

Original Paper

Risk Assessment of Local Government Debt: Evidence from China

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Abstract

The risk of local government debt has been a robust indicator of regional economic development and the smooth operation of local government. The promulgation and implementation of the new Budget Law in 2014 also reflect the determination of China to control government debt risk. Based on the DPSIR model, this paper defines the logical relationship among the driving force, pressure, debt status, influence, debt repayment ability, and local government debt risk. Combined with the entropy method, this paper analyzes the debt risk level of 30 provinces, municipalities, and autonomous regions in China from 2013 to 2019. The results show that there are apparent regional differences in the debt risk of local governments in China. The debt risk evaluation of the southwest region is higher than the average level in other regions. Overall, we show a downward and upward trend through further analysis of the internal structure and causes of local government debt risk. We offer implications for countermeasures and suggestions.

Keywords

local government, debt risk, DPSIR model, entropy method, evaluation

1. Introduction

In 2014, the promulgation of the new Budget Law and the State Council's "opinions on strengthening the management of local government debt" marked a new beginning. China's local government debt has entered a new era of standardized development. Bond issuance mode in China's local government has entered a more standardized spontaneous self-repayment mode. Local governments are responsible for repaying the debts they borrow, and the central government implements the principle of no rescue.

However, with the increasingly fierce competition of regional economic and social development, the government debt management system has improved over time and the scale of local government debt has expanded rapidly and accumulating.

The 2019 China financial report suggested: the Evergrande Research Institute issued government debt risk and a resolution. The repayment period of national debt and local government debt is concentrated in five years from 2020 to 2024, with annual maturity of 2.1 and 2.7 trillion yuan (\$ 3,242 and \$ 4,169), respectively. These actions increase the pressure of capital turnover due to the over-concentration of liquidation.

According to the China macro-economic forum in 2020, the COVID-19 pandemic aggravated regional differentiation, impacting the economy and fiscal revenue. The risk of debt prevailed in the central disaster areas. Due to the excessive debt, ordinary citizens question the solvency of local governments. Moody's, Standard & Poor's, and other international rating agencies tend to downgrade the credit rating of local governments' excessive borrowing. Fitch has reduced China's credit rating from AA-to A+ (Fitch Ratings, 2021). The rising local government debt has triggered two potential major macroeconomic problems in China. On the one hand, because most of the debts of local governments come from bank loans, the outbreak of debt problems may lead to financial crisis and then affect macroeconomic stability. On the other hand, a large number of local governments' borrowing will inevitably crowd out the investment of private enterprises, which will eventually reduce the potential of long-term economic growth. Therefore, under the background of the implementation of the above new debt management policy, it is very necessary to clearly analyze the composition and current situation of local government solvency. Therefore, the analysis of the internal structure of local government debt risk and the establishment of debt scale control and risk prevention mechanism plays a vital role in the future government debt sustainability, government credit, and stable economic operation. Only after we have a comprehensive and systematic grasp of the solvency of local governments can we lay a foundation for targeted prevention and control of local government debt crisis. At present, researchers have divided the risk of local government debt into three aspects. We briefly discuss them in the sections below.

2. Method

2.1 The Formation Mechanism of Local Government Debt Risk and Related Theories

Sometimes the local government cannot pay off the debt and other risks. The debt risk of local government refers to the debt repayment risk of the local government. This risk comes from the basic institutional arrangement of the current financial system, the relationship between the central and local governments, and the fiscal revenue and expenditure (Fan & Lv, 2012). Several theories of local government debt risk include financial federalism theory and budget soft constraint theory.

According to the classic fiscal federalism theory, it is better to use local government loans to finance local projects than fiscal revenue under certain conditions. The loans are more economical, and the

operating costs are lower. Loans help to promote the accountability of local governments (Tiebout, 1956; Swianiewicz, 2004). However, the existence of transfer payment distorts the incentive of local governments to borrow debt. When local governments fall into a financial crisis, the central government will assist them. Local governments facing soft budget constraints have incentives to excessive borrowing and fiscal expenditure (Goodspeed, 2002).

2.2 The Evaluation Model of Local Government Debt

Scholars generally use the traditional principal component analysis, discriminant analysis, cluster analysis, and other multivariate statistical methods to evaluate local debt risk. There is a linear relationship between the main factors of debt risk and the risk index evaluation system. For example, Xu et al. (2020) used factor analysis, cluster analysis, and discriminant analysis to study local government debt risk early warning signs. Through accumulating generation of the original data, with certain rules, by establishing the differential equation model and evaluating over the fitting curve, Zhang et al. (2015) made a Grey Metabolic Forecasting Model (1, 1) model to forecast the amount of the outstanding debt of local government and GDP throughout the years. They then used the debt ratio to evaluate the Chinese government's financial health. Cairen and Guangbing (2010) established the risk assessment model of local government debt based on the risk prediction method of the Back Propagation Neural Network model.

There are several innovative research methods for local debt risk in recent years, such as the "pressure-state-response model" (PSR model) (Xie et al., 2019), and the spatial network characteristics of local debt risk (Wang & Fan, 2012). Zheng et al. (2020) used the dynamic factor model to analyze the debt risk and bank risk of local governments in China. There is a positive correlation between commercial bank risk and government debt risk. Zhang et al. (2021) used KMV developed by the KMV Corporation in the late 1980s, Technique for Order Preference by Similarity to an Ideal Solution Model (TOPSIS Model), and entropy method to analyze the structural debt risk of local government.

When assessing the sustainability of government debt, researchers must adopt a systematic approach, especially under economic uncertainty (Draksaite et al., 2015). The deterministic method contradicts the theoretical basis behind debt assessment in a stochastic economic environment. Based on a macro balance sheet, Li et al. (2018) used an improved "distance to distress" to measure China's local government debt risks. Their social network model identifies the spatial characteristics and the spillover effect. The debt financing of the local government has a robust crowd-out effect on corporate leverage, state-owned enterprises, and non-state-owned enterprises (Liang et al., 2017). Juessen et al. (2009) analyzed the risk premium of government bonds by using the macroeconomic model. The default risk premium of government bonds reflects the probability of this event and the expected interest rate of partial repayment in case of default. Tao (2015) used principal component analysis (PCA) and multiple discriminant analysis (MDA) to identify the credit risk of local government financial instruments based on the traditional economic variables and local government financial situation.

2.3 The Regulation and Resolution of Debt Risk

Gao et al. (2021) suggested that the political power struggle is the basis of a selective breach of contract. Ma (2013) showed that once the government is involved in debt financing, it must establish a total control system of budget and decision-making, establish and improve the debt management system, and improve financial transparency. Guess et al. (2015) argued that the government must first understand the stock and flow of its total debt, establish a framework of public expenditure and fiscal accountability. It is essential to include the debt into the consolidated balance sheet and recognize the deficit.

In China, Dai (2020) proposed a comprehensive risk management system of local government debt under the general framework of “two pillars” to reshape the capitalization ecology of local government finance. Bailey (1999) proposed that researchers explore debt risk by incorporating the primary path of debt liquidation, incremental control, stock removal, platform company transformation, and debt performance evaluation.

