

# *Study on the comprehensive evaluation of regional financial risk*

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**Abstract:** Since 2011, the Chinese government began to pay attention to the prevention of regional financial risk in the financial field. The effective assessment of regional financial risk is an indispensable link in risk prevention, which is of great significance to maintain economic operation. This paper selects 5 first-level indicators and 15 second-level indicators to build a regional financial risk evaluation system. Based on the economic data of Jiangsu from 2015 to 2020, AHP and entropy weight method are used to calculate the corresponding weights of indicators at all levels. The multi-level fuzzy evaluation model is used to evaluate the financial risk in Jiangsu province. The results show that the membership degree of financial risk to the "general security" level is 0.5050 at most, among which the proportion of macro environment is 0.3932 at most, and the degree of external environment is 0.0625 at least. It can be seen that the economic operation of Jiangsu is relatively stable and the financial risk is small.

## **1. Introduction**

In July 2021, the General Office of the CPC Central Committee and The General Office of the State Council issued the Opinions on Strictly cracking Down on Illegal securities Activities in accordance with the Law, requiring a strict crackdown on illegal securities activities in accordance with the law to effectively prevent regional financial risks. Financial risks have strong linkage and self-reinforcing transmission characteristics [1], which are easy to accumulate, spread and then become regional financial risks. At present, the economic situation at home and abroad is changing with each passing day. In order to effectively prevent the occurrence of this situation and maintain the steady development of national economy, it is very important to carry out further comprehensive evaluation and research on regional financial risks.

Chinese scholars have carried out in-depth study on regional financial risk. Tan Zhongming et al. [2] found that Internet finance would impact the "steady state" of regional finance through the direct and indirect mechanisms of Internet finance's impact on regional financial risks, which would gradually accumulate regional financial risks. Ma Ruowei et al. [3] built a linear probability model to analyze the impact of Internet finance based on industrial structure adjustment on regional financial risks. They found that Internet finance has a positive impact on financial risks, and the adjustment of industrial structure has a positive moderating effect on this positive impact, and different industrial

structures have different moderating effects. Chen Lei [4] et al. studied the relationship between the level of fintech development and regional financial risks through the spatial Dubin model and panel threshold model. After their empirical study, they found that the two showed an "inverted U-shaped" relationship, and digital development was helpful to reduce the occurrence of regional financial risks. Li Kaifeng et al. [5] studied the debt risk level of various regions in China through entropy weight TOPSIS method and fuzzy comprehensive evaluation method. Based on Gansu Province, they built a VAR model to evaluate their impact on regional financial risks. The results show that the level of local debt risk in Gansu Province is directly proportional to the possibility of regional financial risk. But this phenomenon has the characteristic of time delay.

At present, there are few studies on the assessment of financial risks in Jiangsu and lack of a complete and effective assessment system. In this paper, the analytic hierarchy process is used to find the weight of the first-level index, and the entropy weight method is used to find the weight of the second-level index, so as to improve the accuracy of the weight results. The five - level evaluation criteria are selected and the multilevel fuzzy comprehensive evaluation model is used to comprehensively evaluate the financial risk in Jiangsu Province. It provides strong reference value for the formulation of financial risk policies in Jiangsu Province [6].

## **2. Construction of regional financial risk index system**

### **2.1 Evaluation index analysis**

The stability of macroeconomic operation is closely related to the risk state of the financial market. The stability of the macro environment indicates that the macro environment has strong resistance to financial risks. This paper selects the local GDP growth rate; Inflation rate; Growth rate of local fixed assets; Local fiscal revenue/expenditure.

The real estate market is of great significance to the study of financial risks. The unstable real estate market may cause social and economic turmoil. This article chooses the index to have the local real estate investment growth rate; Growth rate of commercial housing sales.

The soundness of currency and financial market is a micro factor affecting regional financial risk, and the soundness of its operation is directly related to the possibility of regional financial risk. This paper selects the capital adequacy ratio; Liquidity ratio; Non-performing loan ratio; Leverage ratio, M2/GDP.

