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Original Paper

Research on the Risk of Local Government Special Debt Based on KMV Model: Taking A Province as an Example

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Abstract

Since 2015, the issuance of special bonds by local governments has experienced rapid growth. Special bonds have played a constructive role in stimulating fixed asset investment and infrastructure development, emerging as a pivotal financing mechanism for local governments. This study takes A province as a case study, compiling data on its bond issuance and employing the KMV model to calculate the anticipated default probability and overall default risk of A province's special bonds during 2023-2025. Furthermore, a comparative analysis is conducted with neighboring provinces such as C and B. The findings indicate that A province's government debt risk is generally manageable; however, there exists some level of default risk associated with special bonds. It should be noted that when considering refinancing bond issuance, the repayment of principal and interest on local government special bonds heavily relies on these refinancing instruments, temporarily reducing but not eliminating default risk. Finally, based on empirical analysis results, several policy recommendations are proposed to address the risks posed by local government debt.

Keywords

Special government bonds, Expected default probability, KMV model

1. Introduction

Under the impact of COVID-19, century-old transformations are accelerating, geopolitical conflicts persist, and the external environment is becoming increasingly intricate, severe, and uncertain. China's economic development faces the triple pressure of demand contraction, supply shock, and weakened expectations. As a crucial instrument for stabilizing the macroeconomy, local government special bonds play a pivotal role in managing economic fluctuations and maintaining an appropriate range of

economic operation. In 2022, the Report on the Work of the Government emphasized enhancing proactive fiscal policy effectiveness and leveraging government investment funds to facilitate effective investment expansion. Local governments have expedited infrastructure project construction to bolster effective investment and stabilize the economy. Nationwide issuance of local government bonds reached an additional 4.7566 trillion yuan in 2022, including 4.039 billion yuan worth of special bonds—an increase of 12.46 percent compared to last year—marking a record high for new special bond amounts issued. The issuance of special bonds has effectively ensured financing requirements for key projects while providing vital support for further expanding effective investment and stabilizing overall economic conditions.

