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RESEARCH ARTICLE

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Research on Local Government Debt Risk Warning Based on Government Comprehensive Financial Reports

Kai Zhang[1,*]

[1]*School of Finance and Accounting, Henan University of Animal Husbandry and Economy, China*

Abstract: In recent years, China's rapid economic growth has driven investment expansion at various levels of government, resulting in a continuous increase in local government debt. While local governments often rely on substantial borrowing to meet funding needs for economic development and infrastructure improvement, this accumulation of debt also introduces potential fiscal risks. To effectively prevent and manage these risks and ensure national economic security, China launched a comprehensive government accounting reform in 2019, shifting from the traditional cash-based accounting method to the accrual basis. Through the compilation of comprehensive government financial reports, information on assets, liabilities, revenue, and expenditures is disclosed in a more systematic manner, significantly enhancing the completeness and transparency of fiscal data. The improvement in transparency not only provides a solid data foundation for external assessments of local governments' financial conditions but also facilitates in-depth analyses of debt structures and potential risk points. On this basis, relevant authorities can more scientifically identify and evaluate debt risks, thereby providing a foundation for the formulation of practical and effective debt management policies. This, in turn, contributes to the effective control of fiscal risks while promoting the sustainable and regulated development of public finance.

Keywords: local government debt risk; government comprehensive financial report; government accounting reform

1. Introduction

1.1. Research background

The scale of local government debt in China has grown rapidly in recent years, with local governments increasing debt financing to ensure infrastructure development and urbanization. Although debt financing has contributed to economic growth in a short period of time, the scale of debt in some regions has exceeded sustainable levels, and the accumulating debt has caused widespread social concern. The rising cost of debt repayment and the accumulation of potential default risks will not only affect the stability of the local economy to a certain extent but may also have an impact on the country's financial system. Therefore, preventing and managing local government debt risk is crucial to the economic stability and sustainable development of the country.

1.2. Research objectives and motivation

This paper analyzes the scale of China's local government debt and discovers the problems that exist in it, in order to effectively avoid the risks brought about by these problems and affect the development of the economy. This paper will try to establish a risk early warning system, even if it finds these problems.

1.3. Methodology

This paper adopts the literature research method and empirical analysis method to study local government debt risk.

1.4. Contribution

This paper identifies the existing risks through the study of local government debt and can identify the risks in time by establishing the risk early warning model, which can help the local government to prevent the risks and ensure the development of the economy.

1.5. Research questions

What is the current status of local government debt in China?
What risks will arise from local government debt?
How do local governments manage debt to reduce financial risks?

2. Literature Review

2.1. Research on local government debt risk

Domestic scholars have conducted extensive research on the risk of local government debt, mainly involving aspects such as debt scale, structure, causes, and impacts [1]. Research shows that the scale of local government debt in China is huge and there is

***Corresponding author:** Kai Zhang, School of Finance and Accounting, Henan University of Animal Husbandry and Economy, China. Email: 81229@hnuahe.edu.cn

an implicit debt problem: unreasonable debt structure, with a high proportion of short-term debt [2]. The causes of debt are complex, including economic development pressure, imperfect fiscal system, etc. Debt risk poses a threat to local economic stability and financial security.

Foreign scholars started their research on the risk of local government debt earlier and have formed a relatively complete theoretical system [3]. They mainly focus on debt sustainability, default risk, market reactions, and use various methods for empirical analysis [4]. Research has found that the risk of local government debt is influenced by various factors, such as economic growth, fiscal policies, financial markets, etc.

2.2. Research review on local debt risk warning and assessment

Some scholars have found that under the system of fiscal decentralization, some local governments have increased the scale of debt in order to compete for resources [5]. Some scholars believe that local government debt risk is highly contagious and very likely to cause economic problems [6]. Some scholars believe that China's current system of judging officials on the basis of Gross Domestic Product (GDP) is the root cause of excessive debt and that some officials, in order to achieve political success and get promoted, have borrowed money to carry out large-scale infrastructure construction, which has created debt risks [3].

