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A Local Fiscal Health Index Model Based on Extended Matter-Element Evaluation

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Abstract

Due to the influence of the fiscal crisis, the health of the local finance operation has been paid more and more attention. As a result, this essay puts forward a local fiscal health index model according to the problem of the operation of the local fiscal healthy operation. By describing the related concepts and application mechanism of the extenics and matter-element model, the extended matter-element evaluation model will be constructed, which will be used as the evaluation method of local fiscal health index model. With expert investigation and entropy weight method, the essay selects indicators from all kinds of indicator selections which affect the local fiscal health of the operation, establishing the local fiscal health index model, and use the extended matter-element evaluation model to evaluate the local financial. Results demonstrate that the local fiscal health index model, which is based on the extended matter-element evaluation, is a practical model.

Keywords: The local finance; The extended matter-element evaluation model; Health index model

1. Introduction

As an important part of the national finance, the local finance plays an important role in the rapid and stable development of the country's economy. Local fiscal health run is influenced by various economic and social factors, therefore, existence of potential risks to the future operation effect. Nowadays, many models or

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system can only reflect the past or current local fiscal conditions, which do not reflect the future direction of the local finance. It gets a lot of restrictions in the practical application. Therefore, the practical local fiscal health index model will analysis and monitor the operation of the local financial accurately, which makes a difference in the stable and rapid development of economy.

At present, with the construction of local fiscal index model, there are many widely applied methods, such as expert research method, data mining and so on. Hana Polackova (1998) established the famous fiscal risk matrix--Polackova matrix[1], in which proposes the concept of direct debt, contingent debt, dominant debt, implicit debt. It is an effective tool to analyze and evaluate the local government debt. Lifeng Liu(2001) adopted some internal factors and external factors indicators to evaluate the sustainability and fiscal risk degree of the national debt policy[2]. However, these indicators on reflection of fiscal risk is partial and scattered, which have the certain capriciousness.

Therefore, combining with the extenics and matter-element evaluation theory, the essay constructs the local fiscal health index model based on extended matter-element evaluation, which provides new basis of monitoring the health of the local finance operation.

2. The local fiscal health index model based on extended matter-element evaluation

This essay uses the extended matter-element model to build the local fiscal health index model. The basic thought is that using the extended matter-element method as a evaluation model of local financial health index model, then selecting all the indicators of local fiscal health index model, ensuring the practicability and validity of the model, reducing the complexity of the influence factors in the financial operation process and making the model can monitor the health of the local finance operation through the way of combining the data and the index model. The specific steps of local fiscal health index model based on extended matter-element evaluation are shown in Figure 1.

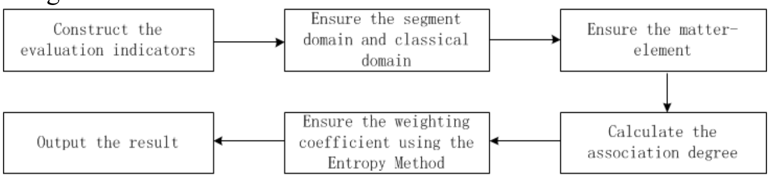

Fig.1. Structure of the local fiscal index model

2.1. The local fiscal indicators at all levels

The indicators selection in this article will center on three key factors that affect the local financial health operation - income, expenditure and debt. After taking experts investigation, the local financial risk comprehensive evaluation can be made of 14 indicators in all. The details are shown in Figure 2.