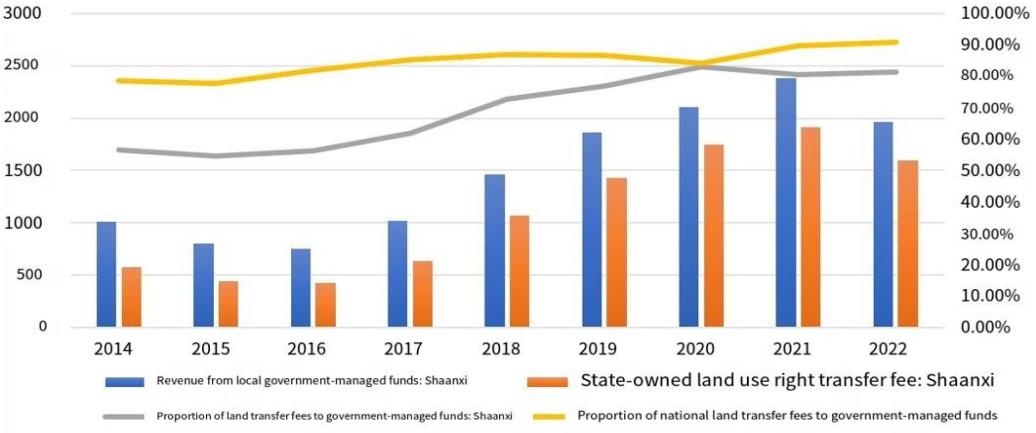

Figure 1. A Provincial Government-managed Fund Income and Land Transfer Fees

In September 2014, The State Council issued the Opinions on Strengthening the Management of Local Government Debt, which stipulates that provincial governments are authorized to issue local government bonds. Furthermore, it mandates that the principal and interest of special government bond financing should be repaid through dedicated project income or governmental fund revenue. Figure 1 illustrates that in 2022, A province's government-managed funds revenue amounted to 196.26 billion yuan, with state-owned land use right transfer fees contributing significantly at 159.44 billion yuan. Land transfer fees accounted for a substantial portion of government-managed funds at 81.24%, marking a notable increase of 26.74 percentage points compared to figures from 2015. Recent years have witnessed a shift in China's government-managed funds growth rate from positive to negative due to factors such as the impact of the epidemic and real estate market downturns. Consequently, national government-managed funds revenue experienced a decline of 22.15% in 2022, while A province observed a year-on-year decrease of 17.60%. As fiscal expenditure becomes increasingly inflexible and special government debt continues expanding its scale against declining state-owned land revenues and prolonged project construction periods coupled with slower growth rates in government-managed fund revenue; the fiscal revenue-expenditure contradiction faced by local governments has intensified considerably along with an elevated risk of default on local government bonds' repayment obligations.

2. Literature Review and Model Introduction

2.1 Literature Review

China's scholars have conducted empirical studies on the default risk of government special bonds. Han Liyan (2003) introduced the concept of municipal bond default risk based on the general situation of municipal bond issuance in the United States. By analyzing fiscal revenue and expenditure data from Beijing and Shanghai, he examined credit risk under different bond issuance scales and derived default probabilities for varying debt levels. Additionally, he established a credit risk assessment method for municipal bonds applicable to general situations by linking credit risk with bond issuance scale. Liu et al. (2016) associated disposable ratios with local government ratings to assign different ratios to provinces and cities, using the KMV model to analyze default risks of local government debt across 30 provinces and cities in China. The results indicate that overall risks associated with local government debt are manageable, leading to policy recommendations for preventing and resolving such risks. Potential (2020) employed panel data from 31 Chinese provinces between 2015 and 2019 to calculate expected default probabilities of local government special bonds from 2020 to 2023 using a model approach. The study reveals that as the scale of local government special bonds expands in China, default risks also accumulate continuously; while refinancing bonds can reduce default risks, they do not eliminate repayment risks entirely. Luo (2018) utilized the KMV model to analyze the risk profile of local government debt before calculating and evaluating new debt scales with controllable risks.

Other scholars have examined the default risk of special government bonds from both theoretical and empirical perspectives. Merton (1974) utilized the Black-Scholes option pricing formula and risk debt pricing theory. Giesecke et al. (2011) conducted a study on corporate bonds spanning from 1866 to 2008, revealing that bond defaults were primarily influenced by gross domestic product, stock volatility, and stock returns. Betty Simkins (2012) employed the modified KMV model to analyze credit risk in financial companies during the financial crisis, demonstrating its enhanced accuracy in predicting enterprise bond defaults. Liu L and Waibel M (2010) investigated the entire process of local government bond issuance and usage, emphasizing that ensuring fiscal revenue sustainability is crucial for credit management of these bonds. Therefore, strict restrictions and regulations should be implemented prior to bond issuance along with rigorous control over fund utilization and bond repayment mechanisms to mitigate default risks. Smith, Park, and Liu (2019) explored credit risks associated with local government debt across four different countries; their findings indicated that quantitative easing monetary policies as well as transfer payment policies designated by central governments contribute positively towards strengthening risk control measures for local government debt. Amaud Mehl et al. (2012), using an empirical analysis approach on a sample of 33 emerging market countries, studied their debt status which revealed excessive financial pressure and high debt ratios among local governments as primary causes of debt risks. Rongzhou Zhang et al. (2021) adopted both the KMV model and Topsis model to measure bond default risks based on samples comprising local government bonds from 30 provinces in China. The research shows that the government debt

status, fiscal revenue and expenditure status and regional economic development level are the three main factors of local government bond default risk.

The main shortcomings of the current literature are as follows: first, the current literature focuses more on the research of local government debt or general debt, and few papers pay attention to the default risk of special bonds. Second, the current literature only takes the revenue of governmental funds as the source of debt repayment, and few studies consider the inclusion of refinancing bonds into the solvency of local governments. Third, the research on the default risk of special government bonds is only limited to a certain region, and few studies have considered the heterogeneity of default risk among different regions.