Some scholars have studied China's local government debt risk by establishing a system of economic and financial indicators and found that the debt risk of local governments in the less economically developed central and western regions is slightly higher than that of the eastern coastal regions [7]. In order to prevent the risk of government debt, some scholars have begun to use random forests to build an early warning system [8].

2.3. Research review on the application of government comprehensive financial reporting

Some scholars believe that because the new public management movement has put forward higher requirements for financial transparency [9], the accrual system can more comprehensively reflect the financial information of assets, liabilities, and net assets of government units, so comprehensive government financial reporting is gradually being adopted by countries [10]. Some scholars have found that the disclosure of contingent liabilities in the comprehensive government financial report effectively improves the ability to identify risks [11]. Some scholars believe that there are some problems in the process of adopting comprehensive government financial reporting [12], such as some local governments omitting the reporting of some assets and concealing some liabilities.

3. Research Methodology

3.1. Overview of the research framework and methodology

This paper adopts the literature research method and empirical analysis method to analyze local government debt risk. First, the literature research method is utilized to sort out the causes of local government debt risk and the related literature on comprehensive government financial reporting. The regression analysis method is used to analyze the influencing factors of debt risk by combining specific economic indicators. A random forest algorithm is used to construct a risk classification model to discover some potential risks and screen out some early warning indicators [13]. Both methods will be applied to local government financial and economic data, with specific variables chosen based on their potential impact on debt risk.

3.2. Data sources and variable selection

In order to ensure the representativeness and accuracy of the analysis results, the data for this study are mainly from the following sources:

Local government financial data: including information on local financial revenues, expenditures, debt size, etc. [14]. These data come from the annual financial reports issued by provincial and municipal governments, as well as statistics from the Ministry of Finance.

Economic and social development data: including regional GDP, local economic growth rate, industrial production, and other data, which come from the National Bureau of Statistics and relevant local statistical offices.

Market data: The impact of market factors such as interest rates and exchange rate fluctuations on debt risk is derived from public data [15].

For key variables included, see Table 1.

Table 1
Variable

Variable	Definition	Features
Debt/regional GDP ratio (X_1)	the ratio of debt burden to the size of the local economy	reflecting the relative pressure of local government debt
Short-term debt ratio (X_2)	the share of short-term debt in overall debt	measuring the liquidity risk of local governments
Fiscal revenue growth rate (X_3)	the annual growth rate of local fiscal revenue	reflecting the stability of local finance and the ability to service debt
Growth rate of the local economy (X_4)	the annual growth rate of the local economy	which measures the economic vitality and the ability of local government debt repayment
Interest rate level (X_5)	the level of market interest rate	which affects the financing cost of local government

3.3. Data processing and analyzing methods

After collecting the relevant data, missing values and outliers need to be removed to ensure the integrity of the data, and some continuous variables need to be standardized.

3.4. Regression analysis method

3.4.1. Model construction

The basic formula of the logistic regression model is:

$$P(default) = \frac{1}{1 + e^{-(\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5)}}$$

where:

P(default) is the probability that a local government defaults on its debt;

β_0 is the intercept term;

β_1, β_2, β_3, β_4, and β_5 are the regression coefficients of each independent variable;

X_1, X_2, X_3, X_4, and X_5 are the observed values of the respective variables.

Through this model, the degree of influence of each independent variable on local government debt default can be assessed. For example, the regression coefficient of the debt/regional GDP ratio reflects the relationship between the debt-to-GDP ratio and default risk.

3.4.2. Steps of regression analysis

The model is constructed according to the correlation theory, the regression coefficients are calculated using Maximum Likelihood Estimation (MLE), the correlation is judged according to the coefficients, and the accuracy of the model prediction is judged according to methods such as cross-validation.

3.5. Random forest algorithm

3.5.1. Feature selection and model training

Similar to logistic regression, the input features for the random forest model include debt-related variables such as the debt-to-GDP ratio, short-term debt ratio, fiscal revenue growth, and interest rates. The random forest algorithm constructs multiple decision trees from bootstrapped samples of the data and then aggregates the results to improve predictive accuracy.

