

# Establishment and Statistical Analysis of Financial System Risk Early Warning Model

Pang Lei<sup>1</sup>, Qiying Wang<sup>2, \*</sup>

<sup>1</sup>Yunnan Normal University, School of Economics and Management, Kunming 650500

<sup>2</sup>Kunming University of Science and Technology, Faculty of Civil Engineering and Mechanics, Kunming 650500

\*Corresponding author

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**Abstract:** This paper uses statistical thoughts and methods to study the risk connotation of financial system, from the perspective of ecology, using the case study and Delphi method to construct a financial system risk early warning indicator system; The AHP analytic method is used to calculate the index weights; Combined with cluster analysis method to determine the critical value of early warning, and finally construct a financial system risk warning model. Using the 2017 statistical yearbook data for empirical research, the early warning analysis of China's financial system risks in 2017, and then propose relevant countermeasures for the problems in China's financial system risks.

## 1. Introduction

Under the trend of economic globalization, the financial industry has developed rapidly and its influence on the economy as a whole has grown. At the same time of the rapid development of the financial industry, the hidden dangers in the financial system risks have caused financial crises to break out frequently. Therefore, how to create a stable and good financial system has become the key to research. From the perspective of preventing problems before they can ensure the sound operation of financial system risks, the most urgent and effective way is to strengthen the financial system risk warning research and establish a corresponding and effective financial system risk warning model. The establishment of the financial system risk early warning model not only plays a preventive role in the crisis, but also provides an important basis for us to choose the financial development path and evaluate the gains and losses of various financial reform measures, and has practical significance for the healthy, stable and sustainable development of China's finance.

## 2. Selection of indicators for early warning model of financial system risk

Based on the analysis of risk factors of financial system and financial system, the author establishes financial subject factors, financial environment factors and financial adjustment factors, and breaks down 18 basic indicators that may affect financial system risks based on these three factors. As shown in Table 1, at the same time, statistical methods are used to find indicators that determine the stability of financial system risk in these basic indicators.

Table 1 Financial system risk primary election early warning indicators

First-level indicator	Second-level indicator	Third-level indicator
Financial subject indicator B1	Financial intermediary	Loan concentration rate (X1) Currency growth rate (X2) Non-performing asset ratio (X3) Capital adequacy ratio (X4) Capital flight growth rate (X5)
	Financial market	P/E ratio (X6) Foreign investment in the securities industry (100 million US dollars) (X7) Foreign insurance premium income (X8) Stock Market Market Value / GDP (X9)
Financial environment indicator B2	Economic basis	Fiscal Revenue/GDP (X10) GDP growth rate (X11) Inflation rate (X12) Output value margin (X13)
	System environment	Non-nationalization rate (X14) Monetary policy transmission efficiency (X15)
	Another environment	1- Engel coefficient (X16) Education Funding/GDP (X17)
Financial regulation indicator B3	Financial Supervision	Financial supervision level (X18)

Date source: The author collated.

This survey used the Delphi method for indicator selection and indicator scoring. The Delphi scores mean table is obtained by three rounds of scoring, as follows:

Table 2. Delphi scores mean table.

Indicator	First round of scoring average	Second round of scoring average	Third round of scoring average	Indicator	First round of scoring average	Second round of scoring average	Third round of scoring average
X1	4.75	4.3	4.4	X10	7.3	7.4	7.5
X2	8.1	7.6	7.7	X11	4.5	4.4	4.6
X3	7.2	7.7	7.5	X12	7.4	7.3	7.6
X4	7.5	7.5	7.6	X13	8.1	7.6	7.7
X5	7.6	7.6	7.4	X14	4.5	4.6	4.5
X6	7.8	7.4	8.2	X15	8.3	8.3	8.3
X7	4.9	4.9	4.6	X16	8.1	8.2	8.3
X8	4.6	4.4	4.6	X17	4.6	4.6	4.4
X9	7.3	8.2	8.3	X18	7.1	7.5	7.3

Date source: The author collated.

Comprehensive comparisons were made by three rounds of scoring results, and indicators with an average score of less than 6 were excluded. After the above statistics, it was decided to abandon the six basic indicators X1, X7, X8, X11, X14 and X17, and construct the remaining 12 indicators into the financial system risk early warning indicator system, as shown in Table 3:

Table 3. Financial system risk early warning indicator system

First-level indicator	Second-level indicator	Third-level indicator
Financial entity indicator	Financial intermediation indicator	Currency growth rate (X2) Non-performing asset ratio (X3) Capital adequacy ratio (X4) Capital flight growth rate (X5)
	Financial market indicators	P/E ratio (X6) Foreign insurance premium income (X8) Stock Market Market Value / GDP (X9)
Financial environment indicator	Economic base indicator	Fiscal Revenue/GDP (X10) Inflation rate (X12) Output value margin (X13)
	System environmental indicators	Monetary policy transmission efficiency (X15)
	Other environmental indicators	1- Engel coefficient (X16)
Financial regulation indicator	Financial regulatory indicators	Financial supervision level (X18)

Date source: The author collated.