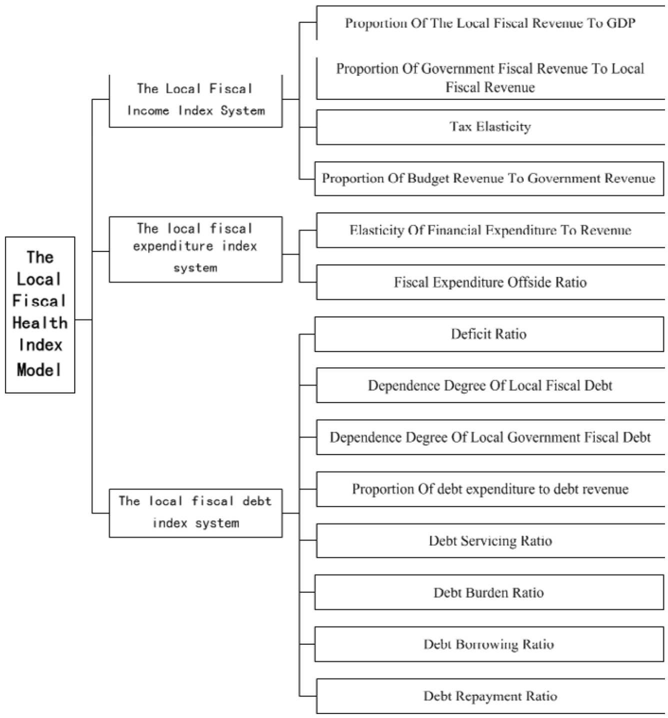

Fig.2. The local fiscal indicators at all levels

(1) Proportion Of The Local Fiscal Revenue To GDP C_1, C_1 = local fiscal income/GDP. (2) Proportion Of Government Fiscal Revenue To Local Fiscal Revenue C_2, C_2 = government fiscal revenue/local fiscal revenue. (3) Tax Elasticity C_3, C_3 = percentage increase in tax/percentage increase in GDP. (4) Proportion Of Budget Revenue To Government Revenue C_4, C_4 = budget revenue/government revenue. (5) Elasticity Of Financial Expenditure To Revenue C_5, C_5 = growth rate of fiscal expenditure/growth rate of financial income. (6) Fiscal Expenditure Offside Ratio C_6, C_6 = fiscal offside expenditure/fiscal total expenditure. (7) Deficit Ratio C_7, C_7 = annual fiscal deficit/annual GDP. (8) Dependence Degree Of Local Fiscal Debt C_8, C_8 = debt the same year/local fiscal expenditure. (9) Dependence Degree Of Local Government Fiscal Debt C_9, C_9 = debt the same year/government fiscal expenditure. (10) Proportion Of debt expenditure to debt revenue C_{10}, C_{10} = debt service the same year/ debt revenue the same year. (11) Debt Servicing Ratio C_{11}, C_{11} = debt service the same year/ fiscal revenue the same year. (12) Debt Burden Ratio C_{12}, C_{12} = debt/GDP the same year. (13) Debt Borrowing Ratio C_{13}, C_{13}= debt occurred in the same year/ GDP that year. (14) Debt Repayment Ratio C_{14}, C_{14} = the interest amount of the maturity debt /GDP.

2.2. The determination of segment domain and classical domain

N_j expresses the jth dipartite risk evaluation level, when j = 1, 2, 3, 4, N_j are respectively {risk level}, {warning level}, {conservative level} and {sefety level}; C_i expresses the ith evaluation indicator. $V_{ji} = (a_{ji}, b_{ji})$ is quantity value range of N_j about C_i , that is, data area classical domain of all items about their corresponding evaluation indicators. When j = 1, 2, 3, 4, the quantity value range is respectively (70, 100), (50.70), (20, 50), (0, 20). Besides, N_p expresses all items, v_{pi} is the quantity value rage of N_p about C_i, which is the segment domain N_p.

Now analysis a local fiscal situation, establish classical domain matter-element matrix R_1, R_2, R_3, R_4, segment domain matter-element matrix Rp and the matter-element matrix R:

$$R_1 = \begin{array}{c} \{\text{risk level}\} \\ \begin{vmatrix} N_1 & C_1 & (70,100) \\ & C_2 & (70,100) \\ & C_3 & (70,100) \\ & C_4 & (70,100) \\ & C_5 & (70,100) \\ & C_6 & (70,100) \\ & C_7 & (70,100) \\ & C_8 & (70,100) \\ & C_9 & (70,100) \\ & C_{10} & (70,100) \\ & C_{11} & (70,100) \\ & C_{12} & (70,100) \\ & C_{13} & (70,100) \\ & C_{14} & (70,100) \end{vmatrix} \end{array} \quad R_2 = \begin{array}{c} \{\text{warming level}\} \\ \begin{vmatrix} N_2 & C_1 & (50,70) \\ & C_2 & (50,70) \\ & C_3 & (50,70) \\ & C_4 & (50,70) \\ & C_5 & (50,70) \\ & C_6 & (50,70) \\ & C_7 & (50,70) \\ & C_8 & (50,70) \\ & C_9 & (50,70) \\ & C_{10} & (50,70) \\ & C_{11} & (50,70) \\ & C_{12} & (50,70) \\ & C_{13} & (50,70) \\ & C_{14} & (50,70) \end{vmatrix} \end{array} \quad R_3 = \begin{array}{c} \{\text{conservative level}\} \\ \begin{vmatrix} N_3 & C_1 & (20,50) \\ & C_2 & (20,50) \\ & C_3 & (20,50) \\ & C_4 & (20,50) \\ & C_5 & (20,50) \\ & C_6 & (20,50) \\ & C_7 & (20,50) \\ & C_8 & (20,50) \\ & C_9 & (20,50) \\ & C_{10} & (20,50) \\ & C_{11} & (20,50) \\ & C_{12} & (20,50) \\ & C_{13} & (20,50) \\ & C_{14} & (20,50) \end{vmatrix} \end{array}$$

