

# *Municipal Bonds: A New Financing Channel for Local Governments under the Tax Distribution System*

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**Abstract:** With the acceleration of China's urbanization process, the deep opening of the capital market and the acceleration of the pace of industrial structure adjustment and upgrading, how to solve the problem of capital source in the process of urban construction has become an important issue that needs to be solved and deserves attention. This paper introduces the relevant theoretical knowledge of municipal bonds, including the concept, classification, characteristics and functions of municipal bonds. The paper focuses on the analysis of the credit risk faced by municipal bonds, and introduces the KMV model to establish a credit risk model. This model evaluates the level of credit risk by considering the relationship between enterprise value and default probability, establishes the credit risk model of municipal bonds by using the KMV model, and puts forward the method of calculating the theoretical default probability. On this basis, a reasonable bond issuance scale is proposed.

## 1. Introduction

With the acceleration of urbanization, the deepening of capital market and the adjustment and upgrading of industrial structure in China, the problem of capital source in the process of urban construction has become increasingly prominent. The funds for urban infrastructure construction at all levels have always been borne by the central government and local governments. Therefore, it is necessary to explore new financing channels for urban construction.

At present, the issuance of municipal bonds is generally regarded as the main financing channel of urban construction funds in the world. Theoretically, municipal bonds refer to long-term debt financing instruments in which local governments or their authorized agents raise funds from the market. In the United States, municipal bonds, also known as state or local government bonds, are long-term debt instruments issued by state and local governments to finance spending on schools, roads, and other large projects, and sometimes to meet day-to-day budget needs. Municipal bonds, as a long-term debt financing tool issued by local governments, can effectively help local governments raise funds from the market. In Western countries, municipal bonds have become an important way of financing local governments in these countries and have played an important role in local infrastructure construction. At present, the proportion of municipal bonds in the whole

government debt system in the United States is about 20%. At the same time, municipal bonds are also an important part of the financial market. Especially in China's bond market, only the national debt issuance system is relatively perfect, while the proportion of corporate bonds and financial bonds issuance is relatively low, so investors have relatively few bond investment channels. Issuing municipal bonds will perfect the bond market of our country better. Through active exploration, scholars in our country have made a lot of research on the introduction of municipal bond financing. The existing literature mainly focuses on the necessity of municipal bond issuance and its significance for the development of real economy and market economy. Issuance of municipal bonds, compared with financial allocation, changed indirect financing to direct financing, using personal deposits to share the burden and risk of urban infrastructure construction; At the same time, municipal bonds have strong binding force and face the pressure of repayment of principal and interest when due, which will inevitably help improve the efficiency of urban infrastructure funds. At the same time, the issuance of municipal bonds can not only reduce the fair burden of large-scale public facilities between generations, but also play an important role in improving the bond market and reducing the burden of local finance. In addition, as an important part of the financial market, municipal bonds' issuance is of great significance to the perfection of China's capital market.

However, in the process of municipal bond issuance, a major difficulty is how to determine the appropriate issuance scale and control the credit risk. For municipal bonds, the reason why they are at risk is that the assets or income sources used to repay maturing debts are mainly local fiscal revenue or cash flow income of investment projects, and their credit risk comes from the uncertainty of these two. Municipal bonds are risky, so to speak.

## **2. Overview of Municipal Bonds**

### **2.1 The Concept of Municipal Bonds**

Municipal Bonds, also known as local government bonds, refer to those issued by local governments or their authorized agencies in the case of insufficient current fiscal revenues and expenditures, in order to meet the needs of local economic and social welfare development, according to the regional social and economic development and the degree of capital shortage, on the basis of principal and interest repayment, A bond publicly issued to the public in accordance with the provisions of relevant laws [1].

The purpose of municipal bonds is generally used for local infrastructure construction, including roads, Bridges, gas supply, water supply, tunnels, waste treatment and other basic industrial facilities and buildings, etc. The principal and interest repayment funds mainly come from the income generated by the investment project itself or the income from other channels, such as government tax guarantee funds. Generally speaking, in the process of local infrastructure construction, there are problems such as huge investment, large fluctuations in subsequent costs, and too long payback period of investment. Therefore, for a long time, the investment subjects of public infrastructure are generally local governments or their agencies, and their construction funds are mainly raised by local governments and their departments issuing municipal bonds. Therefore, municipal bonds can also be equated with local government bonds in a sense. In Western developed countries, municipal bonds have long been an important financing tool in the capital market. At present, our country has not established the municipal bond market, but according to the foreign experience, the complete municipal bond market is of great significance to the perfection of the capital market.