Then, the total weight of the indicator levels is determined, that is, the results of all the levels of the same level are used to calculate the weights of the factors of the previous level, and the total order of the levels needs to be carried out layer by layer from top to bottom. The specific results are shown in Table 4:

Table 4. Financial system risk early warning indicator system weight table

Bi indicator	Weights	C indicator	Weights	Final weight
Financial system main indicators	0.43	Currency growth rate (X2)	0.14	0.0602
		Non-performing asset ratio (X3)	0.34	0.1462
		Capital adequacy ratio (X4)	0.19	0.0817
		Capital flight growth rate (X5)	0.18	0.0774
		P/E ratio (X6)	0.09	0.0387
		Stock Market Market Value / GDP (X9)	0.06	0.0258
Financial system environmental indicators	0.43	Fiscal Revenue/GDP (X10)	0.15	0.0645
		Inflation rate (X12)	0.43	0.1849
		Output value margin (X13)	0.14	0.0602
		Monetary policy transmission efficiency (X15)	0.10	0.0430
		1- Engel coefficient (X16)	0.18	0.0774
Financial system adjustment indicator	0.14	Financial supervision level (X18)	1	0.1400

### 3. Determination of the critical value of the warning

With reference to the macroeconomic monitoring and early warning approach of the National Bureau of Statistics, the author divides the early warning indicators of the financial system into three early warning intervals, that is, sets the three lights display. When the warning degree is measured, the system has the following provisions: The steady state is recorded as 0 points; the "blue light"

indicates the safety status, which is recorded as 1 point; the "red light" indicates the warning state, which is recorded as -1 point. Referring to the relevant literature and the Basel Capital Accord, the scores of the indicators are divided into sections. The specific division results are shown in Table 5:

Table 5. Early warning interval table for financial system risk individual indicators (unit: %)

Indicator name	I (green light) 1 point	II (yellow light) 0 points	III (red light) -1 point
Currency growth rate	$\leq 9$	9-15	$\geq 15$
Non-performing asset ratio	$< 4$	4-8	$\geq 8$
Capital adequacy ratio	$> 7$	4-7	$\leq 3$
Capital flight growth rate	$\leq 0$	0-0.8	$> 0.8$
P/E ratio	$\geq 30$	14-30	$< 14$
Stock market capitalization/GDP	$\geq 50$	40-50	$< 40$
Fiscal revenue/GDP	$\geq 40$	30-40	$< 30$
Inflation rate	$\leq 6$	6-9	$\geq 9$
Output value margin	$> 16$	14-16	$< 14$
Monetary policy transmission efficiency	$> 90$	80-90	$< 80$
1-ENGEL coefficient	$\geq 50$	40-50	$< 40$
Financial supervision level	Strong	General	Weak

At the same time, through numerical standardization processing, the 2000-2009 China Statistical Yearbook data is used to quantify the indicators, and the index values of each system are standardized by  $a_i^* = \frac{a_i - a}{a - a}$ . The specific results are shown in the following table:

Table 6. China's financial system risk warning index and the standardized value of each subsystem crisis early warning index

Year	Financial system risk warning index	Main system	Environmental system	Control system
2007	0.62685	0.495	0.8	0.5
2008	0.53655	0.285	0.8	0.5
2009	0.49355	0.185	0.8	0.5
2010	0.507095	0.365	0.8	0.5
2011	0.6216	0.39	0.73	1
2012	0.52365	0.325	0.73	0.5
2013	0.6677	0.66	0.73	0.5
2014	0.7248	0.51	0.85	1
2015	0.6474	0.615	0.565	1
2016	0.7322	0.86	0.68	0.5

Finally, using K-means clustering method, combined with hill-climbing algorithm and repeated clustering, the critical value of China's financial system risk warning and the warning threshold of each subsystem are determined.

The above table shows the situation in which each class after the output cluster analysis contains samples. The results are divided into three categories, which are the same as the prior regulations, which reflect the early warning clustering of the financial system in China. The last column shows the distance (Euclidean distance) of each sample from the center point of the final class.

Table 7. Cluster Results Table

Serial number	Data indicator	Clustering result	Distance from the center of the class	Serial number	Data indicator	Clustering result	Distance from the center of the class
1	0.62685	3	0.07212	21	0.8	2	0.0255
2	0.53655	3	0.01818	22	0.8	2	0.0255
3	0.49355	3	0.06118	23	0.8	2	0.0255
4	0.507095	3	0.04764	24	0.8	2	0.0255
5	0.6216	3	0.06687	25	0.73	2	0.0955
6	0.52365	3	0.03108	26	0.73	2	0.0955
7	0.6677	3	0.11297	27	0.73	2	0.0955
8	0.7248	2	0.1007	28	0.85	2	0.0245
9	0.6474	3	0.09267	29	0.565	3	0.01027
10	0.7322	2	0.0933	30	0.68	3	0.12527
11	0.495	3	0.05973	31	0.5	3	0.05473
12	0.285	1	0.025	32	0.5	3	0.05473
13	0.185	1	0.125	33	0.5	3	0.05473
14	0.365	1	0.055	34	0.5	3	0.05473
15	0.39	1	0.08	35	1	2	0.1745
16	0.325	1	0.015	36	0.5	3	0.05473
17	0.66	3	0.10527	37	0.5	3	0.05473
18	0.51	3	0.04473	38	1	2	0.1745
19	0.615	3	0.06027	39	1	2	0.1745
20	0.86	2	0.0345	40	0.5	3	0.05473

