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Construction of Early Risk Alarm Index System for Commercial Banks

Zheng Tian[1] and Zhang Li[2]

[1]Academic Adminstration'Hangzhou Wangxiang Polytechnic，Hangzhou, P.R.China

[2]The Department of Economics and Business，Hangzhou Wangxiang Polytechnic，Hangzhou, P.R.China

ashelyzheng@126.com, lizhang55@hotmail.com

Abstract—Financial Institutions' stability is the fundament of the economy. As one kind of special enterprise, the operation of commercial banks has immediate impact on the national economy and financial stability. Therefore, it is important to establish an effective financial risk monitor system, such as evaluating, early alarming and handling systems which can efficiently prevent risks for commercial banks. In this paper, we propose about 40 indexes to reflect the risks in the macro economy, estate and stock markets, and banks. We also present an individual weight for each index by Analytic Hierarchy Process Theory. Based on these works, a new kind of early risk alarm index system is finally constructed.

Keywords-Bank risks; weight; early risk alarm index system; Analytic Hierarchy Process

1. Introduction

Financial institution is the heart of modern economy, and banks are "the biggest agencies in our economy "[1]. In recent decades, the bank crisis has also contributed to the formation and development of the early risk alarm theories, and a large number of achievements and empirical researches have emerged. Fischer (1998) thought that the financial crisis is the debt- deflation of financial matters, [2] while Mckinnon, Diamond and Dybvig (2000) pointed out that the financial crisis originated from the financial information and the asymmetric between assets and liabilities mainly.[3]

Early risk alarm model of bank crisis can be traced back to the 1930s when some scholars started to empirically analyze the operation conditions of a corporation by using financial ratios. In 1968, Altman and some other scholars created an early risk alarm model using the multiple variables analytical methods. Altman's Z-theory is based on some financial indexes to evaluate the assets, incomes and liquidity of banks.

Since then, a great number of statistical methods were applied to bank crisis early risk alarm, for which many achievements were obtained. Horrigan(1966)and some other people used the regression analysis; David, Robert(1974 and 1975)and Sinkey (1975)made the multiple judgment analysis; Pantalone, Martin and Crest adopt Logit analysis methods.

Some domestic scholars also studied the early risk alarm model. Hongxiu Dong (2008) applied the Fuzzy ART neural network for evaluation of banking credit risks[4]. An evaluation of banking credit risk clustering model based on Fuzzy ART is proposed. Donghong Song (2009), constructed a credit risk recognition model for commercial banks by combining Self-Organized Competition neural network superiority in pattern classification with principal component analysis [5] .

In this paper, after analyzing the macroscopic and microscopic factors which may induce the bank risks, about 40 indexes reflecting the risks in the macroscopic economy, estate and stock market and banks are selected, and the relative weight for each index is set by Analytic Hierarchy Process Theory. Based on the above, an early risk alarm index system is finally constructed.

2. Construction Index System

2.1 Analyzing the factors and selecting monitoring indexes

There are various factors which lead to risks in bank operation process. It is so difficult to monitor the risks overall and effectively that we have to get many comprehensive, multi-level variables to reflect the different risks likely occurred, and monitor the bank's risks through various aspects. Based on the origin and exposure format of risks, at least three levels of indexes need to be selected which include monitoring macroscopic economy, the real estate and stock markets and the bank itself. These indexes should be objective, relevant, and predictable.

1) Macroscopical Economy Indexes: Keeping macroscopical economy balance is the premise on stable operation of financial system. If the balance is broken, it will inevitably lead to financial risks and crisis. The macroscopical economy can be reflected by the overall economy conditions, fiscal and financial conditions, monetary policies, international balance of payments.

a) Overall economic conditions: Gross National Product (GDP) and Consumer Price Index (CPI) could be used to monitor the overall economic conditions.

b) Fiscal conditions: To some extent, fiscal conditions indicate the national ability of adjusting and controlling the economic sources in a range of society. The ratio of fiscal deficit /GDP, fiscal incomes/fiscal payments, and the proportion of treasury bond in GDP will be selected to reflect the national fiscal conditions.

c) Financial conditions: The risk degree depends on the stability of financial conditions，such as the credit conditions, the quality of bank's assets and earnings rates. We now choose serial indexes containing the loan growth rate, the ratio of credit assets in GDP, and the proportion of bad assets to monitor the financial conditions.

d) Monetary Policies: Monetary policies refer to various measures taken by government to control money supply and demand, as well as the interest rate, to achieve the specific purpose. The currency supply amount, M_2 growth rate and the exchange rate of foreign currency could reflect a national's monetary policies.

