

# The Regional Financial Risk Early-Warning Model Integrating the Regression of Lagging Factors

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**Abstract:** It is an essential demand to establish an effective financial risk early-warning system for financial security. But some factors have a lagging effect on financial risk. So this paper aims to construct a reasonable and practical indicator system for financial risk early-warning. First, determine the explained variables of the indicator made up by Chinese financial stress index. Second, confirm the explanatory variables consisting of the macroeconomic variable, the currency credit variable, asset price variable and the macroeconomic variable of correlative economic powers. Finally, propose an optimum forecast equation to predict financial systemic risk status. In conclusion, the forecast outcomes indicate that Chinese financial systemic risk is on rising trend in the past three quarters in 2011 and higher than the peak of 2008, whereas financial systemic risk declines at the fourth quarter.

**Keywords:** Financial systemic risk, optimum forecast equation, early-warning index system

## 1. Introduction

The financial risk has increased tempestuously resulted from the globalization of financial service, the mixed management of financial institutions and the fast growth of the finance derivative transaction as well as the emerging of leverage effect, the update of technical system, intricate trading tools and trading strategies [1]. The financial industry in China has faced greater challenges since China formally joined the WTO in 2001. It is difficulty for the financial institutions to compete with foreign financial comers, because it resulted from the small scale, the weak innovation and the passive reputation. Therefore, it is an essential demand to establish an effective financial risk early-warning system, emphasizing on preventing and defusing the financial risk, safeguarding financial security based on the economic globalization and financial opening.

With the outbreak of the financial crisis, researches on financial risk early-warning mechanism have perfected. Foreign scholars have developed many eminent financial risk early-warning models including five important financial risk early-warning models, i.e. KLR model, Probit/Logit model, STV model, DD model and DCSD

model [2-7]. But the hazard of the risk is that it not only affects the current situation, but also has a subsequent influence on the future. Whereas the current research seldom considers a lagging effect on financial risk. Most of the domestic researches are qualitative, which is a theory perspective of establishing a macro financial risk early-warning index system. The research mainly focuses on crisis principle and the early-warning index system. Meanwhile, the sample of empirical test is from Asian financial crisis in 1997, which is mainly examined by KLR model, with the supplement of multivariate statistics and information systems method. However, especially for such countries which seldom have financial crisis like China, the system might be weak because the indexes of the financial risk early-system are based on the common factors from the cause of the financial crisis.

As a consequence, this paper reviews the relevant researches about financial risk lagging factors, and points out the lagging factors having significant influence on financial risk. Besides, the paper establishes indexes of the financial risk early-system model via lagging factors. The process of dealing with the data includes data standardization, weight assignment, risk identification. Finally, this paper draws a conclusion. This paper aims to

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propose an early-warning model based on the lagging factors and introduce the relationship between the financial risks and lagging factors, so that the analysis of model could be more practical and the accuracy of forecasting could be better improved.

## 2. Regional financial risk factors

### 2.1. Regional financial risk factors analysis

Regional financial risk is not only influenced by the external factors (such as the sudden change of macroeconomic policy, unusual change of macro economic and financial), but also restricted by specific economic environment and market infrastructure in local area. Imbalance development in regional economy and finance will lead to the financial risk having strong regional characteristic. Additionally, the resistance of regional finance is weaker, whereupon the local financial turmoil would trigger the regional financial crisis and even national financial crisis.

The financial risk factors mainly follow two principles: the one is the synchronicity, i.e. the selected factors are able to synchronously relate to one or more financial subsystems, and have influence on the risk; the other is the punctuality, i.e. the data of the selected factors could be obtained in time. The choice of the financial risk factors should consider not only the variables reflecting domestic economic conditions, but also the variables of international asset price and the economic variables which have a large effect on China's economy.

However, there are obvious lagging factors among the financial risk factors. Regional financial crisis would produce a lagging impact on the whole financial system and the substantive economy. The outbreak of America's financial crisis results in the delay growth of the U.S. substantive economy even recession, the consequence of the crisis has produced reversal in the trade parity favorable conditions that Latin America economy enjoys in recent years. This situation may have further deteriorated while the U.S. and international economy continue to be weak.

Finally, this paper reviews the index analysis of lagging factors in regional financial risk, and consequently establishes a regional financial risk early-warning model integrating the regression of lagging factors.

