUE (The natural logarithm of) total bond 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).

(ln)TURNOVER_EX (The natural logarithm of) daily turnover rate in the exchange market, defined as daily trading volume in the exchange market divided by total bond outstanding.

(ln)TURNOVER_IB (The natural logarithm of) daily turnover rate in the interbank market, defined as daily trading volume in the interbank market divided by total bond outstanding.

DURATION_EX Modified duration of the bond in the exchange market, which measures the percentage change in bond price for a one-percentage change in bond yield, given by

$$Duration_t = \frac{\sum_{i=1}^{n} \frac{\tau_i CF_i}{(1+y)^{\tau_i+1}}}{\sum_{i=1}^{n} \frac{CF_i}{(1+y)^{\tau_i}}}, \tag{9}$$

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

DURATION_IB Modified duration of the bond in the interbank market.

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.

(ln)ISSUE_CLOSE (The 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.

(ln)ISSUE_FAR (The 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 two to six years of bond i.
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.

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

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.
NTRADE_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 following Eq. (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 non-zero trading days in month t.
NTRADE_IB Number of non-zero trading days within a month in the interbank market.
TRADESIZE_EX Daily trading volume (in millions) divided by the number of trades in the exchange market.
TRADESIZE_IB Daily trading volume (in millions) divided by the number of trades in the interbank market.
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 or below 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.
TradeSize Daily average trade size, which is defined as daily trading volume divided by daily number of trades in the exchange market.
RetailTrade The fraction of retail trading volume, which is defined as retail trading volume divided by total trading volume in the exchange market. A trade is classified as a retail trade if its transaction value is below 100,000 yuan.
RetailOIB Order imbalance of retail investors, which is defined as (buy-initiated retail trading volume - sell-initiated retail trading volume)/ the sum of buy-initiated and sell-initiated retail trading volume in the exchange market.

Appendix B. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jempfin.2018.12.001.

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