2.2 KMV Model

According to the idea of KMV model, this paper establishes a risk assessment model of local government special debt, replaces the value of enterprise repayable assets in the traditional KMV model with repayable debt income y_(t), and replaces the volatility of enterprise asset value in the traditional model with the volatility of repayable funds σ. However, the debt D_t that local governments should repay at maturity represents the principal and interest of the debt that enterprises in the traditional model should repay at maturity. It is assumed that the debt maturity date of the local government is T, and the repayable debt scale of the local government in period T is D_t. At maturity, the repayable debt income of the local government < the repayable debt, that is, y_(t)<D_t, and the local government will have a credit default event. The repayable income of the local government when the debt matures > the debt payable, and the local government will not default. According to the idea of KMV model, the specific derivation process of the default distance of local government special bonds is as follows.

The funds available for debt repayment from local fiscal revenue are subject to the following stochastic process:

$$y_t = f(x_t) \tag{1}$$

Where y_t is the repayable fund in the fiscal revenue of period t, and x_t is a random variable with standard normal distribution, that is, x_t~N(0,1), $f(x_t)$ is a specific function.

$y_t = D_t$ is the default point of local government debt. The expected default probability (EDF) of local government bonds denoted by ρ, then

$$\rho = P(y_t < D_t) = P(f(x_t) < D_t) = P(x_t < f^{-1}(D_t)) = N[f^{-1}(D_t)] \tag{2}$$

According to the calculation formula of KMV model, the default distance dd of local government special bonds at maturity is

$dd = \frac{y_t - D_t}{\sigma}$, σ is the volatility of repayable funds.

It is assumed that the repayable funds in local revenue obey Markov random process, so its probability distribution is assumed to obey geometric Brownian motion, which is generally expressed by Wiener process:

$$dy_t = uy_t dt + \sigma y dx_t \tag{3}$$

Where u is the growth rate of repayable funds, σ is the volatility of repayable funds, dy_t represents the change of repayable income, which follows lognormal distribution, and dx_t is the increment of

Wiener process (standard geometric Brownian motion).

$if\ t = 0,\ y_t = y$

$$if\ t > 0,\ y_t = y\exp[\left(u - \frac{1}{2}\sigma^2\right)t + \sigma\sqrt{t}x_t] \tag{4}$$

The natural logarithm of repayable income is:

$$lny_t = lny_0 + \left(u - \frac{1}{2}\sigma^2\right)t + \sigma\sqrt{t}x_t \tag{5}$$

The mean and variance of the natural logarithm of repayable income are:

$$E(lny_t) = lny_0 + ut - \frac{1}{2}\sigma^2 t \tag{6}$$

$$Var(lny_t) = \sigma^2 t \tag{7}$$

According to the above equation, we can deduce:

$$u = \left[\frac{1}{n-1}\sum_{i=1}^{n-1} ln\frac{y_{t+1}}{y_t} + \frac{1}{2}\sigma^2\right]/T \tag{8}$$

$$\sigma = \sqrt{\frac{1}{n-2}}\sum_{i=1}^{n-1}(ln\frac{y_{t+1}}{y_t} - \frac{1}{n-1}\sum_{i=1}^{n-1} ln\frac{y_{t+1}}{y_t})^2/T \tag{9}$$

T is the debt maturity date, where the default distance and default rate are, respectively

$$dd = \frac{y_t - D_t}{\sigma} = \frac{lny_0 + ut - \frac{1}{2}\sigma^2 t - lnD_t}{Var(lny_t)} = \frac{\ln\frac{y_0}{D_t} + ut - \frac{1}{2}\sigma^2 t}{\sigma\sqrt{t}} \tag{10}$$

$$\rho = N(-dd) = \frac{\ln\frac{D_t}{y_0} - ut + \frac{1}{2}\sigma^2 t}{\sigma\sqrt{t}} \tag{11}$$