Through clustering, we normalized the risk warning of China's financial system, that is, the warnings of various subsystems, and identified three distance center centers. The warning thresholds were initially classified into three categories: dangerous, worthy of attention and safety. The data in the clustering result table is arranged according to the class. By comparing the maximum and minimum values in each class, the critical line of the three types of warnings can be obtained: less than 0.49 is dangerous; 0.49-0.72 is worthy of attention; 0.72-1 is Safety.

#### 4. Establishment and application of financial system risk early warning model

##### (1) Establishment of financial system risk early warning model

In summary, the author establishes a financial system risk early warning indicator model as shown in Table 8:

The specific data is compared with the financial system risk single warning indicator interval table to obtain the scores of each individual indicator. The weighted sum of the individual indicator scores in each system is used to obtain the weighted scores of each system, and standardized, and the financial system risk and the final score of each subsystem are obtained. The final score is compared with the warning threshold to judge the financial system risk and the early warning status of each system, which provides a reliable data basis for further empirical research.

##### (2) Analysis and application of China's financial system risk warning in 2017

According to the contents of the statistical yearbook published in 2017 and the Zephyr database, the statistics of the previous indicators are calculated, and the following table is obtained. The early warning analysis is combined with the early warning model as shown in Table 9.

Table 8. Financial system risk warning model table

Type		Indicator name	Weight	Threshold
Financial system main indicators	Financial intermediary	Currency growth rate (X2)	0.0602	Risk score: <0.49 Worth paying attention to the score: 0.49-0.72 Safety score: >0.72
		Non-performing asset ratio (X3)	0.1462	
		Capital adequacy ratio (X4)	0.0817	
		Capital flight growth rate (X5)	0.0774	
	Financial market	P/E ratio (X6)	0.0387	
		Stock Market Market Value / GDP (X9)	0.0258	
Financial system environmental indicators	Economic basis	Fiscal Revenue/GDP (X10)	0.0645	
		Inflation rate (X12)	0.1849	
		Output value margin (X13)	0.0602	
	System environment	Monetary Policy Transmission Efficiency (X15)	0.0430	
	Another environment	1-ENGEL coefficient (X16)	0.0774	
	Financial system adjustment indicator	Financial supervision level (X18)	0.1400	

Table 9. China's financial system early warning score table in 2017

Type		Indicator and indicator value	Weights	Single score
Financial system main indicators	Financial intermediary	X2=27.70%	0.0602	-1
		X3=1.83%	0.1462	1
		X4=11.4%	0.0817	1
		X5=-30.83%	0.0774	1
	Financial market	X6=34.46%	0.0387	1
		X9=71.02%	0.0258	1
Financial system environmental indicators	Economic basis	X10=20.11%	0.0645	-1
		X12=-6.23%	0.1849	1
		X13=15.5%	0.0602	0
	System environment	X15=76%	0.0430	-1
	Another environment	X16=1-36.5%=63.5%	0.0774	1
	Financial system adjustment indicator	X18 general	0.1400	0

Calculate the final score of China's financial system security based on the weights in the above table:

$$S = \sum W_t \times S_t$$

$$\begin{cases}
 S = (0.0602+0.0645+0.043) \times (-1) + (0.1462+0.0817+0.0774+0.0387+0.0258+0.0774) \\
 = 0.4644 \\
 S_{subject} = 0.3096 \div 0.43 = 0.72 \\
 S_{Environment} = 0.1548 \div 0.43 = 0.36 \\
 S_{Regulation} = 0 \div 0.14 = 0
 \end{cases}$$

The result of standardizing the above scoring results is:

$$\left\{ \begin{array}{l} S' = \frac{0.4644 - (-1)}{1 - (-1)} = 0.7322 \\ S'_{Subject} = \frac{0.72 - (-1)}{1 - (-1)} = 0.86 \\ S'_{Environment} = \frac{0.36 - (-1)}{1 - (-1)} = 0.68 \\ S'_{Regulation} = \frac{0 - (-1)}{1 - (-1)} = 0.5 \end{array} \right.$$

From the perspective of the entire financial system risk, the score is 0.7322 in a safe state, but the score is close to the warning threshold. If the management is not strengthened, the financial system risk warning situation may transition to a state of concern; from the financial entity, the score is significantly higher. In the safe state threshold, it is in a safe state, indicating that the financial system entity is relatively stable at this stage, and should continue to maintain a safe and stable state; from the financial environment, the score is in the score segment worthy of attention, which indicates that there are unstable factors in the financial environment. To do a good job in financial system risk warning, we must start from the financial environment; from the perspective of financial regulation, the score is in a state of concern, and we should adjust the regulatory measures and supervision, and combine financial regulation with the financial system's own risk adjustment.

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