Not All Bonds Are Created Equal – as Benchmarks for Corporate Bonds*

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Abstract

We find among government and quasi-government bonds, municipal corporate bonds (MCB) act as regional benchmarks and improve the quality of the nascent but fast-growing corporate bond market in China by facilitating price discovery and expanding the investment opportunity sets. The MCBs' benchmark effects are more pronounced in corporate bonds with similar maturity, from the same region, in industries directly affected by government spending or traded in the exchange market. Furthermore, we find the supply of long-term MCBs, encourages local corporations to issue long-term bonds, indicating the possibility of complementarity between government and corporate bonds when bond market quality is poor.

Keywords: Municipal corporate bond; Spanning enhancement; Price discovery; Maturity impact.

1 Introduction

China's bond market has achieved remarkable growth over the past decade and ranks the second largest only to the US bond market. A series of market-opening programs have made the market more accessible and attractive to international investors. However, compared with developed bond markets, the bond market in China is still immature - segmented between trading platforms with extremely low default rates and unreliable domestic ratings. Moreover, there is a severe shortage of fixed income benchmark securities which makes it difficult to hedge and price corporate bond portfolios, impeding the improvement of the bond market quality. For example, Chinese treasury market is much smaller in size relative to the comparable US market. At the end of 2018, the outstanding amount of treasuries in China is about 16.19% of GDP while in the US it is 75.72%. Its ratio over non-financial corporate bonds is 70.89% in 2018, much lower than the 200% ratio in the US. Furthermore, the Chinese treasury market is illiquid and its maturity structure is incomplete and biased toward long-tern.

Though there is a shortage of benchmark securities for bond markets at the sovereign level,[1] there are a number of candidates for regional debt instrument benchmarks: municipal bonds (Munis) which has a larger market size than the treasury issued by the local government, quasi-government bonds such as enterprise bonds (issued by non-financial corporations and non-LGFVs, referred as EB in our paper) supporting national industry polices and municipal corporate bonds (MCB). Among all these, MCBs are most liquid and emerges as the leading regional debt instrument candidate for the benchmark function. MCBs are generally perceived as quasi-government debts. They are issued by local government financial vehicles (LGFVs), which are corporate bonds in a legal sense, but enjoy implicit guarantee from local and even central governments.[2] LGFVs are usually supported by local governments with land-use right and other kinds of capital injection. This is different from other credit instruments issued by non-financial firms, which are exposed to more firm-specific risks. Municipal corporate bonds (MCB), have experienced tremendous growth since 2008. By the end of year 2018, the outstanding amount of MCBs is RMB 7.84 trillion,

[1] Policy bank bonds issued by China Development Bank (CDB) are widely regarded as the sovereign benchmark instead of treasuries since they are large in size, with ranges of maturities.

[2] MCBs are similar to the private activity bonds or conduit bonds in the US which is also known as corporate munis. The difference is that private activity bonds are unlikely to be subject to state intervention policies. (See for Gao, Lee, and Murphy (2019) detailed descriptions.)

accounting for 37.33% of all debt securities issued by non-financial corporations in China.

Benchmark debt instruments play a special role in immature bond markets. According to Yuan (2005) and Dittmar and Yuan (2008), the addition of benchmark securities benefit the developing bond market by allowing investors to hedge against systematic risk, thus completing an incomplete market; and hedge against adverse selection cost, thus encouraging investors to obtain more firm-specific information and promoting price discovery. In the context of bond market in China, MCBs capture the systematic risk at regional level and are sensitive to regional solvency risk due to their close relation with governments (Ang, Bai, and Zhou (2019)). Therefore, in this paper, we investigate the benchmark impact of MCBs on the corporate bond market. [3]

Specifically, we explore the role of MCBs from three aspects as of price discovery, spanning enhancement and maturity impact, all three of which are related to the corporate bond market quality. First, MCBs contribute to the process of price discovery. Estimating the information share model in Hasbrouck (1995; 2003), we find that 5%-17% of the spread variations of regular corporate bond (issued by non-financial corporations and non-LGFVs, referred as RCB in our paper) can be explained by MCBs, suggesting the information flowing from MCBs to existing corporate bond securities. For comparison, we also examine the price discovery impact of two other government-related bonds, Munis and EBs. The information share in RCB attributable to EBs or Munis is less than 2%, much lower than that of MCBs. The results show that MCBs play a unique role in facilitating the price discovery. Notably, the explanatory power of MCB is more prominent in cities with high fiscal surplus or GDP per capita, implying that higher degree of government guarantee enhances the benchmark ability of MCB.

We also utilize a few special features about the bond market and MCBs to examine the channels of price discovery. Bonds are traded either on interbank market where large institutional investors are major participants and the trading frequency is low, or exchange market where both institutional and retail investors involve and the trading frequency is relatively high. We find that MCBs traded on the exchange market deliver stronger price discovery impact, as active trading in the exchange market promotes the transmission of information among bonds. We also find that information

[3]The former director of finance department of the National Development and Reform Commission has evaluated the role of municipal corporate bonds, "On the one hand, municipal corporate bonds serve as standardized and transparent financing channels for infrastructure construction, one the other hand, they enrich the fixed-income products for institutional investors." Source: `https://www.ndrc.gov.cn/xxgk/jd/jd/201108/t20110829_1183127.html`

flows along the maturity. MCBs contribute most to explain the spread variations of RCBs with similar maturity. The average information share in short-term RCBs maturing in less than one year attributable to short-term MCBs is largest, up to 21.5%.

We also investigate the different ways in which that MCBs, EBs and Munis promote price discovery. The analyses at regional or industry level show that MCBs stimulate price discovery for RCBs from the same region and for industries that are closely aligned with the purpose of LGFVs – that is, industries related with infrastructure construction or public utility. In particular, the information share attributable to MCBs is the highest in the areas of East and Southwest China, in industries such as Supply and Distribution of Electricity, Heat and Gas as well as Transportation. We find that EBs, which is oriented towards industry development, exert influence mostly at the industry level. The average information share from EBs in most industries is higher than its full sample value. Finally, we find that although largest in size, the price discovery impact of Munis is limited at regional level, which might be due to the low pricing efficiency and low liquidity of muni instruments.

Second, from the perspective of investors, we examine whether bond investors can benefit from the introduction of MCBs. Six spanning tests show that the MCB portfolio enriches the investment opportunity sets relative to existing bond securities. Such spanning enhancement is significant in all kinds of portfolio combinations. We also conduct the spanning analysis at the regional and industry level. We find that higher maximum Sharpe ratios can be achieved by including MCBs in the portfolios for investors who trade in the exchange market (as opposed to interbank market), with a long-term corporate bond portfolio, or with a portfolio focusing on certain region (eg., South, Middle, Northeast, and Southwest regions) or industries related to infrastructure.

Third, we find a complementary impact, rather than crowding out effect, in terms of bond maturity. Long-term MCBs maturing in no less than five years promote the issue of long-term RCBs in the same city by providing relevant pricing information. This positive impact is larger when the pricing information of long-term bond is less available, i.e. when the supply or liquidity of long-term treasury is low. These results further demonstrate that MCBs contribute to improve the immature bond market in China.

Many studies have discussed the negative externalities of government debt. Graham, Leary, and Roberts (2014) show that government debts crowd out corporate debts and investment by affecting

investors' choices and the relative price of assets in the U.S.. Huang, Pagano, and Panizza (2020b) and Liang, Shi, Wang, and Xu (2017) provide similar evidence that local government debt crowds out private investment and leverage in China. Based on the cross-country data, Demirci, Huang, and Sialm (2019) show that corporate leverage is lower in countries with higher government debt. Greenwood, Hanson, and Stein (2010), Greenwood, Hanson, and Stein (2015), Badoer and James (2016), Krishnamurthy and Vissing-Jorgensen (2012; 2015) show the substitution effect between corporate debt and government debt in terms of maturity.

However, in an incomplete market, where investors face severe adverse selection and inefficient benchmark rates, government debt can benefit the bond market (Dittmar and Yuan (2008)). Flannery, Hong, and Wang (2019) analyze the benchmark role of sovereign bonds in China's offshore market and find that USD-denominated Chinese corporate bonds experience a decline in yield spreads, bid-ask spreads, and price volatility after the announcement of sovereign issues. van Bekkum, Grundy, and Verwijmeren (2020) show that government bonds improve corporate issues by offering a high-quality reference rate. Our research complements the literature by showing that bonds issued by local government financial vehicles can improve the quality of the emerging bond market where treasuries cannot provide efficient pricing information. MCBs not only promote price informativeness, but also meet the demand of investor asset allocations. Though the oversupply of local government debts crowds out private credit in terms of quantity, it could generate favourable pricing and maturity impacts on the corporate bond market.

Our paper also makes contributions to the burgeoning literature on China's bond market. Hu, Pan, and Wang (2018) and Amstad and He (2019) offer an overview of the rapidly growing market. Liu, Lyu, and Yu (2017) and Ang et al. (2019) investigate the pricing determinants in MCB spreads. Chen, He, and Liu (2020) link the shadow banking activities with MCB issuances. Several papers analyze the characteristics of China's corporate bonds, such as the market segmentation, implicit guarantees, etc. Liu, Wang, Wei, and Zhong (2019) show that the demand from yield-chasing investors causes the pricing wedge between interbank and exchange markets for dual-listed bonds. Chen, Chen, He, Liu, and Xie (2019) use the market segmentation of one of the markets and a policy shock to estimate the pledgeability premium. Geng and Pan (2019) show the low price discovery in China's corporate bond market, and demonstrate the significant segmentation between SOE and non-SOE issuers due to government support for SOEs. Mo and Subrahmanyam (2020) investigate

the corporate bond liquidity. Huang, Liu, and Shi (2020a) analyze the risk characteristics in commercial paper. Ding, Xiong, and Zhang (2021) uncover the issuance overpricing in China's corporate bond market. Our paper complements all this research by highlighting the benchmark functions of municipal corporate bonds in financial market.

The remainder of the article is organized as follows: section 2 introduces institutional background; section 3 describes data and empirical design; section 4, 5 and 6 conduct three sets of empirical analysis; and section 7 concludes the paper.

2 Institutional Background

In this section, we give an overview of the institutional background of the bond market in China, focusing on the government bonds, such as treasuries and policy bank bonds, as well as the non-financial corporate bonds.

2.1 Government bond

Government bonds in China include treasury, policy bank bonds at the federal level and muni bonds at the local government level. After reopened in 1981, China's treasury bond market has achieved rapid growth, playing an increasingly important role in the financial market. However, compared with the advanced economies, China's treasury market is less mature. First, the market size in China is much smaller relative to that in the U.S.. At the end of year 2018, the outstanding amount of treasuries in China is RMB 14.88 trillion (about USD 2.16 trillion), about 16.19% of GDP. By contrast, the treasury market in the U.S. reaches USD 15.61 trillion, over 7 times of that in China. As shown in Panel A of Figure 1, the outstanding U.S. treasuries accounts for a large fraction of GDP: 75.72%. In addition, the treasury market cannot keep up with the fast growing corporate bond market in China. The ratio of outstanding treasuries over non-financial corporate bonds decreases to 70.89% in 2018, much lower than that in the U.S., which is nearly 200%.

Second, China's treasuries are illiquid as documented in Bai, Fleming, and Horan (2013) and Amstad and He (2019). As shown in Panel B in Figure 1, annual turnover for the Chinese treasury in 2018 is 1.26, far below that of the U.S. treasury which is 8.79. It is difficult for such an inactive market to provide high-quality risk-free interest rate.

[Place Figure 1 about here]

Third, maturity structure of China's treasuries is biased towards long-term. At the end of year 2018, treasuries due in less than one year accounts for 14% of the total outstanding Chinese treasuries, half of the comparable ratio of the US treasury which is 27%. Short-term government bonds are less exposed to inflation risk and reflect short-term monetary policy information. Lacking of them weakens the benchmark role of treasury yield curve.

Policy bank bonds, as another type of federal government bond, is issued by policy financial institutions. It supports all kinds of major projects, such as high-way construction, shanty areas rebuilding. Figure 2 shows that the proportion of outstanding policy bank bond accounts for 17%-29% of the total bond market over 2010 to 2018. Among them, policy bank bond issued by China Development Bank (CDB) is the largest in size, with rich maturities and bond types. CDB usually enjoys higher liquidity than treasury (Amstad and He (2019)), and therefore, typically regarded as sovereign benchmark in practice.

[Place Figure 2 about here]

Municipal bonds, issued by local governments, fund local infrastructure construction and economic development. Starting from year 2009, municipal bonds experience the fastest growth. As shown in Figure 2, the proportion of outstanding municipal bonds accounts for 21.1% of total bond market at the end of year 2018, exceeding that of treasury. Municipal bonds would have been natural regional benchmark securities but they are often illiquid (Wang (2018); Ba, Li, and Zhang (2019)), and reflect poorly the variations in local risks.

Interestingly, there are two types of bonds that are quasi-government in nature that reflect regional risks. These are municipal corporate bond (MCB) and enterprise bond (EB). However both are categorized as corporate bonds by definition, which we turn to next.

2.2 Corporate bond

Non-financial corporate bonds in China have different categories: enterprise bond, exchange-traded corporate bond, medium-term note, commercial paper, private placement note and other bond products (e.g., asset-backed security, convertible bond). Corporate bonds issued by local govern-

ment financial vehicles (LGFVs) which are called municipal corporate bonds, are quasi-government bonds. Different from other corporate bonds, MCBs are issued to meet the financing needs of local government and promotes local economy. Correspondingly, local governments provide supports for LGFVs via various ways, such as the injection of monetary capital, lands, real estates. Though MCBs are corporate bonds in a legal sense, they are regarded to be implicitly guaranteed by local government. The outstanding amount of MCB have tremendous growth from year 2010 to 2018, making up 9.14% of total market, and 37.33% of corporate bonds by the end of 2018.

[Place Figure 3 about here]

Enterprise bonds (EB), another type of quasi-government bonds, are issued by large state-owned enterprises (SOEs), such as institutions affiliated with central government ministries, enterprises solely funded by the state, or state-controlled enterprises. Their issuances are subject to administrative approval from the National Development and Reform Commission (NDRC). The economic function of EBs is similar to that of MCBs. [4] The raised funds are in line with the national industrial policies and the development of the specific industries. As a large proportion of EBs is issued by LGFVs, the outstanding amount of pure EB makes up a small proportion of the corporate bond market, 3% at the end of year 2018.

Figure 4 presents the average annual turnover rate over year 2010 to 2018 of government-related bonds. As we described earlier, turnover of municipal bond is the lowest, and that of treasury is the second lowest. In contrast, CDB and MCB have relatively high turnover over these years, with average annual turnover more than 3, three times of that of treasury.

[Place Figure 4 about here]

Regular corporate bonds (RCB) account for the rest of corporate bond market. These include exchange-traded bond, mid-term note, commercial paper, and private placement note only issued by non-LGFVs. As opposed to affiliated with local governments as EB or MCB, RCBs are issued mainly by corporations to meet their financing needs.[5]

[4] EBs can also be issued by LGFVs (which mostly issue MCBs) or non-LGFVs. To distinguish the EBs issued by non-LGFVs from MCBs, we define EBs in our paper as enterprise bonds issued by non-LGFVs.

[5] RCB may also has certain implicit guarantees if issued by SOEs

3 Data and Tests

3.1 Data

Consistent with Ang et al. (2019), we focus on fixed-rate bonds in our analysis, and only include bonds that are matured or listed in the interbank or exchange markets. The sample period is from January 2010 to June 2019. Data are from the Wind database, which provides detailed bond characteristics and trading variables. For each bond, we can observe the basic information, such as maturity, issuance, rating at issue, issuers' industry and location, and trading information, such as daily price and rating.