## 2.2 Classification of Municipal Bonds

In the United States, municipal bonds are divided into two types: General obligation bonds and Revenue bonds, depending on the issuer, the degree of tax support, and the means of repayment.[2] General liability bonds refer to bonds issued directly by the government and guaranteed by the general taxing capacity and fiscal revenue of state and local governments. The prerequisite for the issuance of general liability bonds is that local governments have fiscal autonomy and can be held accountable for their own economic actions; Moreover, its legal status is clear, that is, local governments can also go bankrupt, so its essence is still a kind of "advance" of financial funds, which belongs to the category of government bonds.

Revenue bonds refer to the bonds issued by local government agencies or authorized agencies and secured by the income generated by the projects invested with the funds raised from the bonds. Most of the revenue bonds are used for the construction of public facilities, such as toll roads, toll Bridges, school dormitories, etc. Income bond is similar to the credit in project financing, and the research and forecast of future income determine the uncertainty of its risk. Due to the uncertainty of future income of the project, the risk of income bond is higher than that of general liability bond.

The fundamental difference between general liability bonds and income bonds lies in that general liability bonds take the credit of the government and all taxes as repayment guarantee, which is closer to tax in nature and can be regarded as the withdrawal and use of future taxes in advance, so their credit rating and security are higher; However, income bonds are mainly guaranteed by the cash flow generated by the bond issuing projects, and are often issued by public institutions such as universities, hospitals, airports, etc., so they have the nature of project bonds logically. Their issuance needs to follow the standard market operation mode, and they have higher risks than general liability bonds.

## 2.3 Characteristics of Municipal Bonds

At present, western countries have generally established a perfect municipal bond market, among which the municipal bond market in the United States is the largest in scale and the most standardized in operation system. Municipal bonds, as an important variety in the US bond market, have great attraction to investors. Combined with the characteristics of the US municipal bond market, municipal bonds mainly have the following characteristics:

### 2.3.1 Tax exemption or partial tax exemption, low financing cost

This is the most prominent feature of municipal bonds, whose interest income is exempt from federal and most local income taxes in the United States. It is this feature that makes municipal bonds more attractive than other bonds other than Treasury bonds. When issued, municipal bonds pay relatively low interest rates compared with other bonds, which allows local governments to obtain needed funds at a lower cost.

### 2.3.2 High credit rating, good security

Generally speaking, the issuer of municipal bonds is the local government or its agency. And in the actual process, it can also achieve the purpose of credit enhancement through the participation of financial guarantee and insurance companies. Therefore, municipal bonds credit rating and security are often relatively high.

### **2.3.3 Municipal bonds have an "early foreclosure" feature, in which the government has the right to repay the bonds it issues early**

The "early foreclosure" feature of bonds allows the government to repay all or part of the bonds early, and the issuer should notify bondholders that their bonds will be redeemed early and state the detailed terms of the redemption. There are three main types of redemption of municipal bonds in the United States: selective early foreclosure, mandatory sinking fund and special early foreclosure.

## **2.4 Characteristics of Municipal Bonds**

The role of municipal bonds is mainly as follows:

### **2.4.1. Reduce the financial burden of central and local governments**

By issuing municipal bonds, local governments can solve the financing of local public construction projects, which alleviates the pressure of current financial funds of the central government and local governments, enables the central government to have more spare power in the allocation of national funds, and also alleviates the pressure of national debt issuance.

### **2.4.2. It is conducive to solving the problem of fair burden of large-scale public investment between children and generations**

From the perspective of the allocation of public goods, the spatial limitation of the scope of benefit requires local governments to undertake the corresponding responsibility of financing and construction. Services that benefit nationally (such as universities) must be provided nationally; Local services that benefit, such as hospitals, should be provided locally. From the perspective of fair burden, for example, when building a public facility that can be used for 30 years, if the local government only relies on the tax revenue for one or two years, the burden of the project will be concentrated on the taxpayers at this stage. If debt is borrowed and spread over the benefit period, the burden is spread among the later generations who benefit from it, and equity issues across generations can be resolved.