*e) International Balance of Payments:*International balance of payments mainly reflects the transaction behavior of the goods, services and benefits among a state from the others. We select the ratio of current account deficit/GDP, short-term debt/foreign exchange reserves, foreign exchange reserves/average monthly imports to describe international balance of payments of a country.

2) Intermediate Indexes: Macro-risk monitor indexes are prior in the early risk alarm system, while micro-risk indexes reflect the operation situation of an organization in the microcosmic level. Both are interacted by changing expectation and behavior of the market actors. Therefore, indexes which reflecting the market situations are intermediate ones. We can use the estate vacancy rate, the ratio of treasury bonds/financial expenditure, earnings ratio and market value of stock/GDP to demonstrate.

3) The *Microscopic* level Indexes: The stability of financial institutions is the solid foundation in the entire financial system. Thus, the microscopic level indexes reflecting the operation of microscopic economy are fundamental. We will measure micro risks from capital adequacy, liquid risks, assets quality, benefits, the market risk sensitivity, off-balance sheet business and the management quality.

a) Capital risk: We use capital rate, core capital rate and the ratio of capital/total assets to describe the capital adequacy.

b) Liquidity risk: We choose 4 indexes reflecting the liquidity risks: liquidity ratio, loan deposit ratio, the proportion of liquid assets, and till money/total savings.

c) Asset quality: We consider from loan of first-ten customers rate, loan of shareholders rate, bad assets rate, the ratio of(core capital+ till money)/total bad assets, earning rate of loan, bad debts provision/loan balance, secured and mortgage loan/total loan, to evaluate the assets quality of a bank.

d) Benefits: ROA, ROE and the ratio of (interest income-interest expenditure)/aggregate income and cost-benefit rate could be used to measure the benefit of a bank.

e) Market risk sensitivity: We choose the ratio of (interest-sensitivity assets)/ (interest- sensitivity debts) to show the degree of market risk sensitivity.

f) Off-balance sheet business risk: According to the practice of accounting standards, off-balance sheet business is the transaction engaged by the commercial banks, which is not included in the bank balance sheet. We use the ratio of off-balance sheet deals/total assets to demonstrate.

2.2 Set the relative weight for each index by Analytic Hierarchy Process Theory

1) Analyzing the relationship of the system between the various factors and establishing the indexes of the hierarchy structure.

a) Apex:

A: an early alarm index system of bank risks

b) Sub-objectives:

B_1: macroscopic risk;

B_2: intermediate market risk

B_3: microscopic risk;

c) Factors and indexes:

All factors and indexes were included in tableI.