A better external environment is a prerequisite for economic stability, and the impact of the external environment will inevitably lead to financial market turbulence. This paper selects the gross value of import and export /GDP; Growth rate of total exports.

The financial activities in the stock market have become an important cause of financial risks. Studying the activities in the stock market can effectively evaluate financial risks. This paper selects the average P/E ratio of Shanghai Stock Index and the total market value of A shares /GDP.

### **2.2 Construction of index system**

Based on the above analysis and combined with the characteristics of regional financial risks, this paper selects 5 first-level indicators and 15 second-level indicators to construct the following regional financial risk comprehensive evaluation index system. As shown in Table 1

Table 1: Comprehensive evaluation index system of regional financial risk

Level indicators	Secondary indicators	Index to explain
<b>Macro environment B1</b>	Growth rate of gross regional product C1	$(\text{Last year's GDP} - \text{previous year's GDP}) / \text{previous year's GDP} * 100\%$
	Rate of inflation C2	The degree to which the general level of prices has risen in a given period
	Growth rate of fixed assets C3	$\text{Net increase of original value of fixed assets in current period} / \text{original value of fixed assets at the beginning of period} * 100\%$
	Fiscal revenue/fiscal expenditure C4	Reflect government revenue and expenditure
<b>Real estate market B2</b>	Growth rate of real estate investment C5	$\text{Increased real estate investment} / \text{original real estate investment}$
	Growth rate of commercial housing sales C6	$\text{Current year commercial housing Sales} / \text{last year commercial housing sales} - 1$
<b>Stock market B5</b>	Average price-earnings ratio C14	$P/E = \text{current market price per share} / \text{net profit per share}$
	Total stock market value /GDP C15	It reflects the investment opportunities and risks of the market, and can reflect whether the stock market is overvalued or undervalued.
<b>Money and financial markets B3</b>	Capital adequacy ratio C7	The ratio of a bank's total capital to its risky assets
	Ratio of liquidity C8	Current ratio is the ratio of current assets to current liabilities
	Non-performing loan ratio of banks C9	$\text{Non-performing loans} / \text{total loans}$
	leverage C10	The ratio of total assets to equity capital in a balance sheet
	M2/gdp C11	In economic transactions, the proportion of exchange in the medium of money
<b>External environment B4</b>	Total value of imports and exports /GDP C12	Describe the proportion of imports and exports in national production
	Growth rate of total exports C13	$\text{Total exports this year} / \text{Total exports last year} - 1$

### 3. Comprehensive risk assessment method

#### 3.1 Determination method of index weight

(1) AHP determines the first-level index weight

1) Construct the judgment matrix:

The nine-degree scoring method is used to make pairwise comparison of the first-level indicators [7]. By collecting the scores of several experts on the importance of the indicators, the average of the scores is taken as the final evaluation result, and the judgment matrix can be obtained:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \quad (1)$$

2) Check the consistency of the judgment matrix, and the calculation steps are as follows:

Step 1: Calculate the consistency index CI

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad (2)$$

Step 2: Find the corresponding average random consistency index RI, As shown in Table 2.

Table 2: Average random consistency index

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54	1.56	1.58	1.59

Step 3: Calculate the consistency ratio CR

$$CR = \frac{CI}{RI} \quad (3)$$

If  $CR < 0.1$ , the consistency of the judgment matrix can be considered acceptable. Otherwise, the judgment matrix needs to be modified

3) Calculate the weight:

If the consistency test of the judgment matrix can be accepted, then the eigenvalue method can be chosen to obtain the weight of the first-level index. The calculation procedure is as follows:

Step 1: Find the maximum eigenvalue of judgment matrix A and its corresponding eigenvector.

Step 2: to normalize the feature vectors can get the desired weight.