### **2.4.3. It is conducive to improving the capital market structure and enriching investors' investment channels**

At present, in the direct financing channel market of our country, the risk of stock market is relatively high; In the bond market, the issuance scale of national debt is generally limited due to the needs of the central fiscal policy and macro-control, while corporate bonds are facing greater credit risks. Municipal bonds are a high-quality investment tool because the yield is higher than Treasury bonds and bank deposits, while the risk is lower than corporate bonds, and the yield is more stable than common stock. Therefore, the introduction of municipal bonds not only improves the structure of capital market, but also enriches the investment varieties of capital market.

## **3. Credit Risk Analysis of Municipal Bonds**

### **3.1 The Meaning of Municipal Bond Credit Risk**

Credit risk is the oldest type of risk in financial markets. Since the emergence of financial markets, credit risk has been born, and it can be said that all bond varieties have credit risk. Credit risk in the traditional sense usually refers to the possibility of loss to the other party when one party in a credit relationship default and fails to fulfill its contractual obligations. In the credit relationship,

there is great uncertainty whether the debtor can repay the principal and interest on time and completely, which is easy to cause the occurrence of default events and lead to the generation of credit risks. That is, credit risk is precisely a measure of this probability of default.

### 3.2 Principle of KMV Model

According to the idea of the KMV model [3], the owners of the enterprise's equity transfer ownership to the lender, but they have the right to buy back the enterprise with the repayment of the debt (the strike price). If the enterprise value exceeds the debt at maturity, the equity holder will repay the debt and hold the residual value of the enterprise; If the value of the maturing enterprise is less than the debt, the equity holder will let the enterprise default.

When this idea is applied to the credit risk assessment of municipal bonds, it can be understood that the issuer of municipal bonds transfers the tax right to the buyer of municipal bonds, but the local government can "redeem" the tax right by repaying the municipal bonds. If, when a municipal bond matures, the fiscal revenue used to secure the bond exceeds the bond, the issuer will repay the bond and "redeem" the tax right; If, at maturity, the fiscal revenue used to guarantee is less than the debt, it means that the local government defaults. According to this idea, we establish the following municipal bond credit risk model.

According to this idea, Han Liyan, Zheng Chengli, Luo Wen and Yang Zhebin [4] established the following municipal bond credit risk model. We refer to its model here.

First, it is assumed that local fiscal revenue follows the following random distribution:

$$A_t = f(Z_t) \quad (1)$$

$A_t$  is the local government revenue at time  $t$ ,  $Z_t$  is a random variable, and  $f(\cdot)$  is a specific function [5-6].

When the municipal bonds mature (the maturity date is  $T$ ), if the local fiscal revenue is less than the face value  $B_T$  of the bonds that should be repaid, the local government will default. That is, the condition for the local government to default can be expressed as:  $A_T < B_T$ . The probability of default is denoted by  $p$ , then

$$p = p[A_T < B_T] = P[f(Z_T) < B_T] = p[Z_T < f^{-1}(B_T)] \quad (2)$$

In Equation (2), if  $Z_T \sim N(0,1)$  is the standard normal distribution, the equation can be changed into

$$p = p[Z_T < f^{-1}(B_T)] = N[f^{-1}(B_T)] \quad (3)$$

Define  $DD = -f^{-1}(B_T)$  as Default Distance. And so:

$$P = N(-DD) \quad (4)$$

If we assume that local fiscal revenue follows the following specific stochastic process:  
 $dA_t = \mu A_t dt + \sigma A_t dz_t$

There  $\sigma$  is the volatility of local fiscal revenue. There  $\mu$  is the instantaneous growth rate of local fiscal revenue; There  $dZ_t$  is the increment of a Wiener process (standard geometric Brownian motion).

If  $t=0$ ,  $A_0=A$ , From the above equation, When  $t>0$ , the local fiscal revenue can be expressed as

$$A_t = A \exp \left\{ \left( \mu - \frac{1}{2} \sigma^2 \right) t + \sigma \sqrt{t} Z_t \right\} \quad (5)$$