Bond spreads and returns are the two main variables in our analysis. Following Geng and Pan (2019), we use CDB yield curve as the reference curve to calculate bond spread, which is the difference between corporate bond yield and CDB yield of the same maturity. Weekly returns for each bond are also computed as the standard method:

$$r_t = \frac{P_t + AI_t + C_t}{P_{t-1} + AI_{t-1}} - 1 \tag{1}$$

where r_t is weekly return, P_t is the clean price at the end of each week, AI_t is accrued interest, and C_t is the coupon payment, if any, in week t.

Table 1 presents the summary statistics of bond characteristics, daily spreads and weekly returns. There are 18,459 RCBs, 11,560 MCBs, 520 EBs and 3,189 Munis in our sample. Compared with RCBs, MCBs have lower bond rating at issue, longer maturity, and tend to have embedded options. The average and median spread and return are also high for MCBs. Munis and EBs are usually issued in high rating, large size and long maturity, which match the substantial financing needs for long-term investment project.

[Place Table 1 about here]

3.2 Tests

As we discussed in the introduction, the literature is split on the impact of government debt on corporate debt. On the one hand, there is plenty of evidence supporting its substitution role:

government debts crowd out the corporate debts. This is shown in two negative relations: one is between the amount of government debts and corporate leverage, and the other is between corporate debt and government debt maturities. The latter is referred to as the gap-filling phenomenon by Greenwood et al. (2010). Both indicate that as borrowers, government and private firms are substitutes. This substitution role of the government debt for corporate debt is more pronounced in the economies with more developed financial market such as US and the EU countries (Demirci et al. (2019)). One interpretation is that in an economy with developed financial markets, corporations can easily switch from issuing debt to equity when government issues more debt, resulting in a financial crowding out. Another interpretation is that too much government debt might prevent corporations from accessing the debt market resulting in a real crowding out. For example, it has been shown that in Chinese cities where there are more LGFVs debts, firms rely less on external financing for investment, indicating that from the borrowers perspective, government might have crowded out corporation in the primary market for debt Huang et al. (2020b).

On the other hand, there is also solid evidence supporting the complementary role of government debt for corporate debt, especially in terms of secondary market quality in economies with developing financial markets. A liquid government debt market is shown to help build the secondary market infrastructure for servicing the trading of fixed income securities. These services could be order execution, unified custodian systems, clearing and settlement schemes. Furthermore, a deep and liquid government debt market is shown theoretically help with price discovery, increases investment portfolio frontier for investors by spanning the systematic risk in the economy, allows better hedging strategies, and sets a reference yield curve for pricing risky corporate bonds (Yuan (2005)). Hence more government bonds may stimulate the development of a secondary corporate bond market. This indicates that government and corporate bonds might be complements from the perspective of secondary market quality. This complementary role of government bonds for corporate bonds with regard to the secondary market quality should be more pronounced for economies with less developed financial market, which have been shown in Dittmar and Yuan (2008). An improved secondary market quality for corporate bonds can, in turn, promote more corporate borrowing and hence mitigate the crowding out impact of government debt mentioned earlier.

In this paper, we focus on examining the impact of government bonds on the quality of corporate

bond market. In the context of Chinese bond market, since treasury is limited in supply, other (federal and local) government bonds are illiquid, quasi-government bonds such as MCBs act instead as benchmark or reference security for corporate bonds. Therefore, we examine whether MCBs affect the price discovery and spanning opportunities in the corporate bond market. We also examine the relationship between government and corporate bond maturity, testing the crowding out or complementary role of government debt.

4 Price Discovery

4.1 Empirical methodology

In this section we examine whether MCBs promote price discovery in RCBs, compare that with EBs and munis. As in Hasbrouck (1995, 2003) and Dittmar and Yuan (2008), we use variance decompositions from a vector autoregression representation of the yield spreads on RCBs and MCBs (EBs and munis) to evaluate the contribution of MCBs (EBs and munis) to price discovery in RCBs.

Specifically, to explore the price discovery beyond the impact of government bond such as treasuries, we first form equal-weighted portfolio for RCBs and MCBs (EBs and munis), and then obtain the orthogonalized yield spreads for each bond portfolio as the residuals in the following regression:

$$ys_{\{RCB,MCB,EB,muni\},t} = \delta_0 + \beta' X_t + ys^{\perp}_{\{RCB,MCB,EB,muni\},t} \tag{2}$$

where X_t denotes the vector of three principal components (level, slope, curvature) extracted from the on-the-run treasuries closest to 90 days, 1 year, 3 years, 5 years, 7 years, and 10 years. The residuals, $ys^{\perp}_{\{RCB,MCB,EB,muni\},t}$, represent the orthogonalized yield spreads of bond portfolios.

Based on the residual spreads, we can conduct variance decomposition via VAR system. Hasbrouck (1995; 2003) refers to the portion of the unconditional variance attributable to an element of the VAR as the "information share" of the market, since innovations in the series represent unanticipated news. We report the fraction of the unconditional variance in RCB yield spreads that can be attributed to orthogonalized variations in MCB/EB/muni yield spreads and interpret

this quantity as a measure of how much of corporate market-relevant information is discovered in the MCB/EB/muni market.

We place the bounds on the variance contribution by reordering the variables in the VAR. When the MCB/EB/muni portfolio is the first variable in the VAR, an upper bound on the proportion of volatility in RCB attributable to MCB/EB/muni can be obtained. The lower bound is estimated when MCB/EB/muni portfolio is the last variable. The lag length in the VAR is determined via BIC statistics. In most of our analyses, it is 6, slightly over a week. The results are not affected by increasing the number of lags.

To analyze the impact of MCB/EB/muni on price discovery, we also examine the cumulative impulse response functions for the vector autoregressions. These response functions represent the long-run impact of a shock in MCB/EB/muni on pricing in RCB. They indicate the eventual impact of a shock in MCB/EB/muni on the yield spread in the corporate market if there are no shocks to the corporate market, and no new information arrives in the market. That is, the impulse response functions indicate the eventual impact of discovery of information in the MCB/EB/muni on pricing in the corporate market.

4.2 Empirical results

We report the bounds on the information share of RCB attributable to MCB/EB/muni for the whole sample in Table 2. According to the first row, the information share in RCB attributable to MCB ranges from 4.73% to 17.40%. By comparison, both EB and Muni can only explain a small proportion of RCB yield spread variations. According to the last two rows of Table 2, the information share in RCB from EB is less than 1%, and from Muni ranges from 0.90% to 1.42%, which is much smaller than that of MCB. These findings indicate that MCBs have the superior price discovery impact in the regular corporate bond market.

[Place Table 2 about here]

We also report the cumulative impulse response functions for the vector autoregressions in 2 for the MCB portfolio. Impulse response functions in Figure 6 present the cumulative impact of a standard-deviation change – which is about 53 basis points – in the spread of MCBs on the spread of RCBs. RCBs react slowly to the shock. As shown in the figure, the long-run impact of the MCB

shock on RCB is significant, about 1.5 standard-deviation change for RCB. The magnitude is large since the sample standard deviation of residual RCB is 28 basis points.

[Place Figure 6 about here]

Compared with RCBs, the unique feature of MCBs is that it undertakes certain social functions, meets the financing needs of local government, and therefore, is widely perceived by the market participants to enjoy the implicit guarantee from government. A natural question is: Is the price discovery impact of MCBs related to the degree of implicit backup? If local governments are in weak fiscal conditions, thus unable to cover the debts, or unwilling to provide guarantees for LGFVs, MCBs will face high credit risk as most LGFVs are not profitable. Under this circumstance, MCBs are similar to RCBs, less likely to improve the market quality by supplementing quasi-benchmark securities. On the contrary, if MCBs receive strong guarantee from local government, they serve more like a type of government bond. In this case, MCBs are not only sensitive to regional pricing information, but also provides investors with tools to hedge regional risk, which encourages investors to explore more information about RCBs and then improve the price discovery. To investigate this conjecture, we discuss the price discovery of MCBs according to the degree of local government guarantees.

Literature usually use fiscal or economic conditions to measure the degree of local government guarantees (Luo and Liu (2016); Ang et al. (2019)). So we calculate two variables for each city in our sample : (1) fiscal surplus, the difference between fiscal revenue and fiscal expenditure scaled by local GDP; (2) GDP per capita. Higher fiscal surplus or higher GDP per capita indicates stronger local government guarantee for MCB. We also use the administration level of LGFVs to proxy the degree government guarantee. According to the Wind database, the administration level of LGFVs can be classified into three categories: county-level, prefecture-city level and provincial level. Generally speaking, a higher administration level is associated with stronger government support. In the empirical tests, all cities in our sample are equally divided into three groups according to their annual fiscal surplus or GDP per capita. In each city group, we construct equal weighted portfolios for RCBs and MCBs, and examine the price discovery impact of MCBs on RCBs. We also construct equal weighted MCBs portfolios at county level, prefecture-city level and provincial level, and investigate their explanatory power for RCBs formed on all regular corporate

bonds, respectively. Table 3 reports the heterogeneity results.

In line with our expectation, MCBs with strong local government support play a more important role in facilitating price discovery process. As shown in Panel A and Panel B of Table 3, with the increase of local fiscal surplus or GDP per capita, the information share in RCBs attributable to MCBs monotonically increases. For example, the maximum information share from MCBs whose issuers are located in high fiscal surplus cities reaches 16.90%, while for MCBs whose issuers are in low fiscal surplus cities, the maximum information share is only 1.55%. The tests by the administration level in Panel C also provide some weak evidence that the higher the administration level is, the larger the maximum information share attributable to MCBs is. Therefore, the results suggest that the implicit guarantee behind MCBs enhances its ability of promoting price discovery in the regular corporate bond market.

[Place Table 3 about here]

4.3 Features of information flow in the process of price discovery

4.3.1 Across trading platforms. After establishing MCBs' price discovery role, we now examine whether trading platforms affect this role. There are primarily two platforms for trading bonds in China: interbank market (IB) and exchange market (EX). Previous studies have documented the significant segmentation between interbank and exchange market. For example, enterprise bonds can be traded on both interbank market and exchange market. Exchange-traded corporate bonds are only allowed to be traded on the exchange market. Medium-term notes, commercial papers and private-placement notes are only allowed to be traded on the interbank market. In terms of investors, large institutions are major participants in the interbank market, while small and medium-size institutions and retail investors mainly participate in the exchange market. In which bond market will the role of MCBs be more prominent? Guo and Yang (2007) have shown that due to the rich investor structure and high trading frequency in the exchange market, the prices of exchange treasuries lead interbank treasuries, implying that MCBs traded on the exchange market may be more sensitive to new information and aid the process of price discovery. To test this implication, we perform the VAR estimation and information share calculation by trading markets and report the results in Table 4.

First, according to the first and fourth row of the first three columns, the average information share in exchange-RCB attributable to exchange-MCB reaches 20%, while that in interbank-RCB attributable to interbank-MCB is only 3.47%, implying that MCBs react to information more quickly in the exchange market, therefore contributes more to the price discovery in the exchange market. The results in the second and third row of the first three columns further show that, exchange-MCB can even explain the yield spread variations in interbank-RCB, the information share up to 15.8%. Our findings are consistent with Guo and Yang (2007). More frequent tradings in the exchange market aid the transmission of information and strengthen the role of MCB's price discovery. Second, we also compare the performance of EBs and Munis with MCBs by market. As shown in the last four columns of Table 4, the price discovery impact of EBs is slight, with information share less than 1% in all market examinations. Munis show some price discovery impact on RCBs in the same market. In the exchange market, the average information share is 19.85%, and in the interbank market, the average information share is 4.69%, better than the full sample performance in Table 2. But in cross-market examinations, Munis do not deliver meaningful impact.

[Place Table 4 about here]

4.3.2 Across bond maturities. Flannery et al. (2019) point out that government bonds generate more significant impact on corporate bonds with similar maturities. We explore whether the information in MCBs will be transmitted along the maturity dimension, so as to promote price discovery of RCBs by maturity. Specifically, we divide all bonds into three groups: maturing in less than one year(0,1), one to five years [1,5), and no less than five years [5,...). For each maturity bin, we construct equal weighted portfolios of RCBs, MCBs, EBs and Munis. Table 5 present the information share in RCBs from MCBs, EBs and Munis for each maturity bin.

[Place Table 5 about here]

First, MCBs have the strongest price discovery impact on RCBs belonging to the same maturity bucket. For example, in RCBs with maturity of (0,1), the average information share attributable to MCBs of (0,1) reaches 21.50%, while MCBs of [1,5) and [5,...) is less than 10%. It suggests that

pricing information does flow along the maturity dimension. Second, among the three maturity bins, i.e., "(0,1),(0,1)", "[1,5),[1,5)" and "[5,...),[5,...)", price discovery impact of MCB on short-term (0,1) dimension is the largest. As mentioned in Section 2, the supply of short-term treasuries is at a low level in China's bond market, and therefore, MCBs show more complementary role in facilitating the price discovery of short-term RCB. Finally, compared with EBs and Munis, MCBs still make the largest contribution. In most tests by maturity, the information share from EBs or Munis is much lower than that from MCBs. So Table 5 shows that RCBs benefit more from MCBs, especially from MCBs with similar maturity.

4.3.3 Location dimension. Next we utilise the difference in the information content between MCBs, EBs and Munis to pinpoint the source of the price discovery roles of these government-related instruments. MCBs, issued by LGFVs and mainly for local economic development, may contribute to more price discovery along location lines since they reflect regional systematic risks. Munis, directly related to local government, should also perform better at regional level if their prices can reflect local economic risk. To examine whether the price discovery impact of MCB and Muni is more prominent on RCB in the same regions, we divide the sample into seven groups according to the seven geographical regions in China (Chen et al., 2020), i.e., North China, East China, Center China, Northeast, Northwest, Southwest. In each region, we construct equal weighted portfolios for each type of bonds, and conduct empirical tests as previous procedures.

Table 6 reports the average information share in RCB in each region. According to the first three columns, RCBs in East China and West South benefit most from local MCB, where the average information share attributable to MCBs is larger than 14%. In the remaining five regions, the average information share from local MCBs ranges from 2.52% to 4.75%. By comparison, according to the last four columns in Table 6, average information share from EBs (or Munis) exceed MCBs only in two (or one) of the seven regions. Thus, MCBs still performs better than EBs and Munis at the regional level. Considering that the trading of Munis is inactive, Muni prices do not fully reflect regional macro conditions, so it is reasonable that the price discovery impact of Munis is also small in most regions. [6]

[6]To examine whether the degree of marketization affects price discovery in bond market, we also sort the provinces in our sample into three groups according to the marketization index (Wang, Fan, and Hu (2019)). Equal weighted RCBs, MCBs, EBs and Munis are formed in each group and information shares in RCBs are estimated. The results

[Place Table 6 about here]

4.3.4 Industry dimension. Huang et al. (2020b) mention that LGFVs directly affect several sectors, including electricity production and distribution, heat production and distribution, gas distribution, water supply and sewage treatment, construction, environmental management and public facilities management. Will MCBs also contribute to more price discovery in these sectors? Besides, EBs, typically issued to promote national industrial policies, may contain significant pricing information along industry lines, and therefore, can explain the variations in the spread of RCBs in the same industries.

We construct industry-sorted portfolios of RCBs, MCBs and EBs based on the industry classification of China Securities Regulatory Commission in 2012. Table 7 presents the information share in RCBs attributable to MCBs or EBs in each industry. Price discovery impact of MCBs concentrates on the industry of "Production and Distribution of Electricity, Heat and Gas", and "Transportation", with average information share over 12%. As for EBs, it shows strong ability to explain the spread variations of RCBs in the industry of "Production and Distribution of Electricity, Heat and Gas", "Public Utility" and "Transportation". The average information share from EBs in these industries is substantial, ranging from 6.32% to 14.8%. The performance of EB in most industries is also better than in full sample. These results confirmed our conjectures to some extent. EBs exert pricing influence along the industry lines, and MCBs make contributions along the location mostly but also along the industry lines.