(1) Entropy weight method is used to determine the weight of secondary index

Let's assume that there are n years, m evaluation indicators constitute the original matrix X, and put X forward, the results are as follows:

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} \quad (4)$$

1) The matrix Z is obtained by standardizing the forward matrix X and judging whether the input matrix has negative values. If so, it needs to be re-standardized to the non-negative interval. Where each element of Z:

$$Z_{ij} = x_{ij} / \sqrt{\sum_{i=1}^n x_{ij}^2} \quad (5)$$

2) Calculate the proportion of the ith data under the JTH index, and regard it as the probability used in the calculation of information entropy: calculate the probability matrix P, and each element in P:

$$p_{ij} = \frac{z_{ij}}{\sum_{i=1}^n z_{ij}} \quad (6)$$

3) The information entropy of each index and its corresponding information utility value, namely the difference coefficient, are calculated, and the entropy weight of each index is obtained by normalization.

For the JTH index, the calculation formula of information entropy is:

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^n p_{ij} \ln(p_{ij}), j = 1, 2, \dots, m \quad (7)$$

Information utility value:

$$d_j = 1 - e_j \quad (8)$$

The information utility value is normalized to obtain the entropy weight of each indicator:

$$W_j = \frac{d_j}{\sum_{i=1}^m d_j}, (j = 1, 2, \dots, m) \quad (9)$$

### 3.2 Fuzzy comprehensive evaluation method

(1) Set of determined factors:  $U$ : First order factor set. Assuming that the number of first-level indicators is  $n$ , then:  $U = \{U_1, U_2, \dots, U_n\}$ .  $U_i$ : Set of second-order elements. If the number of second-level indicators corresponding to the  $i$ th first-level indicator is  $k$ , then:  $U_i = \{u_i^1, u_i^2, \dots, u_i^k\}$

(2) Determine the set of comments: Suppose that there are  $m$  levels, and thus the set of comments is denoted as:  $V = \{v_1, v_2, \dots, v_m\}$

(3) Determine the weight of each factor:

The weight of  $U = \{U_1, U_2, \dots, U_n\}$  can be recorded as:  $A = [a_1, a_2, \dots, a_n]$ .

The weight of  $U_i = \{u_i^1, u_i^2, \dots, u_i^k\}$  is recorded as:  $A_i = [a_i^1, a_i^2, \dots, a_i^k]$ .

(1) Determine the fuzzy comprehensive judgment matrix:

For each index, the membership degree of each comment is the fuzzy shadow set on  $V$ . In this paper, the membership degree of the index is determined by fuzzy statistical method. the evaluation of the first level index  $U_i$  is denoted as  $R_i = [r_{i1}, r_{i2}, \dots, r_{im}]$ , then the fuzzy comprehensive judgment matrix of each index is:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \quad (10)$$

(2) Comprehensive evaluation:

If there is a fuzzy relation from U to V, then R can be used to get a fuzzy transformation, so as to get the final comprehensive evaluation result:

$$B = A * R \quad (11)$$

The comprehensive evaluation result can be regarded as a fuzzy vector on V, denoted as:  $B = [b_1, b_2, \dots, b_m]$ .

#### 4. Regional financial risk assessment

##### 4.1 Index weight determination

The 12 experts adopted the 9-degree scoring method to construct the judgment matrix respectively, and assigned 1/12 weight to each expert for weighted average. The final judgment matrix result was obtained by comprehensively considering the impact of each index on regional financial risk assessment, as shown in Table 3:

Table 3: Judgment matrix

A	B1	B2	B3	B4	B5
B1	1	4	2	5	2
B2	1/4	1	1/3	2	1/2
B3	1/2	3	1	4	2
B4	1/5	1/2	1/4	1	1/3
B5	1/2	2	1/2	3	1

Table 4: Index weight table

Level indicators	Weight	Secondary indicators	Entropy weight
Macro environment B1	0.3932	Growth rate of gross regional product C1	0.3563
		Rate of inflation C2	0.1962
		Growth rate of fixed assets C3	0.1692
		Fiscal revenue/fiscal expenditure C4	0.2783
Real estate market B2	0.0987	Growth rate of real estate investment C5	0.1856
		Growth rate of commercial housing sales C6	0.8144
Money and financial markets B3	0.2694	Capital adequacy ratio C7	0.0011
		Ratio of liquidity C8	0.3089
		Non-performing loan ratio of banks C9	0.3404
		leverage C10	0.1808
		M2/gdp C11	0.1689
External environment B4	0.0625	Total value of imports and exports /GDP C12	0.5477
		Growth rate of total exports C13	0.4523
Stock market B5	0.1762	Average price-earnings ratio C14	0.6695
		Total stock market value /GDP C15	0.3305

Through Matlab calculation:  $\lambda_{\max} = 5.065$ ,  $CI = 0.0163$ ,  $CR = 0.0145 < 0.1$ , the judgment matrix passes the consistency test.

The eigenvector corresponding to the largest eigenvalue is normalized to obtain the weight of the first-level index: 0.3932, 0.0987, 0.2694, 0.0625, 0.1762.

The entropy weight method determines the weight of the second-level index, in which the data comes from CSMAR, and the relevant data is input into Matlab to obtain the entropy weight of the second-level index.

In summary, the index weight results are shown in Table 4.

## 4.2 Comprehensive evaluation result

(1) Determining factor set: The first level factor set:  $U = \{B_1, B_2, B_3, B_4, B_5\}$ , set of second-level elements. Take  $B_1$  as an example:  $B_1 = \{C_1, C_2, C_3\}$ , and so on.

(2) Determine the evaluation set: This paper adopts the 5-level 5-point system and divides the evaluation set into 5 levels,  $V = \{\text{very safe, general safe, critical state, general dangerous, very dangerous}\}$

(3) Determine the weight:

$$A = [0.3932, 0.0987, 0.2694, 0.0625, 0.1762]$$

$$A_1 = [0.3563, 0.1962, 0.1692, 0.2783]$$

$$A_2 = [0.1856, 0.8144]$$

$$A_3 = [0.0011, 0.3089, 0.3404, 0.1808, 0.1689]$$

$$A_4 = [0.5477, 0.4523]$$

$$A_5 = [0.6695, 0.3305]$$

(4) Determine the fuzzy comprehensive evaluation matrix: Take the macro-environment  $B_1$  as an example, determine the fuzzy comprehensive evaluation matrix according to the fuzzy statistical method:

$$R_1 = \begin{bmatrix} 0.4 & 0.5 & 0.1 & 0 & 0 \\ 0.3 & 0.5 & 0.2 & 0 & 0 \\ 0.3 & 0.5 & 0.1 & 0.1 & 0 \\ 0.3 & 0.5 & 0.13 & 0.07 & 0 \end{bmatrix}$$

Similarly, the fuzzy comprehensive evaluation matrix of real estate market, money and financial market, external environment and stock market can be obtained as follows:

$$R_2 = \begin{bmatrix} 0.3 & 0.5 & 0.15 & 0.05 & 0 \\ 0.3 & 0.5 & 0.2 & 0 & 0 \end{bmatrix}$$

$$R_3 = \begin{bmatrix} 0.3 & 0.8 & 0 & 0 & 0 \\ 0.2 & 0.4 & 0.35 & 0.05 & 0 \\ 0.2 & 0.6 & 0.09 & 0.01 & 0 \\ 0.2 & 0.4 & 0.3 & 0.1 & 0 \\ 0.2 & 0.5 & 0.1 & 0.15 & 0.05 \end{bmatrix}$$

$$R_4 = \begin{bmatrix} 0.3 & 0.5 & 0.18 & 0.02 & 0 \\ 0.1 & 0.4 & 0.3 & 0.2 & 0 \end{bmatrix}$$

$$R_5 = \begin{bmatrix} 0.2 & 0.6 & 0.15 & 0.05 & 0 \\ 0.2 & 0.5 & 0.25 & 0.05 & 0 \end{bmatrix}$$