Where  $Z_t \sim N(0, 1)$ . In this case, the local fiscal revenue follows the lognormal distribution, and its mean and variance are as follows:

$$E[\ln A_t] = \ln A + \mu t - \frac{1}{2}\sigma^2 t$$

$$VAR[\ln A_t] = \sigma^2 t$$

In the specific calculation, the time interval  $t=1$  can be taken, that is, the default probability after one year can be obtained

$$\mu = \frac{1}{n-1} \sum_{t=1}^{n-1} \ln \frac{A_{t+1}}{A_t} + \frac{1}{2}\sigma^2 \quad (6)$$

$$\sigma = \sqrt{\frac{1}{n-2} \sum_{t=1}^{n-1} \left( \ln \frac{A_{t+1}}{A_t} - \frac{1}{n-1} \sum_{t=1}^{n-1} \ln \frac{A_{t+1}}{A_t} \right)^2} \quad (7)$$

Since the logarithm of local fiscal revenue follows the normal distribution, the default distance and default probability are respectively:

$$DD = \frac{\ln(A/B_T) + \mu T - \frac{1}{2}\sigma^2 T}{\sigma\sqrt{T}} \quad (8)$$

$$p = N \left[ \frac{\ln B_T - \ln A - \mu T + \frac{1}{2}\sigma^2 T}{\sigma\sqrt{T}} \right] \quad (9)$$

Table 1: GDP and fiscal revenue and expenditure of Beijing from 1996 to 2011 (Unit: 100 million yuan)

Year	GDP		Fiscal revenue		Fiscal expenditure		Proportion of Fiscal expenditure in fiscal revenue (%)
	Amount of money	Growth (%)	Amount of money	Growth (%)	Amount of money	Growth (%)	
1996	1789.20	18.67	150.90	30.92	187.45	21.40	124.22
1997	2075.60	16.01	209.91	39.10	262.20	39.88	124.91
1998	2376.00	14.47	265.61	26.54	316.84	20.84	119.29
1999	2677.60	12.69	320.44	20.64	398.53	25.78	124.37
2000	3161.00	18.05	398.39	24.33	490.34	23.04	123.08
2001	3710.50	17.38	507.68	27.43	614.92	25.41	121.12
2002	4330.40	16.71	600.96	18.37	683.98	11.23	113.81
2003	5023.80	16.01	665.94	10.81	809.39	18.33	121.54
2004	6060.30	20.63	830.03	24.64	974.17	20.36	117.37
2005	6886.30	13.63	1007.35	21.36	1137.28	16.74	112.90
2006	7870.30	14.29	1117.15	10.90	1411.58	24.12	126.36
2007	9353.32	18.84	1492.64	33.61	1649.50	16.86	110.51
2008	11115.00	18.83	1837.30	23.09	1956.00	18.58	106.46
2009	12153.00	9.34	2026.81	10.31	2319.37	18.58	114.43
2010	13777.90	13.37	2353.90	16.14	2716.00	17.10	115.38
2011	16000.40	16.13	1352.8	-7.1	3006.30	27.72	222.22

Data source: China Statistical Yearbook (<http://www.stats.gov.cn>)

In order to more intuitively show the relationship between the size of municipal bonds issued by local governments and their credit risk, we choose Beijing as an example, and the data are shown in Table 1.

According to the practice, assuming that the period length of the default probability prediction is

one year ( $T=1$ ), using the data of Beijing's GDP, local fiscal revenue and local fiscal expenditure from 1996 to 2011, and using the measurement method, the fiscal revenue in 2012 is estimated to be 330.652 billion yuan. However, in practical application, because local governments must guarantee some necessary expenditures, it is impossible for all fiscal revenue to be used as the debt repayment guarantee of municipal bonds. In this way, the fiscal revenue  $A$  needs to be multiplied by the guarantee ratio in the above model. Generally speaking, according to international practice and the actual situation in our country, 50% guarantee ratio is selected [7-8].

The mean value of the fiscal revenue growth rate calculated according to Formulas (6) and (7) is 0.1594, and the standard deviation is 0.1023. We discuss the default probability of municipal bonds issued by Beijing in different bond issuance sizes, and the calculation results are shown in Table 2.

Table 2: Default probability calculated for different bond issuance sizes (Unit: 100 million yuan)

Scale of bond issuance	75	100	125	150	175	200	225
Distance to default	9.82	7.19	5.15	3.48	2.07	0.85	0.23
Probability of default	0	0	0	0.02	1.92	19.77	40.9

From the above table, we can see that for the bond issuance scale below 15 billion yuan, the default probability of municipal bonds is very small, close to 0. When the bond issuance scale is 15 billion yuan, there is a default probability of 0.02%. Therefore, under the assumption that the local fiscal revenue of Beijing follows the lognormal distribution, when the bond issuance scale is less than 15 billion yuan, the default probability of municipal bonds is basically zero [9-10].