[Place Table 7 about here]

5 Spanning Enhancement

5.1 Spanning test

Spanning test answers the question whether an investor, conditional on having a portfolio of K existing assets, can benefit by investing in a new set of N assets. In other words, it tests the

in Table A2 show that marketization promotes the price discovery role of MCBs and Munis. In provinces with high level of marketization, the average information attributable to MCBs or Munis is high, though the magnitude from Munis is still small relative to that from MCBs.

hypothesis of whether N test assets can be spanned or replicated in the mean-variance space by a set of K existing assets. In this setting, the test asset is equal weighted portfolio of MCBs/EBs/Munis and the existing asset is equal weighted portfolio of RCBs (or plus treasury and CDB portfolio). We examine whether MCBs contain important pricing information for RCBs.

There are two frameworks for mean-variance spanning test. One is regression based test (Huberman and Kandel, 1987), the other is SDF based test (De Santis, 1994; Bekaert and Urias, 1996; Dittmar and Yuan, 2008). In regression based test, we regress the returns of test assets on the returns of existing assets:

$$R_{T,t} = \alpha + \beta R_{B,t} + \epsilon_t \tag{3}$$

where $R_{T,t}$ and $R_{B,t}$ are the returns of K test assets and N existing assets, respectively. The spanning hypothesis is:

$$H_0 : \alpha = 0_N, \delta = 0_N \tag{4}$$

where $\delta = 1_N - \beta 1_K$. Rejecting the null hypothesis indicates that MCBs cannot be fully replicated by existing bonds, and hence, MCBs can improve the investment opportunity set relative to existing assets.

Santis (1993), Bekaert and Urias (1996), and Dittmar and Yuan (2008) provide another framework to investigate the same issue. In SDF based test, we assume two pricing kernels with different means:

$$M_{1t} = \alpha_1 + \beta_1^B (R_t^B - \mu_B) + \beta_1^T (R_t^T - \mu_T) \tag{5}$$

$$M_{2t} = \alpha_2 + \beta_2^B (R_t^B - \mu_B) + \beta_2^T (R_t^T - \mu_T) \tag{6}$$

where μ_B and μ_T are the expected gross returns of existing assets and test asset, respectively, and the means of the pricing kernels, α_1 and α_2, are constrained to differ. For a given mean of the pricing kernel, following Hansen and Jagannathan (1991), we can construct a minimum variance pricing kernel that is in the linear span of the asset payoffs. We estimate the set of parameters $\beta_1^B, \beta_1^T, \beta_2^B, \beta_2^T$ via GMM based on the moment conditions:

$$\frac{1}{T}\sum_{t=1}^{T} M_{1t}\{R_t^B; R_t^T\} - \iota = 0 \tag{7}$$

$$\frac{1}{T}\sum_{t=1}^{T} M_{2t}\{R_t^B; R_t^T\} - \iota = 0 \tag{8}$$

where ι denotes a conforming vector of ones. That is, the parameters are estimated so that the pricing kernels M_{1t} and M_{2t} satisfy the sample analog of the standard Euler equation. If we find that both pricing kernels price both existing and test assets, but depends only on the payoffs of existing assets, that means that existing assets span test assets since any two (minimum variance) pricing kernels with arbitrary (and different) means and different variances describe the frontier. Therefore, the null hypothesis is:

$$H_0 : \beta_1^T = \beta_2^T = 0 \tag{9}$$

Rejection of H_0 means that existing assets cannot span test assest, i.e., the information in MCBs is important for pricing RCBs. This would demonstrate the necessity of MCBs in the pricing kernel and its ability to enhance the efficient frontier.

As with Kan and Zhou (2012), we carry out six spanning tests to examine the null hypothesis: Wald test under conditional homoscedasticity (W); Wald test under independent and identically distributed (IID) elliptical distribution (We); Wald test under conditional heteroskedasticity (Wa); Bekerart-Urias spanning test with errors-in-variables (EIV) adjustment (J_1); Bekerart-Urias spanning test without the EIV adjustment (J_2); De Santis spanning test (J_3). The first three are regression based and the last three are SDF based. All six tests have asymptotic χ-squared distribution with $2N$ ($N = 1$) degrees of freedom.

Following Dittmar and Yuan (2008), we also adopt the economic evaluation statistics, i.e., maximum Sharpe ratio achievable with the assets. We calculate the annualized Sharpe ratio of the pricing kernel with mean equal to the risk-free rate and minimum variance.

5.2 Empirical results

In Table 8 we present the spanning test results for the full sample period. In Panel A, equal weighted portfolio of MCBs is the test asset. According to the first two rows where the existing asset is equal

weighted portfolio of RCBs, all six tests are strongly rejected, indicating that MCBs expand the opportunity set relative to the existing bonds. Next, we include the portfolio of treasuries or CDBs into the set of existing assets. As discussed in Dittmar and Yuan (2008), it is possible that some of the spanning enhancement in MCBs relative to RCBs occur because MCBs permit investors to better span risks in the default-free term structure. Both treasury and CDB can be regarded as risk-free securities which provide a natural way of hedging risks and spanning the existing bonds, so we include them in the existing assets. As shown in the third to sixth rows of Panel A, test statistics are smaller after the inclusion of treasury and CDB portfolios, but all of them are still significant, confirming that MCBs have additional pricing information for the bond market. However, we do not find much improvement in the annual Sharpe ratio in the full sample test. MCBs may contribute to improve the minimum variance portfolio in the efficient frontier, but generate less improvement in the tangency portfolio. Hansen and Jagannathan (1991) bounds for the sets of securities in Figure 5 further support the spanning enhancement of MCBs. The bound is shifted upward after introducing MCBs into existing assets.

[Place Table 8 about here]

[Place Figure 5 about here]

For comparison, we also investigate the spanning ability of EBs and Munis by replacing the test asset with EBs or Munis. In Panel B and Panel C of Table 8 we report the results. As shown in Panel B, when existing assets include RCBs, treasuries and CDBs, EBs also significantly span the bond market, though test statistics are much smaller than those for MCBs. The spanning enhancement from Munis is a little weak. Panel C shows that for Munis the null hypothesis is rejected at 10% significance level. Since EBs and Munis also show some spanning enhancement, we may worry that the information in MCBs coincide with EBs and Munis, and then, MCBs can be spanned by EBs and Munis. To alleviate this concern, we examine the spanning ability of MCBs when EBs and Munis are included in the existing assets. As shown in the last two rows of Panel A, for MCBs the null hypothesis is still rejected at 1% significance level, indicating the unique role of MCBs in the efficient frontier.

In Section 4.2 we have shown that higher degree of implicit guarantee can strengthen the price

discovery impact of MCBs. In this section, we also examine how government backup affects the spanning enhancement of MCBs. Following previous procedures, spanning tests are performed in three groups divided by city-level fiscal surplus or GDP per capita. For each group, existing assets are set to be RCB portfolio (formed on regular corporate bonds in each group), treasury portfolio and CDB portfolio. Test asset is MCB portfolio (formed on municipal corporate bonds in each group). We present the results in Panel A and Panel B in Table A6.[7] MCBs show significant spanning enhancement in all groups. In cities where MCBs potentially receive stronger implicit guarantee, the test statistics are larger, in line with their prominent price discovery role in these cities as discovered in Table 3. Notice that the maximum Sharpe ratio is improved in cities with low fiscal surplus or low GDP per capita. For example, in cities where the fiscal surplus are low, the maximum Sharpe ratio can increase 35% by introducing MCB into the portfolio. The results suggest that MCBs with stronger implicit guarantee may provide investors with better hedging tools to control risks by improving the minimum variance portfolio, and MCBs with lower implicit guarantee could economically improve the portfolio returns. The investigation based on LGFVs' administration levels in Panel C of Table 9 also yields similar results in that implicit guarantee affects MCB's spanning enhancement.

[Place Table 9 about here]

For robustness, we also change the way a portfolio is constructed to test the spanning impact. Existing assets always include RCBs, Treasuries and CDBs. First, we examine the performance of MCBs across trading markets. Table A4 shows that MCBs significantly span the bond assets in the same or different market. Especially, as the row "EX,EX" shown, the maximum Sharpe ratio increases 39% with the addition of exchange-MCB for investors who participant in the exchange market. In contrast, the statistically significance level and economical improvement from EBs or Munis is lower. Second, in Table A5, we examine the spanning enhancement of MCBs by maturities. Significant spanning power is discovered in all maturity bins. For investors who invest in long-term bonds maturing in over five years, the maximum Sharpe ratio increases from 1.67 to 3.01 with the addition of long-term MCBs. Third, we examine the spanning enhancement at regional or industry level. As shown in Table A6 and Table A7, MCBs significantly span 6 of 7

[7]The results based on six spanning test statistics are consistent. For simplification, we only report J_1 test.

region sorted portfolios, and 9 of 14 industry sorted portfolios. In terms of economic evaluation, the improvement in maximum Sharpe ratio ranges from 1% to 31% at the regional level. Investors focusing on industries directly affected by LGFVs spendings also benefit from MCBs. The maximum Sharpe ratio increases 6% in "Production and distribution of Electricity, Heat and Gas", 14% in "Transportation". Finally, in most cases, compared with MCBs, the contribution made by EBs or Munis is less.

6 Maturity impact of MCB Supply

Literature also discuss about the maturity relation between government bond and corporate bond. Greenwood et al. (2010) document the gap filling phenomenon. When the supply of short-term government debt increases, firms will fill the resulting gap by issuing more long-term debt. Greenwood et al. (2015), Badoer and James (2016), Krishnamurthy and Vissing-Jorgensen (2012; 2015) provide more evidences about the negative relationship between government and corporate bond maturity choice. On the other hand, van Bekkum et al. (2020) show that government issues promote corporate issues when the market lacks of high-quality reference rate. Considering the inefficient financial function of treasury bond market in China, we conjecture that the complementary relationship between government related bond maturity and corporate bond maturity is more likely to hold in China. MCBs may contribute to provide additional maturity information.

Previous analysis has shown that MCBs generate more prominent price discovery effect on RCBs belonging to the same maturity bin or in the same regions. To extract the reference information more accurately, we investigate the maturity impact of MCBs at city level in this section. In other words, we examine how the maturity supply of MCBs affects the bond maturity choice of non-financial corporations in the same city.

Figure A2 plots the distribution of RCBs and MCBs across maturities for bonds issued from January 2010 to June 2019. Non-financial corporations rarely issue long-term debts. The fraction of RCBs due in more than seven years is less than 2%. Consistent with the convention in China's market, we define maturity in [5, ...) years as long term for corporate bond. We focus on the long-term impact of MCBs since firms usually have more difficulties in issuing long-term debt. Compared with short-term bonds, long-term bonds are more sensitive to the changes in corporate

value and more likely to be mis-priced (Flannery (1986)). Therefore, it could be more urgent for long-term reference pricing information in the market.

Following Badoer and James (2016), we use logit model to investigate this issue. The dependent variable takes a value of one if RCB has a maturity of [5, ...) years, and zero otherwise. Consistent with the literature, we use the long-term MCB level share to measure the supply of MCBs, which is the outstanding amount of long-term MCBs over total outstanding amount of MCBs in each city ($MCBY5$). As firms may decide to issue long-term bonds after observing the reference information in the market, we lag the MCB maturity measure one quarter. So in the empirical test, we regress the dummy variable indicating RCB maturity on the lagged local long-term MCB level share. A set of issuers characteristics and city-level macro variables are controlled, including: IssuerRating, which equals 1 when the issuer is rated AAA, 2 when rated AA+, and 3 when rated AA, etc.; SOE; Log(Asset); Lev; ROA; AssetMat, which is asset maturity calculated as Stohs and Mauer (1996), measured by (Current asset/ (Current asset+Fixed asset))+(Fixed asset/(Current asset+Fixed asset))*(Fixed asset/Depreciation); Log(GDP); FiscalSurplus, the difference of fiscal revenue and expenditure scaled by local GDP; and LGFVr, calculated as Huang et al. (2020b), which is the total debts of local government financing vehicles scaled by local GDP. We provide details about the control variables in Table A1.[8] City, industry and year-quarter fixed effect are also controlled. A significant positive coefficient of MCBY5 indicates that long-term MCBs encourage local long-term RCB issues.

We present the logic regression results in the first two columns in Table 10. We find significant positive relationship between long-term RCB issues and the supply of local long-term MCB. As shown in Column (1) of Panel A, the coefficient of MCBY5 is positive and significant at 5%. Panel B presents the marginal effect estimated at the mean values of covariates for changes in MCBY5. The result implies that 1% increase in local MCBY5 will increase the likelihood of issuing long-term bond by about 0.06% for non-financial firms. Though the economic magnitude is relatively small, it is interesting that we do not find crowding out effect along the maturity dimension. MCBs may contain additional information on local economic development, which is relevant with the pricing of local long-term debt, and then promote local long-term corporate financing. Column (2) estimates the same regression using the OLS method. The positive impact of long-term MCB is robust.

[8]Summary statistics by maturity bins can be found in Table A9

The coefficient of MCBY5 is 0.062 and significant at 1%, consistent with the findings based on logit regression. We also control the ratio of total debt of LGFVs over local GDP (LGFVr) in the regression. Column (1) and (2) shows that the coefficient of LGFVr is positive, indicating that the total debt of LGFVs may only exert negative influence on the quantity of corporate financing which is documented in Huang et al. (2020b), but no significant crowding out impact on corporate debt maturity choice.

[Place Table 10 about here]

One concern about the results in Column (1) and (2) is that omitted variables may drive the positive relationship between long-term MCB supply and long-term RCB issues. For example, both LGFVs and non-financial corporations are likely to time the market, and rely more on long-term debt when long-term market interest rate is decreasing, thus benefiting from the decreasing financing cost. In this case, the supply of long-term MCB changes is only a reflection of the market interest rate, instead of the actual driving force.

We include time fixed effect in the regression to control the time trend, and to further address the omitted variable concerns, we conduct a placebo test. In Column (3) and (4) of Table 10, we replace the local long-term MCB supply with non-local long-term MCB supply ($MCBY5_{NonLocal}$). $MCBY5_{NonLocal}$ is the sum of long-term MCB in cities except city i over total outstanding MCB in cities except city i, which describes the maturity changes of MCB in other cities. If market interest rate change is the main driver, the supply of non-local long-term MCB will also change in the same direction, and generate positive relation with local corporate debt maturity choice. However, if we do not observe significant positive impact of $MCBY5_{NonLocal}$, the positive coefficient in front of MCBY5 should be attributable to the promotion effect of MCB rather than omitted market variables.

As shown in Column (3) and (4), both the coefficient and t-stat of $MCBY5_{NonLocal}$ are much smaller than MCBY5. The changes in the supply of non-local long-term MCB do not significantly affect the maturity choice of local long-term corporate debt. The results support our argument that local long-term MCB complements the treasury market as benchmarks by introducing local information, and finally promoting the local long-term corporate financing.

