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Формирование модели управления долговыми обязательствами местных органов власти

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Основной целью данной статьи является изучение текущей ситуации управления долгом в экономике местных органов власти Китая, построение мо Китая, построение мо дели оценки местного долга в экономическом развитии местных органов власти с помощью анализа главных компонент (PCA), а также еее оценка на основе данных муниципалитета Пекина с помощью PCA, которая показывает, что экономическая ситуация муниципалитета Пекина находится в хорошем состоянии, как показы вают результаты оценки. Таким образом, экономическая политика, проводимая в настоящее время муниципальным правительством Пекина, изучается для тог о, чтобы другие города могли извлечь из нее уроки при корректировке своей экономической политики.

Ключевые слова: экономическое развитие; управление долгом; экономическая оценка; PCA.

Introduction

In the current economic landscape, the challenge posed by local government debt in China has garnered significant attention from national economists, highlighting its critical impact on the nation's financial health and growth. By the close of February 2023, local government debt in China reached a staggering 36.227 trillion Yuan, divided into general debt (14.69 trillion Yuan) and special debt (21.53 trillion Yuan). Additionally, the issue of concealed debt among local governments is noteworthy. Research by Xu Qiyuan and Sheng Zhongming reveals that the interest-bearing debt linked to urban investments, which are closely associated with local governments, is nearly 60 trillion Yuan, with about 40 trillion Yuan considered as hidden debt. This data underscores the urgent need for regulatory measures in managing local government debt through suitable policies.[9] Larson Lee and colleagues, along with He Dexu and team, have observed that while the overall risk of government debt in China is manageable, the debt risks vary significantly across different regions due to disparities in economic growth and debt repayment capacities.[1,4] The presence of these regional risks indicates that, despite the overall manageability, the debt issue cannot be overlooked. Consequently, this study aims to utilize the Principal Component Analysis (PCA) method to delve into the assessment of local government debt management in China. It focuses on developing a robust mechanism for monitoring and evaluating local government debt risks and establishing an efficient early warning system for these risks.

Study on the Current Status of Local Government Debt in China in the Past Five Years

The inception of significant local government debt in China traces back to 2009, catalyzed by the 2008 global financial crisis. In an effort to mitigate the crisis's effects, China embarked on an expansive fiscal strategy, launching a massive 4 trillion yuan investment initiative. [4] This action precipitated a marked escalation in the debt levels across local governments. By the end of February 2023, local government debt in China soared to an astonishing 362.2 trillion yuan, with general and special debts accounting for 146.9 billion yuan and 215.3 billion yuan, respectively. The period between 2021 and 2022 saw the government possibly intensifying its fiscal policies and refining its debt management approaches, highlighted by the raised caps on general and special debts. Such adjustments likely signify the government's efforts to fuel economic growth or tackle the prevailing crisis. Concurrently, the reduction in debt levels in 2022 could suggest an active governmental engagement in risk management, emphasizing a commitment to fiscal prudence. It seems the government's strategy on debt management is progressively orienting towards enhancing sustainability and fortifying risk oversight.

The Chinese government has implemented several crucial initiatives since 2018 to enhance the management of local government debt, aligning these efforts with the financial security objectives outlined in the 14th Five-Year Plan. These initiatives aim to bolster debt risk management and support fiscal health. Key strategies have included refining the debt and budget management frameworks, creating a structured approach for local government bond issuance, and working to increase the issuance volume of local bonds to enhance debt transparency. Additionally, efforts to advance the debt risk assessment system, focusing particularly on debt ratios, have been made. The government has also restructured the management of Public-Private Partnership (PPP) projects and clarified the distinctions between local financing platforms and local government debt, aiming to mitigate the escalation of concealed debt and lessen the financial burden on local governments. These comprehensive steps are designed not just to preserve fiscal stability and foster sustainable economic growth but also to fulfill the broader financial security and stability ambitions of the 14th Five-Year Plan.