### 3.3 Evaluation of the Advantages and Disadvantages of KMV Model

#### 3.3.1. Advantages of KMV model

(1) The KMV model is a dynamic model, which can timely reflect the changes in the level of credit risk.

(2) The KMV model is a Forward-looking method, which to some extent overcomes the defect that "history can replicate itself in the future" of the mathematical statistical model that relies on historical data to look Back.

(3) The indicators provided by the KMV model are essentially a cardinal measure of risk. Different from the ordinal method, the cardinal method is more accurate in measuring risk because it can not only reflect the order of risk levels of different enterprises, but also reflect the degree of difference in risk levels. It also makes it easier to price loans. However, the ordinal measure can only reflect the order of credit risk among enterprises, for example, BBB is higher than BB, but it cannot clearly explain to what extent [11-12].

#### 3.3.2. Defects of KMV model

(1) The scope of use of the model is limited. The KMV model is generally suitable for evaluating the credit risk of listed companies, while it is more difficult to evaluate the credit risk of unlisted companies, and the results are not very accurate.

(2) The model assumes that the asset value of borrowing enterprises is normally distributed, and it is based on this assumption that the model can calculate the theoretical expected default frequency (EDF) value, but in reality, not all borrowing enterprises' asset value is normally distributed;

(3) The model cannot distinguish the different types of long-term debt. In fact, we can distinguish different long-term debts according to their priority repayment order, whether they are guaranteed, whether they have contracts, whether they can be converted, etc., which may lead to inaccurate determination of default points and inaccurate output variables of the model.

#### 4. Conclusions and Reflections

Although municipal bonds are known as "bank-side bonds", the risks contained in them cannot be ignored, which are directly related to whether the bonds can be sold as scheduled after being listed. Because China's municipal bond market is in its infancy, the bond issuance and circulation mechanism is not perfect, which will be the external reason for the default risk of China's municipal bonds. At the same time, many regions still have a large debt burden before issuing municipal bonds, which will bring potential crisis to bond issuance.

Due to the factors of decision-making system, investors' rating of local government credit is not high, which affects the development of local government bond market at the present stage. There is some difference between the real distribution of fiscal revenue and the theoretical distribution, which affects the prediction accuracy of the model.

Municipal bonds are new things in our country's capital market, so there is a certain process for investors' recognition and market cultivation. But it is undeniable that municipal bonds will certainly play a positive role in promoting local economic prosperity and development. From the perspective of standardizing local government debt management, it is necessary to study and establish a set of basic institutional framework including scale control, risk early warning, debt budget and debt examination and approval, so as to reasonably evaluate the debt paying ability of the area applying for bond issuance, strictly strengthen the management of municipal bonds, scientifically guide the healthy development of municipal bond market and serve the local economic construction.

The issuance scale of municipal bonds is directly related to the guarantee funds of local governments, which are mainly determined by the net value of local fiscal revenue and credit rating. Therefore, local governments should strengthen the economic strength of the region, improve the regional economic system and management system, and improve the ability to deal with risks. Adjust the industrial structure, rational use of funds, so as to reduce the economic cycle risk and industrial policy risk of bonds.

Local governments should formulate a set of effective risk factor control plans to reduce the impact of interest rate risk, repayment risk and liquidity risk on the final bond repayment risk, so as to improve the credit rating of bonds. We can selectively use the advanced theories and experience of foreign bond issuance, improve relevant laws and regulations, strengthen the supervision of bond issuance and credit rating, and control debt repayment risks in a targeted manner based on China's specific conditions. At the same time, local governments should use a series of technical means to reasonably plan the repayment cycle and avoid the peak of debt repayment.

Local governments should make reasonable plans for their previous debts, and consider gradually eliminating the stock of debts and reducing the increase of debts in the form of debt bioindication. Only under the condition that the total amount of local debt is small and the local debt crisis is basically lifted, can local governments be able to guarantee the smooth issuance of municipal bonds. Once the debt scale of local governments is large, the issuance of municipal bonds may aggravate the debt crisis of local governments, which will not be conducive to the issuance of municipal bonds. Therefore, the size of debt has become an important constraint for municipal bond issuance, and the expansion of municipal bond issuance must be premised on the reduction of the size of debt.

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