Our literature review suggests: First, many scholars have studied the risk evaluation of the local debt. It provides an important idea for the risk assessment of local government debt default in China. However, due to the continuous evolution of the formation of local debt and the constant expansion of implicit debt, researchers must build a new risk evaluation model of local debt to evaluate them accurately. Second, although many scholars have studied the formation mechanism of local government debt risk, the formulation of its risk evaluation indicators has not reflected the relevant factors, such as soft budget constraints and land finance. Third, research on government debt risk evaluation systems shows a list of indicators without the corresponding logical relationship. Most of these studies carried out a static analysis with a single research object, a single province, or city (Wang & Fan, 2012). Fourth, most scholars (e.g., Zhao, 2006) only focus on the impact of debt pressure and scale on local government debt risk, without investigating the driving force, impact, and response of government debt.

This paper is the first to apply the DPSIR (Driving Forces-Pressure-State-Impact-Response) model to build the local government debt risk evaluation index system. We introduce the DPSIR model into regional government debt risk. The DPSIR model helps us analyze the risk level of 30 provinces, municipalities, and autonomous regions in China from 2013 to 2019. We offer comprehensive, innovative, and systematic findings and practical implications.

2.4 The Construction of an Index System of Debt Risk for Local Government

2.4.1 Theoretical Analysis

Most importantly, financial sustainability and social stability rely on the accurate evaluation of the causes and current local government debt risk situation, seeking the right solutions. Based on the DPSIR model in environmental quality assessment, this paper establishes the DPSIR framework specifically for local government to conduct an evaluation index for debt risk assessment. Using this method, we define the logical relationship among the driving force, pressure, debt status, influence,

debt repayment ability, and local government debt risk.

The European Environment Agency (EEA) developed the DPSIR model by integrating United Nations Economic Cooperation Agency's (UNECA) PSR model and the United Nations Commission's DSR model for sustainable development. At present, most researchers have applied the model mainly in natural resource evaluation (Sun et al., 2016), ecological environment evaluation (Malekmohammadi & Jahanishakib, 2017), and tourism quality evaluation (Hu et al., 2021; Ruan et al., 2019).

In recent years, scholars have gradually applied the DPSIR model to economic research. Chen et al. (2018) used the DPSIR model to assess whether local officials would sacrifice economic growth rates to maintain low emissions due to an official incentive system. Xiong and Zhang (2020) used DPSIR to discuss the performance evaluation of financial education funds. Others employed DPSIR widely in the assessment of the environment and natural resources. Resource limitation is similar to the nature of government debt. The accumulation of local government debt risk may lead to debt's unsustainability. The causal relationships between driving force, pressure, state, impact, and response formulate debt risk. It is reasonable to introduce the DPSIR model in environmental assessment to local debt risk assessment.

DPSIR is a theoretical model based on sustainable development, which puts forward problems and contains strong logical causality. It is an associated state framework model based on some assumptions and influence, and there is an internal relationship based on driving force (D), pressure (P), state (S), influence (I) and response (R). Local government debt has great complexity, and its essence is a problem of sustainable development. DPSIR model can analyze and describe the relationship between various factors affecting government borrowing under the current economic system in detail, and analyze the results and feedback of government borrowing from the framework of "policy-economic-social-policy".

According to the equity risk matrix proposed by Hana, local government debt can be divided into direct debt and contingent debt. The so-called direct explicit debt refers to the government's statutory or contractual liabilities that will occur in any case. Explicit debt is mainly government debt publicly issued by local governments in the market, including partial replacement bonds and newly issued local bonds. In the process of debt control, due to the controllability of direct explicit debt, the corresponding direct financial risk is also controllable. Its dominant characteristics make it easier to achieve control effect.

The essence of the formation of local government implicit contingent liabilities by local state-owned enterprises is that the debts of state-owned enterprises are transferred to government departments under specific circumstances. The debt scale of state-owned enterprises is an important factor determining the implicit contingent liabilities scale of local governments. The higher the debt scale of state-owned enterprises, the larger the potential implicit contingent liabilities scale of local governments. However, the debts of state-owned enterprises are not equal to the implicit contingent liabilities of local governments. The government's implicit contingent liabilities will be formed only when the

state-owned enterprises have specific problems such as default risk. Therefore, in addition to the debt scale of state-owned enterprises, the important influencing factors of the government's implicit contingent liabilities also include the enterprise's own solvency, the proportion of enterprise debt loss borne by the local government and the probability of policy support provided by the local government. Generally speaking, the implicit contingent debt pressure of local governments is a certain proportion of the debt scale of local state-owned enterprises. In addition, the implicit contingent liabilities of local governments are not equal to the simple addition of the liabilities of local state-owned enterprises. China's state-owned enterprises are concentrated in the traditional industrial field. The concentration of industry distribution leads to the high correlation of enterprise default risk. There is a risk contagion effect between enterprises. The default risk of an enterprise causes more debt pressure on the local government through contagion to other local enterprises. That is, the implicit contingent liabilities of the local government are higher than the simple sum of the local government debt pressure formed by a single enterprise.

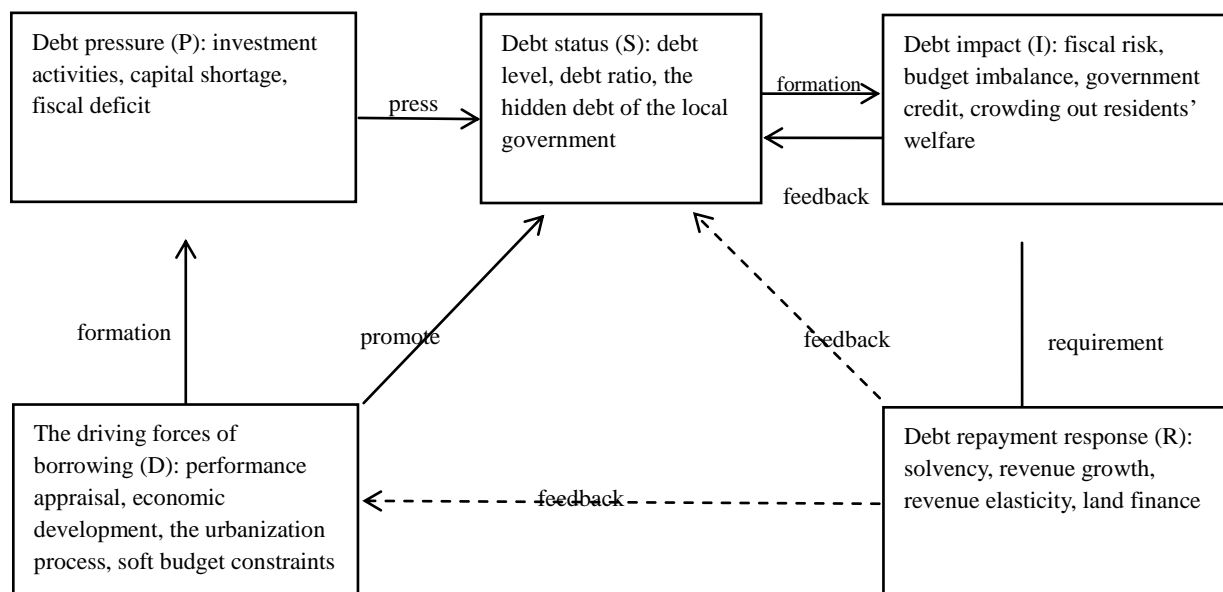


Figure 1. Internal Logic Framework of the Local Government Debt Risk Formation Based on the DPSIR Model

Debt driving force (D). In the 1980s, the political promotion standard of Chinese officials changed from political performance to economic performance (Yao & Zhang, 2015). Economic performance, i.e., the growth rate of economic development, urbanization, and infrastructure construction, requires continuous financial support, leading to government debt.