Early Warning Analysis of Background Local Government Debt Risks Based on the PCA Approach

1. **Research Approach.** In our research, we integrate findings from Zhang Xiaofeng, Tan Yun, and others to employ Principal Component Analysis (PCA) for evaluating early warning signs of local government debt in Beijing[8,10]. PCA is a statistical procedure that simplifies complex datasets by reducing their dimensionality, transforming a wide range of variables into a smaller set of essential indicators. This method achieves simplification by linearly projecting the original data onto a new set of axes, with the first axis capturing the maximum variance in the data (identified as the first principal component), followed by the second axis capturing the next highest variance (the second principal component), and so forth. By condensing the dataset into a few principal components, PCA makes it easier to analyze and interpret the data effectively.
2. **Selection of indicators.** In our investigation, we chose indicators to forecast the risk associated with the debt of the Beijing government by adhering to criteria that prioritize scientific rigor, significance, relevance, reliability, and practicality. The initial step in developing our evaluation framework was to establish its scientific basis, ensuring that the structure of the system was coherent, logical, and applicable. This involved integrating cutting-edge theories and empirical insights while also considering the specific context of the case studies to bridge the gap between theoretical understanding and practical application. Building on the foundation of scientific rigor, the principle of significance was applied to highlight indicators with a profound influence on local debt risk, focusing on aspects like the Beijing municipal government's ability to generate revenue and meet its debt obligations. The relevance criterion dictated the selection of indicators directly tied to the dynamics of government debt risk, including factors that contribute to debt accumulation and the prospects for mitigating such risks in the future. The principles of reliability and practicality were crucial in ensuring the authenticity of the data and its accessibility for analysis. Guided by these comprehensive criteria, ten indicators were meticulously chosen for in-depth examination in this study (tab. 1).

Table 1. Selection of Early Warning Indicators for Local Government Debt Risks

Indicator code	Indicator name	formula
X1	Fixed Asset Investment / Gross Regional Product	Investment in fixed assets / GDP x 100%
X2	gearing	Balance of debt at the end of the year / Gross regional product of the year x 100 percent
X3	debt ratio	Year-end debt balance / current year's revenue x 100%
X4	GDP growth rate	(current year's GDP – previous year's GDP) / previous year's GDP x 100%
X5	Fiscal revenue tax rate	Tax revenues / local revenues x 100%
X6	deficit ratio	(Fiscal Expenditure – Fiscal Revenue) / Gross Regional Product for the year x 100%
X7	unemployment rate	Publicly available data is directly accessible
X8	Government budget expenditure rate	Local general budget expenditures / GDP x 100%
X9	General budget income and expenditure rate	Local general budget expenditure/ local general budget revenue x 100%
X10	Investment infrastructure expenditure rate	Financial capital expenditure / total fixed asset investment x 100%

To validate the reliability and feasibility of the early warning system for local government debt risk, our study sources raw data from the Beijing Municipal Statistical Yearbook, published by the Bureau of Statistics, and financial figures disclosed by the Beijing Municipal Bureau of Finance. By examining the fiscal data for Beijing from 2020 to 2022, it is observed that investment in fixed assets has increased from 47,035,586 million to 5,395,660 million, indicating a steady rise that signifies ongoing economic development and capital investment growth. Additionally, the substantial growth in regional GDP, notably the increase to 4,104,560 million in 2021, signals robust economic expansion, although the pace of growth slightly decelerates to 4,161,090 million in 2022. Yet, the sharp escalation in debt levels by year-end, with a notable doubling to 877,070 million in 2021 and a further increase to 105,653 million in 2022, points to an escalating debt obligation, presenting a critical challenge for fiscal governance.