3. Empirical Analysis

3.1 Sample Source and Data Processing

The Opinions of The State Council on Strengthening the Management of Local Government Debts explicitly include general debts in the management of general public budgets and should primarily be repaid using fiscal revenues from budgets. Meanwhile, special debts are included in the management of government-managed funds budgets and should primarily be repaid using revenues from government-managed funds and special revenues from budgets. Therefore, considering the flow perspective, China's local governments' solvency mainly relies on three sources: fiscal revenue in the general public budget, fund and special revenue in the governmental fund budget, and liquid state-owned assets. The portion of local government revenue mentioned above that can be utilized to repay current year's debts is referred to as financial guaranteed income. In China, general rigid expenditures for local governments mainly encompass 12 broad categories such as general public services along with 5 narrow categories like general public services. Diao Weitao (2017) discovered that since land leasing revenue was incorporated into the government fund budget, its proportion within local government-managed fund income has remained around 85%. Hong et al. (2018) found that broad rigid expenditure accounted for a stable proportion of approximately 80% in fiscal revenue while narrow rigid expenditure accounted for about 50%

Referring to the research methodologies employed by Hong (2018), Nixing (2002), and other scholars,

this study assumes that the proportion of expenditure on other debt repayment and land leasing revenue in local governmental fund revenue remains constant. It estimates the available revenue for debt repayment in two scenarios: maximum and conservative. In the maximum case, repayable debt income is calculated as governmental fund income multiplied by 20%. In the conservative case, repayable debt income is calculated as governmental fund income multiplied by 10%. The analysis focuses on the specific situation of state-owned land revenue and expenditure in Province A from 2015 to 2022. Without considering refinancing bonds, debt repayment income equals governmental fund income multiplied by ρ. When considering refinancing bonds, debt service income includes both governmental fund income multiplied by ρ and refinancing special bond income. This paper examines the default risk of special bonds during 2023-2025 (T=1,2,3) necessitating a prediction of the scale of special bond issuance during this period. The calculation method is outlined as follows:

$$D_T = r_i \sum DV + (1 + r_i) \sum D V_T$$

WhereD_T represents the sum of principal and interest of special bonds to be repaid in period T, $\sum DV$ denotes the outstanding principal of special bonds in the current period, r_i signifies the average coupon rate of outstanding special bonds across different provinces, $\sum DV_T$ indicates the scale of special bonds in the current period, and $r_j$represents the average coupon rate of special bonds in various provinces for this specific period. The details are as follows:

Table 1. Estimation of the Sum of Principal and Interest to be Repaid on the Special Government Bonds of A Province in 2023-2025

Regions	Year	$\sum DV$	r_i	Interest expense on unmatured special bonds	$\sum DV_T$	r_j	Interest expense on maturing special bonds	D_T
A province	2023	3745.56	3.43%	128.47	506.7	3.51%	524.49	652.97
	2024	3450.04	3.42%	118.34	295.52	3.63%	306.24	424.57
	2025	3165.34	3.40%	108.57	284.69	3.72%	295.29	402.9

According to the previous model construction process, when using the KMV model to calculate the default distance (DD) of local government special bonds and evaluate the default risk, it is necessary to first obtain the debt paying ability of local government in the beginning period (T=0) and the sum of principal and interest payable for future periods T. In order to facilitate analysis, this paper uses the KMV model to evaluate the expected default probability of local government special bonds in 2023-2025 (T=1,2,3). Since China implemented a new budget law in 2015, financing for local

government special bonds has entered a new phase. Therefore, by substituting governmental fund data from 2015 to 2022 into Formula (8) and Formula (9), this paper obtains the expected growth rate and volatility of repayable debt income. After obtaining relevant sample data on local governments' debt paying ability and principal and interest repayment scale, these data are inputted into Formula (10) and Formula (11) to obtain future special bond's default distance and default probability.

