Risk Periodization: The Spectrogram Monitoring Model of Financial System Risk of China

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Abstract

The purpose of this study is to build a high-frequency, practical and more effective system of financial risk monitoring indicators in order to provide the financial risk early warning. The high-frequency monitoring indicators of financial risk is built, by applying the method of expert opinion, literature analysis, indicator attribute group on selecting and analyzing numerous "cloud" indicators of risk. The spectrum graph model of financial risk monitoring is established by using the clustering analysis and 2008 financial crisis case. The empirical result shows that financial risk monitoring system is statistically significant and realistic. It can timely reflect changes of the financial risk. The result also shows that the financial system risk monitoring spectrum is simple to use, is very intuitive and effective monitoring.

Key words: Financial risk; Risk monitoring; High-frequency monitoring; Indicator monitoring system

INTRODUCTION

The establishment of indicator system of financial risk monitoring both for institutional investors, and for financial regulators are crucial. It is really harmful to personal interests, area interests, even the interests of the whole country, because of the financial risk, such as the harm of the Southeast Asian financial crisis and the 2008 Subprime Mortgage Crisis in the United States. Although the risk is hard to predict, but its risk can be monitored, thus establishing a reliable and timely financial risk monitoring indicator system is really important for substantially reducing the harm by financial risk. The previous researchers have made unremitting researches on this problem. Gu (2013), Lü (2010), Xu (2011), Wu (2011), Yang (2012) and so on, who are put forward their own ideas for the construction of financial risk monitoring indicator system. These researches have laid a good foundation for further study on the problem of financial risk monitoring indicator system. While they have made some achievements in the problem of financial risk monitoring indicator system, they are still in the initial stage; this problem is still the research crux to scholars of financial risk management. There are three points have not been better solved in this problem. The first one is the study of the past research which focused on part of financial risk indicators, and lack in comprehensive quantitative analysis. The second point is that researches are lack of empirical analysis, for example, a length of time is short, and some are only 3 to 4 years. The third one is that the past research is just focused on the quarterly indicator or annual indicator analysis, but lack of monthly indicator analysis, thus there is a longer delay. It is difficult to detect risk changes and cope with risks. The purpose of this study is to build a practical financial risk dynamic monitoring indicator system based on monthly data, in order to track, recognize, find the change of financial risk, so as to provide reference for the financial risk early warning.

1. PRELIMINARY SCREENING OF CLUSTERING: THE FRAMEWORK OF FINANCIAL RISK MONITORING INDICATOR SYSTEM

According to the indicator attribute grouping method, these indicators can be grouped into bank, securities, insurance, foreign exchange and comprehensive financial, which are grouped by financial industry type. Using the Documental Analysis Method to sift from numerous financial risk indicators, we can obtain five kinds of financial risk monitoring indicators. The Chinese financial risk monitoring indicator system, which contains six categories and 27 indicators, can be established using the above method. The indicators of Bank risk monitoring can be grouped into 17 types, which are the short-term loan amount indicator, loan weighted rate indicator, one-year deposit rate indicator, one-year lending rate indicator, short-term interest rates indicator, long-term lending rates indicator, RMB loans indicator, long-term loans indicator, savings deposit indicator, deposit and loan interest rate indicator, the interbank offered rate indicator, LIBOR Trading volume indicator, fixed asset investment loans indicator, deposit reserve rate indicator, China credit gap indicator, the amount of bad loans indicator and commercial bank non-performing loan rate indicator. And these indicators are marked as $x1$ to $x17$. Foreign exchange and insurance risk monitoring is grouped into funds outstanding for foreign exchange indicator and foreign debt indicator, which are marked as $x18$ and $x19$. Monitoring the risk of securities may be referred to stock index indicator, and it can be labeled as $x20$. And in the comprehensive financial and other financial risk monitoring, there are 7 indicators, marked as $x21$ to $x27$. They are commodity residential indicator, commercial business premises indicator, social financing scale indicator, currency withdrawal indicator, putting currency into circulation indicator, M2 (broad money) indicator and M1(narrow money) indicator.