### 2.2. Regional financial risk factors' index design

Because of the diffusivity in regional financial crisis, the regional financial crisis would result in extensive financial crisis, even the global financial crisis. The financial crisis caused by America's subprime mortgage crisis ranges from regional to worldwide, transmits from the developed

countries to the emerging countries and developing countries, and spread from the financial industry to the substantive economy.

Owing to the passive impact of the international financial crisis, most countries have a sharp slow-down in economic growth, and the world's economy was trapped in recession. IMF had cut the forecasts of global economy growth in 2009 to 2.2%, in contrast to the previous data was 3%. The World Bank also predicted that developed economies would be entrapped in overall negative growth in 2009. Nevertheless, the negative growth of the economy indicated that the next year's economic development was restrained, and it might have a subsequent effect on the financial crisis. It is obvious that economic growth has a lagging effect on financial crisis.

It shows that the economic growth has an enormous influence on the financial crisis, while one country's economic development level is usually measured by economic monetized rate.

According to Chinese common method at present, i.e. using the method M2 (generalized currency) divided by GDP to show the economic monetized index, we could calculate the result as follow:

**Table 1** Chinese economic monetized index

Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	
Economic Monetized Index (96)	36.1	40.8	46.0	48.9	51.8	57.8	54.4	61.4	64.1	62.2	
Economic Currency Growth	13.1	12.7	6.3	5.9	11.6	-5.7	12.7	4.4	-3.0	-	
Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Economic Monetized Index (96)	64.4	82.5	89.5	95.4	100.7	100.4	103.9	112.2	122.2	132.1	146.1
Economic Currency Growth	3.9	27.7	8.5	6.6	5.6	-0.3	3.5	7.9	9.0	8.1	10.6

Note: established according to volume of "China Statistical Yearbook" and "1999 China Statistics Bulletin" by author.

From the calculated results above, it is obvious that along with the rapid development of the economy, Chinese economic monetized growth situation is very remarkable. In other words, currency relation as a form of economic relation has achieved a fair extent of deepening and generalization in China.

M2 reflects not only the real purchasing power, but also the potential purchasing power. If the M2 growth is faster, then the investment and the middle market are active. Accordingly, the Central Bank and other commercial banks could judge the monetary policy by it. M2 is commonly measured by DM2 (generalized currency growth rate).

Another important content of economic growth is foreign trade. Foreign trade is the core issue among various countries' economic relations. It plays an irreplaceable role in the economic development, and is

also the significant strategy on economic development. Since the reform and opening up, the foreign trade has always been the "propeller" of Chinese economic development, it contributes the imports and the exports ranging from trade deficit into surplus, besides the abundant foreign exchange reserve has become the reassuring force for the healthy development of economy and society. Import and export trade's balance of payments of a country is the significant part of current account in its international payments.

Foreign trade multiplier theory of Keynesian economics suggests that exports produce double aggrandized effect to national income and output, while the imports produce double shrank effect to its national income. As a result, the greater trade deficit would lead to the economic recession, the rising unemployment and the increasing possibility to the financial crisis. The scale of the trade balance would eventually affect the economic development in China, and then produce the financial risk indirectly.

Besides, banking, real estate and other factors might also have a lagging effect in financial risk. The expansion of the commercial banks' credit would accumulate risk, and therefore soar as well as the impact triggered by small financial crisis would consequently make the increasing uncertainty risk of real estate exposed completely.

Meanwhile, the international oil price, the economic growth and the deposit interest margin will also have a certain effect in financial risk.

Through the screening of numerous domestic and foreign economic variables via the stepwise regression method, the paper finally have confirmed the regional financial risk factors: Gross Domestic Product (GDP), GDP growth(DGDP), economic monetized rate(MRATE), broad money growth rate(DM2), balance of trade(TRADEBASA), the bank credit balance in China (SODCSA), Chinese estate price index (HOUSEPINDEX), international crude oil prices rate(OIL), Japanese GDP growth rate(JPDGDP), and the one-year deposit spreads between China and the United States(DR).

### 3. Early-warning model of regional financial risk

#### 3.1. An analysis of financial risk early-warning model

Because of the lagging factors in the financial risk, the paper firstly establishes a general regression model with a dependent variable of lagging factor.