3.2 Risk Assessment of Local Government Special Bonds in Province A

3.2.1 Risk Assessment of Special Bonds without Considering Refinancing Bonds

According to the existing literature research, corporate bonds with credit ratings above Moody's Baaa3 exhibit rare instances of default. Potentia (2020) and other scholars have also emphasized that the credit rating of government bonds should be equivalent to that of corporate bonds. Specifically, when the expected default probability of government bonds is lower than 0.4%, the likelihood of credit risk pairs reaches its minimum level. Based on the calculation results presented in Table 2, it can be observed that when 10% of governmental funds' revenue can be allocated towards repaying maturing debts, the expected default probabilities for A province's special bonds during 2023-2025 are estimated at 4.388%, 0.6507%, and 0.449% respectively. These calculations indicate that throughout this period, A province's special bonds all possess an expected default probability higher than 0.4%, suggesting a certain level of default risk associated with these bonds. However, when considering a scenario where 20% of governmental funds' revenue can be utilized for debt repayment purposes, the anticipated default probabilities for A province's special bonds during 2023-2025 decrease significantly to values as low as 0.1161%, 0.0003%, and even reaching as low as 0.0001%. Consequently, under such circumstances, it becomes evident that the expected default probability falls below the threshold value of 0.4%, indicating a reduced level of default risk associated with these special bonds. These findings highlight how governmental fund income exerts a substantial influence on the potential risks related to bond defaults: smaller proportions available for debt repayment correspond to higher levels of bond defaults while larger proportions result in decreased levels thereof.

Table 2. Expected Default Probability of Special Government Bonds of Province A in 2023-2025

Repayable debt income	Forecast time	Special local government debt	Distance to default	Expected default probability (%)
Governmental fund income *10%	2023	652.9674	1.7073	4.3880
	2024	424.5728	2.4834	0.6507
	2025	402.9046	2.6128	0.4490
Income from government-managed funds *20%	2023	652.9674	3.0456	0.1161
	2024	424.5728	4.5416	0.0003
	2025	402.9046	4.7817	0.0001

3.2.2 Special Bond Risk Assessment Considering the Refinancing Bonds

In May 2018, the Ministry of Finance provided clarification that refinancing bonds can be utilized for partial repayment of maturing local bond principal. As some local bonds had relatively short issuance periods initially, a portion of them have now reached their maturity date for principal repayment. The introduction of refinancing bonds has effectively alleviated the debt repayment pressure faced by local governments. In accordance with the document 'Measures for the Budget Management of Local Government Special Debt' (Finance [2016] No. 155), special debt principal can be repaid through issuing refinancing special bonds, among other means. Therefore, this study incorporates refinancing bonds into repayable debt income alongside governmental fund income as part of repayable debt income and investigates whether it contributes to reducing default risk associated with local government special bonds.

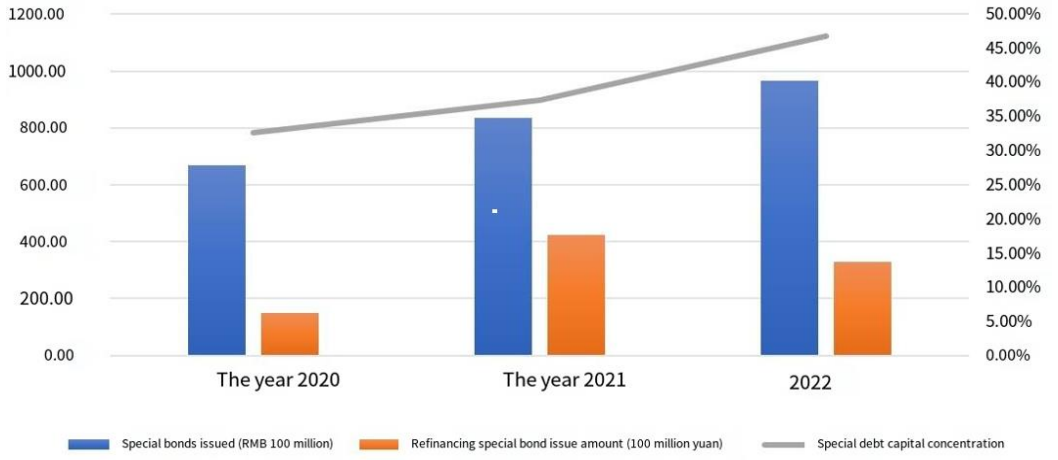

Figure 2. The Issuance of Special Bonds for Refinancing in A province

The issuance of refinancing bonds in Province A commenced in 2020, and by 2022, it reached a total of 32.762 billion yuan, accounting for 16.97% of the province's overall bond issuance. This significant increase in refinancing bonds has effectively alleviated the debt repayment pressure faced by Province A. Considering the impact of these refinancing bonds as demonstrated in Table 3, it is evident that the expected default risk associated with special government bonds issued by Province A has been significantly reduced. The default probability for the year 2023 dropped from 4.3880% to an impressively low value of 0.0041%, while default probabilities for other years have also decreased to negligible levels close to zero percent. Thus, the effectiveness of utilizing refinancing bonds in mitigating debt repayment risks is clearly apparent.