2. ELABORATE SCREENING CLUSTERING: BUILDING THE FINANCIAL RISK MONITORING INDICATOR SYSTEM

By theoretical analysis (or qualitative elaborate screening) and empirical analysis (or quantitative elaborate screening), the objective and the method of elaborate screening is to select on financial risk monitoring indicators with more sufficient theoretical basis and empirical evidence supporting, which is based on the results of preliminary screening.

We use expert opinion method, documental analysis, empirical analysis for qualitative screening and quantitative screening, analysis results are as follows. The short-term loan amount indicator ($x1$) reflects the change of liquidity risk in the financial system, and its flow has a large effect on the speculative opportunities, thus the indicator should be retained (Ni, 2012). The loan weighted rate indicator ($x2$) is an important parameter in our financial leverage (Zhao, 2008). It can effectively reflect the favorable opportunity of profit and finance in Chinese financial market; therefore we should retain this indicator. The risk of China's financial system can be well monitored, through the observation of the one-year nominal interest rate indicator's change and the one-year deposit rate indicator's change ($x3$), and analyzing the effect of the change. Therefore we retain the indicator (Han, 2006). There is a co integration relationship between one-year lending rate indicator ($x4$) and risk indicators (Li, 2009; Gao, 2010). Li (2009) and Gao (2010) believes that the one-year lending rate indicator's change can directly have a influence on the change of the financial system risk, function and efficiency of the financial market, so I would retain the indicator.

The short-term interest rates indicator's ($x5$) feature and the change of market interest rate are directly related to the risk of the banking system, therefore this indicator should be remained (Dai, 2006). That the indicator would be retained, since that Long-term lending rates indicator ($x6$) reflects the change of the interest rate risk in the financial system (Qin, 2008). Wang (2012) and Paul Liu believe that the RMB loans indicator ($X7$) has effectiveness of time, and it can reflect the dynamics of the banking system and credit scale. It reflects the financial system liquidity risk and policy risk, thus I would retain the indicator. The long-term loans indicator ($x8$) can directly reflect the change of policy financial system risk, and its proportion change makes an impact on the size of bank bankruptcy probability, so as to affect the stability of the banking system, and the stability affects the risk of the financial system, so the indicator can be remained (Zhang, 2011). Considering that Li (2011) has a conclusion that the impact from savings deposit indicator ($x9$) on the risk of the financial system change is indirect, this indicator should be retained. Because this study is monitoring risk of the financial system, the deposit and loan interest rate indicator ($X10$) tend to have an influence on micro financial indicator, thus I would eliminate the indicator. The interbank offered rate indicator ($X11$) is the core of financial market rates, and is also the representation of the entire financial market interest rate (Zhu, 2009). Gu's (2013) empirical analysis result indicates that inter-bank interest rate's fluctuations will affect the risks of banking system, thereby affect China's financial system risk. Accordingly, this indicator should be retained. Considering that the LIBOR Trading volume indicator ($X12$) is a "quantity indicator", it is hard to accurately measure its proportion (Liu, 2012). As a consequence, the indicator need to be excluded. Yang (2009) and Yang (2007) believe that fixed asset investment loans indicator

(x13) is one of the most important credit indicator in the bank system of our country and its change can directly reflect the changes of credit risk, policy risk and interest rate risk in China's financial system, and the development of China's finance and economy. Therefore, I would retain the indicator. The deposit reserve rate (x14) can affect the credit expansion of financial institutions, the slightly changes of deposit reserve rate have a great impact on the monetary aggregates (Zhai, 2013). Therefore, we would retain the indicator. Considering that the credit gap indicator (x15) is lack of continuous official date as reference, we would exclude this indicator. The amount of non-performing loans (x16) and non-performing loan rate (x17) of commercial banks not only reflect the credit risk of the financial system, but also reflect the fluctuation of economic cycle and the changes of risk. But considering that the official data this indicator use is quarterly data and the interval is short, we would eliminate the indicator. Since the foreign exchange (x18) reflects the policy risk and liquidity risk in the financial system, and affect the independence of the central bank monetary policy (Wang, 2014), which affects the risk of the financial system, I would retain the indicator.