The growth rate of urbanization reflects the driving force of borrowing money, an indication of government officials' performance. A higher rate of urbanization represents a greater driving force of government debt.

On the other hand, based on the soft budget constraint theory, local governments know, in advance, that when they encounter financial difficulties, the central government will help them. Thus, local governments seek extra-budgetary revenue (issuing local bonds) to maintain economic growth. The soft budget constraints of local governments and state-owned enterprises drive the issuance of local bonds. Their financial shortage and enterprise losses can get external help. The capital investment is arbitrary. The soft budget constraints trigger moral hazard, which causes the government to over-borrow, constituting the driving force of local bonds. However, after 2015, the “spontaneous self-repayment” bonds of local governments have been fully implemented in all provinces and cities across China, and the problem of soft budget constraints has been alleviated to a certain extent. In addition, local implicit debt comes from local financing platform companies, and its related debts mainly include loans from local financing platforms to banks, bonds issued by local financing platforms, and loans from local financing platforms to trust companies. Local government financing platforms with a large number of loans are both state-owned enterprises and can be regarded as administrative organs of local governments to some extent. Local governments often over promise and guarantee their loans. We use the ratio of local extra-budgetary income to GDP to express the degree of the local government’s soft budget constraint. It is difficult to obtain the asset-liability ratio of state-owned enterprises in all provinces. Thus, this research explores the asset-liability ratio of state-owned industrial enterprises in the whole province to express the degree of state-owned enterprises’ soft budget constraints.

Debt pressure (P). With the pressure of fiscal gap caused by the upward transfer of financial power and the decentralization of local government, and with the acceleration of urbanization, the demand for public services such as infrastructure construction is increasing rapidly. The government development mode leads to the pressure of debt financing. Thus, the local government needs to get the corresponding extra-budgetary revenue by issuing bonds so as to solve the financial problems faced by the local government. The political incentive centered on the promotion and evaluation mechanism of local officials has promoted the continuous borrowing of local governments. In the process of economic decentralization reform, higher-level governments assess the political achievements of local officials according to the economic growth rate, and local government officials have the tendency of active debt. While alleviating the financial pressure, the political promotion system defines the capital investment direction for local borrowing through target incentive, and guides local officials to give priority to municipal construction to highlight their political achievements. Therefore, political promotion incentive has become the direct reason and goal constraint for local officials to carry out debt financing.

Debt status (S). In this context, local governments continue to issue bonds under pressure, and the scale of debt also increases. Debt status refers to the current scale of government debt. It does not directly compare the balance of local government debt among regions but generally eliminates the differences between regions by adding the comparison of local GDP and fiscal revenue. In addition to the explicit debt included in the government budget system, the implicit debt formed by local

governments through Public-Private Partnership (PPP) or urban investment debt has gradually attracted the attention of the central government. In order to bring the implicit debt risk into the evaluation system, this paper uses the ratio of urban investment debt to GDP to measure the level of implicit debt. PPP debt is far lower than Local Government Financing Vehicles (LGFV) debt in the total local government debt, and the medium and long-term financial expenditure formed by standardized PPP projects does not belong to local government implicit debt. Therefore, it is reasonable to use LGFV debt to represent implicit debt in debt status.

Debt impact (I). The expansion of the debt scale has a significant impact on fiscal sustainability. Debt growth exceeding the growth of residents' income may cause financial risk, budget imbalance, and even affect government credit (Horton, 1972). In addition, excessive government debt will also affect the livelihood of residents. The local welfare expenditure squeezed to repay the debt, resulting in the decline of residents' welfare levels. Some scholars, such as Coccia (2017), based on the research of European developed countries, concluded that excessive social welfare expenditure is an essential factor in debt accumulation. However, the data show that the average proportion of social security expenditure in the 27 EU member states in 2009 was 26.9%. Still, the average contribution rate of social security payments was as high as 59%, and the proportion paid by the government's general tax was only 38%. The contribution of social security and welfare expenditure to the high deficit and government debt was not enormous (Avi-Yonah, 2000). Let alone; China is a developing country with low social welfare. In 2020, the national social security expenditure will only account for 3% of GDP and only about 13% of the total fiscal expenditure. In addition, some scholars pointed out that the current local government debt management in China lacks a scientific, effective, and standardized constraint mechanism. The output of local government debt deviates from the public social demand, which affects social welfare (Yuan & Huimin, 2019). This paper only considers the impact of different debt scales on residents' welfare.

Debt repayment response (R). With the expansion of the debt scale to repay the debt and reduce the adverse effects of excessive debt scale, the requirements of local governments on debt repayment ability are gradually increasing. The local government's response to the debt can only be to repay the debt. When the solvency is not enough to cope with the expansion of its debt scale, the local government may issue new debt to repay the old debt. The revenue and expenditure of fiscal is an essential factor in the debt repayment ability. This paper selects the growth rate of fiscal revenue and the elasticity of fiscal revenue to measure local governments' debt repayment response ability. In addition, if the government relies too much on the revenue from land transfers, it is challenging to meet the financial demand through land sales in the long run. When we consider the impact of land finance, we add a new indicator to measure the debt repayment potential of local governments. Due to the lack of data on land transfer fees in various provinces, the government fund revenue replaces land transfers' revenue because the land transfer fees are the main body of government fund revenue. We used the proportion of government fund revenue in fiscal revenue to measure the government's dependence on

land revenue.

2.4.2 Indicator System and Explanation

Based on the above theoretical analysis of the DPSIR model of local debt risk, this paper constructs an indicator system from five aspects: the driving forces of borrowing, the pressure of debt, the debt status, the impact of debt, and the solvency response of debt. First, this system follows the principles of purpose, comprehensiveness, typicality, feasibility, and quantification to reflect the local government debt risk from different aspects. Second, considering the availability of data, and finally drawing on the research results of existing scholars, we establish the index system for local government debt risk. Table 1 shows the indexes and calculation methods.