Table 3. Expected Default Probability of Special Bonds of Province A in 2023-2025 Considering Refinancing Bonds

Unit: 100 million yuan

Repayable debt income	Forecast time	Special local government debt	Distance default	Expected default probability (%)
Governmental fund income *10%	2023	652.9674	3.9413	0.0041
	2024	424.5728	5.9191	0.0000
	2025	402.9046	6.2333	0.0000
Income from government-managed funds *20%	2023	652.9674	5.2796	0.0000
	2024	424.5728	7.9773	0.0000
	2025	402.9046	8.4022	0.0000

3.3 Overall Risk Assessment of A Provincial Government Debt

This paper also estimates the income that can be used for debt repayment in the fund budget according to the maximum and the conservative situation: in the maximum case, the solvency of the local government = comprehensive financial resources × 30%. In the conservative case, the solvency of local governments = comprehensive financial resources ×5%.

Table 4. Government Debt and Comprehensive Financial Resources of Province A

Unit: CNY 100 million

Year	General public budget revenues	Revenue from government-managed funds	Revenue from state capital operations	Comprehensive financial resources
2017	2006.39	1018.41	9.04	3033.84
2018	2243.14	1464.73	28.29	3736.16
2019	2287.73	1859.64	128	4275.37
2020	2257.23	2104.74	116.92	4478.89
2021	2775.30	2385.40	124.4	5285.10
2022	3311.60	1955.64	187.29	5454.53

Note. The above data are from the government debt credit rating report published on the website of the Finance Department of A Province. Comprehensive financial resources = general public budget revenue + governmental funds revenue + state capital revenue.

Table 5. Default Risk of Government Bonds of Province A in 2023-2025

Repayable debt income	Forecast time	Special local government debt	growth rate of government fund income	volatility of government fund revenues	Distance to default	Expected default probability (%)
Comprehensive financial resources *5%	2023	1412.1013	11.39%	7.67%	3.8786	0.0053
	2024	916.8537	5.69%	5.42%	5.2115	0.0000
	2025	1361.2345	3.80%	4.43%	3.9932	0.0033
Comprehensive financial resources *10%	2023	1412.1013	11.39%	7.67%	6.3107	0.0000
	2024	916.8537	5.69%	5.42%	8.9572	0.0000
	2025	1361.2345	3.80%	4.43%	6.518	0.0000
Comprehensive financial resources *30%	2023	1412.1013	11.39%	7.67%	16.0389	0.0000
	2024	916.8537	5.69%	5.42%	23.9402	0.0000
	2025	1361.2345	3.80%	4.43%	16.6097	0.0000

To comprehend the fluctuation in default risk of A province's government bonds, this study conducts a comparative analysis of the anticipated default probability. The calculation results presented in Table 5 reveal that when 5% of government fund income is allocated for repaying maturing debt, the expected default probability for A province's special bond in 2023 is 0.0053%, with no expected default probability in 2024 and an expected default probability of 0.0033% in 2025. When utilizing 10% and 20% of governmental fund revenue to repay maturing debts, the projected default probabilities for A province's special bonds from 2023 to 2025 are all zero, indicating a consistently low overall government debt default rate.

4. Further Analysis

To further analyze the default risk of special government bonds in Province A and conduct a comparative analysis of bond default risks across different regions, this study selects Province B (a central province) and Province C (an eastern province) for comparison with Province A. Table 6 reveals that in terms of economic development level, fiscal revenue, governmental fund revenue, and state-owned land use right transfer revenue, Province A closely aligns with both Province B and Province C. Therefore, selecting these two provinces for comparative analysis is representative.