Although the external debt balance indicator (X19) is important in theory, it is lack of strong empirical evidence, therefore this indicator is pending. Xue (2009) believes that the stock price indicator (X20) reflects the stock market trends; it is an important indicator of measuring the development of a country's stock market and risk changes. Thus, it is crucial to do statistical monitoring on stock price indicator in the financial system area. we would retain the indicator. The changes of commodity residential indicator (x21) reflect the policy, the economic status of people, and the risk changes in the economic system, but the impact on the financial system risk change is indirect (Li, 2011). Therefore this indicator should be eliminated. Considering that it is lack of commercial business premises indicator (x22) and financial risk significantly influence empirical analysis of evidence, and considering that the impact on the financial system risk change is indirect, thus the indicator should be eliminated (Li, 2013). Social financing scale indicator (x23) is an important indicator to reflect the risk relationship between financial system and economic system, and it is also the total indicator of the financial support form financial system to entity economy (Yin, 2013). So I would retain the indicator. The business of open market is a very important operation of the central bank, currency withdrawal indicator (x24) and putting currency into circulation indicator (x25) will directly affect the change of interest rate risk (Chen, 2013) , which affects the risk of the banking system and financial system risk changes, therefore retain the indicator. Considering that M2 (broad money) indicator (x26) and M1 (narrow money) indicator (x27) reflect the investment in financial system and the

middle market activity (Chen, 2010) , and monetary aggregates is one of the most important indicator that the central bank consider in policy formulation, the indicator would be retained.

To sum up, through the use of expert opinion method, documental analysis, comparative analysis and empirical analysis of the results for qualitative screening and quantitative screening, there are 19 indicators that are appropriate for financial system risk monitoring. They are x1-x8, x11, x13, x14, x18-x20, x23-x27.

3. STATISTICAL CLUSTERING: FINANCIAL SYSTEM RISK MONITORING INDICATOR VALIDATION

3.1 Case Background

The case period is selected from 2007 to 2009 in China, because during this period the change of the financial system risk trend is typical, and China is suffered from the effect of American financial crisis and the serious imbalance of China's economy in 2008. And there are 19 indicators which were screened in the third chapter.

3.2 Analysis and Verification of Indicator Statistical Clustering

The results from the study can be seen that the minimum of the nonlinear participation coefficient by Ward's method is much smaller, the maximum is much bigger, compared to the nonlinear participation coefficient by between groups linkage method, centroid clustering method, and nearest neighbor method, because within-groups' distance is very narrow, and between-groups' distance is very broad. In other words, compared to other three methods, the result of clustering analysis of Ward's method is more ideal and better in this case. The process and calculation results of iterative clustering of Ward's method by spss16 are shown in Table 1.

Table 1
The Distance Between the Final Cluster Centers

Clustering	1	2	3
1		7.801	3.965
2	7.801		5.408
3	3.965	5.408	

Table 1 shows the center distance of three kinds of clustering, and we can see that the center distance between the first clustering and the second clustering is 7.801, the center distance between the first clustering and the third clustering is 3.965, the center distance between the second clustering and the third clustering is 5.408.

The F Test method was performed on clustering results of these 19 indicators, the results are shown in Table 2.

Table 2
**The Distance Between the Final Cluster Centers**

Indicator	*F*	Sig.	Indicator	*F*	Sig.
x1	33.953	0	x13	4.447	0.02
x2	117.684	0	x14	27.3	0
x3	4.886	0.014	x18	30.12	0
x4	127.37	0	x20	138.7	0
x5	119.326	0	x23	0.02	0.98
x6	125.791	0	x24	10.97	0
x7	60.972	0	x25	2.626	0.087
x8	43.343	0	x26	68.18	0
x9	130.28	0	x27	40.95	0
x11	65.751	0			

The Sig in the last column of Table 2 is the *P* to decide the significance between variables. The criteria for significance is that if *P* is less than 0.05, then the hypothesis should be denied, and there is a significant difference between the 19 variables. In other words, the financial system risk indicator model is effective in the statistical point of view. If *P* is greater than 0.05, the hypothesis should be accepted, and there are indicator variables that have not significant difference from this indicator model in the 19 indicator variables. After excluding these variables, the financial system risk indicator model is effective in the statistical point of view.