Revenue volatility is a significant observation, highlighted by a revenue peak at $593,231 million in 2021 before a decline to $571,436 million in 2022, suggesting the effects of shifts in the tax base or economic cycles. A similar trend is observed in tax revenues, with an increase in 2021 followed by a decrease to $486.707 billion in 2022. Moreover, the consistent year-over-year increase in fiscal spending, including local general budget expenditures, indicates the government's commitment to maintaining steady fiscal policies. The marked increase in fiscal capital expenditures from $52.710 billion to $58.925 billion underscores the importance of infrastructure investments in fueling economic expansion. Utilizing the presented data allows for the straightforward computation of the relevant indicators X1-X10, as detailed in Table 2.

Table 2. 2020–2022 Beijing Municipal Government Related Data (III) PCA Principal Component Analysis

	2020	2021	2022
Fixed Asset Investment / Gross Regional Product X1	1.31	1.23	1.30
Debt ratio X2	0.14	0.21	0.25
Debt ratio X3	0.89	1.48	1.85
GDP growth X 4	1.10%	8.50%	1.38%
Tax rate on fiscal revenues X 5	0.85	0.87	0.85
Deficit rate X6	0.05	0.03	0.04
Unemployment rate X 7	4.7%	3.2%	2.6%
Government budget expenditure rate X 8	0.20	0.18	0.18
General budget expenditure and income ratio X 9	1.30	1.21	1.31
Investment infrastructure expenditure rate X 10	0.01	0.01	0.01

According to the above Beijing 2020–2022 X1-X10 ten indicators value, using SPSS software to carry out PCA principal component analysis, the analysis results are shown in Table 3.

Table 3. Explanation of total variance of early warning indicators in Beijing

ingredient	Initial eigenvalue			Extract the sum of the squares of the loads		
	(grand) total	Percentage of variance	Cumulative %	(grand) total	Percentage of variance	Cumulative %
1	7.262	72.619	72.619	7.262	72.619	72.619
2	2.738	27.381	100.000	2.738	27.381	100.000
3	6.277×10^{-16}	6.277×10^{-15}	100.000			
4	2.701×10^{-16}	2.701×10^{-15}	100.000			
5	$1.928E\times10^{-16}$	1.928×10^{-15}	100.000			
6	1.363×10^{-17}	1.363×10^{-16}	100.000			
7	-1.441×10^{-16}	-1.441×10^{-15}	100.000			
8	-2.742×10^{-16}	-2.742×10^{-15}	100.000			
9	-4.979×10^{-16}	-4.979×10^{-15}	100.000			
10	-1.038×10^{-15}	-1.038×10^{-14}	100.000			

Extraction method: principal component analysis.

The outcomes of the Principal Component Analysis (PCA) presented in Table 3 reveal that two principal components have been identified, with their combined eigenvalues constituting 100% of the total variance. This signifies that these two principal components fully account for the variability across all variables from X1 to X10. To delve into how each variable contributes to the identified principal components, the loadings on these components for Beijing's early warning indicators are detailed in Table 4.

To enhance the interpretability and significance of the coefficients within the factor loading matrix, and thereby assign practical relevance to the identified male factors, the initial factor loading matrix underwent rotation. This process redefined the associations between the factors and the original variables. Table 5 illustrates that, post-rotation, the number of extracted common factors remains at two, yet there is a shift in the variance contribution ratio for each factor. To thoroughly assess the risk associated with the debt of the Beijing municipal government, SPSS software was employed to examine the factor score coefficient matrix derived from the rotated total variance explanation.

Table 4. Explanation of the component matrix

	ingredient	
	1	2
Fixed Asset Investment / Gross Regional Product X1	0.939	0.343
Debt ratio X2	-0.631	0.776
Debt ratio X3	-0.590	0.807
GDP growth X 4	-0.894	-0.449

Окончание

	ingredient	
	1	2
Tax rate on fiscal revenues X 5	-0.955	-0.297
Deficit rate X6	0.960	0.279
Unemployment rate X 7	0.675	-0.738
Government budget expenditure rate X 8	0.928	-0.373
General budget income and expenditure rate X 9	0.830	0.558
Investment infrastructure expenditure rate X 10	0.997	0.073
Extraction method: principal component analysis.		
a. Two components were extracted.		