We also estimate the impact of short-term (0,1) MCB on local short-term corporate bond

issues, and mid-term [1,5) MCB on local mid-term corporate bond issues. As shown in Figure 7, the coefficient of local MCBY0 (level share of local MCB due in (0,1)) is negative but insignificant, and local MCBY1 (level share of local MCB due in [1,5)) is positive but insignificant. The results suggest that the promotion effect of MCBs mainly exists in the long-term dimension, since long-term corporate bond is more potentially to be mis-priced. The information in MCBs is more valuable for local long-term corporate bond pricing. As only provincial level governments are allowed to issue municipal bonds, we also compare the maturity impact of MCBs and Munis at provincial level. We compute the level share of local Muni due in [5,...) years (MuniY5) and local MCBs due in [5,...) years for each province, and run the same logit regressions as in Column (1) of Table 10. Figure 8 presents the coefficients of local Muni and MCB In Panel A, there is no significant positive impact from local municipal bonds on local RCB issues. In contrast, long-term MCBs still significantly encourages the issues of long-term RCBs in the same province, as shown in Panel B. The results indicate that long-term MCBs contain more useful reference information for long-term RCBs than Munis.

[Place Figure 7 about here]

[Place Figure 8 about here]

Based on these findings, we continue to explore the time-series and cross-sectional variations in the long-term promotion effect. First, based on the hypothesis that MCBs complement the role of treasury, we explore if the impact of MCB is more significant when treasury market is less efficient. To do so, we employ three measures to proxy the conditions of treasury market: (1) I_{TSY5}, which equals one when outstanding amount of long-term treasury over total outstanding treasury is below its sample median, and zero otherwise; (2) $I_{TSGDPY5}$, which equals one when outstanding amount of long-term treasury over GDP is below its sample median value, and zero otherwise; (3) I_{TSTOY5}, which equals one when quarterly turnover rate of long-term treasury is below its sample median value, and zero otherwise. So when the three dummy takes the value of one, it indicates that the supply of long-term treasury is at low level or treasury liquidity is low.

In Table 11, we include the interaction term between MCBY5 and dummy variables proxying treasury market conditions. Panel A displays the estimated results and Panel B is the marginal

effect for subsamples when treasury market is in good or weak condition. First, MCBY5 is still significantly positive across all regressions, indicating the robust promotion effect of long-term MCB. Second, as expected, the interaction term, $MCBY5 \times I_{TSY5}$, $MCBY5 \times I_{TSYGDP5}$ and $MCBY5 \times I_{TSTOY5}$ is positive in all three columns, not significant though. The marginal effect estimated with respect to MCBY5 is relatively larger and has larger t-stat for subsamples when long-term treasury supply is low or treasury turnover rate is small. For example, according to Column (2) in Panel B, 1% increase in local MCBY5 will increase the likelihood of issuing long-term bond by about 0.07% for non-financial firms and significant at 1% level when the supply of long-term treasury is below the sample median, but 0.04% significant at 10% level when long-term treasury supply is above the sample median. These results are consistent with our expectation. The complement role of MCB is more valuable when there is less available information in treasury market.

[Place Table 11 about here]

Second, we try to explore which type of MCB contributes more to the maturity impact. An intuitive conjecture is that MCBs that are directly related to economic activities may reflect more information, e.g., expectations about future local economic development. Chen et al. (2020) classify MCB into three categories by the funding purposes: repayment of existing bank loans; investment in projects; and others (such as replenishing working capital, financing for other entities through entrusted loans). We expect that MCBs issued for investment projects play a more significant role in promoting local issues of long-term RCB. Therefore, we employ the MCB classification in our analysis, [9] and calculate the fraction of long-term MCBs in each category over total outstanding MCBs for each city, i.e., $MCBY5_{BankLoan}$, $MCBY5_{Invest}$, and $MCBY5_{Other}$.

Table 12 provides the logit regression results on the relationship between long-term RCB issues and the supply of long-term MCB in different categories. Comparing the first three columns in Table 12, long-term MCB funding for investment or other purposes show significant positive impact on the issues of local long-term RCB. While $MCBY5_{Other}$ is significant at 5% level, $MCBY5_{Invest}$ is significant at 1% level. The coefficient of $MCBY5_{BankLoan}$ is positive but insignificant. It seems

[9] Issuance purposes of MCB need to be manually collected. Thanks Chen et al. (2020) for sharing this dataset with us. The dataset ends at December 2016.

that MCBs for investment project provide the most relevant information. MCBs used for repaying bank loans are less related with real economic activities, and exert no influence on local corporate debt maturity choice. When including all three types of long-term MCBs into the regression together, as shown in Column (4), $MCBY5_{Invest}$ still generate the most significant maturity impact.

[Place Table 12 about here]

Third, we examine which type of firms benefit most from long-term of MCBs. MCBs may provide more relevant pricing information for non-financial corporations that have close business connection with LGFVs. Investors can infer the risks of RCBs by referring to the prices of local MCBs. Huang et al. (2020b) find that firms directly affected by LGFVs experience less crowding out in investment. We are wondering whether these firms, main suppliers to LGFVs with high exposure to government spending, are able to issue more long-term RCB. To examine this issue, we construct the industry exposure index following Huang et al. (2020b). $High$ equals 1 if the firm operates in industries with high exposure to government spending (the value of industry exposure is larger than the sample median), and zero otherwise. By running logit regression and estimating marginal effects of MCB over subsamples divided by $High$, we find that MCBs mainly encourage firms with high exposure to government spending to issue long-term RCB. The marginal effect of MCBs is 0.071 and significant at 1% level for firms with high exposure to LGFVs. In contrast, the marginal effect of MCBs in only 0.032 and insignificant in subsample with low exposure to LGFVs. Figure 9 further plots the issue of long-term RCBs and MCBY5 in the two subsamples. The slope in subsample with high exposure to LGFVs is steeper, indicating the larger promotion effect of MCBs. The results suggest that the pricing information in MCBs is more relevant for firms that are closely related to LGFVs, so that these firms can use more long-term financing based on the reference rate.

[Place Figure 9 about here]

Finally, we turn to the relationship between corporate debt issue cost and supply of long-term MCBs. We examine whether MCBs promote the issue of long-term RCBs by reducing long-term financing cost. The local information in MCBs may help alleviate the mispricing risk of long-term bonds and reduce the issue spread of RCB.

Issue spread of RCBs is computed as the difference between interest rate and the yield of CDBs with similar maturity. We regress RCB issue spread on local long-term MCB level share or non-local long-term MCB level share, respectively. In Column (1) and (3) of Table 13, we control the characteristics of RCB, including: Issuance, BondRating, Embed, FixRate, MarketID and SOE. Panel B of Table A9 present the summary statistics of bond features. In Column (2) and (4), we also add issuer and city characteristics into the regressions. As shown in the first two columns, the coefficient of $MCBY5$ is significantly negative, which means that the increase in the supply of local long-term MCBs decrease the issue spread of local long-term RCBs. In terms of economic magnitude, according to Column (1), with 1% increase in $MCBY5$, the issue spread of local long-term RCB decreases 0.252%, which is quite large relative to the mean spread of long-term RCBs of 1.83%. By contrast, in Column (3) and (4), the supply of non-local MCBs do not exert significant pricing impact on local long-term RCBs. Combined with the findings in Table 10, the results imply that only local long-term MCBs contain important pricing information for local RCB, which contribute to lower the issue cost and promote local non-financial corporations to issue long-term RCBs. [10]

[Place Table 13 about here]

7 Conclusion

In this paper, we study the impact of MCBs as benchmark securities in developing China's bond market. MCBs are distinguished from other corporate debt instruments in terms of its implicit government backup. When lacking of high-quality treasury market and in the presence of illiquid local government bonds (Munis), we show that MCBs are able to provide the benchmark functions.

Our empirical analyses support the important role of MCBs in improving three aspects of the corporate bond market quality. First MCBs contain valuable pricing information, beyond the systematic information derived from treasury and CDB which leads to the enhancement in price discovery. Second, They provide spanning enhancement and improve efficient frontier. Specifically,

[10] We also examine the impact of outstanding share of MCB on RCB issue spread across maturity bins. Figure A3 plots the coefficient and 95% confidence interval of MCBY0, MCBY1 and MCBY5. Neither MCBY0 nor MCBY1 is significantly negative. The graph shows that only long-term MCB significantly decreases long-term RCB issue spread.

MCBs with stronger government guarantees present larger explanatory power for existing bond securities. Finally we find MCBs deliver positive impact along maturity dimension by promoting the issue of local long-term regular corporate bonds. By comparison, other two less liquid government-related bonds, EBs and Munis, generate less improvement for the corporate bond market.

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Figure 1.
China and U.S. Treasury.
Panel A presents the fraction of China and U.S. outstanding treasury over GDP or over outstanding non-financial corporate bond at the end of year 2018. Panel B presents the annual turnover of China and U.S. treasury. Turnover is calculated as the aggregate annual trading volume scaled by outstanding amount. Data source: Wind, SIFMA, Fed.

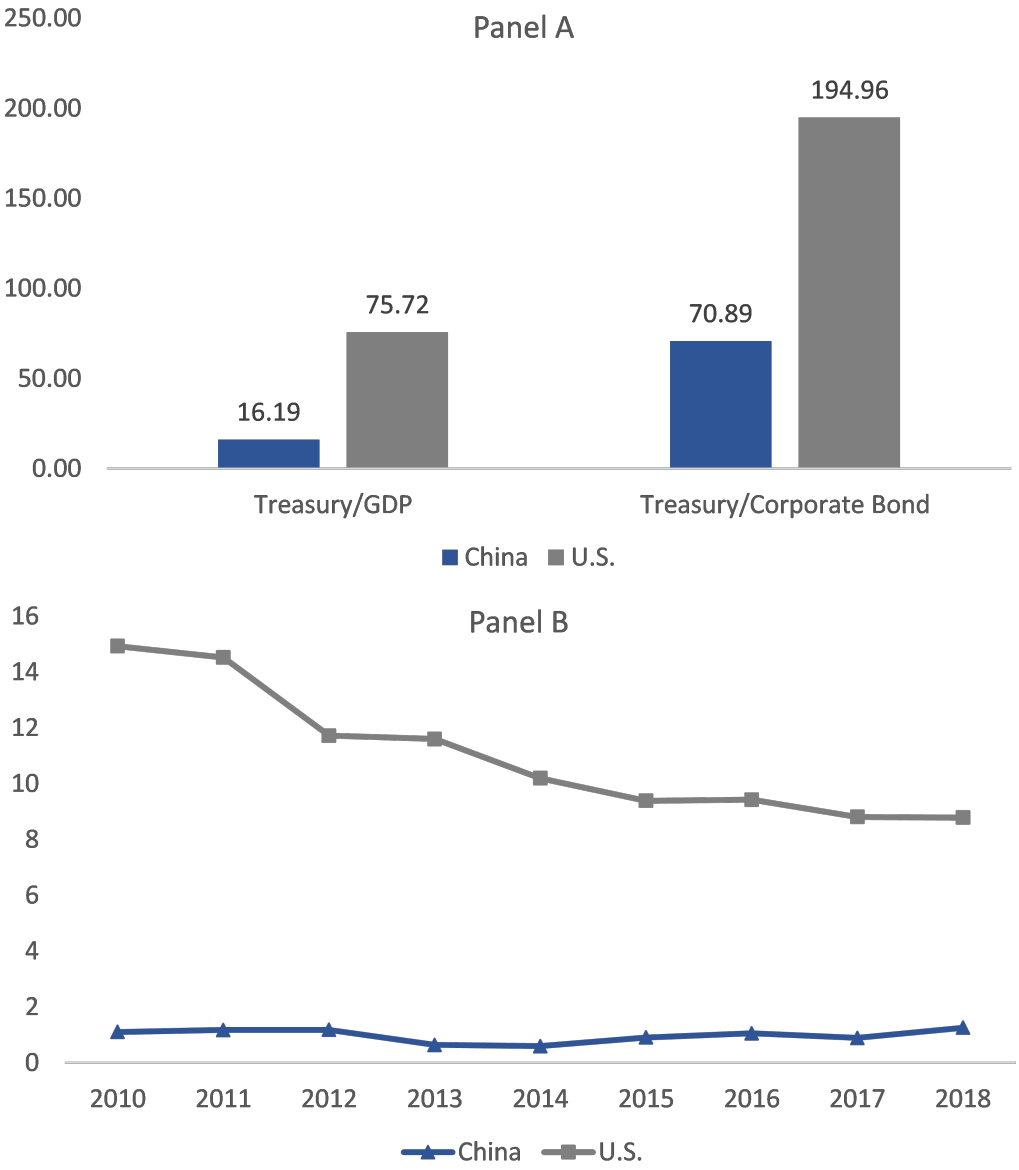

Figure 2.
Growth of Chinas bond market.
This figure depicts the total amount outstanding of bond in China (RMB billion) at the end of each year and the fraction by instrument category.

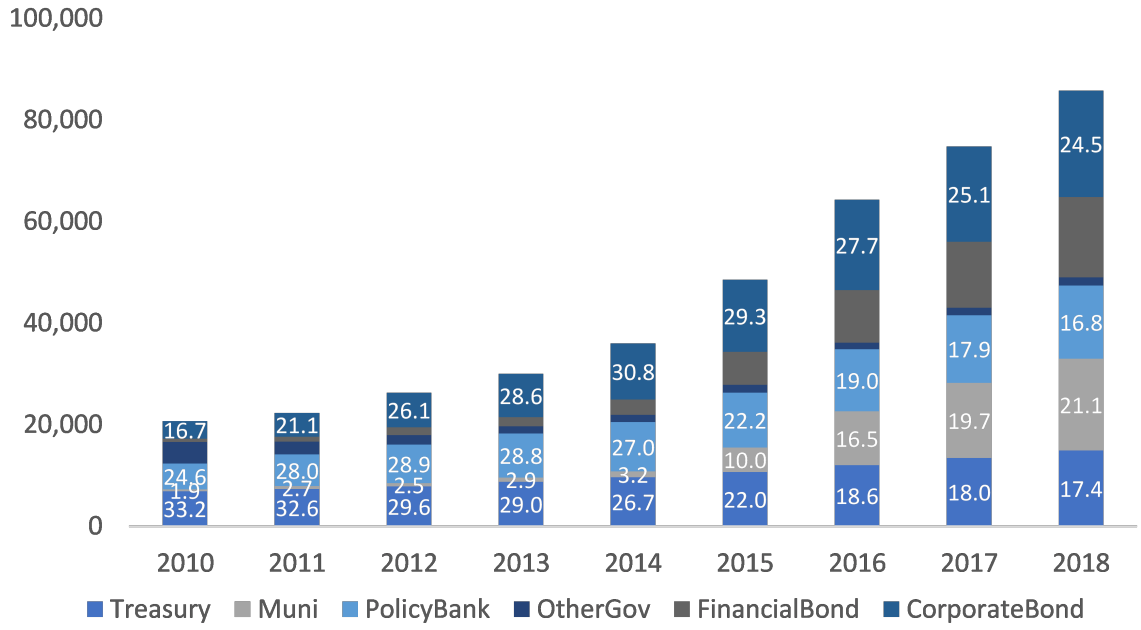

Figure 3.
Growth of MCB.
This figure depicts the total amount outstanding of MCB in (RMB billion, left axis) and the fraction of MCB over outstanding non-financial corporate bond (%, right axis) at the end of each year.