Table 1. An Index System to Measure the Risk of the Local Government Debt

Target layer	Criteria layer	Specific layer	Indicator connotation and calculation method	Index direction	Reference	
The local debt risk index	The driving forces of borrowing (D)	Urbanization growth rate	Denotes the growth rate of urbanization (urbanization rate of this year - urbanization rate of last year)/urbanization rate of this year	+	(Li & Qi, 2017)	
		Degree of soft budget constraints	Denotes the dependence of local governments on the central government, extra budgetary revenue/GDP	+	(Hongsheng & Jun, 2009)	
		The asset-liability ratio of state-owned industrial enterprises	Indicates the implicit liabilities of state-owned enterprises trial enterprises	+	(Zhang et al., 2017)	
	Debt pressure (P)	The deficit to GDP ratio	Denotes the proportion of fiscal deficit to GDP, (revenue - expenditure) /GDP	+	(Li & Cao, 2020)	
		Fixed asset investment per capita	Denotes per capita economic activity in the construction and purchase of fixed assets in a given region in a given period, the amount of fixed asset investment/population	+	(Li et al., 2018)	
		Debt dependence		Denotes the government maintains the relationship of fiscal expenditure by issuing government bonds, the balance of local government debt/fiscal expenditure	+	(Ye & Chen, 2019)

	Debt ratio	Denotes the ratio of outstanding debt to GDP; the ratio of outstanding local government debt to GDP	+	(Xu et al., 2020)
Debt status (S)	Debt balance as a proportion of government revenue	Denotes the relationship between debt balance and fiscal revenue, local government debt balance/finance minister income	+	(Tao, 2015)
	Hidden debt level	Denotes the implicit debt level of local government, urban Investment Bond Issuance /GDP	+	(Ouyang & Li, 2021)
	Per capita debt burden	Denotes government debt balance per capita, local government debt balance per population	+	(Ye & Chen, 2019)
Debt impact (I)	Debt growth rate and resident income growth rate ratio	Denotes the relationship between debt growth and resident income, debt growth rate/per capita disposable income growth rate	+	(Horton, 1972)
	The proportion of social security expenditure	Denotes the measurement level of social welfare, social security, and employment expenditure /GDP	-	(Yuan & Huimin, 2019)
Debt repayment response (R)	Financial dependence degree of land	Denotes the measurement of the government's dependence on land transfer revenue, government-managed fund revenue/fiscal revenue	+	(Wang & Fan, 2012)
	The growth rate of fiscal revenue	Denotes the measurement of fiscal revenue capacity (current fiscal revenue - previous fiscal revenue)/current fiscal revenue	-	(Wang & Fan, 2012)
	The elasticity of fiscal revenue	Denotes a measurement of whether fiscal revenue exceeds GDP growth, fiscal revenue growth rate /GDP growth rate	-	(Wang & Fan, 2012)

3. Result

3.1 Data Source and Processing

Considering the availability and authenticity of the data, it is difficult to obtain the relevant data of local governments at lower levels because there is a lot of missing data before 2013. We obtained local government debt from the annual budget implementation reports of the provinces, the disclosure

documents of government bond issuance and the audit report of government debt, as well as the Wind database. This paper selected the data of 30 provinces and municipalities in China from 2013 to 2019, excluding the following regions due to the lack of data, Tibet Autonomous Region, Hong Kong, Macao, and Taiwan. We gathered other indicators from the provincial statistical yearbook and China's fiscal yearbook.

To avoid various dimensionless effects among data, we processed the original data in a dimensionless manner. There are both positive and negative indicators. We selected the extremum method as the dimensionless treatment method and the specific operation method follows.

For the positive index, we processed according to the following formula:

$$X_{ij}^t = \frac{x_{ij}^t - m_j^t}{M_j^t - m_j^t} \quad (1)$$

Among them, we define m_j as the minimum value of x_{ij} , M_j as the maximum value of x_{ij} , $t = 2013, 2014, \dots, 2019$.

For negative indicators, we applied the following formula:

$$X_{ij}^t = \frac{M_j^t - x_{ij}^t}{M_j^t - m_j^t} \quad (2)$$

To make the values meaningful in the subsequent calculation, we modified all the dimensionless indicators by 0.0001 to meet the calculation requirements.

3.2 Determination of Index Weight and Calculation of Risk Index

Researchers have employed subjective weighting methods, such as the Delphi method and the Analytic Hierarchy Process (AHP), to determine the weight of attributes. Decision-makers (experts) attach importance to each attribute subjectively, with strong subjective arbitrariness (Zhang et al., 2021). Therefore, we used the entropy value method of objective weighting method to determine the weight of each index. We listed the specific calculation steps as follows:

In this paper, we selected 210 samples from 30 provinces over seven years. There are 15 evaluation indexes in this evaluation system. X_{ij} Represents the j evaluation index value of the i province ($i = 1, 2, \dots, n; j = 1, 2, \dots, m$).

(1) After we treated the original data as dimensionless, we calculated the contribution degree of the i sample under the j index.

$$p_{ij}^t = \frac{x_{ij}^t}{\sum_{i=1}^n x_{ij}^t} \quad (3)$$

(2) Calculate the entropy of the j index.

$$e_j^t = -\frac{1}{\ln n} \sum_{i=1}^n p_{ij}^t \ln p_{ij}^t \quad (4)$$

(3) Calculate the information utility value of the j index.

$$g_j^t = 1 - e_j^t \quad (5)$$

(4) Determine the weight of each index.

$$w_j^t = \frac{g_j^t}{\sum_{j=1}^m g_j^t} \quad (6)$$

(5) Calculate the risk index of local government debt.

$$S_j^t = \sum_{j=1}^m w_j^t X_{ij}^t \quad (7)$$

Based on the calculations of the entropy value method, we obtained the weights of 30 provincial government debt risk assessment indicators, see Table 2.

Table 2. Index Weights of Risk Assessment of Local Government Debt

Target layer	Criteria layer	Specific layer	Weight (%)
Local debt risk index	The driving forces of borrowing	Urbanization growth rate	1.53
		Degree of soft budget constraints	11.64
		Asset-liability ratio of state-owned industrial enterprises	2.13
		The deficit to GDP ratio	9.83
	Debt pressure	Fixed asset investment per capita	3.72
		Debt dependence	8.59
		Debt ratio	11.74
	Debt status	Debt balance as a proportion of government revenue	8.59
		Hidden debt level	12.32
	Debt impact	Per capita debt burden	9.98
Debt growth rate and resident income growth rate ratio		1.3	
The proportion of social		1.8	

	security expenditure	
Debt	Financial dependence degree	5.1
repayment	of land	
response	Growth rate of fiscal revenue	0.92
	Elasticity of fiscal revenue	10.72

3.3 Overall Assessment of Local Debt Risk

Based on the calculation of the entropy value method, we obtained the risk assessment results of local government debt in China from 2013 to 2019, see Table 3. We demonstrated that the overall risk of local government debt in China fluctuated from 2013 to 2019. The risk of local government debt in most regions decreased from 2013 to 2015 and then increased, showing a U-shaped distribution.