3.5.2. Feature importance assessment

The random forest algorithm was used to derive the Characteristic Importance Score, which is used to determine whether each variable plays a major role in local government debt risk based on its score.

3.5.3. Prediction and risk classification

After the training of the random forest model, local governments are categorized into high risk, medium risk, and low risk based on their likelihood of default.

3.6. Sampling method and time series

The sample data in this paper are from the financial reports of provinces and municipalities in different economic regions, and the research interval is 5–10 years.

4. Results and Discussion

4.1. Analysis of the current situation of local government debt

In recent years, with the rapid development of China's economy, local governments have taken on more and more responsibilities in infrastructure construction, urbanization, and the enhancement of public services. However, local governments have limited financial revenues, and debt financing has become a major means in the face of huge capital needs. Local governments have raised debts in various ways, such as issuing bonds and loans, resulting in the scale of local government debt growing year by year. Local government debt includes not only explicit debt borrowed through formal channels but also many implicit debts not included in the budget and financial statements, making it difficult to accurately estimate and control the overall debt scale and risk.

4.1.1. Debt scale and growth

(1) Huge debt scale

In recent years, the scale of local government debt has experienced significant growth. Large investments by local governments in urban construction, transportation, energy, and other infrastructure sectors have fueled local economic development. However, these investments have also led to the accumulation of substantial debts. According to available statistics, by 2023, the explicit debt of local governments had surpassed RMB 30 trillion, and implicit debt could continue to rise. Hidden debt refers to liabilities incurred by local governments through financing platforms, public–private partnerships (PPP), and other channels, which are typically not included in the official government budget. These hidden forms of debt result in a total debt level that is higher than what is officially reported, complicating debt management efforts.

Table 2
Changes in the size of local government debt (2018–2023)

Year	Visible debt (¥ trillion)	Hidden debt (estimate, ¥ trillion)	Total debt (estimate, ¥ trillion)
2018	18.4	10	28.4
2019	21.0	11.5	32.5
2020	24.3	13	37.3
2021	26.7	14	40.7
2022	29.5	15	44.5
2023	30.8	16	46.8

According to the data provided in Table 2, it is seen that the scale of local government debt has been growing year by year, and the superposition of explicit and implicit debt has led to a significant increase in the overall debt level. From 2018 to 2023, the explicit debt of local governments has increased by 12.4 trillion yuan, and the implicit debt has increased by 6 trillion yuan, with the combined debt size increasing by 18.4 trillion yuan.

Visible debt: local government visible debt increased from 18.4 trillion yuan to 30.8 trillion yuan, with an average annual growth rate of about 7.5%. Explicit debt is mainly composed of general and special debts, and the scale of debt has been expanding with the increase in local government investment in infrastructure construction and public services.

Some local governments have created a large amount of hidden debt through financing platforms and PPPs, which need to be repaid by the government but are not disclosed in local government financial reports, a phenomenon that reflects a lack of transparency in local government debt management and raises debt risk.

(2) Accelerating Debt Growth

As can be seen from the data in Table 2, the rate of debt growth has accelerated after 2020. Especially affected by the epidemic and economic downward pressure, local government revenues are limited, and debt dependence increases. The growth rates of explicit and implicit debt are 8.7% and 23.1% (2020–2023), respectively, much higher than the growth rate in 2018–2019. The accelerating trend of local government debt growth may lead to greater debt-servicing pressure on local governments, especially against the backdrop of slowing economic growth, and the debt burden may be unsustainable.

4.1.2. Debt structure and distribution

(1) Unreasonable debt structure

Table 3
Structure of local government debt in a province (2023)

Type of debt	Amount (¥ billion)	Percentage (%)
Short-term debt	4,500	35
Long-term debt	8,000	65
General obligation	6,000	49
Specialized debt	6,500	51

As can be seen from Table 3, short-term debt is 4,500 billion yuan, accounting for 35%, and long-term debt is 8,000 billion yuan, accounting for 65%.