TABLE I: Factor and Indexes

Factors	Indexes
(C_{11}) Economy conditions	(D_{111}) GDP growth
	(D_{112}) CPI
(C_{12}) Fiscal conditions,	(D_{121}) fiscal deficit /GDP
	(D_{122}) revenue balance
	(D_{123}) treasury bonds/GDP
(C_{13}) Financial conditions,	(D_{131}) loan volume/GDP of last year
	(D_{132}) the proportion of credit assets which were invested in securities and real estates.
	(D_{133}) bad assets rate
(C_{14}) Monetary policies	(D_{141}) money supply growth
	(D_{142})M_2 growth
	(D_{143}) the exchange rate of foreign currency
(C_{15}) International balance of payments	(D_{151}) current account deficit/GDP
	(D_{152}) short-term debt/foreign exchange reserves
	(D_{153}) foreign exchange reserves/ average monthly imports
	(D_{154}) (foreign investment + current account deficit)/GDP
(C_{21}) Real estate situation	(D_{211}) estate vacancy ratio
(C_{22}) Stock situation	(D_{221}) incomes of treasury bonds/ financial expenditure
	(D_{222}) earnings ratio
	(D_{223}) market value of stock/GDP
(C_{31}) Capital risk	(D_{311}) capital ratio
	(D_{312}) core capital ratio
	(D_{313}) capital / total assets
(C_{32}) Liquidity risk	(D_{321}) liquidity ratio
	(D_{322}) loan deposit ratio
	(D_{323}) the proportion of liquid assets
	(D_{324}) till money / total savings
(C_{33}) Asset quality	(D_{331}) loan of first-ten customers ratio
	(D_{332}) loan of shareholders ratio
	(D_{333}) bad assets ratio
	(D_{334})(core capital + till money)/ total bad assets
	(D_{335}) earning rate of loan
	(D_{336}) bad debts provision/loan balance
	(D_{337}) secured and mortgage loan / total loan

(C_{34}) Benefits	(D_{341}) ROA
	(D_{342}) ROE
	(D_{343}) (interest income-interest expenditure)/aggregate income
	(D_{344}) cost-benefit ratio
(C_{35}) Market risk sensitivity	(D_{351}) (interests － sensitivity assets)/ (interests－ sensitivity debts)
(C_{36}) Off-balance sheet business risk	(D_{361}) off-balance sheet deals / total assets
(C_{37}) Management quality.	(D_{371}) the effectiveness of the internal control system,(D_{372}) management and administrative ability of leadership, (D_{373})plan and the ability to adapt to change, (D_{374})the Inspire mechanism, (D_{375}) the staff training.

2) Comparing the same hierarchy of the elements in pairs according to the importance in some criteria, structure the comparative judged Matrix, attached the value from 1--9 of the degree of relative importance.

The meaning of the number 1-9 was as the table2 below.

TABLE 2 THE Meaning Of "1-9"

data	meaning
1	equal importance
3	weak importance
5	essential importance
7	very strong importance
9	absolute importance
2/4/6/8	intermediate values

For example: compared the macroscopic risks (B_1), intermediate market risks (B_2) and microscopic risks (B_3) to the importance of the general risk, experts gave the following judged matrix A：

Judged matrix A:(the general risk)

$$\begin{array}{c} \\ B_1 \\ B_2 \\ B_3 \end{array} \begin{array}{c} \begin{array}{ccc} B_1 & B_2 & B_3 \end{array} \\ \begin{bmatrix} 1 & 3 & 1/5 \\ 1/3 & 1 & 1/5 \\ 5 & 5 & 1 \end{bmatrix} \end{array}$$

3) Calculating the relative weight of the elements and taking coherency tests.

a) *Normalizing the matrix according to* $\mathbf{a_{ij}=a_{ij}/\sum a_{ij}}$

$$A=\begin{bmatrix} 0.158 & 0.333 & 0.143 \\ 0.053 & 0.111 & 0.143 \\ 0.790 & 0.556 & 0.714 \end{bmatrix}$$

b) Standard column average

$$W_1=\sum a_{1j}/3=(0.158+0.333+0.143)/3=0.211$$
$$W_2=\sum a_{2j}/3=(0.053+0.111+0.143)/3=0.102$$
$$W_3=\sum a_{3j}/3=(0.790+0.556+0.714)/3=0.687$$
$$W=[0.211 \quad 0.102 \quad 0.687]^T$$

c) Calculating the Max-Eigenvalu λ_{max} *of the judged matrix A:*

$$AW=\begin{bmatrix} 1 & 3 & 1/5 \\ 1/3 & 1 & 1/5 \\ 5 & 5 & 1 \end{bmatrix} \quad \begin{bmatrix} 0.211 \\ 0.102 \\ 0.687 \end{bmatrix}$$