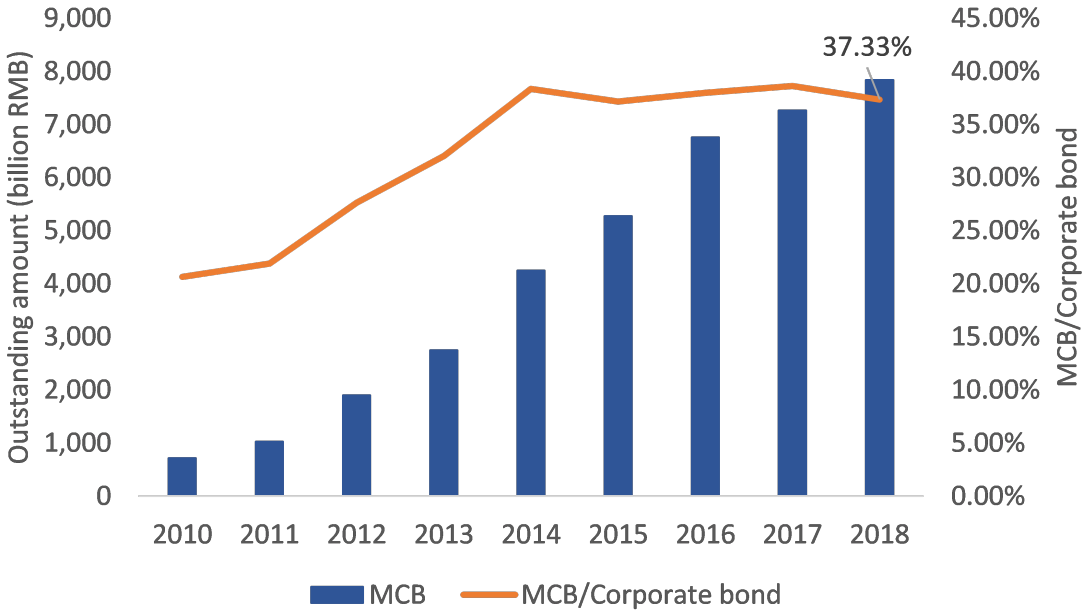

Figure 4.
Average annual turnover.
This figure depicts the average annual turnover of government related bonds (Treasury, CDB, Muni, MCB and EB) over 2010 to 2018.

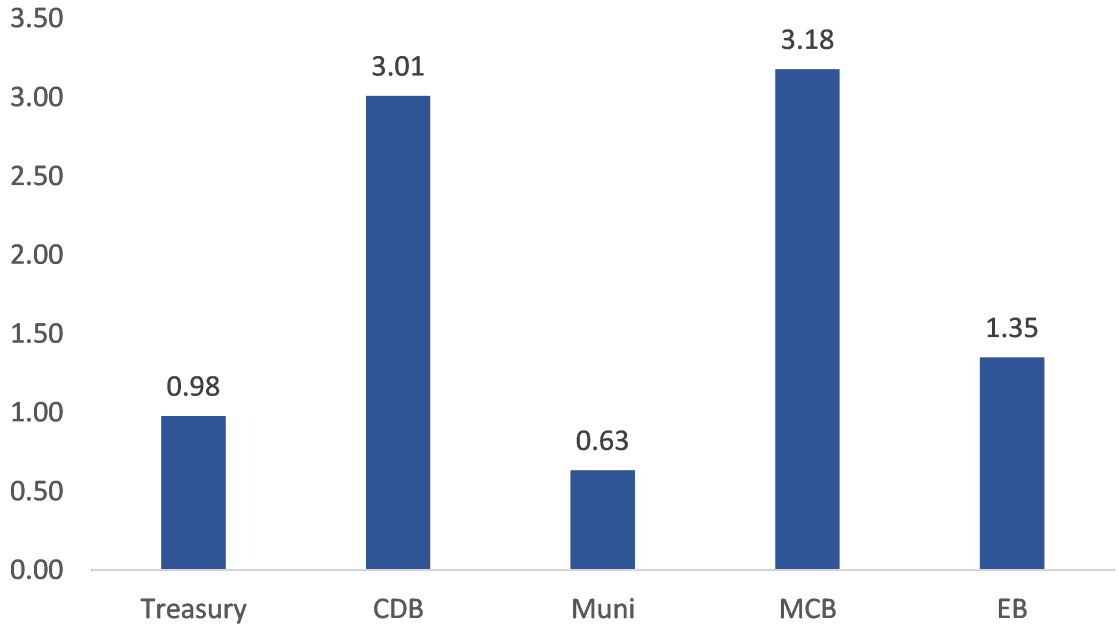

Figure 5.
Hansen-Jagannathan bounds.
This figure depicts Hansen-Jagannathan (1991) bounds on admissible pricing kernels for two asset sets: benchmark assets consisting of RCB, CDB and treasury in solid blue lines, and benchmark plus test assets consisting of RCB, CDB and treasury and MCB in dotted red lines. The bounds are constructed using weekly returns on equal weighted portfolios of bonds.

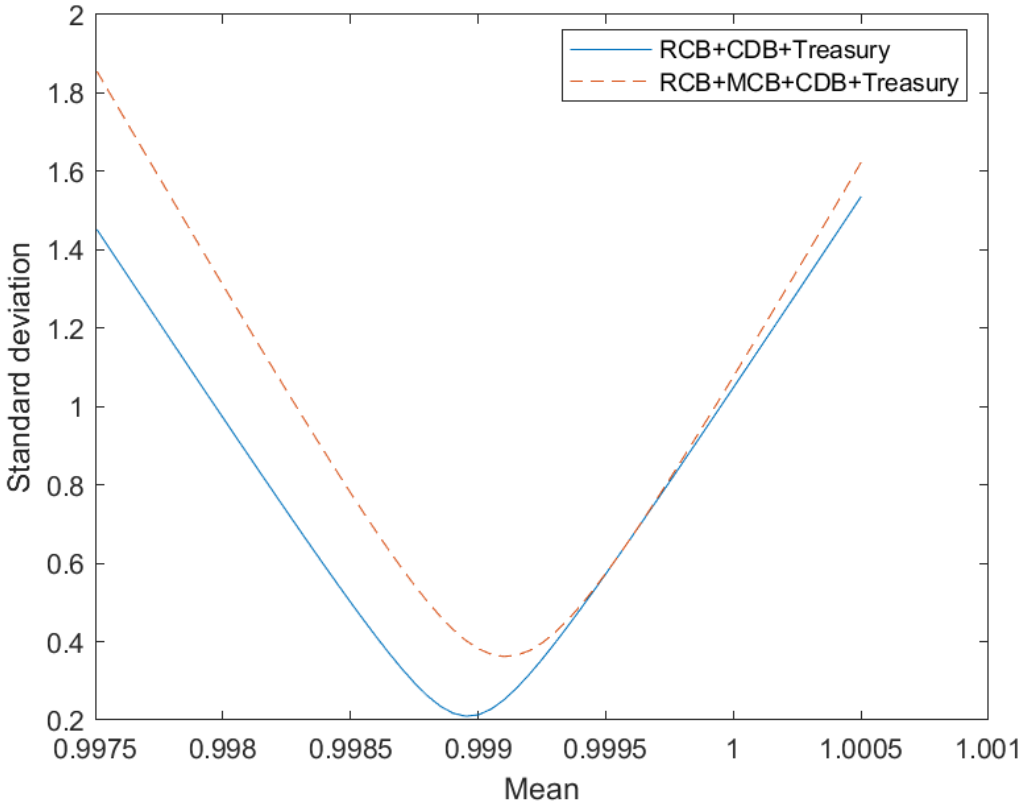

Figure 6.
Impulse response.
This figure presents impulse response functions for the effect of a one-standard-deviation shock in the residual spread of MCB portfolio on the residual spread of RCB portfolio. Shocks are orthogonalized using a Cholesky decomposition, and are based on the VAR results in Table 2. Sample period is from January 2010 to June 2019.

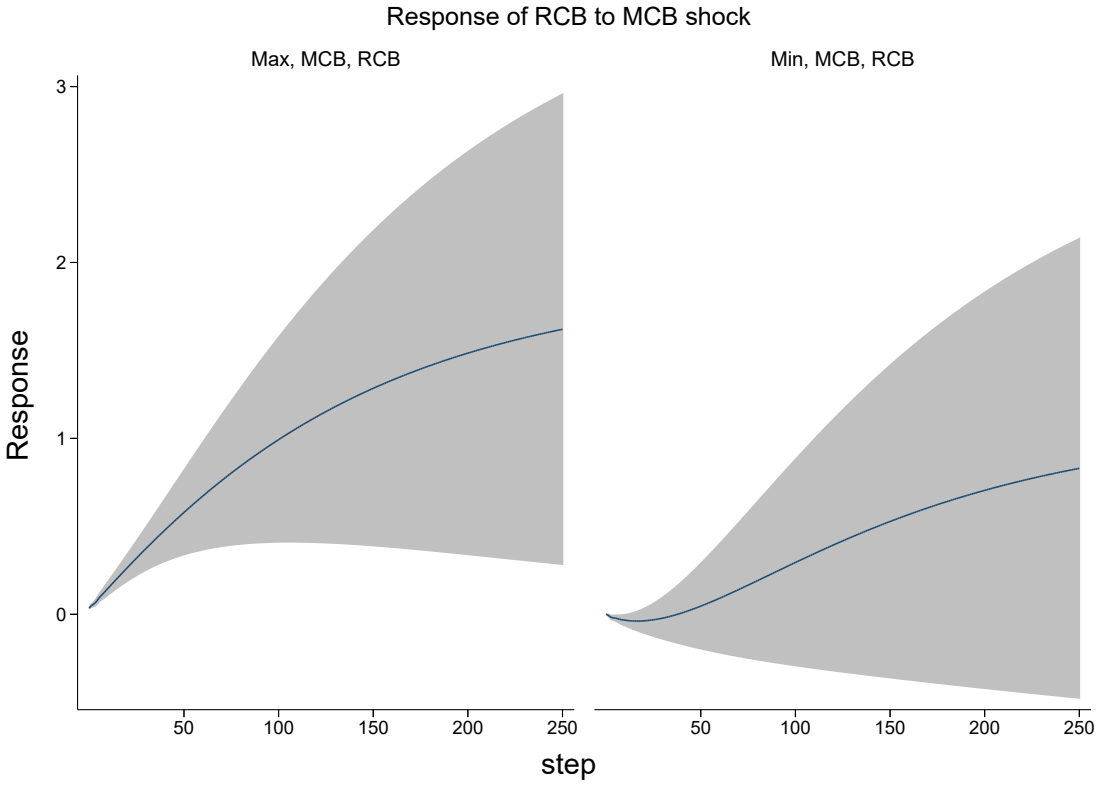

Figure 7.
Maturity impact of MCB: different maturity bins.
This figure presents the impact of MCB on different maturities. For each city, we calculate the fraction of MCB maturing in less than one year (MCBY0), one to five years (MCBY1) and no less than five years (MCBY5). The coefficient and 95% confidence interval of MCBY0 estimated from logit regression where the dependent variable takes a value of one if RCB has a maturity of (0,1) year and zero otherwise, MCBY1 from regression where the dependent variable takes a value of one if RCB has a maturity of [1,5) years and zero otherwise, and MCBY5 from regression where the dependent variable takes a value of one if RCB has a maturity of [5,) years and zero otherwise are displayed.

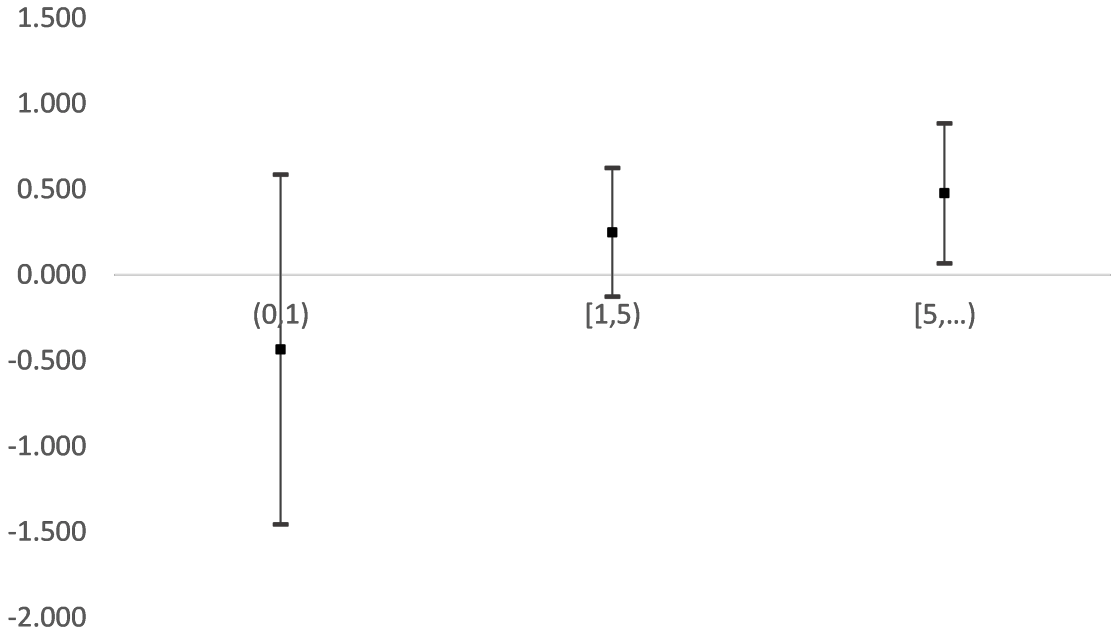

Figure 8.
Maturity impact of Muni and MCB: Provincial Level.
This figure presents the maturity impact of Muni and MCB at provincial level. For each province, we calculate the fraction of Muni or MCB maturing in less than one year (MuniY0, MCBY0), one to five years (MuniY1, MCBY1) and no less than five years (MuniY5, MCBY5). Panel A displays the coefficient and 95% confidence interval of MuniY0 estimated from logit regression where the dependent variable takes a value of one if RCB has a maturity of (0,1) year and zero otherwise, MuniY1 from regression where the dependent variable takes a value of one if RCB has a maturity of [1,5) years and zero otherwise, and MuniY5 from regression where the dependent variable takes a value of one if RCB has a maturity of [5,) years and zero otherwise. Panel B displays the estimates of MCBY0, MCBY1 and MCBY5.

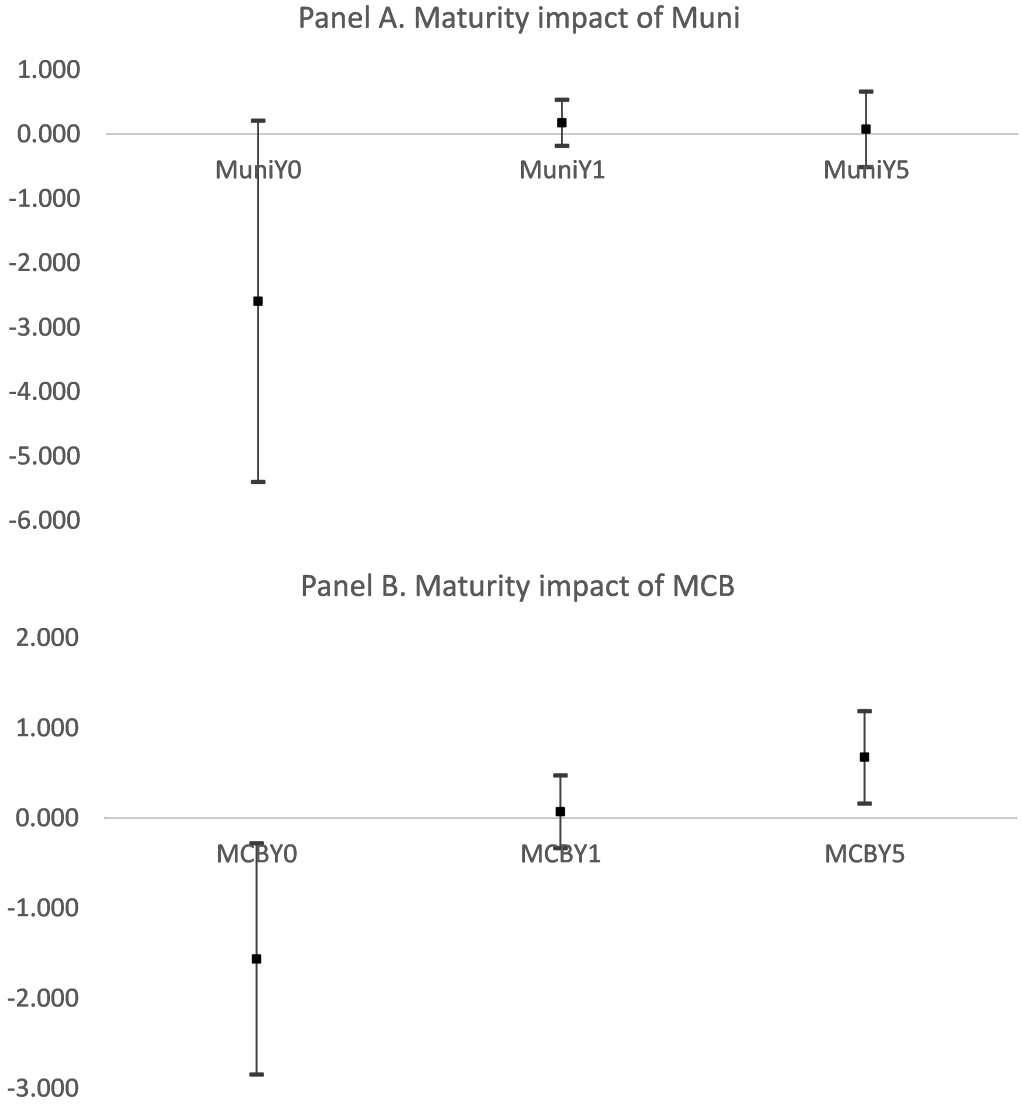

Figure 9.
The issue of long-term RCB and long-term MCB in different subsamples.
This figure shows how the issue of long-term RCB varies with the outstanding share of long-term MCB for firms with high or low exposure to government spending. The graphs are based on the estimation of logit estimation of Column (1) in Table 10 with the interaction term between MCBY5 and High. The shadow areas are 95% confidence intervals.