$$R_4 = \begin{array}{c} \{\text{safety level}\} \\ \begin{vmatrix} N_4 & C_1 & (0,20) \\ & C_2 & (0,20) \\ & C_3 & (0,20) \\ & C_4 & (0,20) \\ & C_5 & (0,20) \\ & C_6 & (0,20) \\ & C_7 & (0,20) \\ & C_8 & (0,20) \\ & C_9 & (0,20) \\ & C_{10} & (0,20) \\ & C_{11} & (0,20) \\ & C_{12} & (0,20) \\ & C_{13} & (0,20) \\ & C_{14} & (0,20) \end{vmatrix} \end{array} \quad R_p = \begin{vmatrix} N_p & C_1 & (0,100) \\ & C_2 & (0,100) \\ & C_3 & (0,100) \\ & C_4 & (0,100) \\ & C_5 & (0,100) \\ & C_6 & (0,100) \\ & C_7 & (0,100) \\ & C_8 & (0,100) \\ & C_9 & (0,100) \\ & C_{10} & (0,100) \\ & C_{11} & (0,100) \\ & C_{12} & (0,100) \\ & C_{13} & (0,100) \\ & C_{14} & (0,100) \end{vmatrix} \quad R_0 = \begin{vmatrix} N_0 & C_1 & 40 \\ & C_2 & 43.6 \\ & C_3 & 22 \\ & C_4 & 26.5 \\ & C_5 & 21.2 \\ & C_6 & 22 \\ & C_7 & 35.3 \\ & C_8 & 58.4 \\ & C_9 & 45.2 \\ & C_{10} & 26 \\ & C_{11} & 34.8 \\ & C_{12} & 24.3 \\ & C_{13} & 30.5 \\ & C_{14} & 32.1 \end{vmatrix}$$

2.3. The association degree calculation of the matter-element about the various evaluation rank

T (x_i, v_{ji}) expresses the distance between point x_i and classical domain interval v_{ji}. T (x_i, v_{pi}) expresses the distance between point x_i and segment domain interval v_{pi}. The association degree $K_j(x_i)$ expresses the membership degree of all indicators of matter-element about all the evaluation rank j. If K_j (x_i) = Max K_j (x_i), j ∈ (1, 2,..., m), the evaluation indicator xi belongs to rank j.

$$K_j(x_i) = \begin{cases} -\dfrac{T(x_i, v_{ji})}{|v_{ji}|}, (x_i \in v_{ji}) \\ -\dfrac{T(x_i, v_{ji})}{T(x_i, v_{pi}) - T(x_i, v_{ji})}, (x_i \notin v_{ji}) \end{cases} \tag{1}$$

$$T(x_i, v_{ji}) = \left| x_i - \frac{1}{2}(a_{ji} + b_{ji}) \right| - \frac{1}{2}(b_{ji} - a_{ji}) \tag{2}$$

$$T(x_i, v_{pi}) = \left| x_i - \frac{1}{2}(a_{ji} + b_{ji}) \right| - \frac{1}{2}(b_{pi} - a_{pi}) \tag{3}$$

$$|v_{ji}| = |b_{ji} - a_{pi}|, (i = 1,2,\dots,n;\ j = 1,2,\dots,m) \tag{4}$$

Calculating matter-element according to formulas (1)-(4) calculation can work out Kj (xi), in which i = 1, 2,... , 14; j = 1, 2,... ,4.The result is as shown in Table 1.