Table 3. Local Government Debt Risk Index from 2013 to 2019

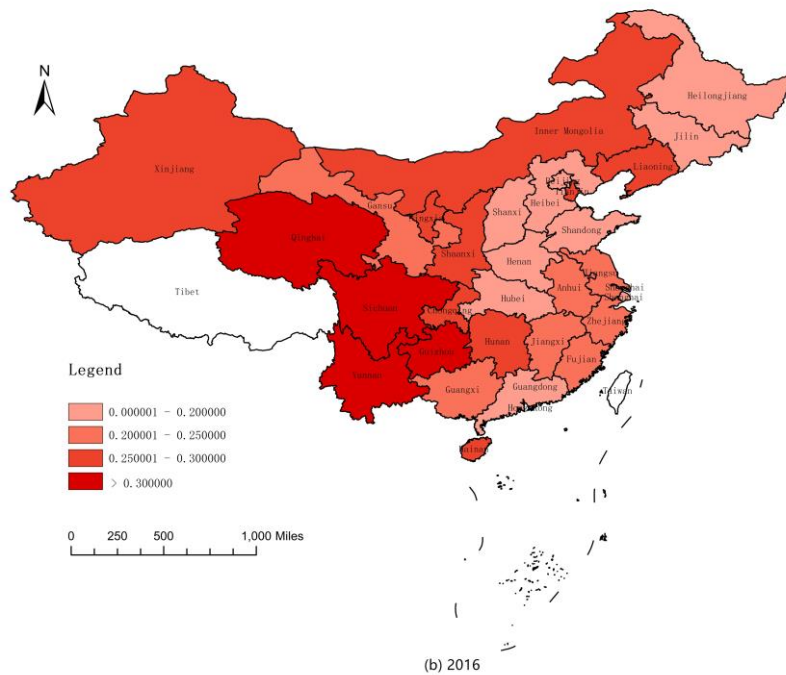
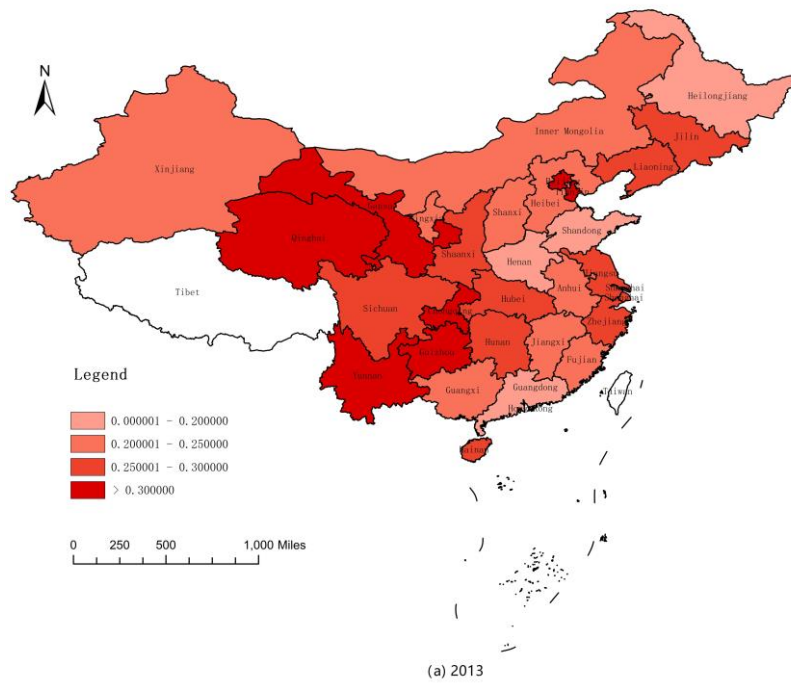
Province	2013	2014	2015	2016	2017	2018	2019
Guangdong	0.1458	0.1287	0.1207	0.1094	0.1129	0.1168	0.1311
Shanghai	0.2925	0.2134	0.1526	0.1401	0.1269	0.1404	0.1615
Shanxi	0.2333	0.1362	0.2264	0.1691	0.1440	0.1528	0.1797
The Beijing municipal	0.3937	0.2975	0.2400	0.1665	0.1613	0.1862	0.1993
Henan	0.1763	0.1675	0.1546	0.1717	0.1709	0.1839	0.2010
Hebei	0.2376	0.1899	0.1710	0.1773	0.1824	0.2043	0.2239
Fujian	0.2464	0.2121	0.2241	0.2316	0.1931	0.2038	0.2281
Shandong	0.1772	0.1964	0.1767	0.1794	0.1826	0.2091	0.2342
Sichuan	0.2638	0.2292	0.2241	0.3319	0.2341	0.2363	0.2416
Hubei	0.2711	0.1809	0.1641	0.1893	0.2005	0.2189	0.2450
Heilongjiang	0.1924	0.1546	0.1838	0.1774	0.1800	0.2217	0.2480
Anhui	0.2294	0.2277	0.2100	0.2338	0.2434	0.2292	0.2531
Liaoning	0.2541	0.2807	0.4050	0.2960	0.2121	0.2497	0.2573
Xinjiang Uygur Autonomous Region	0.2165	0.2377	0.2411	0.2561	0.2597	0.2552	0.2637
Jiangxi	0.2261	0.2000	0.1986	0.2198	0.2126	0.2567	0.2755
Hainan	0.2855	0.2434	0.2519	0.2638	0.2663	0.2750	0.2847
Shaanxi	0.2914	0.2461	0.2255	0.2512	0.2548	0.2672	0.2876
Gansu	0.3228	0.2380	0.2323	0.2245	0.2245	0.2502	0.2885

Hunan	0.2655	0.2253	0.2181	0.2504	0.2534	0.2579	0.2944
Jiangsu	0.2664	0.2195	0.2156	0.2480	0.2356	0.2471	0.2967
Guangxi Zhuang Autonomous Region	0.2346	0.2461	0.2341	0.2448	0.2460	0.2725	0.3003
Zhejiang	0.2811	0.2564	0.2046	0.2272	0.2401	0.2666	0.3016
Jilin	0.2607	0.1800	0.2014	0.1949	0.2171	0.2768	0.3038
Chongqing	0.4275	0.2500	0.2465	0.2791	0.2497	0.2600	0.3130
Inner Mongolia Autonomous Region	0.2314	0.2807	0.2529	0.2778	0.2987	0.2846	0.3220
Ningxia Hui Autonomous Region	0.2361	0.2595	0.2791	0.2822	0.2726	0.2976	0.3332
Yunnan	0.3048	0.3132	0.3172	0.3093	0.3164	0.3108	0.3362
Tianjin	0.3611	0.2487	0.2270	0.2566	0.2531	0.3738	0.4188
Guizhou	0.4102	0.5223	0.5008	0.5151	0.4397	0.4118	0.4550
Qinghai	0.3765	0.4241	0.3980	0.3990	0.4367	0.4634	0.5447

It is easy to see the following. The local government debt risk of all provinces and cities in 2013 was very high. Until 2019, the local government debt risk of 12 provinces was still lower than that of 2013, especially in some more developed regions, such as Beijing, Guangdong, and Shanghai. The local government debt risk in 2019 was much lower than that of 2013. We offer the following rationale. Local governments, aware of local government debt risks, have made great efforts to reduce their debt scale. By the end of 2015, 15 provinces in China had achieved a decrease in their debt balance. Although a few years ago, officials controlled the local government debt risk, presenting a downward trend. From 2015 to 2019, the national local government debt risk began to rise again. Thus, it is particularly important to contain local government debt risk in China.

To intuitively observe the debt risk comparison among different regions, we managed the ArcGIS software to map and display the local debt risk index in 2013, 2016 and 2019. Software to map and display the local debt risk index in 2013, 2016 and 2019. We divided the calculated results into four grades according to the distribution of data. The first category is the lowest local government debt risk area (local government debt risk coefficient < 0.2), the second type of low-risk area (risk coefficient interval: (0.2-0.25)), the third type of moderate risk area (risk coefficient interval: (0.25-0.3)), the fourth type of high-risk area (risk coefficient > 0.3). Figure 2 shows that after the risk of local government debt falling from 2013 to 2015, the trend continued downward in 2016, within the debt risk index range of 0-0.2. From 2013 to 2015, three provinces in north China (Henan, Hebei, and Shandong) had the lowest debt risk and showed rendering area aggregation. In 2016, Yunnan, Guizhou, Sichuan, Guangxi, and other places also presented higher debt risk aggregation of the risk of local debt. This also

confirmed the research conclusion of Li et al. (2018) that the risk of local government debt is contagion by network connection.