Due to the diffusivity of regional financial risk, this paper chooses Chinese Financial Stress Index (CFSI) as the explained variable in the financial risk early-warning model.

Canadian Bank economists Illing and Liu firstly proposed the concept of financial stress and established financial stress index. According to Illing and Liu, "financial stress is a continuous variable, its extremum is called financial crisis." [8] The financial stress would rise upon the rising of expect financial loss, risk or uncertainty.

For example, "Kansan Financial Stress Index (KCFSI)" was structured via 11 variables based on the characteristics of financial stress. Cardarelli et al established financial stress index about 17 countries via 7 variables on the basis of the bank department's rolling coefficients, exchange rate volatility, TED interest spread, corporate bonds spread, stock index fell percentage, the stock market volatility and the slope of yield curve [9]. Additionally, EM-FSI chose five variables, respectively bank department coefficients, the yield of stock, time-varying stock index returns volatility, sovereign debt spreads and foreign exchange market pressure index (EMPI). Swiss Bank stress index was constructed via the data of five variables; there were the market price, the data of the Balance Sheet, the nonpublic data of regulators and other structural variables. In addition, the stress index also reviewed the influence of the bank stress index under the economic environment and macroeconomic imbalance.

According to the lagging factors of financial risk and relevant references, the explanatory variables are eventually determined as follow: CFSI lagging variables (AR (K)), GDP, GDP growth (DGDP), economic monetized rate (MRATE), generalized currency growth rate (DM2), trade balance (TRADEBASA), Chinese bank credit balance (SODCSA), Chinese estate price index (HOUSEPINDEX), international crude oil prices rate(OIL), Japanese GDP growth rate(JPDGDP) and the one-year deposit spreads between China and the United States(DR).

#### 3.2. The processing of financial risk early-warning model data

Because the financial risk early-warning demands a large number of background supportive data, it requires effective supervision on various lagging factors in financial risk. Yet, nature and significance of each monitoring and warning index is different. For instance, some indexes are positive indicators which are better if they are bigger, some others are negative indicators which are the better if they are smaller, and some are suitability indicators. Therefore, the index data requires standardization processing in order to reflect the level of risk. There are a variety of measurements about data standardization processing, this paper deploys the method of mapping to map the index unified fraction. Specially speaking, for every value of index, according to its relative position between the upper and lower threshold of

warning threshold in diverse risk situation, it is mapped to the corresponding position between the upper and lower threshold in same proportion.

### 3.3. The weight assignment of financial risk early-warning model index

It is obvious that each lagging factor in financial risk occupies different proportion, and therefore requires weight assignment. There are a lot of weight assignment methods which are mainly summarized into subjective method and objective method. Subjective methods assign weight on the basis of index attribute concerned degree, including the expertise process, the analytic hierarchy process, the evaluation process and so on; while objective methods assign weight on the basis of the index information, e.g. the most famous one is entropy method. However, neither the subjective nor the objective methods are flaw. In consequence, the paper deploys the method combining analytic hierarchy process (AHP) and entropy method to assign the weight. It takes the preference of index attribute into consideration as well as the balance of subjectivity and objectivity by reducing the subjective capriciousness, in addition, the method also combines the static and dynamic weight assignment together to enhance the objectivity, scientificity and accuracy. Firstly, use the expert evaluation process to produce the data of early-warning index, and then adopt the AHP to assign the initial firstling and secondary weight of index. Additionally, introduce the concept of "entropy", process the data with the method of entropy, and then get the entropy weight. Finally, adjust the initial dynamic entropy weight determined by AHP, and then produce the combination weight of index.

### 3.4. The calculation of financial risk early-warning model risk degree

After the standardization fraction of the index value, it will obtain a value via scientific method, which could comprehensively reflect regional financial risk (namely comprehensive risk degree). The value could accurately identify the overall degree of regional finance risk. Comprehensive risk degree is the weighted average value of comprehensive regional financial risk factors. The calculation formula can be expressed as:

$$M(x) = \sum_{i=1}^4 w_i x_i \quad (1)$$

Where  $M(x)$  is the comprehensive risk degree of regional financial risk factors determined by  $x$ , while  $w_i$ ,  $x_i$  are respectively the combination weight and mapping fraction value of regional financial risk factor index.