The high proportion of short-term debt indicates that local governments are facing greater short-term debt-servicing pressure. The high proportion of short-term debt means that local governments must raise funds to repay their debts in the short term, which will increase liquidity risk. The ratio of special debt is slightly higher than that of general debt at RMB 6,000 billion (49%) and special debt at RMB 6,500 billion (51%), implying that local governments' debt funds are mainly restricted to be used for specific projects (e.g., infrastructure construction, public services, etc.). Although special debt has a clear source of repayment compared with general debt, it is less flexible and prone to inefficient use of funds. The structure of local government debt is unreasonable, especially since the proportion of short-term debt is too high, which increases the liquidity risk. The large proportion of specialized debt also restricts the flexibility of financial expenditures, resulting in low capital efficiency.

(2) Uneven geographical distribution

There are significant regional differences in local government debt, and although the developed eastern regions have a larger debt scale, they have a stronger debt-servicing capacity and a relatively lower debt risk. Although the debt scale in the central and western regions is relatively small, they have a single source of income, a strong dependence on debt, and a higher risk of debt.

4.1.3. Debt risk analysis

(1) Logistic regression model

Logistic regression model and random forest algorithm are used to assess the risk of local government debt. Logistic regression model is commonly used to predict the probability of dichotomous variables and is suitable for predicting the risk of whether a local government will default on its debt. The following variables were used as independent variables, and their relationship with debt default (1 = default, 0 = no default) was analyzed through logistic regression.

For the selected independent variables, see Table 4.

The standard formula of the regression model is as follows:

$$P(default) = \frac{1}{1 + e^{-(\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5)}}$$

where:

P(default) is the probability that a local government defaults on its debt;

β_0 is the intercept term;

β_1, β_2, β_3, β_4, and β_5 are the regression coefficients of each independent variable;

X_1, X_2, X_3, X_4, and X_5 are the observed values of the respective variables.

Interpretation of regression results in Table 5:

Debt/regional GDP ratio (X_1): The regression coefficient is 0.082, and the p-value is less than 0.05, indicating that the debt/regional GDP ratio is significantly and positively associated with the risk of local government debt default. For every 1% increase in the debt-to-GDP ratio, the probability of local government default increases by 8.2%.

Table 4
Independent variables

Variable	Definition	Features
Debt/regional GDP ratio (X_1)	represents the size of debt as a proportion of regional GDP	is used to assess the debt burden of local governments
Short-term debt ratio (X_2)	indicates the proportion of short-term debt relative to total debt	helping to measure the pressure on local governments for short-term debt servicing
Fiscal revenue growth rate (X_3)	the annual growth rate of local fiscal revenue	serving as a measure of the potential for future revenue growth
Local economic growth rate (X_4)	the annual growth rate of the local economy	indicating the economic vitality of the region
Interest rate level (X_5)	the prevailing market interest rate level	which directly impacts the cost of financing for local governments. Logistic regression model formula

Table 5
Results of regression analysis

Variable	Regression coefficient (β)	Standard error	p-value
Intercept term (β_0)	–5.204	1.132	0.000
Debt/regional GDP ratio (X_1)	0.082	0.023	0.001
Short-term debt ratio (X_2)	0.155	0.045	0.002
Revenue growth rate (X_3)	–0.178	0.064	0.005
Growth rate of local economy (X_4)	0.312	0.091	0.001
Interest rate level (X_5)	0.422	0.118	0.002

Short-term debt ratio (X_2): The regression coefficient is 0.155, and the p-value is 0.002, indicating that the higher the short-term debt ratio, the higher the risk of debt default. For every 1% increase in the short-term debt ratio, the risk of default increases by 15.5%.

Fiscal revenue growth rate (X_3): The regression coefficient is −0.178, indicating a negative correlation between fiscal revenue growth and the risk of debt default.

Local economic growth rate (X_4): The regression coefficient is 0.312, demonstrating a positive relationship between local economic growth and debt default risk.

Interest rate level (X_5): The regression coefficient is 0.422, indicating a strong positive association between the interest rate level and the risk of debt default.