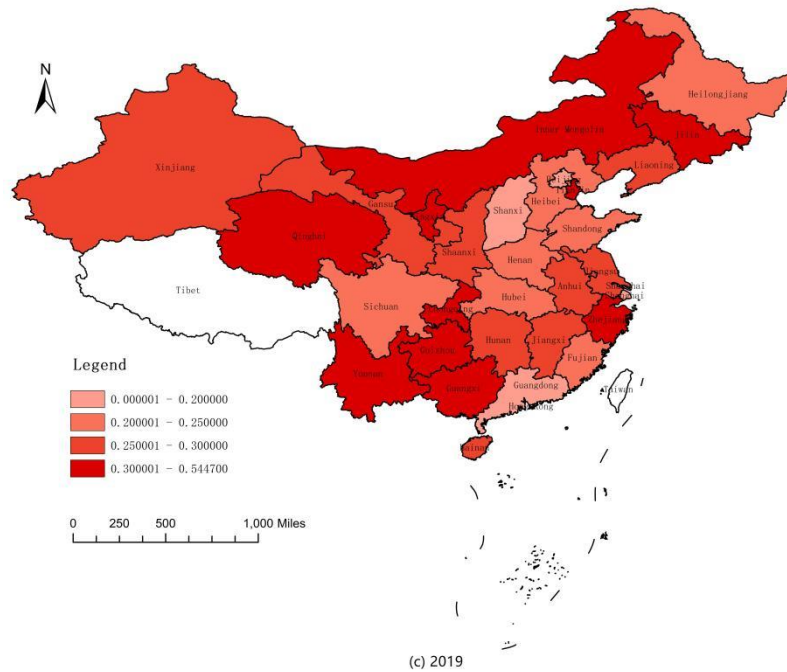


Figure 2. Local Government Debt Risk Coefficients of 30 Provinces in China in 2013, 2016 and 2019

However, the expansion of hidden debt in the past two years reduced the number of provinces in the range of 0-0.2 to 4 provinces in 2019. The local debt risk of Yunnan and Guangxi in the central and western regions has increased rapidly, which is related to the promotion and incentive policies of “China-ASEAN” cooperation and opening up. The demand for infrastructure construction has increased. In addition, the two places are located in mountainous areas, resulting in high construction cost, large capital demand and weak financial resources. In the case of insufficient social investment, the government takes borrowing as an important way to effectively expand investment. Sichuan’s debt risk has changed from medium risk to low risk. This is because Sichuan, as the province with the largest scale of issuing local bonds in China, has a centralized repayment period in 2013 and 2014. Debt repayment occupies a certain amount of financial expenditure and reduces the financial support for economic development, resulting in large fluctuations in debt risk index., but in the Northwest, the debt risk of Inner Mongolia increased the fastest with its debt risk index from 0.2361 in 2013 to 0.2976 in 2019. Ningxia’s debt risk is also rising, which is due to the sharp decline in public budget revenue caused by the decline in economic growth, and the debt risk is rising when the debt burden remains unchanged. In addition, Shanxi and Gansu are in a medium risk state. On the whole, the government debt of the northwest region has not been well managed. On the one hand, the northwest region is located inland, with inconvenient transportation, mostly traditional industries and lack of scientific and technological innovation enterprises to drive economic growth. On the other hand, because the fragile natural ecological environment needs a lot of funds for maintenance, this part of expenditure forms

huge social and ecological benefits, but the economic benefits are limited, resulting in huge financial expenditure, which will inevitably lead to the formation and increase of debt. From the average value of debt risk index from 2013 to 2019, Guangdong, Shanghai and Shanxi are the regions with the lowest debt risk index respectively. Guangdong and Shanghai are at the cutting edge of economic development, having rich resources of fiscal revenue. Although Shanxi is not an economically developed region, its debt pressure and debt status are at a low level. Qinghai and Guizhou respectively have the highest debt risk index, and are the only provinces with the average risk of local debt exceeding 0.4. Qinghai is relatively poor, the national economic and financial strength ranks lower than the middle level, the comprehensive strength does not match the high debt, and the support of population, industry and real estate to the economy is also relatively limited, lacking the financial revenue sources and high fiscal deficit ratio, so it can only issue bonds to make up for fiscal expenditures.

In the past, Guizhou is traditionally an agricultural province with a weak industrial foundation, becoming an investment driven province. Guizhou has a large poor population and a profound degree of poverty. To speed up urbanization and poverty alleviation, it has invested a lot in rural areas and public infrastructure, but a low level of financial self-sufficiency. It depends on the central governmental support and debt. The budget is not enough to support the funds needed for large-scale investment, leading to large-scale borrowing. In the northwest border areas such as Yunnan, Inner Mongolia, Xinjiang, and Qinghai, the debt risk remains high. The debt risk of the North China's Plain is relatively low, showing an upward trend. The debt risk indexes of the three northeastern provinces are above medium risk, and Heilongjiang and Jilin are on the rise, mainly due to the slow economic growth. The industrial pillar of Northeast China is traditional heavy industry. However, due to the decline in the importance of investment and manufacturing in the whole economy, the demand for industrial products has decreased significantly. The local transformation and upgrading did not keep up with the great changes in market transformation, resulting in economic downturn, resulting in labor loss and low land financial revenue, which affected the financial revenue. Due to the rigid capital demand for industrial upgrading under the background of industrial transformation and upgrading, the government may add a large amount of debt. The debt risk of local governments in Central China, such as Hubei, Hunan, and Anhui, is at a medium level. The eastern coastal areas are low risk except Zhejiang and Tianjin, which is closely related to the level of regional economic development. Generally speaking, the higher the level of economic development, the lower the risk of local government debt. As far as Tianjin is concerned, it belongs to the Beijing Tianjin Hebei economic circle, and takes it as an important political task to undertake the relief of Beijing's non capital functions. In order to undertake the spillover of Beijing's functional elements such as industry, technology and talents, it is necessary for Tianjin to borrow money to build an interconnected transportation system and industrial bearing platform; Zhejiang is located in the Yangtze River Delta economic circle. In the Yangtze River Delta economic circle, in addition to the reduction of debt risk in Shanghai, the debt risk indexes of Jiangsu, Anhui and Zhejiang are on the rise. Shanghai has experienced inter industry transfer out and

intra industry transfer out, and gradually transferred the manufacturing industry to Jiangsu and Anhui. Zhejiang receives the largest industrial radiation from Shanghai, undertakes most of the manufacturing industries transferred from Shanghai, and then transfers to neighboring provinces and cities such as Jiangsu and Anhui. Jiangsu absorbs labor, capital and technology intensive industries transferred from Shanghai and Zhejiang. It can be seen that Jiangsu, Anhui and Zhejiang also need to borrow to improve infrastructure construction to undertake industrial transfer.

Different from the results of previous studies, existing studies, such as Zhu (2019), believe that the relatively high level of economic development and the relatively loose financial pressure with good external economic environment at the coastal areas, the risk of local debt in coastal areas is relatively low. But according to the DPSIR local government debt risk evaluation model of calculation, our results show that the risk of local debt in coastal areas such as Jiangsu, Zhejiang, and Tianjin are not significantly lower than that in central areas. Jiangsu and Zhejiang are even significantly higher than that in central areas such as Hubei and Jiangxi. The reasons are that DPSIR model did not include the soft budget constraints and the degree of land financial dependence in the model of local debt, leading to a large potential impact on the future risk of local government debt. There is a rising trend of debt risk in most parts of the country, especially in the less developed areas of central and Western China.