### 3.5. The establishment of the financial risk early-warning model

According to the explanatory variables, the explained variables and the correlation among the indexes, the regression model is optimized as follow:

$$CFSI_t = \alpha + \beta CFSI_{t-k} + \gamma X_{t-ki} + \varepsilon_t \quad (2)$$

Where  $CFSI_{t-k}$  represents  $CFSI$  lagging  $K$  phase(s), and  $X_{t-ki}$  represents other explanatory lagging  $K$  phase(s). Through the stepwise regression analysis, using T-test, R-squared-test, DW test, AIC information judgment, we could decide the best variable combination and the optimum forecast equation. The regression analysis demonstrates that the prediction of financial stress index in China can be extremely accurate through the combination of these variables: the balance of trade lagging 6 phases, Japanese GDP growth lagging 8 phases, the crude oil rate of change lagging 4 phases, SUMGDP, the ratio of general currency and GDP, GDP growth, real estate price index, general currency growth, the credit balance, the balance of international trade, the one-year deposit margin between China and the United States and the early FSI. While the regression coefficients of the crude oil change rate, SUMGDP, the ratio of general currency and GDP, the one-year deposit margin between China and the United States, and Japanese GDP growth are negative, it indicates that if these variables increase, the financial stress index in China will decline accordingly. The regression coefficients of the GDP growth rate, real estate price index, the general currency growth and the credit balance, the balance of international trade and the early FSI are positive in contrast. The statistics test indexes in the equation are the best. At 5 percent significant level, all explanatory variables have passed the T-test. The fitting goodness of the equation is higher, R-squared and Adjusted R-squared are 0.970219 and 0.949745, and parameter sequence is smooth. According to the results of the Table 2, we can deduce the following optimum forecast equation of the financial stress index:

$$\begin{aligned} CFSI_t = & 38.65159 + 0.421267AR(4) + 0.43508GDP_{t-4} \\ & + 0.39413HOUSEINDEX_{t-4} - 4.745299OIL_{t-4} \\ & - 0.001607GDP_{t-4} - 198.7936MR_{t-4} - 0.717549DR_{t-4} \\ & + 0.357039DM_{t-4} + 0.004065SODCSA_{t-4} \\ & + 0.066912TRADEBASA_{t-6} - 0.332322JPDGDP_{t-8} \quad (3) \end{aligned}$$

## 4. Experimental analysis

Checking the actual value, the fitted value and the residual value of financial stress index in China via Eviews software, we compare the relation between the actual value and the fitted value of financial stress index

**Table 2** The regression results of optimum forecast model

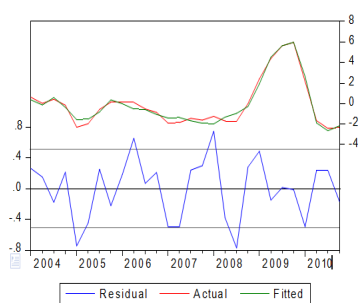
variable	coefficient	Std.error	t-Statistic	Prob.
C	38.65159	17.12479	2.257054	0.0383
DGDP	0.435080	0.144108	3.019128	0.0081
HOUSAPINDEX(-4)	0.394130	0.062755	6.280487	0.0000
OIL(-4)	-4.745299	0.550066	-8.626780	0.0000
GDP(-4)	-0.001607	0.00024	-7.174505	0.0000
DM/GDP(-4)	-198.7936	30.89468	-6.434557	0.0000
DR(-4)	-0.717549	0.155294	-4.620577	0.0003
DM2(-4)	0.357039	0.094160	3.791848	0.0016
SODCSA(-4)	0.004065	0.000580	7.010241	0.000
TRADEBASA(-6)	0.066912	0.017246	3.879856	0.0013
JPDGDP(-8)	-0.332322	0.0987789	-3.363976	0.0039
AR(4)	0.421267	0.087949	4.789874	0.0002
R-squared	0.970219	Mean dependent var	-0.0796395	
Adjusted R-squared	0.949745	S.D. dependent var	2.291420	
S.E. of regression	0.513684	akaike info criterion	1.803122	
sum squared resid	4.221947	Schwarz criterion	2.374056	
Log likelihood	-13.24356	F-statistic	47.38681	
Durbin-Watson stat	1.883751	prob(F-statistic)	-0.000000	
Inverted AR Roots	0.81	.00+.81i	.00+.81i	-.81