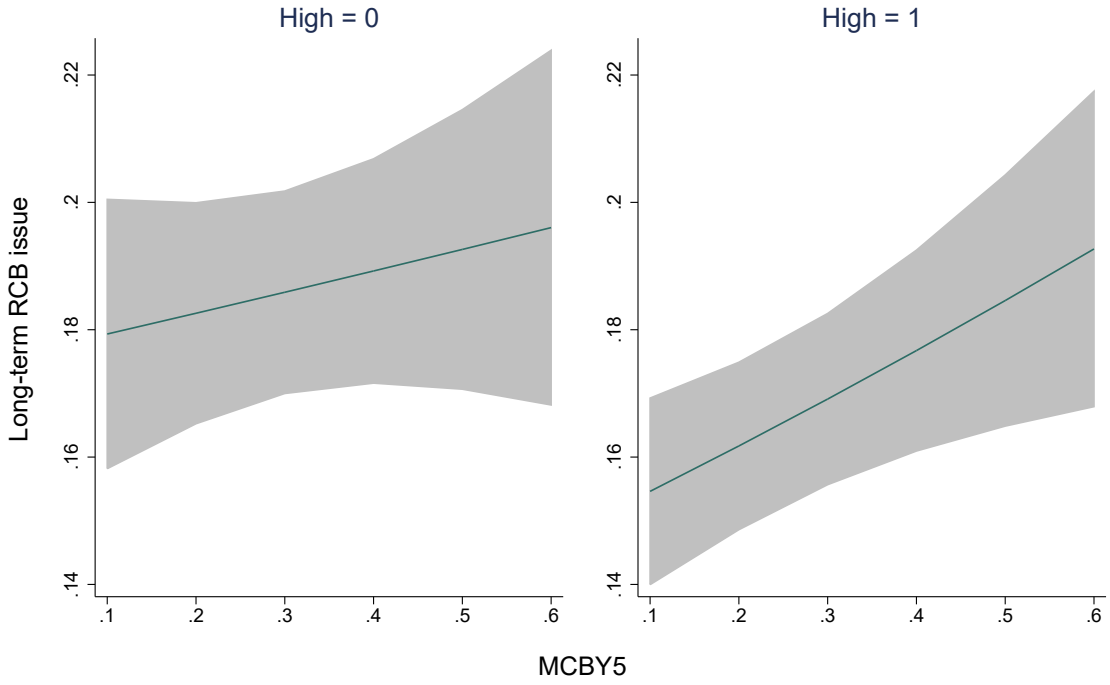

Table 1.
Summary statistics.
This table reports the summary statistics for RCB, MCB, EB and Muni. Bond characteristics include: coupon rate, bond rating at issue (1= AAA, 2=AA+, 3=AA, etc.), maturity (year), issuance (Billion RMB), Embed with 1 indicating that the bond is issued with special terms and 0 otherwise, IB with 1 indicating that the bond is traded on the interbank market and 0 indicating that it is traded on the exchange market, SOE with 1 indicating that the issuer is SOE and 0 otherwise, daily yield spread and weekly bond return (%). Distribution statistics include mean, median, standard deviation and number of observations. The sample period is from January 2010 to June 2019.

	RCB				MCB			
	Mean	Median	Std	Obs	Mean	Median	Std	Obs
Coupon	4.85	4.80	1.34	18459	5.51	5.48	1.42	11560
BondRating	1.36	1.00	0.72	10546	2.06	2.00	0.87	7852
Maturity	1.71	1.00	1.63	18459	4.03	5.00	2.65	11560
Issuance	14.62	10.00	19.23	18459	9.99	10.00	6.77	11560
Embed	0.14	0.00	0.35	18459	0.45	0.00	0.50	11560
IB	0.95	1.00	0.21	18459	0.87	1.00	0.34	11560
SOE	0.75	1.00	0.43	18040	1.00	1.00	0.02	11474
DailySpread	1.54	1.19	1.18	681907	1.80	1.68	0.97	544433
WeeklyRet	0.11	0.08	0.52	198184	0.16	0.09	0.86	152697
	EB				Muni			
	Mean	Median	Std	Obs	Mean	Median	Std	Obs
Coupon	5.32	5.15	1.16	520	3.49	3.51	0.52	3189
BondRating	1.45	1.00	0.81	520	1.00	1.00	0.00	3092
Maturity	9.11	10.00	3.92	520	6.21	5.00	3.30	3189
Issuance	23.82	15.00	28.05	520	60.94	42.28	62.08	3189
Embed	0.23	0.00	0.42	520	0.00	0.00	0.05	3189
IB	0.69	1.00	0.46	520	0.88	1.00	0.33	3189
SOE	0.94	1.00	0.24	417				
DailySpread	1.53	1.02	1.48	60097	-0.08	-0.09	0.31	33238
WeeklyRet	0.13	0.09	0.96	16737	0.11	0.07	0.41	7018

Table 2.
Price discovery.
This table reports the information share in RCB attributable to MCB, EB or Muni using the daily orthogonalized yield spreads via VARs. The column labeled Max denotes the variance decomposition with MCB, EB or Muni ordered first in the system; the column labeled Min denotes the variance decomposition with MCB, EB or Muni ordered last in the system. N is the number of daily observations. Sample period is from January 2010 to June 2019.

VAR	Max	Min	N
MCB	17.40%	4.73%	2360
Comparison			
EB	0.62%	0.09%	2345
Muni	1.42%	0.90%	1866

Table 3.
Price discovery: Degree of implicit guarantee.
This table reports the price discovery of MCB by the degree of implicit guarantee. In Panel A and Panel B, we sort all cities in our sample into three groups according to their annual fiscal surplus or GDP per capita, respectively. In each group, we form equal weighted RCB and MCB portfolios, and estimate the information share in RCB from MCB. In Panel C, we construct three categories of MCB portfolios according to LGFVs' administration level. Information share in RCB formed on all RCBs attributable to three types of MCB are reported. Sample period is from January 2010 to June 2019.

	Max	Min	N
Panel A. Fiscal Surplus			
Low	1.55%	1.30%	2108
Medium	4.13%	2.73%	2343
High	16.90%	4.58%	2360
Panel B. GDP per Capita			
Low	0.15%	0.09%	2289
Medium	6.06%	3.90%	2346
High	16.50%	4.80%	2359
Panel C. Administration Level			
County	12.40%	11.50%	2341
City	12.50%	9.93%	2353
Province	15.70%	2.19%	2360

Table 4.
Price discovery across markets.
This table reports the average information share in RCB traded in each of the two trading platforms – Interbank market (IB) versus exchange market (EX) attributable to MCB, EB or Muni either in the same or different trading platforms. Avg. is the average value of maximum and minimum information share.

Market	Avg.	N	Avg.	N	Avg.	N
RCB, Test	MCB		EB		Muni	
EX,EX	20.00%	2299	0.50%	2299	19.85%	858
EX,IB	5.73%	2298	0.27%	2267	0.12%	1777
IB,EX	15.80%	2299	0.77%	2299	0.72%	858
IB,IB	3.47%	2359	0.27%	2313	4.69%	1811

Table 5.
Price discovery across maturity bins.
This table reports the average information share in RCB attributable to MCB, EB or Muni either in the same or different maturity bins. Three maturity bins, i.e., (0,1), [1,5) and [5,...), are examined.

Maturity	Avg.	N	Avg.	N	Avg.	N
RCB, Test	MCB		EB		Muni	
(0,1),(0,1)	**21.50%**	1456	0.16%	2157	1.74%	737
(0,1),[1,5)	6.59%	2353	0.38%	2326	0.25%	1796
(0,1),[5,)	6.04%	2349	0.13%	2328	0.48%	957
$[1,5),(0,1)$	1.16%	1456	0.07%	2157	0.16%	737
[1,5),[1,5)	**12.16%**	2353	0.87%	2326	0.25%	1796
$[1,5),[5,)$	6.27%	2349	4.99%	2328	1.35%	957
$[5,),(0,1)$	1.46%	1338	1.88%	2073	0.07%	641
$[5,),[1,5)$	4.60%	2229	2.74%	2223	0.20%	1691
[5,),[5,)	**6.33%**	2235	1.32%	2226	1.22%	853

Table 6.
Price discovery in the location dimension.
This table compares the price discovery impact of MCB, EB and Muni on RCB for each of the seven regions in China. Average information share in RCB in each region attributable to MCB, EB or Muni is reported.

Region	Avg.	N	Avg.	N	Avg.	N
	MCB		EB		Muni	
North China	2.52%	2350	1.47%	2340	0.60%	789
East China	14.70%	2356	0.17%	2286	0.63%	1029
South China	4.75%	2224	3.59%	1960	6.65%	854
Center China	4.32%	2334	4.90%	2158	0.70%	745
Northeast	4.67%	2326	0.98%	1332	0.35%	646
Northwest	2.61%	2214	3.63%	566	0.90%	644
Southwest	15.45%	2326	0.57%	1563	1.60%	851

Table 7.
Price discovery in the industry dimension.
This table compares the price discovery impact of MCB and EB on RCB by industries. Average information share in RCB in each industry attributable to MCB, EB or Muni is reported.

	Avg.	N	Avg.	N
	MCB		EB	
Agriculture	0.41%	361	0.28%	210
Mining	2.43%	458	1.94%	1892
Manufacturing	2.33%	1439	2.49%	1616
Electricity,Heat & Gas	**12.15%**	**2317**	**14.80%**	**2322**
Construction	4.63%	2346	4.40%	2189
Wholesale & Retail	0.87%	2067	2.45%	706
Transportation	**19.15%**	**1836**	**6.32%**	**1528**
Accommodation & Catering	0.50%	317		
IT	1.81%	492	4.11%	728
Real Estate	5.80%	1891	1.61%	1437
Leasing	2.64%	1443		
Public utility	3.81%	1418	**8.52%**	**698**
Other Services	2.45%	420		
Comprehensive Industry	2.66%	1857	1.41%	1758

Table 8.
Spanning enhancement.
This table reports the full sample spanning test results. Test asset is the equal weighted portfolio of MCB in Panel A, EB in Panel B and Muni in Panel C. The constituents of existing assets are labelled in the first row. The spanning hypothesis is that existing asset returns span test asset returns. We employ six spanning test statistics in Kan and Zhou (2012) using the weekly bond portfolio returns. W is the Wald test under conditional homoscedasticity; We is the Wald test under the IID elliptical; Wa is the Wald test under the conditional heteroscedasticity; J_1 is the Bekaert-Urias test with the Errors-in-Variables (EIV) adjustment; J_2 is the Bekaert-Urias test without the EIV adjustment; J_3 is the DeSantis test. All six tests have an asymptotic chi-squared distribution with $2N$ ($N = 1$) degrees of freedom. We also present the annualized Sharpe ratios of portfolios of existing assets alone (λ_B) and bench assets plus test assets (λ_{B+T}), and the number of weekly observations (T). The sample period is from January 2010 to June 2019.

Existing	W	We	Wa	J_1	J_2	J_3	λ_B/λ_{B+T}	T
Panel A. Test Asset: MCB								
RCB	220.35	121.71	103.24	50.82	45.00	119.24	4.11/4.11	483
P-value	0.00	0.00	0.00	0.00	0.00	0.00		
RCB+Treasury	219.90	127.86	104.41	50.70	44.90	117.90	4.49/4.49	483
P-value	0.00	0.00	0.00	0.00	0.00	0.00		
RCB+Treasury+CDB	209.59	132.48	107.16	50.82	45.21	110.80	4.69/4.69	483
P-value	0.00	0.00	0.00	0.00	0.00	0.00		
RCB+EB+Muni+ Treasury+CDB	133.06	67.04	55.23	29.94	26.13	67.63	4.29/4.30	388
P-value	0.00	0.00	0.00	0.00	0.00	0.00		
Panel B. Test Asset: EB								
RCB+Treasury+CDB	27.36	23.82	24.39	21.19	21.25	21.77	4.73/4.78	482
P-value	0.00	0.00	0.00	0.00	0.00	0.00		
Panel C. Test Asset: Muni								
RCB+Treasury+CDB	4.90	2.37	5.75	5.52	5.50	4.97	4.24/4.24	388
P-value	0.09	0.31	0.06	0.06	0.06	0.08		

Table 9.
Spanning enhancement: Degree of implicit guarantee.
This table reports the spanning enhancement of MCB by the degree of implicit guarantee. In Panel A and Panel B, we sort all cities in our sample into three groups according to their annual fiscal surplus or GDP per capita, respectively. In each group, we form equal weighted RCB and MCB portfolio, and investigate whether MCB spans the set of RCB, treasury and CDB portfolio. In Panel C, we construct three categories of MCB portfolios according to LGFVs' administration level, and examine their improvement in opportunity sets relative to RCB, treasury and CDB. Sample period is from January 2010 to June 2019.

	J_1	λ_B/λ_{B+T}	T
Panel A. Fiscal Surplus			
Low	14.00***	1.82/2.46	454
Medium	14.96***	3.33/3.79	480
High	64.99***	4.56/4.56	483
Panel B. GDP per Capita			
Low	16.47***	2.20/2.77	471
Medium	20.27***	3.59/3.84	480
High	65.32***	4.61/4.61	482
Panel C. Administration Level			
County	24.43***	4.68/4.69	478
City	45.96***	4.69/4.69	482
Province	56.74***	4.69/4.70	483

Table 10.
Maturity impact of MCB.
This table presents logit models of long-term RCB issues where the dependent variable takes a value of one if the bond a maturity of [5,...) years, and zero otherwise. In Column (1) and (2), indenpendent variable is the fraction of MCB due in no less than five years in city i where RCB issuers and MCB issuers are located. In Column (3) and (4), indenpendent variable is the fraction of MCB due in no less than five years in other cities except city i. Column (1) and (3) are estimated through logit regressions, and Column (2) and (4) are estimated through OLS regressions. The sample consists of all RCB issues between January 2010 to June 2019. Panel A displays the coefficient estimates of the logit or OLS regressions. Panel B displays marginal effects for outstanding share of MCB in logit regressions where the other covariates are evaluated at the mean values. Absolute values of t-statistics are in parentheses below the corresponding coefficient estimates. *p <0.10,**p <0.05,***p <0.01.