Table 6. Tables of Provincial Local Government Revenues in Provinces A, B and C

Regions	Year	GDP	Generalpublic budget revenues	Revenue from local government-managed funds	Fees from transferring state-owned land use rights	Proportion of land transfer fees in government-managed funds
	2019	25793.17	2287.9	1859.9	1427.16	76.73%
A	2020	26181.86	2257.23	2104.74	1745.97	82.95%
Province	2021	29800.98	2775.42	2381.71	1913.13	80.33%
	2022	32772.68	3311.6	1962.6	1594.4	81.24%
	2019	24757.5	2486.5	2812.3	2294.2	81.58%
Province	2020	25691.5	2507.5	3101.5	2835.5	91.42%
B	2021	29619.67	2812.3	2971.8	2674.3	89.99%
	2022	32074.7	2948.3	2252	1635.82	72.64%
	2019	37113.98	3182.54	3374.19	3113.1	92.26%
Province	2020	38680.63	3215.96	3144.58	2774	88.22%
C	2021	42959.18	3498.19	3516.18	3243.41	92.24%
	2022	45045	3589	-	-	-

Note. The government-managed fund income and state-owned land use right transfer income of C province have not been published yet, so the data of this part are missing

The results of the calculations presented in Table 7 demonstrate that, under conservative circumstances, 10% of governmental funds' revenue is allocated for the repayment of special bonds. Furthermore, it is observed that the expected default probability of Province A's special bonds in 2023 is lower than that of Province C (4.5368%) and Province B (6.28%). Similarly, the expected default probability of Province A's special bonds in 2024 is significantly lower compared to province C (2.0099%) and province B (8.8673%). Overall, it can be concluded that the anticipated default risk associated with A province's special bonds during 2023-2024 is comparatively lower than both provinces due to its relatively smaller maturing debt volume within this period. However, it should be noted that the expected default probability for A province's special bonds in 2025 reaches a level as high as 0.449%, which surpasses those of both provinces C and B. In scenarios where up to 20% of government-managed funds' revenue can be utilized for repaying maturing special bonds, there will be a significant decrease in the anticipated default probabilities for all three provinces' special bonds between 2022-2025. Notably, throughout these three years, Province A consistently exhibits lower expected default probabilities compared to Provinces C and B. The enhancement in debt repayment guarantee and subsequent reduction in expected default risks for special bonds are further realized when considering an increased proportion (up to 20%) of government-managed funds' revenue

available for such repayments.

In general, during the period from 2023 to 2025, Province A exhibits a comparatively lower expected default probability of special bonds among the three provinces (Province B and Province C), primarily attributed to its smaller debt scale. However, it is crucial to remain vigilant regarding potential disruptions caused by the high volatility of local government-managed fund revenue on fiscal revenue generation. In certain years, difficulties in repaying maturing debt with government-managed fund revenue may lead to default risks associated with special bonds.

Table 7. Expected Default Probability of special Bonds of B and C Provinces in 2023-2025

Regions	Repayable debt income	Forecast time	Special local government debt	Distance default	Expected default probability (%)
Province B	Income from government-managed funds *10%	2023	755.97	1.5317	6.2800
		2024	938.5	1.349	8.8673
		2025	366.35	2.9371	0.1656
	Income from government-managed funds *20%	2023	755.97	2.7783	0.2732
		2024	938.5	2.3531	0.9308
		2025	366.35	5.5095	0.0000
Province C	Income from government-managed funds *10%	2023	1676.44	1.6915	4.5368
		2024	1348.16	2.0517	2.0099
		2025	703.56	3.6051	0.0156
	Income from government-managed funds *20%	2023	1676.44	3.0461	0.1159
		2024	1348.16	3.7361	0.0093
		2025	703.56	6.8328	0.0000

