Evaluation of provincial government debt risk based on fuzzy comprehensive evaluation method in H province

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Abstract: In this study, analytic hierarchy process and fuzzy comprehensive evaluation model were used to construct the early warning model of provincial government debt risk in H province, so that the government's assessment of debt risk was not limited to qualitative analysis, but further quantified, and thus easier to operate and judge. Due to the debt risk control optimization method is based on H province government debt situation, financial situation, economic situation, the comprehensive research in aspects of debt control situation, thus more in line with the actual situation in H province, the optimization method is no longer confined to theoretical analysis, and began to have very good practicality and operability, and the debt risk warning has played a great help.

1. Introduction

In recent years, many scholars have carried out many researches on provincial government debt risk assessment. Shao Ruiyin (2013) divided the debt risk based on the type of debt, selected 12 risk warning indicators, and used the fuzzy comprehensive model to conduct risk analysis. He believed that there was debt risk in Henan Province. Yan Xiaolin and Fu Runmin (2014) analyze provincial debt risks from a sustainability perspective. Zhu Wenwei and Chen Yong (2015) used the provincial government debts of 30 provinces and municipalities in 2014 as the evaluation targets. Based on the factor analysis method, the overall risk level was controllable and the risk in some areas was high. Jiang Hongqing and Yu Hong (2017) designed the debt risk indicator system based on the identification of various factors affecting debt risk, and used fuzzy comprehensive evaluation method to achieve risk assessment and early warning.

From the research results of international scholars, the development of the United States, Japan and other countries has been quite mature, providing practical and effective ideas for the article. Robin Greenwood (2015) proposed the theory of optimal government debt maturity, he get in the extended hold risk-free short-term securities after the model of the monetary service: if there is a negative externalities associated with private money creation, the government should make it tend to be short-term bonds, which to a certain extent, crowd out the private sector for the use of short-term debt, to prevent and control the role of debt risk.

With the more serious local government debt problem in China, the risk of local government debt is more worthy of attention. This paper is based on the provincial government debt of H Province, based on the current policy, combined with the results of expert research, reasonable selection of index indicators, through the construction of a fuzzy comprehensive evaluation model for risk warning of provincial government debt in H Province, quantify the debt risk assessment, and thus propose control a more effective solution to risk.

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2. The construction of provincial government debt early warning model

2.1. Selection of indicators and establishment of safety intervals

A safety interval is a range of values that do not exceed a certain risk threshold. The definition of the safety interval is based on the following principles: first, reference to the safety warning line standards set by international authoritative organizations, second, to the existing provincial laws and regulations and regional development goals[1], and third, In the standard case, select the average of the historical indicators of various provincial governments in China, and consult the literature to confirm its rationality.

2.2. Fuzzy comprehensive evaluation method model

The fuzzy comprehensive evaluation method is based on the membership theory of fuzzy mathematics. It is a mathematical method that quantifies the uncertainty problem and can make an overall evaluation of objects subject to various factors. Considering the characteristics of the provincial government debt research described above, this paper uses this method to construct a provincial government risk early warning system model. Specific steps are as follows:

(1) Determine the risk factor set U. Using the five indicators set above, these main indicators form a set: U= {U1, U2, U3, U4, U5}, which is the set of factors for judging risk. The meanings of the evaluation indicators are: U1 = debt ratio, U2 = fiscal debt ratio, U3 = input-output ratio, U4 = debt dependency and U5 = deficit rate.

(2) Determine the set of reviews V that judge the risk level. V is a collection of all levels of evaluation made for the risk profile of provincial government debt. V= {V1, V2, V3, V4, V5}.The risk levels are V1 = no risk, V2 = low risk, V3 = medium risk, V4 = high risk, V5 = serious risk. The safety interval described above is used as a reference for judging.

(3) Determine the weight set A of the risk. A= {A1, A2, A3, A4, A5}, where A1+A2+A3+A4+A5=1.In the fuzzy evaluation method, the weight set A reflects the importance degree of each index U, and each index U corresponds to a certain weight Ai. Different sets of weights have a very large impact on the results, so it is necessary to choose a scientific and reasonable method to determine the set of weights. In practice, the weight is determined by the expert estimation method. Considering that the government data has certain confidentiality, and the authoritative organizations at home and abroad do not provide relevant weights, it is more feasible to adopt the expert decision-making method and the literature review method [2].