	(1) Logit	(2) OLS	(3) Logit	(4) OLS
Panel A. Logit models estimate				
L1 $MCBY5$	0.476**	0.062***		
	(2.29)	(3.70)		
L1 $MCBY5_{NonLocal}$			0.303	0.042
			(0.74)	(1.22)
IssuerRating	-0.675***	-0.086***	-0.674***	-0.086***
	(-6.53)	(-4.92)	(-6.45)	(-4.86)
SOE	0.385***	0.047**	0.382***	0.047**
	(2.96)	(2.36)	(2.94)	(2.35)
Log(Asset)	-0.281***	-0.039**	-0.283***	-0.039**
	(-3.73)	(-2.40)	(-3.73)	(-2.39)
Lev	-0.025***	-0.003***	-0.025***	-0.003***
	(-9.16)	(-5.35)	(-9.14)	(-5.42)
ROA	-0.022*	-0.003	-0.022*	-0.003
	(-1.73)	(-1.33)	(-1.75)	(-1.38)
AssetMat	0.017***	0.003***	0.017***	0.003***
	(2.68)	(3.50)	(2.64)	(3.42)
Log(GDP)	0.208	-0.022	0.339	-0.003
	(0.53)	(-0.47)	(0.88)	(-0.06)
FiscalSurplus	0.052	0.007	0.040	0.006
	(1.19)	(1.48)	(0.83)	(1.05)
LGFVr	0.008	0.001*	0.008	0.001
	(1.61)	(1.78)	(1.44)	(1.67)
Constant	-2.106	0.779**	-2.989	0.659*
	(-0.67)	(2.39)	(-0.96)	(2.05)
Ind, City & YQ FE	Yes	Yes	Yes	Yes
Obs.	13,781	14,050	13,781	14,050
Pseudo/Adj. R2	0.133	0.122	0.133	0.121
Panel B. Marginal effects evaluated at means				
	0.057**		0.036	
	(2.29)		(0.74)	

Table 11.
Maturity impact of MCB under different treasury market conditions.
This table presents logit models of long-term RCB issues where the dependent variable takes a value of one if the bond issue had a maturity of [5,...) years, and zero otherwise. Treasury market conditions are proxied by three variables: $TSY5$, the ratio of treasuries due in no less than five years over total outstanding treasuries; $TSGDPY5$, the ratio of treasuries due in no less than five years over GDP; $TSTOY5$, turnover rate of treasuries due in no less than five years. I_{TSY5} ($I_{TSGDPY5}$ or I_{TSTOY5}) equals one if $TSY5$ ($TSGDP5$, or $TSTOY5$) is smaller than the sample median, and zero otherwise. Panel A displays the coefficient estimates of the logit model. Panel B displays marginal effects for outstanding share of MCB where the other covariates are evaluated at the mean values the indicated subsamples. Absolute values of t-statistics are in parentheses below the corresponding coefficient estimates. *p <0.10,**p <0.05,***p <0.01.

	(1)	(2)	(3)
Panel A. Logit models estimate			
L1 $MCBY5$	0.422**	0.349*	0.375*
	(2.33)	(1.80)	(1.95)
L1 $MCBY5 \times I_{TSY5}$	0.125		
	(0.50)		
L1 $MCBY5 \times I_{TSGDPY5}$		0.241	
		(1.01)	
L1 $MCBY5 \times I_{TSTOY5}$			0.199
			(0.85)
Control	Yes	Yes	Yes
Ind, City & YQ FE	Yes	Yes	Yes
Obs.	13,781	13,781	13,781
Pseudo R2	0.133	0.133	0.133
Panel B. Marginal effects evaluated at means			
$\leq$ Median	0.061***	0.071***	0.063***
	(2.64)	(3.14)	(3.08)
$>$ Median	0.054**	0.042*	0.049*
	(2.33)	(1.80)	(1.96)

Table 12.
Maturity impact of MCB by issuance purposes.
This table presents logit models of long-term RCB issues where the dependent variable takes a value of one if the bond issue had a maturity of [5,...) years, and zero otherwise. Independent variable is: the fraction of local MCB due in no less than five years used for bank loan repayment ($MCBY5_{BankLoan}$) in Column (1); the fraction of local MCB due in no less than five years used for investment ($MCBY5_{Invest}$) in Column (2); and the fraction of local MCB due in no less than five years used for other purposes ($MCBY5_{Other}$) in Column (3). Panel A displays the coefficient estimates of the logit model. Panel B displays marginal effects for outstanding share of MCB where the other covariates are evaluated at the mean values. Absolute values of t-statistics are in parentheses below the corresponding coefficient estimates. *p <0.10,**p <0.05,***p <0.01.

	(1)	(2)	(3)	(4)
Panel A. Logit models estimate				
L1 $MCBY5_{BankLoan}$	1.978			2.063
	(1.56)			(1.64)
L1 $MCBY5_{Invest}$		0.497***		0.529***
		(3.00)		(3.19)
L1 $MCBY5_{Other}$			3.968**	3.899**
			(2.57)	(2.47)
Control	Yes	Yes	Yes	Yes
Ind, City & YQ FE	Yes	Yes	Yes	Yes
Obs.	8,713	8,713	8,713	8,713
Pseudo R2	0.150	0.150	0.150	0.151
Panel B. Marginal effects evaluated at means				
	0.255	0.064***	0.512**	
	(1.56)	(3.00)	(2.57)	

Table 13.
RCB issue spread and MCB maturity.
This table shows the impact of MCB maturity on RCB issue spread. Dependent variable is the issue spread of RCB belonging to maturity bin of [5,...). Independent variable is: the local outstanding fraction of MCB due in no less than five years in Column (1) and (2), and the non-local outstanding fraction of MCB due in no less than five years in Column (3) and (4). Industry, city and year-quarter fixed effects are controlled. Standard errors are clustered at issuer, city and year-quarter level. *p <0.10,**p <0.05,***p <0.01.

	(1)	(2)	(3)	(4)
L1 $MCBY5$	-0.252**	-0.218*		
	(-2.58)	(-2.02)		
L1 $MCBY5_{NonLocal}$			-0.199	-0.089
			(-0.89)	(-0.41)
Log(Issuance)	-0.099***	-0.082***	-0.099***	-0.081***
	(-5.50)	(-2.93)	(-5.56)	(-2.92)
Maturity	0.021	0.031*	0.021	0.031*
	(0.98)	(1.83)	(0.98)	(1.77)
BondRating	0.598***	0.552***	0.598***	0.551***
	(15.45)	(13.56)	(15.45)	(13.46)
Embed	0.472***	0.425***	0.473***	0.423***
	(5.65)	(6.91)	(5.72)	(6.85)
FixRate	0.366***	0.376***	0.366***	0.374***
	(4.54)	(5.50)	(4.58)	(5.45)
MarketID	0.086	0.066	0.090	0.070
	(1.07)	(0.82)	(1.11)	(0.85)
SOE	-0.584***	-0.749***	-0.588***	-0.753***
	(-7.91)	(-7.74)	(-7.99)	(-7.80)
Log(Asset)		-0.052		-0.052
		(-1.42)		(-1.43)
Lev		0.006***		0.006***
		(2.78)		(2.73)
ROA		-0.050***		-0.051***
		(-6.73)		(-6.89)
AssetMat		-0.000***		-0.000***
		(-5.99)		(-5.99)
Log(GDP)		-0.002		-0.038
		(-0.01)		(-0.10)
FiscalSurplus		-0.009		-0.004
		(-0.33)		(-0.13)
LGFVr		0.008**		0.008**
		(2.57)		(2.66)
Constant	0.397**	0.144	0.380**	0.352
	(2.69)	(0.06)	(2.24)	(0.14)
Ind, City & YQ FE	Yes	Yes	Yes	Yes
Obs.	2,854	2,436	2,854	2,436
Adjusted R2	0.554	0.601	0.553	0.600

Figure A1.
Bond market investor.
This figure presents the investor structure for major bond securities reported by CCDC in June 2019.

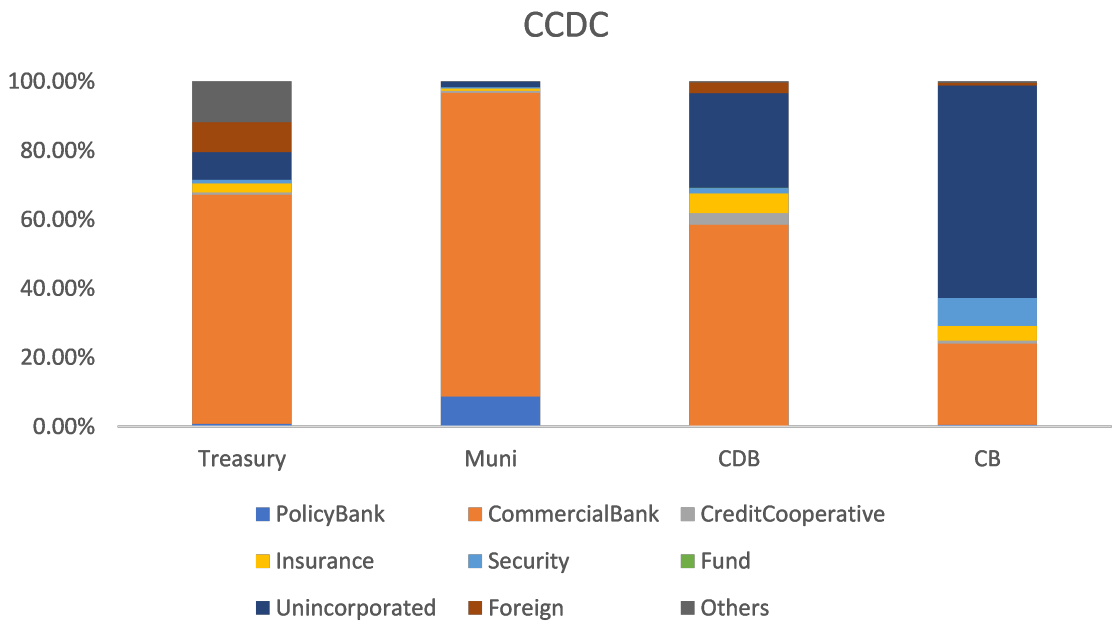

Figure A2.
Fraction of bonds, per maturity bin.
This figure plots the distribution of number of corporate bond across maturities for bonds issued between January 2010 and June 2019.

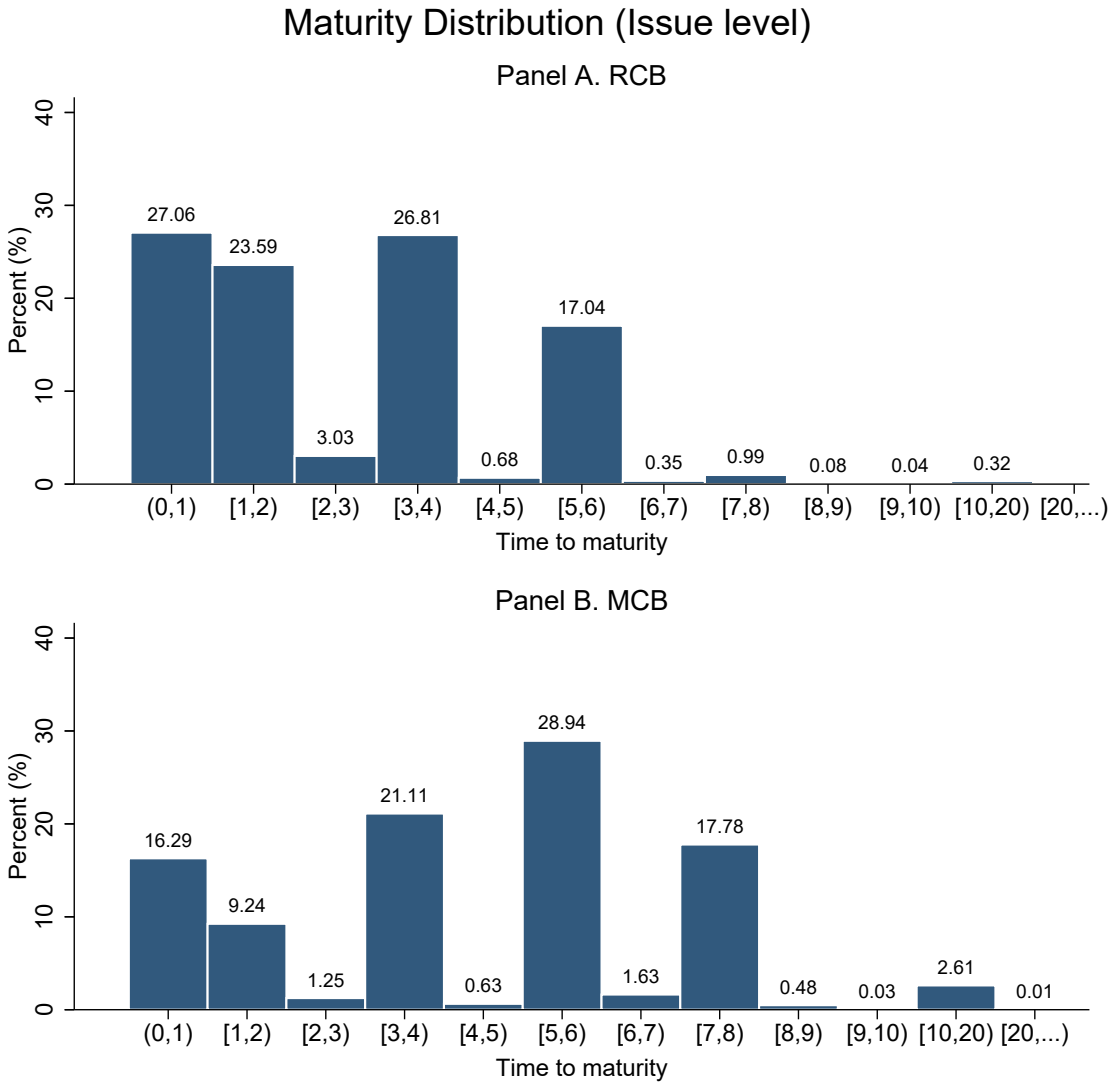

Figure A3.
Impact of MCB on RCB issue spread: across maturity bins.
This figure shows the impact of MCB maturity on RCB issue spread across maturity bins by regressing RCB issue spread on outstanding share of MCB belonging to the same maturity bin. The coefficient and 95% confidence intervals of MCBY0, MCBY1 and MCBY5 are presented.