(5) Comprehensive evaluation:

$$B_1 = A_1 * R_1 = [0.3563, 0.1962, 0.1692, 0.2783] * \begin{bmatrix} 0.4 & 0.5 & 0.1 & 0 & 0 \\ 0.3 & 0.5 & 0.2 & 0 & 0 \\ 0.3 & 0.5 & 0.1 & 0.1 & 0 \\ 0.3 & 0.5 & 0.13 & 0.07 & 0 \end{bmatrix}$$

Thus:  $B_1 = [0.3356, 0.5000, 0.1280, 0.0364, 0]$

Similarly:  $B_2 = [0.3000, 0.5000, 0.1907, 0.0093, 0]$ ;  $B_3 = [0.2001, 0.4854, 0.2099, 0.0623, 0.0084]$ ;

$B_4 = [0.2095, 0.4548, 0.2343, 0.1014, 0]$ ;  $B_5 = [0.2000, 0.5670, 0.1830, 0.0500, 0]$ ;

Thus, the fuzzy comprehensive judgment matrix of each first-level index to the research object is obtained:

$$R = \begin{bmatrix} 0.3356 & 0.5000 & 0.1280 & 0.0364 & 0 \\ 0.3000 & 0.5000 & 0.1907 & 0.0093 & 0 \\ 0.2001 & 0.4854 & 0.2099 & 0.0623 & 0.0084 \\ 0.0084 & 0.4548 & 0.2343 & 0.1014 & 0 \\ 0.2000 & 0.5670 & 0.1830 & 0.0500 & 0 \end{bmatrix}$$

Thus:  $B = A * R = [0.2638, 0.5050, 0.1726, 0.0472, 0.0023]$

#### 4.3 Analysis of evaluation results

Based on the above analysis conclusion, since 0.5050 is the largest, that is, the membership degree of "general security" is the largest, financial risks in Jiangsu can be considered as "general security". Among the first-level indicators, the macro environmental factor with the largest weight is 0.3932, indicating that the macro environment has the greatest impact on financial risks in Jiangsu Province. The remaining factors are currency and financial market factors, stock market factors, real estate market factors, and external environmental factors with a minimum of 0.0625[8].

From the perspective of macro environmental factors, the maximum evaluation result of the index for the research object is 0.3356, which belongs to the "very safe" grade. Among them, the largest proportion of GDP growth rate is 0.3563, and the smallest proportion of fixed assets growth rate is 0.1692.

From the perspective of monetary and financial market factors, the maximum evaluation result of the index for the research object is 0.5000, which belongs to the "general safety level". Among them, the proportion of non-performing loan ratio of banks is 0.3404 at the maximum, and the proportion of capital adequacy ratio is 0.0011 at the minimum.

From the perspective of real estate market factors, the maximum evaluation result of the index for the research object is 0.4854, which belongs to the "general safety level". Among them, the growth rate of commercial housing sales accounts for the largest proportion of 0.8144, and the growth rate of real estate investment accounts for the smallest proportion of 0.1856.

From the perspective of external environmental factors, the maximum evaluation result of the index for the research object is 0.4548, which belongs to the "general safety level", in which the proportion of total import and export volume /GDP is 0.5477, and the proportion of total export growth rate is 0.4523 at the minimum.

From the perspective of stock market factors, the maximum evaluation result of the index for the



research object is 0.5670, which belongs to the "general safety level", in which the proportion of the average price-earnings ratio is 0.6695, and the proportion of the total stock market value /GDP is 0.3305.

## 5. Conclusion

This paper establishes an evaluation system from five aspects of macro environment, monetary and financial market, stock market, real estate market and external environment. Through screening, 15 risk indicators are obtained and the relevant weights of the indicators are determined to determine a complete and efficient regional financial risk evaluation system. On this basis, the multi-level fuzzy comprehensive rating model is used to further evaluate the financial risk status in Jiangsu province, so as to help the people's government of Jiangsu Province effectively prevent risks and promote the stable and coordinated development of regional economy[9].

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