As shown in Table 2, except the *P* values of currency withdrawal indicator and social financing scale indicator, other *P* values of indicator variables are less than 0.05. Therefore, I remove the currency withdrawal indicator and the social financing scale indicator, and there is a significant difference between the 17 indicator variables. In addition, the financial system risk indicator model that established on 17 indicator variables which are divided into three clustering is effective in the statistical point of view.

3.3 Validation of Results of Monitoring Indicators in Line With the Actual Situation

In order to survey the financial system risk dynamic change in China distinctly, I introduce and design the financial system risk monitoring spectrum diagram. The diagram is Figure 1.
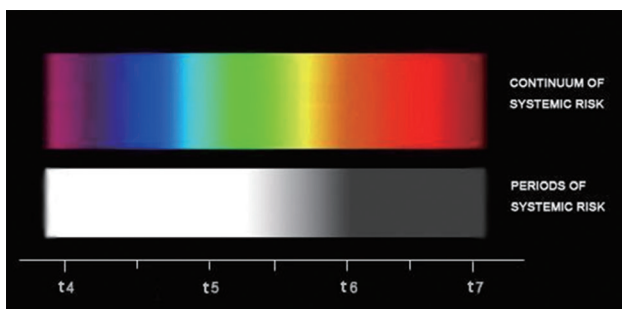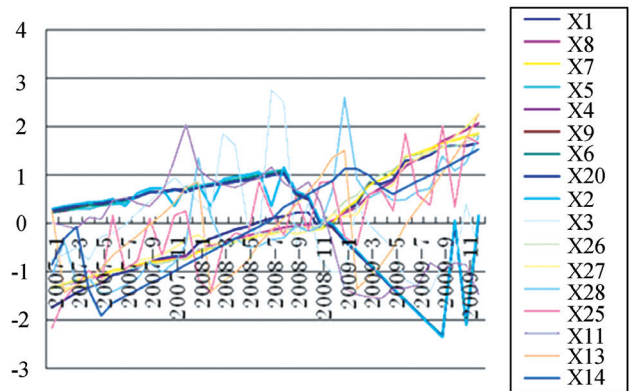

Figure 1
The Spectrogram Monitoring Model of Financial System Risk

In Figure 1, the analysis for financial system risk change and the characteristics of each stage are as follow: During the white period, financial assets' foam is continuous accumulated, and it is the financial rise period of the financial cycle. Besides, the previous and the next month of the grey period month are opposite in financial foam change trend. In other words, it is the financial inflection period between rise and release period. During black period, financial foam state is in release. Namely, it is financial release period.

In Figure 1, the cycle of financial system risk change could also be presented in colorful chart, in order to reflect the change of risk. Additionally, this chart can express more detail. Green represents that the financial system risk is in normal level, same as white period. Red represents that the financial system risk is in danger level, same as grey period. Purple represents that the financial system risk is in release period, same as black period.

We selected January 2007 to December 2009 as the case analysis period. Observing the actual situation of China in this period, I got an intuitive indicator change chart in Figure 2. We can see that it is hard to survey the trend of financial risk change by single indicator, but the financial system risk monitoring spectrum diagram has this ability.

Figure 2
The Trend of the 17 Indicator Variables in the Period of 2008 Financial Crisis Impact in China (2007-2009)

After observing the actual situation from January 2007 to December 2009 in China and contrasting the actual situation with the monitoring result in that period, we can see that they are identical. During the typical period of China's financial crisis, the result of monitoring model showed the actual situation of the financial system risk in China. In other words, the financial system risk monitoring model that established on these 17 indicator variables can reflects the change of financial system risk in China effectively and promptly.

We use the above-mentioned cases as the original data, and firstly, I clustering analyzed these financial system risk monitoring indicators.