To comprehend the alterations in default risk of local government special bonds in B and C provinces resulting from the issuance of refinancing bonds, this study conducts a comparative analysis on the anticipated probability of default for the special bonds in these provinces after considering the impact of refinancing bonds. The results presented in Table 8 demonstrate a significant decrease in expected default probability for all provinces when accounting for the influence of refinancing bonds. Notably, province A exhibits a lower expected default probability compared to province B and province C during 2023-2025. Specifically, when 10% of governmental funds' revenue is allocated towards repaying maturing debts, the expected default probability for Province A's special bonds decreases from 4.388% to 0.0041% in 2023, with an expected default probability of zero for subsequent years (2024-2025). Moreover, when 20% of governmental funds' revenue can be utilized to repay maturing debt, Province A's special bond's expected default probability remains at zero throughout 2022-2025.

These findings indicate that incorporating funds from issuing refinancing bonds into repayable debt income further enhances the guarantee level for debt repayment associated with special bonds while mitigating potential default risks.

Table 8. The Expected Default Probability of Special Government Bonds of B and C Provinces in 2023-2025 Considering the Refinancing Bonds

Regions	Repayable debt income	Forecast time	Special local government debt	Distance default	Expected default probability (%)
Province B	Revenue from government-managed funds*10%	2023	755.97	2.1455	1.5957
		2024	938.5	1.8434	3.2635
		2025	366.35	4.2037	0.0013
	Revenue from government-managed funds *20%	2023	755.97	3.3921	0.0347
		2024	938.5	2.8475	0.2203
		2025	366.35	6.7761	0.0000
Province C	Revenue from government-managed funds*10%	2023	1676.44	3.7556	0.0086
		2024	1348.16	4.6184	0.0002
		2025	703.56	8.5234	0.0000
	Revenue from government-managed funds*20%	2023	1676.44	5.1102	0.0000
		2024	1348.16	6.3028	0.0000
		2025	703.56	11.7511	0.0000

5. Conclusions and Suggestions

5.1 Conclusion

Firstly, the management of risks associated with provincial government debt is generally well-controlled. Based on our calculations, even in a conservative scenario, the highest expected default probability for provincial government debt is only 0.0053%. Furthermore, in the most extreme case, the anticipated default probability of provincial government bonds diminishes to zero. According to Moody's corporate bond credit ratings criteria, a significant default risk is defined as an expected probability of default exceeding 0.4%. Therefore, this study asserts that overall risk pertaining to provincial government bonds remains manageable. Secondly, there are certain default risks associated with provincial government special bonds. Our calculations indicate that the highest expected default probability for these bonds between 2022 and 2025 is 4.3888%. In accordance with Moody's credit rating measurement for corporate bonds, there exists a certain level of default risk concerning special bonds issued by provincial governments. Generally speaking, B and C provinces exhibit relatively low levels of default risk regarding their special treasury bonds compared to neighboring provinces during

the period from 2023 to 2053. Finally, although refinancing bonds have mitigated some extent of default risk associated with special purpose bonds issuance; however, residual risks still persistently exist.

5.2 Suggestions

Firstly, policy makers should enhance the management of special government debt and bolster the capacity for early risk detection. In practice, it is imperative to establish a scientific and rational system for early warning and evaluation of default risks associated with local government special debt, based on the growth of government-managed funds as well as the construction and operation of special debt projects. This will enable a comprehensive assessment of the default risk within a given year. For high-risk special debt, mitigating measures such as expediting project construction and enhancing operational efficiency can effectively reduce the probability of default. Secondly, policy makers should Diminish reliance on refinancing bonds. While income from refinancing bonds may temporarily alleviate default risks to some extent, they cannot be utilized for interest repayment, thus failing to address this crucial issue adequately and leaving room for potential defaults. Consequently, in terms of debt repayment strategies, maximizing project-generated revenue should be prioritized while reducing dependence on refinancing bonds. Lastly, policy makers should Strengthen oversight over special debt projects during their initiation phase. Introducing third-party institutions like commercial banks and securities companies in conducting preliminary assessments for special bond projects can enhance accuracy and precision throughout their lifecycle—expanding application fields and investment scopes for specialized funds—and ensuring an optimal balance between project income generation and financing schemes from inception.

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