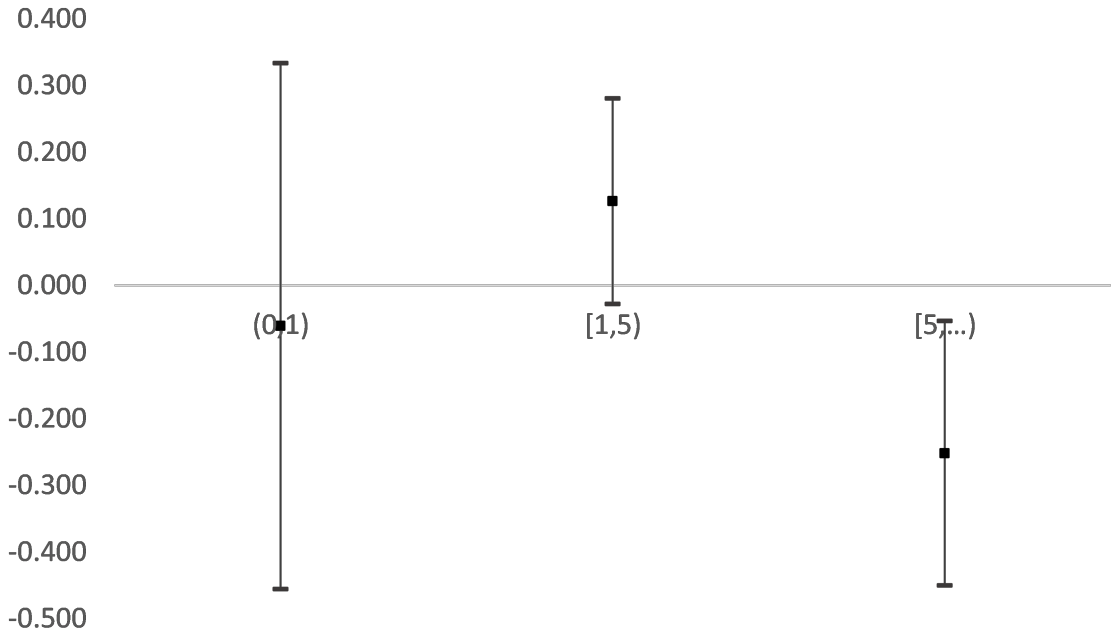

Table A1.
Variable list and descriptions.

Variable	Descriptions
Coupon	Annual coupon payments paid by the issuer relative to the bond's face or par value
BondRating	1=AAA, 2=AA+, 3=AA, etc
Maturity	Number of years remaining until maturity
Issuance	Billon RMB
Embed	Equals one if the bond is issued with special terms, and zero otherwise
FixRate	Equals one if the bond is fixed-rate, and zero otherwise
IB	Equals one if the bond is traded on interbank market, and zero if traded on exchange market
SOE	Equals one if bond issuer is state-owned, and zero if it is non-state-owned
Spread	Bond yield minus CDB yield with similar maturity
$MCBY5$	Fraction of MCB maturing in over five years, measured quarterly, city level
$MCBY5_{NonLocal}$	Fraction of MCB whose issuers are located in cities except city i maturing in over five years, measured quarterly, city level
I_{TSY5}	Equals one if outstanding amount of treasury maturing in no less than five years over total outstanding treasury is below the sample median, and zero otherwise.
$I_{TSGDPY5}$	Equals one if outstanding amount of treasury maturing in no less than five years over GDP is below the sample median, and zero otherwise.
I_{TSTOY5}	Equals one if the turnover of treasury maturing in no less than five years is below the sample median, and zero otherwise. Turnover is defined as the aggregate quarterly trading volume scaled by outstanding amount.
$MCBY5_{BankLoan}$	Fraction of MCB used for bank loan repayment maturing in over five year, measured quarterly, city level
$MCBY5_{Invest}$	Fraction of MCB used for investment maturing in over five year, measured quarterly, city level
$MCBY5_{Other}$	Fraction of MCB used for other purposes maturing in over five year, measured quarterly, city level
Log(GDP)	Log of local GDP
FiscalSurplus	Difference of fiscal revenue and expenditure scaled by local GDP
EstateInv	Completed investment in real estate industry scaled by local GDP
LGFVr	LGFV debt oustanding from MCB issuers' short- and long-term liabilities (defined as in Huang et al. (2020b) scaled by local GDP
Term	The spread between the 10-year treasury yield and 1-year treasury yield, measured quarterly.
Def	The spread between AAA corporate bond and 10-year treasury yield, measured quarterly.
Trea10y	10-year treasury yield

Table A2.
Price discovery: Degree of marketization.
This table reports the price discovery impact by the degree of marketization. In Panel A and Panel B, we sort all provinces in our sample into three groups according to the marketization index in Wang et al. (2019). In each group, we form equal weighted RCB, MCB, EB and Muni portfolio, and estimate the information share of MCB, EB or Muni in RCB.

Marketization	Avg.	N	Avg.	N	Avg.	N
	MCB		EB		Muni	
Low	0.44%	2345	5.67%	2061	0.32%	860
Medium	9.78%	2344	0.10%	1960	0.45%	902
High	15.96%	2359	1.15%	2340	0.64%	1150

Table A3.
Price discovery: Issuer characteristics.
This table reports the price discovery impact by issuer characteristics. We sort all bonds in our sample into two groups (AAA and Below AAA) according to the issuers rating in Panel A, and sort all bonds into SOE and NonSOE in Panel B. In each group, we form equal weighted RCB and MCB portfolio, and estimate the information share of MCB in RCB.

RCB, MCB	Max	Min	N
Panel A. Issuer Rating			
AAA,AAA	6.98%	0.61%	2344
AAA,Below AAA	3.98%	1.82%	2357
Below AAA,AAA	5.01%	1.54%	2343
Below AAA,Below AAA	15.50%	11.60%	2357
Panel B. SOE			
SOE,SOE	17.30%	5.04%	2360
NonSOE,SOE	19.90%	14.90%	2356

Table A4.
Spanning enhancement across markets.
This table reports the spanning enhancement of MCB relative to RCB, treasury and CDB either in the same or different trading platforms. We also compare the performance of MCB with EB and Muni. J_1 test statistic, maximum Sharpe ratio and number of weekly observations are reported.

Market	J_1	λ_B/λ_{B+T}	T	J_1	λ_B/λ_{B+T}	T	J_1	λ_B/λ_{B+T}	T
	Test: MCB			Test: EB			Test: Muni		
EX,EX	30.36***	4.58/6.35	294	2.23	4.58/4.65	294	4.21	4.89/4.94	153
EX,IB	9.63***	4.58/5.12	294	0.97	4.53/4.56	286	15.56***	4.26/4.28	225
IB,EX	24.55***	4.54/5.00	474	13.48***	4.54/5.66	474	1.51	5.46/5.50	189
IB,IB	58.86***	4.42/4.42	483	9.85***	4.44/4.45	474	1.74	3.93/3.93	372

Table A5.
Spanning enhancement by maturity.
This table reports the spanning enhancement of MCB relative to RCB, treasury and CDB with similar maturities. Three maturity bins, i.e., (0,1), [1,5) and [5,...), are examined. We also compare the performance of MCB with EB and Muni. J_1 test statistic, maximum Sharpe ratio and number of weekly observations are reported.

Maturity	J_1	λ_B/λ_{B+T}	T	J_1	λ_B/λ_{B+T}	T	J_1	λ_B/λ_{B+T}	T
	Test: MCB			Test: EB			Test: Muni		
(0,1),(0,1)	5.64**	7.85/8.00	301	2.93	6.00/6.05	470	3.31	7.47/7.47	155
$[1,5),[1,5)$	19.68***	3.26/3.52	483	10.38***	3.27/3.37	479	16.00***	2.67/2.70	373
$[5,),[5,)$	43.15***	1.67/3.01	459	23.56***	1.63/2.21	458	12.48***	1.62/1.83	165

Table A6.
Spanning enhancement at regional dimension.
This table compares the spanning enhancement of MCB, EB and Muni relative to existing assets at regional level. For each of the seven regions in China, we construct equal weighted portfolios of RCB, MCB, EB and Muni. Existing assets include regional RCB portfolio, whole market treasury and CDB portfolio. Test asset is regional MCB, EB or Muni portfolio. J_1 test statistic, maximum Sharpe ratio and number of weekly observations are reported.

Area	J_1	λ_B/λ_{B+T}	T	J_1	λ_B/λ_{B+T}	T	J_1	λ_B/λ_{B+T}	T
	Test: MCB			Test: EB			Test: Muni		
North China	29.29***	3.89/3.92	480	10.79***	3.89/3.94	480	0.38	5.52/5.52	152
East China	43.13***	4.21/4.29	481	3.90	4.25/4.35	479	0.95	5.94/5.97	205
South China	13.05***	3.04/3.15	463	0.47	3.06/3.06	444	1.45	3.71/3.72	163
Center China	19.89***	3.02/3.67	476	0.68	2.92/2.93	465	24.30***	3.74/4.89	136
Northeast	17.04***	2.46/3.11	478	4.42	2.17/2.37	313	0.88	3.04/3.06	132
Northwest	3.14	3.07/3.10	464	8.40**	2.51/2.78	147	1.05	3.99/4.05	112
Southwest	13.17***	2.29/3.01	481	4.55	2.60/2.66	359	9.86***	2.95/3.30	176

Table A7.
Spanning enhancement at industry dimension.
This table compares the spanning enhancement of MCB and EB relative to existing assets at industry level. For each industry, we construct equal weighted portfolios of RCB, MCB and EB. Existing assets include industry RCB portfolio, whole market treasury and CDB portfolio. Test asset is industry MCB or EB portfolio. J_1 test statistic, maximum Sharpe ratio and number of weekly observations are reported.

Industry	J_1	λ_B/λ_{B+T}	T	J_1	λ_B/λ_{B+T}	T
	Test: MCB			Test: EB		
Agriculture	5.78*	2.09/2.64	91	5.08**	3.44/3.63	66
Mining	2.66	5.47/5.57	143	8.14**	3.12/3.17	436
Manufacturing	1.81	5.00/5.00	333	7.16**	4.02/4.03	373
Electricity,Heat & Gas	17.24***	2.94/3.13	477	8.86**	2.96/3.05	479
Construction	23.80***	2.68/3.66	480	7.73**	2.72/2.92	470
Wholesale & Retail	2.47	3.47/3.50	447	3.79	2.42/2.67	153
Transportation	15.54***	3.08/3.52	379	0.34	2.19/2.20	369
Accommodation & Catering	0.69	0.34/0.45	88			
IT	1.04	1.27/1.30	140	0.12	1.39/1.40	248
Real Estate	11.89***	2.75/3.22	400	5.41*	1.77/1.80	353
Leasing	24.81***	1.95/2.88	327			
Public utility	6.23**	2.14/2.37	334	5.00*	1.92/2.18	235
Other Services	6.77**	1.43/2.01	130			
Comprehensive Industry	40.25***	3.51/4.79	379	13.69***	3.47/3.97	375

Table A8.
Spanning enhancement: Degree of marketization.
This table reports the spanning enhancement by the degree of marketization. In Panel A and Panel B, we sort all provinces in our sample into three groups according to the marketization index in Wang et al. (2019). In each group, we form equal weighted RCB, MCB, EB and Muni portfolio, and investigate whether MCB, EB or Muni spans the set of RCB, treasury and CDB portfolio.

Marketization	J_1	λ_B/λ_{B+T}	T	J_1	λ_B/λ_{B+T}	T	J_1	λ_B/λ_{B+T}	T
	Test: MCB			Test: EB			Test: Muni		
Low	23.15***	4.04/4.29	482	1.64	3.95/3.97	454	1.04	5.67/5.70	167
Medium	21.25***	3.51/3.78	481	2.41	3.36/3.41	443	2.98	4.90/5.50	184
High	63.74***	4.45/4.46	481	18.31***	4.47/4.49	481	0.01	5.78/5.79	227

Table A9.
Summary statistics by maturity at issue.
This table presents issue-level summary statistics for RCB by different maturity buckets. The sample consists of RCBs issued from January 2010 to June 2019. Panel A displays summary statistics for the level share of local MCB belonging to different maturity bins. MCBY0, MCBY1 and MCBY5 are lagged one quarter relative to the issue date of RCB. Panel B is about the characteristics of individual RCB. Panel C presents the characteristics for issuers and cities. Panel D summarizes market conditions at the time of issuance. To mitigate the influence of extreme outliers, continuous variables have been winsorized at the 1st and 99th percentiles.

	(0,1)				[1,5)				[5,)			
	Mean	Median	Std	N	Mean	Median	Std	N	Mean	Median	Std	N
Panel A. Outstanding share of MCB												
MCBY0	0.19	0.20	0.12	4876	0.12	0.09	0.12	8409	0.13	0.14	0.12	3217
MCBY1	0.63	0.64	0.15	4876	0.55	0.60	0.25	8409	0.56	0.61	0.24	3217
MCBY5	0.18	0.15	0.15	4876	0.30	0.22	0.28	8409	0.29	0.20	0.27	3217
Panel B. Bond Characteristics												
Issuance	1.16	0.80	1.26	4876	0.88	0.50	1.16	8408	1.29	0.90	1.54	3216
BondRating	6.82	7.00	1.01	4876	2.59	1.00	2.28	8408	2.55	2.00	1.74	3216
Embed	0.19	0.00	0.39	4876	0.25	0.00	0.43	8408	0.67	1.00	0.47	3216
FixRate	1.00	1.00	0.00	4876	0.84	1.00	0.37	8408	0.37	0.00	0.48	3216
IB	1.00	1.00	0.01	4876	0.78	1.00	0.41	8408	0.36	0.00	0.48	3216
Panel C. Issuer and City Characteristics												
IssuerRating	1.78	2.00	0.84	4677	2.64	3.00	1.09	7431	2.17	2.00	0.90	2667
SOE	0.68	1.00	0.47	4677	0.48	0.00	0.50	7431	0.63	1.00	0.48	2667
Log(Asset)	3.95	3.86	1.14	4677	3.12	3.02	1.24	7431	3.37	3.31	1.34	2667
Lev	66.61	68.35	12.97	4677	63.58	65.18	14.69	7431	61.31	63.76	16.19	2667
ROA	2.98	2.50	2.77	4677	3.46	2.70	3.25	7431	3.63	2.90	3.27	2667
AssetMat	6.71	4.56	7.98	4677	6.44	4.54	7.58	7431	8.35	5.20	11.01	2667
Log(GDP)	6.88	7.03	0.93	4677	6.46	6.55	1.03	7431	6.59	6.66	1.05	2667
FiscalSurplus	-3.34	-2.93	2.80	4677	-3.84	-2.96	3.54	7431	-3.97	-3.06	3.50	2667
LGFVr	52.94	45.52	32.35	4677	44.94	40.88	34.12	7431	48.68	44.85	34.87	2667
Panel D. Market Condition												
Term	0.60	0.59	0.24	4876	0.66	0.62	0.27	8409	0.62	0.60	0.25	3217
Def	1.19	1.21	0.24	4876	1.31	1.30	0.29	8409	1.23	1.21	0.30	3217
Trea10y	3.38	3.43	0.39	4876	3.51	3.49	0.42	8409	3.38	3.43	0.41	3217

Table A10.
Maturity impact of MCB: robust check
This table presents the maturity impact of MCB at city-city level. For each city, we calculate the fraction of RCB and MCB maturing in less than one year (RCBY0, MCBY0), one to five years (RCBY1, MCBY1) and no less than five years (RCBY5, MCBY5). In Column (1)-(3), we regress RCBY0 on lagged MCBY0, RCBY1 on lagged MCBY1, and RCBY5 on lagged MCBY5 with city-level variables controlled, respectively. Absolute values of t-statistics are in parentheses below the corresponding coefficient estimates. *p <0.10,**p <0.05,***p <0.01.

	(1) (0,1)	(2) [1,5)	(3) [5,)
L1 MCBY0	2.051		
	(0.25)		
L1 MCBY1		-6.709**	
		(-2.03)	
L1 MCBY5			1.733
			(1.00)
Log(GDP)	-12.506	17.788*	-6.623
	(-1.48)	(1.93)	(-1.35)
FiscalSurplus	-0.354	0.305	0.092
	(-0.71)	(0.56)	(0.32)
LGFVr	-0.137	0.044	0.079
	(-1.58)	(0.44)	(1.01)
Constant	96.868**	-28.431	41.577
	(2.09)	(-0.57)	(1.54)
Observations	7,297	7,297	7,297
City & YQ FE	Yes	Yes	Yes
Adjusted R2	0.293	0.279	0.401