**Table 3** The data of forecast model index in 2011

SUMGDP(first half year)	20445.9 billion RMB
DGDP	9.6 %
MRATE	1.82
DM2	17.2 %
TRADEBASA	Trade surplus 44.93 billion dollar
SODCSA	4.17 thousand billion RMB
HOUSEPINDEX	Year-on-year increase 4.85 % (June)
OIL	fell 4.3 %
JPDGDP	rise 8.7 %
DR	3 %

of which would achieve the maximum 20.96625, whereas the financial stress index of the fourth quarter in 2011 would be prone to decline. Table 4 presents the four quarters' forecast value of financial stress index in 2011 through equation (2). Meanwhile, Figure 2 illustrates the trend of annual financial stress index forecast in China.

in China from 2004 to 2010. The figure could be referred as Figure 1:



**Figure 1** The actual and predictive value of exponent

Figure 1 shows the relation between the actual value and the fitted value of financial stress index from 2004 to 2010, the two of which are almost identical in the figure. It is obvious that the accuracy of the forecasting equation is quite satisfactory.

Through the literature review, we can obtain the data of the explanatory variables in 2011, which shown in the following Table 3.

Note: the data is that of the first half year 2011, the growth rate is similarly accordingly.

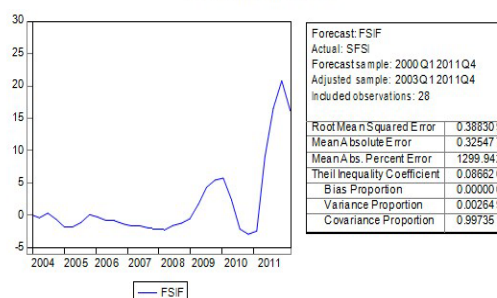
Then we put the data above into the equation (3), and forecast financial stress index in 2011. The result is as below:

The result demonstrates that the financial stress index in 2011 was greater than the peak of that since 2002, i.e. the financial stress index was greater than the fourth quarter in 2008.

Obviously, financial stress index of the past three quarters in 2011 would keep increasing, the third quarter

**Table 4** The Predicted value of CFSI in 2011

Time	2011 1st season	2012 2nd season	2011 3rd season	2011 4th season
Predicted value of CFSI	9.350985	16.73679	20.96625	16.37018



**Figure 2** The trend of our stress predictive value

The model demonstrates that the financial stress index trend could be simulated properly through the explanatory variables lagging four quarters (two other variables are lagging six quarters and eight quarters respectively). In other words, according to the current financial stress index and other values of explanatory variables, the financial stress index in the last four quarters could be forecast.

It could be inferred from the regression outcome that the GDP growth, real estate price index, general currency growth, the credit balance and the balance of international trade will have a positive influence on financial stress index, whereas the price of crude oil rate of change,

SUMGDP, the ratio of general currency and GDP, the one-year deposit margin between China and the United States and Japanese GDP growth will have a negative influence. Since the collinearity among the explanatory variables, it would lead to such a fact that the coefficients of explanatory variables are not identical to the actual ones. However, the collinearity will not affect the CFSI to the predictive result, where explanatory variables are regarded as a whole.

## 5. Conclusion

This paper has established the financial stress index forecast model according to following steps. Firstly, construct the indexes of financial risk based on the financial risk synchronization indexes. Secondly, points out the explanatory variables consisting of the lagging factors of financial stress index and advanced economic and financial indicators. Finally, the model has been established via demonstration analysis. The optimum forecast equations of the financial systemic risk or the financial systemic risk early-warning system is available and practical.

Yet, in light of the sequence length of the original data, the robustness of the model remains further test in practice. In sum, the future research directions would concentrate on several aspects. Firstly, the accuracy and timeliness of the data collection should be ensured. Financial risk early-warning demands a higher requirement to the latest data. The updated data can make the original model adjusted to more adaptive range so that the effectiveness and accuracy of financial risk early-warning will be improved. Secondly, a more in-depth analysis about the model should be managed. The deep factors which result in a change of the model index should be discussed to reveal the essential nature.

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