Based on the matrix of component score coefficients after the rotation of the indicator, the following expressions for each common factor can be derived:

$$f1 = 0.176x1 + 0.076x2 + 0.087x3 - 0.191x4 - 0.169x5 + 0.166x6 - 0.064x7 + 0.036x8 + 0.205x9 - 0.131x10$$

$$F2 = -0.038X1 - 0.286X2 - 0.293X3 + 0.074X4 + 0.023X5 - 0.016X6 + 0.278X7 + 0.183X8 - 0.112X9 + 0.05X10$$

Table 5. Explanation of total variance after rotation of Beijing's early warning indicators

ingredient	Initial eigenvalue			Extract the sum of the squares of the loads			Rotational load sum of squares		
	(grand) total	Percentage of variance	Cumulative %	(grand) total	Percentage of variance	Cumulative %	(grand) total	Percentage of variance	Cumulative %
1	7.262	72.619	72.619	7.262	72.619	72.619	5.996	59.957	59.957
2	2.738	27.381	100.000	2.738	27.381	100.000	4.004	40.043	100.000
3	6.277×10^{-16}	6.277×10^{-15}	100.000						
4	2.701×10^{-16}	2.701×10^{-15}	100.000						
5	1.928×10^{-16}	1.928×10^{-15}	100.000						
6	1.363×10^{-17}	$1.363E\times10^{-16}$	100.000						
7	-1.441×10^{-16}	-1.441×10^{-15}	100.000						
8	-2.742×10^{-16}	-2.742×10^{-15}	100.000						
9	-4.979×10^{-16}	-4.979×10^{-15}	100.000						
10	-1.038E-15	-1.038×10^{-14}	100.000						
Extraction method: principal component analysis. Rotation method: kaiser normalized maximum variance method.									

Table 6. Matrix of component score coefficients

	ingredient	
	1	2
Fixed Asset Investment / Gross Regional Product X1	0.176	-0.038
Debt ratio X2	0.076	-0.286
Debt ratio X3	0.087	-0.293
GDP growth X 4	-0.191	0.074
Tax rate on fiscal revenues X 5	-0.169	0.023
Deficit rate X6	0.166	-0.016
Unemployment rate X 7	-0.064	0.278
Government budget expenditure rate X 8	0.036	0.183
General budget income and expenditure rate X 9	0.205	-0.112
Investment infrastructure expenditure rate X 10	0.131	0.050
Extraction method: principal component analysis. Rotation method: kaiser normalized maximum variance method.		

Since the two public factors F1 and F2 reflect the risk level of local government debt in Province H from different aspects, it is difficult to make a comprehensive evaluation by using one public factor alone, so the rotated proportion of the variance contribution rate of each public factor is used as the weight to calculate the comprehensive score:

$$Score=59.957\%\ F1+40.043\%\ F2$$

Meanwhile, for the 2020–2022 local government debt risk early warning evaluation score of Beijing, this paper draws on Pei Yu el research result. [6] The results of many people's research, according to the score determine the five risk variation intervals, namely [0, 0.2], [0.2, 0.4], [0.4, 0.6], [0.6, 0.8], [0.8, 1]. The value can be understood as a probability value, that is, the probability of possible debt risk, the five score intervals correspond to no risk, low risk, medium risk, high risk, and high risk warning intervals, and draw on the 2016 State Council General Office of the local government debt risk emergency disposal plan issued by the State Council supplemented with colorless, green, blue, orange, red five warning lights as a reminder to help the government debt early warning work carried out. As a result, the results of Beijing's debt risk early warning for 2020–2022 are shown in Table 7 (with two decimal places).