Table 1. The result of association degree calculation

$K_j(x_i)$	K_1	K_2	K_3	K_4	$\max K_j(x_i)$	Conclusion
x_1	−0.429	−0.200	0.333	−0.333	0.333	conservative level
x_2	−0.377	−0.128	0.172	−0.351	0.172	conservative level
x_3	−0.686	−0.560	0.100	−0.083	0.100	conservative level

x_4	−0.479	−0.270	0.587	−0.311	0.587	conservative level
x_5	−0.411	−0.176	0.272	−0.340	0.272	conservative level
x_6	−0.686	−0.560	0.100	−0.083	0.100	conservative level
x_7	−0.496	−0.294	0.714	−0.302	0.714	conservative level
x_8	−0.218	0.253	−0.168	−0.480	0.253	warning level
x_9	−0.354	−0.096	0.119	−0.358	0.119	conservative level
x_{10}	−0.629	−0.480	0.300	−0.188	0.300	conservative level
x_{11}	−0.503	−0.304	0.740	−0.298	0.740	conservative level
x_{12}	−0.653	−0.514	0.215	−0.150	0.215	conservative level
x_{13}	−0.564	−0.390	0.525	−0.256	0.525	conservative level
x_{14}	−0.541	−0.358	0.605	−0.274	0.605	conservative level

2.4. The determination of the weighting coefficients by Entropy Method

The information entropy can be used to evaluate the degree of system information order and its utility. the judgment matrix consists of evaluation indicators determine the weighting coefficient of indicators. The calculation procedure is as follows:

(1) Construct judgment matrix R of m things and n evaluation indications: $R_{mn} = (x_{ij})_{mn} (i = 1,2,\ldots,n; j = 1,2,\ldots m)$

(2) Normalize the judgment matrix and use the following formula to get normalized judgment matrix B:

$$b_{ij} = (x_{ij} - \min x_i)/(\max x_{ij} - \min x_i) \tag{5}$$

In the formula: $\max x_{ij}$ is the most satisfied one and $\min x_i$ is the most unsatisfied one among the different things with the same evaluation indicator.

(3) According to the definition of entropy, the entropy of n evaluation things and m evaluation indicators is as follows:

$$H = -\sum_{j=1}^{m} f_{ij} \ln(f_{ij}) \Big/ \ln(m) \, (i = 1,2,3,\ldots,n; j = 1,2,3,\ldots,m) \quad \text{where} \quad f_{ij} = (1 + b_{ij}) \Big/ \sum_{j=1}^{m} (1 + b_{ij}) \tag{6}$$

(4) Calculate the evaluate indicator entropy weight:

$$W = (w_i)_{i \times n}; w_i = (1 - H_i) \Big/ (n - \sum_{i=1}^{n} H_i), \text{where} \quad \sum_{i=1}^{n} w_i = 1 \tag{7}$$

Calculate entropy weight of evaluation indicators W_i according to the formulas (5)-(7):

W_i =(0.087010707， 0.087010707， 0.015625817， 0.033454935， 0.033454935， 0.015625817， 0.087010707，0.054178356，0.033454935，0.033454935，0.054178356，0.194610695，0.135464545，0.135464545)^T (i=1，2，…，14)

2.5. The determination of the weighting coefficients by Entropy Method

The comprehensive association degree of matter-element about level j:

$$K_j(p_o) = \sum_{i=1}^{n} a_i K_j(v_i), (i = 1,2,3,\ldots,n; j = 1,2,3,\ldots,m) \tag{8}$$

In the formula: K_j (p_0) is the comprehensive association degree of matter-element about level j. K_j (v_i) is the association degree of matter-element about level j. w_i is the weighting coefficient of every evaluation indicators. If K_j (p_0) = maxK_j (p_0), j $\in$ (1, 2, 3,..., m), the evaluation indicator v_i belongs to level j.

According to the formula (8), K_1 (p_0) = 0.513219348, K_2 (p_0) = 0.309932985, K_3 (p_0) = 0.376313759, K_4 (p_0) = 0.275210922. Because Max K_j (p_0) = K_3 (p_0) = 0.376313759 belongs to the conservative level, although it don't have much risk, it's still far away from security level, it is necessary to pay more attention to the development of the local fiscal health K_3 (p_0).

3. Peroration

The essay puts forward local fiscal health index model based on extended matter-element evaluation to ensure segment domain and classical domain through of indicators at all levels through the extended matter-element evaluation, calculating the weighting coefficient of indicators at all levels through entropy method, analyzing the association degree and finally arrive at the situation of local finance operation. Experiment shows that the local fiscal health index model constructed by extenics theory can make the complex uncertainty questions be abstracted as formalized model. It has clear concepts, simple calculation and high resolution of evaluation results.

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