(4) Establish a fuzzy relationship matrix R. R represents the degree of membership of the evaluation object to the comment set V. To obtain the evaluation set R, firstly, an index Un should be extracted from the factor set U, and the index can be evaluated by the expert scoring method to obtain the first evaluation set R1. For example, for a certain U1 debt ratio, for risk-free, low-risk, medium-risk, high-risk, and serious risk, five risk levels correspond to 30%, 30%, 10%, 20%, and 10% of experts' choices, respectively. Then, the evaluation set of the land U1 is R1 = [0.3, 0.3, 0.1, 0.2, 0.1]. After obtaining R1, the U2~U5 indicators are evaluated one by one, and the evaluation sets R2, R3, R4, R5, and R6 are obtained. Furthermore, the fuzzy relation matrix R= [R1 R2 R3 R4 R5 R6] of all risk indicators can be obtained. $R=\begin{pmatrix} r11 & \cdots & r15 \\ \vdots & \ddots & \vdots \\ r51 & \cdots & r55 \end{pmatrix}$

(5) Synthetic fuzzy comprehensive evaluation mathematical model. Using the appropriate fuzzy operator o, the fuzzy relation matrix r and the index weight set a are arithmetically processed to obtain the fuzzy comprehensive evaluation mathematical model B= {B1, B2, B3, B4, B5}, and its basic form is: $B=A\circ R=\{A1, A2, A3, A4, A5\} \circ \begin{pmatrix} r11 & \cdots & r15 \\ \vdots & \ddots & \vdots \\ r51 & \cdots & r55 \end{pmatrix}$. For the selection of the fuzzy operator o, the small large operator Bn=max {min (Ai, Rij)} is used here. The specific step is to compare Ai with the corresponding value of the first column of the matrix R to obtain a smaller value min(Ai, Ri1), and then extract the maximum value from the five values of min(Ai, Ri1) as the

first value B1 in matrix B. Similarly, the corresponding values of each column in Ai and R are successively compared, and the values of B1, B2, B3, B4, and B5 are obtained to form a matrix B. Then, according to the principle of maximum membership, the risk level V corresponding to the maximum value of Bn is the evaluation level of the government debt obtained by the fuzzy comprehensive evaluation method.

3. Empirical Analysis of Provincial Government Debt in H Province

3.1. Overview of provincial government debt data in H Province

The data comes from H Provincial Finance Department and China Government Securities Depository Trust & Clearing Co., Ltd., Comprehensive fiscal revenue = General public budget income + Government fund income + State-owned capital operating budget income. In view of 2018 new debt issuance and fixed asset investment, which have not been announced yet, this paper replaces the current new debt issuance with the current debt limit, and based on the 2012-2017 data, the Matlab software is used to construct the fitting function to calculate the current fixed asset investment.

Table.1. Basic data of provincial government debt in H Province in 2018.

Data name	Numerical value
Year-end debt	668.57 billion
GDP	39366.6 billion
Comprehensive fiscal revenue	718.1 billion
Fixed assets investment	3,558 billion
New debts issued in the current year	101.5 billion
Financial expenditure for the year	12198.4 billion
Debt repayment of principal amount	241.44 billion

3.2. Establishing a fuzzy analysis and evaluation model

Table.2. Find the value of u1-u5 based on the above data.

Early warning indicator	Numerical value	Safety interval
U1	17.01%	<9.9%
U2	66.08%	<100%
U3	89.98%	<65%
U4	8.20%	<15%
U5	11.64%	<2.5%

Use the expert evaluation method to rank the importance of each indicator to confirm the respective weights, and obtain the weight set A.

Table.3. Risk indicator weight set.

Limiting factor	One-layer weight	Evaluation index	Layer 2 weight a
Issuance scale	0.38	U1	0.147
		U2	0.233
payment capacity	0.24	U3	0.124
		U4	0.116
Deficit risk	0.38	U5	0.380

Conduct a risk assessment on the five indicators of U1-U5 and obtain a fuzzy relation matrix R.

$$R = \begin{pmatrix} 0.11 & 0.19 & 0.23 & 0.25 & 0.22 \\ 0.20 & 0.33 & 0.27 & 0.13 & 0.07 \\ 0.10 & 0.17 & 0.27 & 0.32 & 0.14 \\ 0.26 & 0.20 & 0.34 & 0.11 & 0.09 \\ 0.09 & 0.08 & 0.25 & 0.31 & 0.27 \end{pmatrix} \quad (1)$$

$$B = A \circ R = (0.147, 0.233, 0.124, 0.116, 0.380) \circ \begin{pmatrix} 0.11 & 0.19 & 0.23 & 0.25 & 0.22 \\ 0.20 & 0.33 & 0.27 & 0.13 & 0.07 \\ 0.10 & 0.17 & 0.27 & 0.32 & 0.14 \\ 0.26 & 0.20 & 0.34 & 0.11 & 0.09 \\ 0.09 & 0.10 & 0.23 & 0.31 & 0.27 \end{pmatrix} \quad (2)$$

$$B = (0.200, 0.233, 0.233, 0.310, 0.270) \quad (3)$$

4. Conclusion

According to the principle of maximum subordination, since the risk level corresponding to the maximum value of 0.310 in Bn is “high risk”, it can be judged that the debt risk level of H Province is relatively high. The reason is that the weight distribution of each indicator can be used to determine the impact of the deficit rate on debt risk far greater than other indicators. It can be seen that the H provincial government should focus on controlling general public budget expenditures and general public budget revenue.

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