Table 7. Beijing's Government Debt Risk Warning Results, 2020–2022

particular year	2020	2021	2022
score	0.10	0.03	0.02
risk interval	risk-free	risk-free	risk-free
Where's the warning light?	colorless	colorless	colorless

The results show that, as far as Beijing is concerned, the government debt risk has been in a risk-free state during the period from 2020 to 2022, while the score is decreasing year by year, which means that, in recent years, a series of risk prevention and control policies adopted by Beijing have made good progress.

Details of Beijing's Government Debt Risk Prevention and Control Policies Adopted in Recent Years

Over the past two years, Beijing has implemented a comprehensive strategy for managing and mitigating government debt, focusing on three key areas:

1. **Enhancement of Strategic Planning and Regulatory Frameworks.** The city has updated and refined the Beijing Municipal Government Debt Management Regulations, setting clear guidelines, foundational principles, oversight, and control mechanisms for debt management, thus reinforcing the legal framework governing this area. An action plan for mitigating and managing municipal government debt risks has been launched, detailing goals, responsibilities, and strategies for risk prevention and management, alongside the establishment of a monitoring and early warning system for government debt risk. This system regularly evaluates potential debt risks, ensuring timely identification and mitigation of latent threats.
2. **Strict Regulation of Debt Accumulation.** The government has imposed stringent controls on new debt accrual, adhering to the limits prescribed by the Fourteenth Five-Year Plan and maintaining debt levels within sustainable boundaries. Efforts to refine the debt portfolio include optimizing the structure of government debt, adjusting the terms, interest rates, and currencies of the debt instruments, and enhancing the city's capacity for debt risk management. Enhanced oversight of debt fund utilization ensures that investments are channeled into pivotal projects, maximizing the utility of borrowed funds.
3. **Fortification of the Debt Repayment Framework.** A robust budget management system for debt servicing has been established, guaranteeing timely and complete repayment of debt principal and interest. Initiatives to streamline debt settlement processes and enhance resolution efficiency have been prioritized. Furthermore, the city has reinforced its commitment to debt risk prevention and control, instituting a comprehensive accountability framework that mandates strict adherence to risk management protocols, thereby ensuring the effective implementation of debt risk prevention measures.

Conclusion

Utilizing the PCA methodology, it's entirely feasible to devise a model for managing local government debt within the framework of economic development. This approach enables the effective monitoring and evaluation of risks associated with local government debt, thereby assisting governments at various levels in timely detecting and addressing potential financial challenges. This ensures the continuous and robust growth of local economies. Risk assessment, in this context, serves not just as a methodological tool but also as a crucial strategy for maintaining fiscal health and promoting sustainable economic progress. Moreover, local authorities are encouraged to take inspiration from Beijing's recent economic strategies, focusing on enhancing strategic planning, refining regulatory frameworks, and ensuring there are robust mechanisms in place for managing government debt. By strictly regulating new debt accruals, fine-tuning the composition of debt, and minimizing associated risks, local governments can establish a solid foundation for debt management. Building on this foundation, there's a significant opportunity to invigorate the economy, contributing substantively to the broader trajectory of China's economic development.

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FORMATION OF A MODEL FOR MANAGING DEBT OBLIGATIONS OF LOCAL AUTHORITIES

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The main purpose of this article is to study the current situation of debt management in China's local government economy, using principal component analysis (PCA) to build an evaluation model of local debt in local government economic development, and use PCA to evaluate based on Beijing's local government economic development. The main purpose of this article is to study the current situation of debt management in China's local government economy, using principal component analysis (PCA) to build an evaluation model of local debt in local government economic development and use PCA to evaluate based on Beijing data. From the evaluation results, Beijing The city government is in good economic shape. Therefore, the current economic policies adopted by the Beijing Municipal Government are studied so that the current economic policies of the Beijing Municipal Government can be implemented. Therefore, the current economic policies adopted by the Beijing Municipal Government are studied so that other cities can learn from them when adjusting their economic policies.

Keywords: economic development; debt management; economic assessment; PCA.

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