As shown in Figure 3, when clustered into 3 classes,

35th, 33rd, 32nd, 31st, 30th is classified as a class, 36th, 34th, 29th, 28th, 27th, 26th, 25th, 24th, 23rd is classified as a class, the other months are classified as a category.
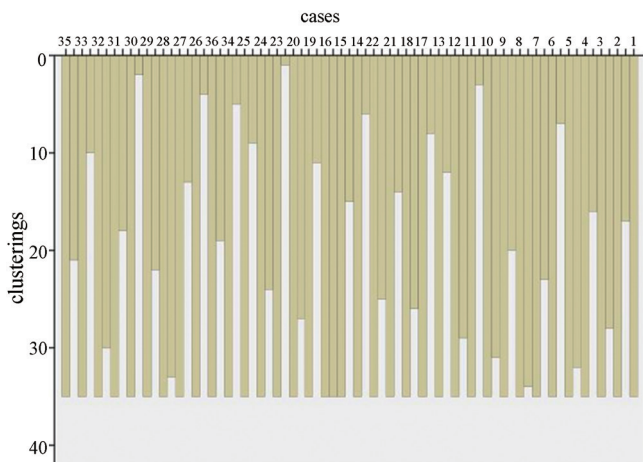
Figure 3
Ward's Method Icicle

The clustering target is dividing these 36 months into 3 groups: white period, grey period and black period. Using the result of clustering and the method of designing financial system risk monitoring spectrum diagram, I drew the financial system risk monitoring spectrum diagram of this period in Figure 4. The result of cluster analysis shows that there are 5 months in the grey period, 23 months in the black period and 8 months in the white period. White period is as follows: 1st, 2nd, 3rd, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th, 13th, 14th, 15th, 16th, 17th, 18th, 19th, 20th, 21st, 22nd months. Grey period: 23rd, 24th, 25th, 26th, 27th, 28th, 29th, 34th, 36th months. Black period: 30th, 31st, 32nd, 33rd, 35th months.
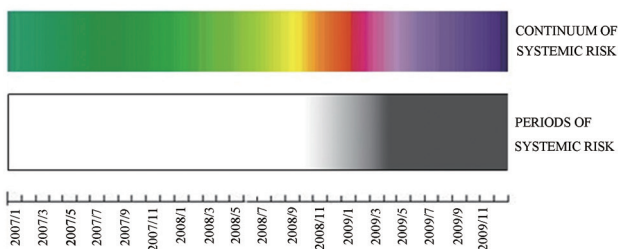
Figure 4
The Spectrogram Monitoring of Financial System Risk of China (200701-200912 Monthly Data)

Comparing Figure 2 with Figure 4, Figure 2 reflects actual dynamic change of financial system risk by miscellaneous financial system risk indicator curves, becomes very complex disorder. Figure 4 reflects actual dynamic change of financial system risk by financial system risk monitoring spectrum diagram, using colorful blocks to represent different risk period, more concise and intuitive. Consequently, using financial system risk monitoring spectrum diagram in Figure 4 for describing financial system risk is more outstanding.

Comparing Figure 4 with actual situation of China, we can see that Figure 4 is consistent with the actual situation. Observing the actual situation of China from January 2007 to December 2009, the financial risk have significant fluctuations in the 2008 financial crisis (October), and the overall economic situation is rising in the first half part, down in the later half part. The Figure 4 can reflect its dynamic change.

CONCLUSION

In conclusion, We got 19 risk indicators, by preliminary screening and elaborate screening in the first step. Then the currency withdrawal indicator and social financing scale indicator are removed through case verification. So the Chinese financial risk monitoring indicator system has 17 financial risk monitoring indicators finally, which are RMB loans indicator, short-term loan amount indicator, long-term loans indicator, loan weighted rate indicator, short-term interest rates indicator, long-term lending rates indicator, savings deposit indicator, stock index indicator, one-year deposit rate indicator, the interbank offered rate indicator, fixed asset investment loans indicator, M2 (broad money) indicator, M1(narrow money) indicator, M0 (cash), foreign exchange indicator, putting currency into circulation indicator, and deposit reserve rate indicator. According to the research in this paper, the financial risk monitoring indicator system is qualified, consistent with the statistical test and in accord with actual situation of China in the empirical test.

It should be pointed out that the financial system risks exist objectively. Although the establishment of financial risk predicting indicator system is very tough, to establish the financial risk monitoring indicator system is feasible. It is fabulous to establish the China financial risk monitoring indicator system, which can give early warning of the financial risk and provide basis for financial risk monitoring decision by government and financial institutions' financial investment risk decisions. By means of the high-frequent dynamic quantized monitoring of the Chinese financial system risk, the ability of quick response for financial system can be significantly improved, and the loss that caused by financial crisis could be substantially reduced.

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