3.4 Analysis on Risk Structure of Local Government Debt

Through the subsection evaluation and analysis of debt risk, we observe the internal composition of local government debt risk, and draw the DPSIR sub evaluation results of local government debt risk, as shown in Figure 3, 4 and 5.

From the perspective of debt driving force (2013-2019), the proportion of debt driving force in the local debt risk index is small, and the change is not big. The gap of debt driving force among provinces is also small. Although the overall risk of local debt is rising, the debt driving force shows a slow downward trend in recent years. The changes may be related to the weakening of soft budget constraints because of China's financial system development.

From the perspective of debt financing pressure, the developed areas of Beijing, Shanghai, and Guangzhou have the least debt pressure. The regional characteristics reveal high financing pressure in the West and the South and low in the East and the North. Considering the different levels of economic development in different parts of the country, the level of economic development in the eastern region is significantly higher than that in the western region. The better economic foundation has also brought good fiscal revenue to the local governments. When dealing with infrastructure construction, improving people's livelihood and welfare, and improving water equality in urbanization, the financial funds are relatively abundant, and the pressure of borrowing is relatively small. However, the Western region is deficient in these aspects.

According to Figure 3's results of debt status analysis, the high level of local debt risk in 2013 came from the high financing pressure and debt status. On a deeper level, the debt dependence and debt ratio are significantly higher than the average in recent years. Thanks to the introduction of the new *Budget*

Law in 2014 and the strengthening of debt control measures, in the following years, the growth rate of debt balance slowed down or even decreased. At the end of 2015, compared with the end of 2014, 14 provinces' government debt balance decreased, accounting for about half of the country.

Figure 4 suggests that the debt status in 2016 was significantly lower than that in 2013. Thus, the constraints of the new *Budget Law*, controlled the scale of local government debt, reducing the debt risk level. However, the local debt risk has increased year by year from 2017 to 2019. During this period, the main reason for the increase of local debt risk was the expansion of the scale of implicit liabilities such as urban investment bonds and PPP projects.

Figure 5 illustrates that the debt level in the western region is relatively high. The three provinces with the highest score of debt status in 2019 are Tianjin, Guizhou, and Qinghai, with the score of 0.1756, 0.1709, and 0.1903, respectively. The combined effect of debt pressure and debt scale leads to the largest local debt risk index in these three provinces. In addition, the debt status of Guangxi, Yunnan, and other places is also on the high side year-round. The Western region has both a large scale of debt and a high pressure of borrowing.