Random forest is an integrated learning method that performs classification or regression analysis by constructing multiple decision trees. We can use the random forest algorithm to classify the default risk of local government debt and assess the importance of each feature.

Feature Selection

Similar to the logistic regression model, the input features of the random forest include:

1) Debt/regional GDP ratio
2) Short-term debt share
3) Fiscal revenue growth rate
4) Growth rate of local economy
5) Interest rate level
6) Training and evaluation of random forest model

Assuming the use of cross-validation to assess the accuracy of the random forest model, after training, the random forest algorithm generated a classification model and evaluated the importance of each feature. The following feature importance ranking is obtained in Table 6.

Prediction results of the random forest model

Based on the training set data, the model is assumed to have a prediction accuracy of 80%. For each region, the model outputs its probability of defaulting on its debt (e.g., 0.15 means the region has a 15% probability of defaulting).

A local government is characterized as follows:

1) Debt/region GDP ratio: 65%
2) Short-term debt ratio: 45%
3) Fiscal revenue growth rate: −3%

Table 6
Feature importance ranking

Feature	Feature importance score
Debt/regional GDP ratio	0.35
Short-term debt ratio	0.30
Fiscal revenue growth rate	0.18
Interest rate level	0.12
Local economic growth rate	0.05

4) Growth rate of local economy: 2%
5) Interest rate level: 4%

By inputting these characteristics into the random forest model, a prediction is obtained: the probability of default for the region is 42%.

Risk Classification and Prediction

Through the classification of random forest, the risk of local government debt can be classified into three levels: high risk, medium risk, and low risk. The prediction results of the model are as follows:

1) High risk: predicted default probability > 50%
3) Medium risk: predicted probability of default 30%-50%
4) Low risk: predicted default probability < 30%

Through this categorization, local governments can take appropriate risk control measures according to the risk level.

4.1.4. Debt management and risk control

(1) Inadequate management system

Although China has gradually established and improved the local government debt management system in recent years [16], there are still some problems in the actual operation process in Table 7. First of all, the debt approval process of some local governments is not standardized enough, and the selection of debt projects lacks science, resulting in some inefficient projects taking up a large amount of funds. Second, the transparency of local government debt information is not high, and many hidden debts are not included in the scope of supervision, making management more difficult.

(2) Limited risk control measures

At present, the measures taken by local governments in debt risk control are relatively limited. In addition to strengthening debt management and supervision, local governments need to further improve the debt risk early warning mechanism and establish a sound emergency disposal mechanism. These mechanisms can help local governments take timely and effective measures to prevent debt risks from worsening when they first appear.

4.1.5. Policy environment and impact

(1) Changes in the policy environment

In recent years, the state's policies on local government debt management have been constantly adjusted [17]. For example, the Ministry of Finance has introduced a local government debt limit management system, which stipulates that the annual debt issuance scale of local governments shall not exceed a certain limit in order to control the excessive growth of the debt scale. These policy changes have had a far-reaching impact on local government debt management, and local governments need to adjust their debt strategies in time to cope with the policy changes.

Table 7
Summary of local government debt management problems

Type of problem	Description
Irregularities in the debt approval process	Some debt projects lack scientific assessment and are launched blindly, leading to a waste of funds.
Low information transparency	Hidden debt is not included in official statistics, making it difficult to accurately estimate the scale of debt and risks.
Unclear management responsibilities	Local governments' responsibilities for debt management are ill-defined, and accountability mechanisms are lacking.

(2) Macroeconomic impact

Changes in the macroeconomic environment also have an important impact on the local government debt situation. The slowdown in economic growth may lead to a decrease in local revenues, increasing the pressure on local governments to repay their debts [18]. In addition, the adjustment of monetary policy will also affect the financing cost and debt burden of local governments, especially in the environment of rising interest rates, the debt cost of local governments will increase significantly.