$(AW)_1=1\times0.211+3\times0.102+1/5\times0.687=0.654$

$(AW)_2=1/3\times0.211+1\times0.102+1/5\times0.687=0.309$

$(AW)_3=5\times0.211+5\times0.102+1\times0.687=2.252$

$\lambda_{max}=1/3\sum(AW)_i / W_i=3.036$

d) Calculating the Consistency Index

$CI=\lambda_{max}-(n/n-1)=3.036-3/3-1=0.018$

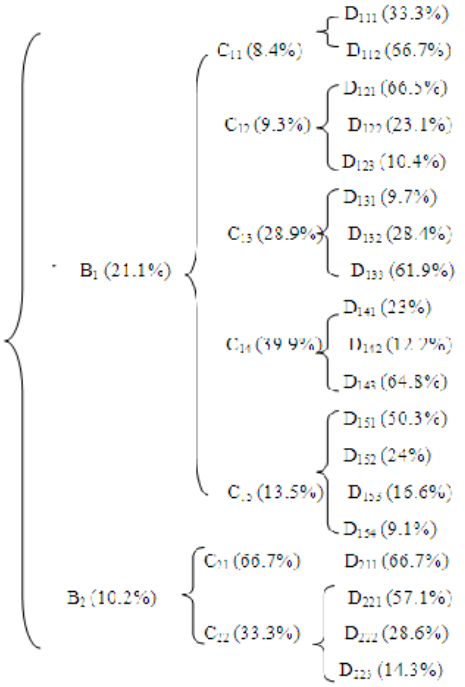
e) Calculating the Consistency Ratio

$CR=CI/RI=0.018/0.58=0.031$

Because $0.031<0.1$, so we can judge it with satisfaction that the judged matrix A were consistent with the inspection requirements. As a result, the weight of individual index B_1, B_2, B_3 was 21.1%, 10.2%, 68.7% respectively. In accordance with this method, we can calculate the weight of all indexes. The results are as the following Figure1.

3. Conclusion and Suggestion

After analysis of macroscopic and microscopic factors which may induce risks of commercial banks, about 40 indexes reflecting the risks in the macroscopic economy, intermediate markets and individual bank are selected, and the relative weight for each index was set by AHP method. Based on these works, an early risk alarm index system was finally constructed. However, most commercial banks won't keep their financial data in public due to the fierce market competition. It is hard to collect enough data for the statistical analysis, so that we choose the indexes by the domestic and foreign data, combine with some present well-rounded indicating systems in our country as well. Thus, it may lead to somewhere subjective. In addition, due to the lack of adequate data, it is impossible to test the effectiveness of the indexes, and they are still needed to be evaluated practically in their accuracy and sensitivity.



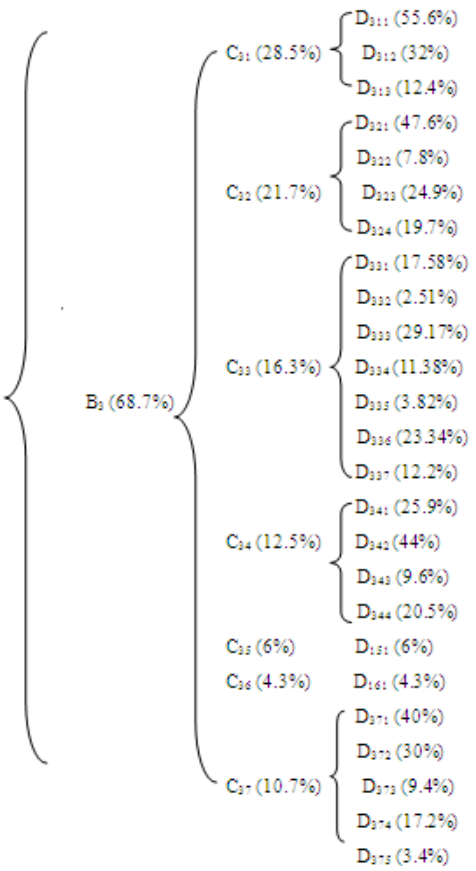


Figure 1. The weight of each index

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