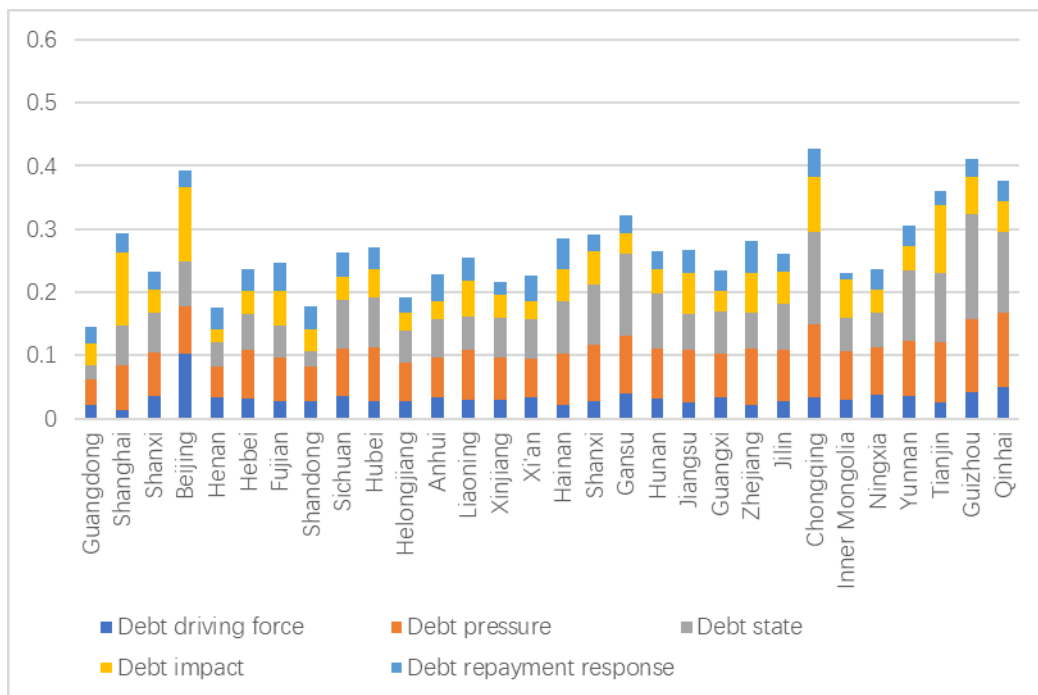


Figure 3. DPSIR Section Evaluation Results of Local Government Debt Risk in 2013

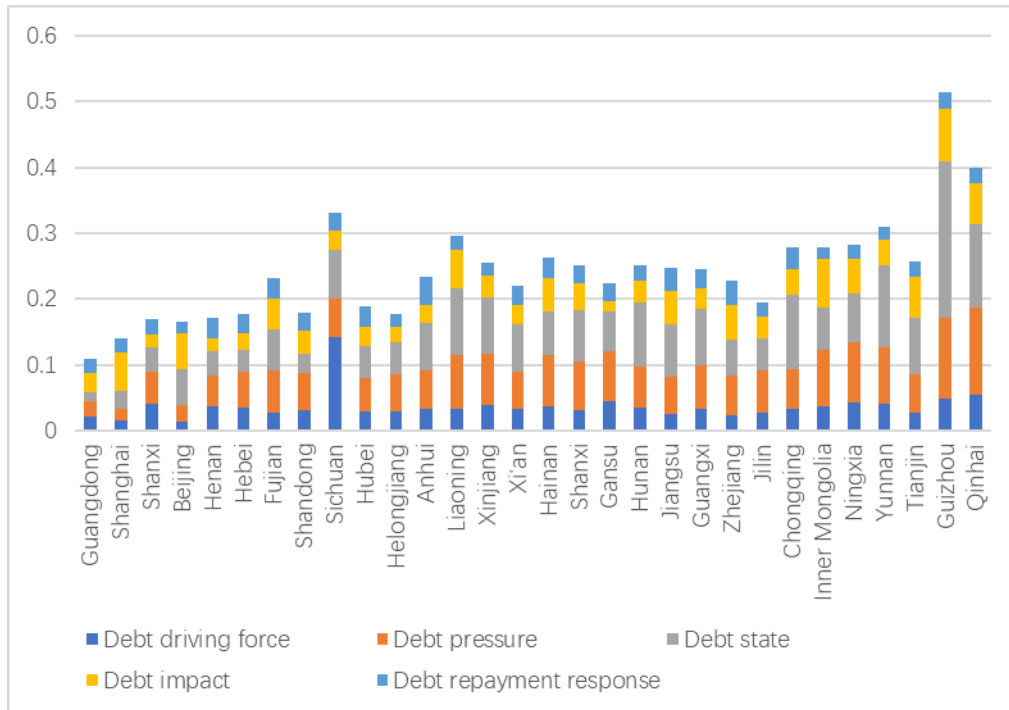


Figure 4. DPSIR Section Evaluation Results of Local Government Debt Risk in 2016

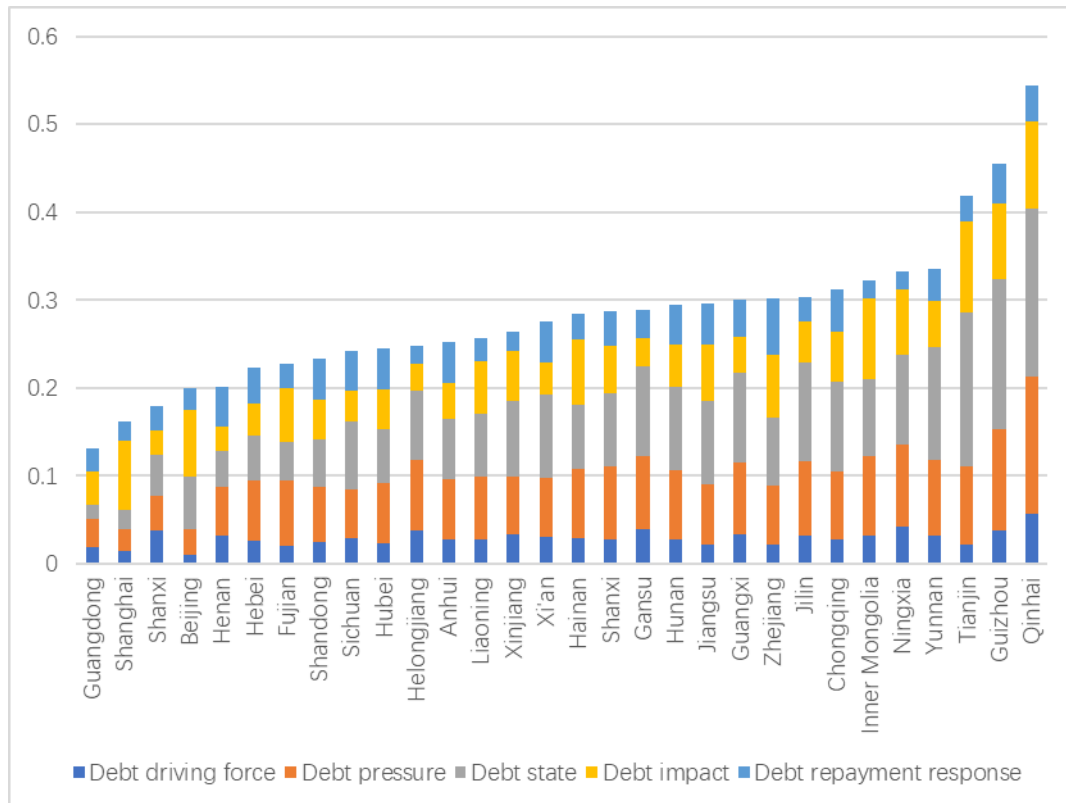


Figure 5. DPSIR Section Evaluation Results of Local Government Debt Risk in 2019

The debt impact score is generally not high, indicating that China's current government debt has not

had a significant impact on finance and residential life. However, when the repayment period of local government debt is long and expanding, the accumulation of local government debt may lead to the rising pressure of future interest rates. Policy-makers must be vigilant regarding the long-term impacts. The areas with rapid growth of fiscal revenue and low land price experience strong solvency. However, areas such as Heilongjiang, Inner Mongolia, and Xinjiang cannot rely on land finance. This is due to its small economic volume and high growth rate of fiscal revenue. All kinds of infrastructure projects start late. There are many engineering projects with great investment potential. To attracting investment, the local government must increase the fiscal revenue, accordingly. The main reason for the low solvency response of Zhejiang, Chongqing, and other provinces is that the financing of local governments in these provinces is highly dependent on land transfer income. However, due to the limited land resources, land finance is not sustainable, a potential source of local debt risk in the long term.

4. Discussion

In this paper, based on the DPSIR internal logic of local government debt risk formation, we constructed the evaluation index system and then used the entropy method to construct the risk evaluation model. Our novel discoveries show the dynamic trend of the national local debt risk. This trend first decreases and then increases. There are obvious regional differences across 30 Chinese provinces. We illustrate the debt risk evaluation of the regions: higher in the southwest border region, lower in the North China Plain, and the medium level at other provinces. Finally, based on these above conclusions, we offer main suggestions as follows:

First, researchers must clearly identify factors that affect the local debt risk and reduce the debt risk in a targeted way. To analyze the debt risk of each province, we compare the ranking of each index in the country according to results of the above five dimensions to find out the main factors leading to high debt risk and then put forward countermeasures according to the main factors. For example, in 2019, Zhejiang's four index levels are at the medium to low level. However, a high score of debt repayment response ability index reveals the weakest debt repayment ability (0.063), suggesting higher score than all other provinces in the same year. This index improves the overall score of government debt risk in Zhejiang. After clarifying the main causes of debt risk, the government debt risk can be reduced by controlling land financial dependence.

Second, it is necessary for local governments to control the scale of debt and curb the irrational interest drive. From the driving force of debt increasing, economic growth (as the main basis of performance evaluation of government officials) and the moral hazard (caused by soft budget constraints) lead to the irrational interests of debt expansion. The scale control of local government debt and the repayment factors are not within the scope of government officials' assessment. The transfer of debt liability promotes the government to increase debt finance. To curb the local government's irrational interests of borrowing, we can include the government debt scale control into the performance evaluation of officials, establish the accountability mechanism for government debt repayment, prevent the excessive

expansion of debt, and reduce the risk of local government debt.

Third, we should speed up the reform of the fiscal and taxation system and tap new sources of power for tax creation. On the one hand, policy-makers may establish local independent tax sources and build a local tax system with real estate tax and consumption tax. On the other hand, leaders may dynamically adjust the proportion of tax distribution between the central and local governments and the proportion of transfer payment between the central and local governments. For the Western provinces with less developed economies, decision-makers may increase the proportion of local tax distribution appropriately. Eastern provinces with relatively developed economies may reduce the proportion of local tax distribution. Researchers may explore a new generation of a business model based on value co-creation, vigorously cultivate emerging e-commerce and high-tech industries, strengthening contributions to the tax creation.

Fourth, the local government financial bankruptcy system may restrict the government's borrowing behavior. Soft budget constraints offer local governments and financial institutions the illusion that the central government can help solve the local debt. The debt raising becomes blind and random. Many countries have established a local government bankruptcy mechanism, yet China does not have one. The Ministry of Finance has changed the way of local debt management since 2016, adhering to the principle of no central government rescue. Local governments with difficulties to repay their debts must solve the debt problem through debt restructuring, reorganization, or refinancing. The bankruptcy mechanism of local governments is a constraint on the government's financial expenditure and blind borrowing. To avoid bankruptcy, local governments must live within their means, reduce vanity projects, excessive investment, improve the efficiency of financial funds, and reduce the debt ratio as much as possible.

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