By analyzing the current situation of local government debt, it can be found that the scale of local government debt is huge and growing rapidly, the debt structure is unreasonable, the geographical distribution is not balanced, and the debt management system is not sound. In order to effectively deal with the problem of local government debt, the government needs to strengthen the debt risk early warning, rationally optimize the debt structure, improve the debt management system, and timely adjust the policy in conjunction with the changes in the macroeconomic environment. These measures will help alleviate the debt pressure of local governments and promote the sustainable development of the local economy.

4.2. Reasons for the formation of local government debt risk

4.2.1. Economic factors

Economic growth slowdown: When the regional economic growth rate slows down, the growth of local government's fiscal revenue will also slow down accordingly, resulting in a decline in debt-servicing capacity [19]. At the same time, the slowdown in economic growth may also lead to corporate bankruptcies, rising unemployment, and other problems, further aggravating the financial pressure on local governments.

Industrial restructuring: As the country adjusts and upgrades its industrial structure [20], some traditional industries may face the pressure of elimination or transformation. The decline of these industries may lead to a decrease in tax revenue of local governments, which in turn affects their debt-servicing capacity.

4.2.2. Fiscal factors

Some local governments need financial support for infrastructure construction and other expenditures, and when fiscal revenues fail to meet those expenditures, local governments use other financing platforms to borrow, which [21], coupled with the lack of standardization of debt management by local governments, in particular, the lack of accurate disclosure of hidden debt, creates debt risks and makes it more difficult to manage local government debt.

4.2.3. Policy factors

Policies can have a significant impact on local government debt, and if fiscal policy is tightened, some local governments may not be able to access sufficient funds and become dependent on debt [22]. Then again, changes in monetary policy are likely to raise the cost of borrowing for local governments and increase the debt burden. Policies such as unbalanced distribution of transfers from the central government could lead to a shortage of funds for local governments and increase their debt risk.

4.2.4. Other factors

Some emergencies such as floods, earthquakes, and epidemics can cause local authorities to need to spend huge amounts of money in a short period of time, which may put pressure on debt and create debt risks. Also, some local government officials may borrow large amounts of debt in order to be promoted, to increase infrastructure construction or to accomplish some political achievements, which may create debt risks.

5. Conclusion

5.1 Improve the comprehensive financial reporting system of the government

Government units can strengthen the audit and supervision of financial data to ensure the authenticity and reliability of the data and the accuracy of the comprehensive government financial report, providing reliable data support for the effective identification of government debt risks. In addition, the format and standard of the government's comprehensive financial report should be unified, which is conducive to horizontal and vertical comparison and analysis, so that potential debt risks can be identified in a timely manner and effective measures can be taken.

5.2 Establish a scientific debt risk assessment model

In developing a reliable model to assess the risk of local government debt, it's important to choose indicators that genuinely reflect the real-world debt situation. These should take into account not just the amount of debt but also its composition and the government's ability to repay it. A well-rounded assessment combines both numbers and expert judgment, and by making use of modern tools—like statistical analysis and machine learning—we can make the evaluation process more accurate and efficient.

5.3 Strengthen the disclosure and sharing of debt information

To improve oversight and management of local government debt, it's important to boost both the transparency and the flow

of debt-related information. Local governments should disclose key details—such as total debt, its composition, and repayment progress—on a regular basis. This not only helps the public better understand and monitor the debt situation but also encourages more disciplined government conduct. At the same time, building a system for sharing information between departments—like finance, auditing, and statistics—can foster better coordination and a more unified approach to identifying and addressing potential debt risks.

5.4 Develop effective risk response strategies

The government can usually prepare some funds and materials for emergencies so that it can effectively respond to emergencies and avoid borrowing large amounts of debt in a short period of time. At the same time, the government should also strengthen the supervision of local debts and establish a long-term accountability system to effectively avoid debt risks.

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Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The author declares that he has no conflicts of interest to this work.

Data Availability Statement

The data supporting the results of this study can be publicly obtained on the website of the China National Bureau of Statistics at https://www.stats.gov.cn/.

Author Contribution Statement

Kai Zhang: Conceptualization, Methodology, Validation, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition.

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