The study of commercial bank credit management based on fuzzy comprehensive evaluation method

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Abstract

Under the background of globalization, along with the continuous reform of financial system in China, foreign banks enter China's financial market, Chinese commercial banks are facing more and more intense competition, accompanied by the rise of the Internet Finance and it's continuous development, the traditional advantage of commercial banks also have been hit, to continue to maintain market share, enhance customer viscosity, must strengthen the risk management of commercial banks, improve bank credit. Commercial banks as an important component of the financial market, many risks facing in the development, credit risk is the main risk form of the commercial banks, because the credit risk is the concentrated reflection of the whole social activities risk, widely always existing in the whole commercial bank business activities, more harm on the commercial bank business activities.In this paper, using fuzzy comprehensive evaluation method for Chinese commercial bank credit management modeling analysis, to study the present situation, and aims at the existing problems to propose the optimized countermeasures.

Keywords

Commercial Bank; credit; fuzzy comprehensive evaluation method.

1. Introduction

As the financial globalization process is accelerating, China's commercial banks not only have to compete with domestic banks, more to meet the international advanced commercial banks in the challenge, therefore financial risk management is the increasingly high demand. And for all kinds of financial risks faced by commercial banks, credit risk is one of the oldest and most important risks, today more and more attention to the prevention of commercial bank credit risk, credit rating has become an important technique to improve the credit risk management ability, the commercial banks of our country started late in the credit rating, is not perfect yet, while facing greater external pressure [1]. Therefore, in the new situation, China's commercial banks must assess and prevent more scientific, effective on their credit risk.

China's commercial banks in credit management process face home and abroad duel pressures, On one hand, China as the member of Basel Committee on Banking Supervision, must abide by the "The new Basel Capital Accord" of commission formal implementation in 2006[2]. The accord proposed minimum capital requirements, external regulation, market discipline "the three pillars", introduced the internal rating method into the measurement of credit risk [3]. And the international financial market participants would use the new accord to analyze China's banking capital status. Therefore, China's commercial banks facing the external pressure have to reconsider their own credit risk management problems. On the other hand, China is affected by the planned economy for decades, banks more reflect policy. In the process of risk management, more emphasis is policy risk, not credit risk. Although China continuously promotes the financial system credit reform, the credit risk management level of commercial banks in China compared with foreign commercial banks is still quite a distance, and China's commercial banks in the credit management have many problems such as starts late, slow progress and single analysis method [4]. Therefore, face to the increasingly fierce competition, China's commercial banks must face up to their own credit risk, build scientific internal

credit rating system to speed up the commercialization process of transformation, to shorten the distance with advanced foreign commercial banks in credit risk management, comprehensively promote China's commercial banks in line with international modern commercial banks.

2. The establishment of the model

2.1 Fuzzy comprehensive evaluation method and the steps

Fuzzy comprehensive evaluation method

Fuzzy comprehensive evaluation method is established by 20 century 60 time American scientist L.A. Zadeh , it is an evaluation model and method designed for a large number of fuzzy economic phenomena, using the structure of level fuzzy subset to quantify fuzzy index to reflect the rated objects, and then use fuzzy transform principle for classification and comprehensive evaluation of the evaluation results.

The steps of evaluation

1. Determine the evaluation object factor set. The factor set is composed of a number of evaluation indicators, including all the evaluation indexes of each layer. Each element U_i(i=1, 2, 3, …, p) represents each evaluation index of level one, while U_i is generally the set consists of some level two index, that is: $U_{ij}=\{X_{i1},X_{i2},X_{i3},\ldots,X_{ij}\}$, where j is the number of X_i corresponding to the level two index（i=1, 2, 3, …, p；j=1, 2, 3, …, m）.

2. Determine the evaluation object comment set. Comment set is the evaluation result set (or evaluation grade) for all kinds of evaluation objects may belong, is the grades of the evaluation projects. Usually we use V like $V=\{V_1,V_2, V_3, \ldots Vn\}$ represents. The model we set n=4, and the V_1, V_2, V_3, V_4 are defined as excellent, good, medium, poor, four grades.

3. The establishment of the fuzzy relation matrix R

After the build of level fuzzy subset, the rated things were quantified from each factor $u_i\left(i=1,2,\cdots\cdots,p\right)$ one by one, determine from the view of single factor that rated thing membership degree $\left(R\,|\,u_i\right)$ to the grade fuzzy subset, then obtains the fuzzy relation matrix:

$$R=\begin{bmatrix} R\,|\,u_1 \\ R\,|\,u_2 \\ \cdots \\ R\,|\,u_p \end{bmatrix}=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{p1} & r_{p2} & \cdots & r_{pm} \end{bmatrix}_{p.m}$$

The line i column j element r_{ij} in matrix R , represent the membership degree of some rated thing from the view of factor u_i to v_j grade fuzzy subset.

4. Determine the weight vector of evaluation factors

Determine the weight vector of evaluation factors: $A=\left(a_1,a_2,\cdots\cdots,a_p\right)$. This article uses the analytic hierarchy process, and then normalized to determine the weight coefficient.

5. Synthesis fuzzy comprehensive evaluation result vector.

By using appropriate operator to synthesis A and the rated thing R, get the fuzzy comprehensive evaluation result vector B of each rated thing. That is:

$$A\circ R=\left(a_1,a_2,\cdots\cdots,a_p\right)\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{p1} & r_{p2} & \cdots & r_{pm} \end{bmatrix}=\left(b_1,b_2,\cdots\cdots,b_m\right)=B$$

b_1 is created by computing operation from A and j column of R ,it represents the membership degree to the grade fuzzy subset v_j from the whole view of rated things .

2.2 Use analytic hierarchy process to determine the weight

Analytic hierarchy process

AHP is proposed by twentieth Century 70's American Pittsburgh university professor T.L.Saaty (1926 —) . This method simulates human decision thinking process with comprehensive characteristic of qualitative analysis and quantitative, especially suitable for complicated structure and missing data multiple factors social system.

The steps of analytic hierarchy process

1. Determine the objectives and evaluation factors. P is the amount of factors, $u=\{u_1,u_2,\cdots\cdots,u_p\}$.

2. Constructing judgment matrix. Judgment matrix element values generally use 1 - 9 and the reciprocal scaling method. When the importance of mutual comparison of the factors can use practical significance ratio to illustrate, corresponding judgment matrix element values while taking this ratio. It is the obtained judgment matrix $S=(u_{ij})_{p\times p}$.

3. Calculation of judgment matrix. Use software Mathematica to calculate and judge the greatest characteristic root $\lambda_{\max}$ of matrix S , and the corresponding eigenvector A is the distribution of weight coefficient.

4. Consistency test. By calculating the consistency index $CI=\frac{\lambda_{\max}-n}{n-1}$ to check the consistency of the judgment matrix, when the random consistency ratio $CR=\frac{CI}{RI}<0.10$ (RI : average random consistency index), the level analysis sequencing results have satisfy consistency, that means the coefficient distribution is reasonable. Otherwise adjust the element values of judgment matrix, redistribute weight coefficient value.

Table 1 Commercial bank credit management index system table

Target	Category	Evaluation index
Commercial bank credit management	Asset credit	Overdue loan ratio
		Single loan ratio
		Single group client credit concentration ratio
		Non-performing asset ratio
		Bad loan ratio
	Debt Credit	All correlation
		Cash reserve ratio
		Liquidity ratio
		Deposit fund ratio
		Lending fund ratio
	Intermediate business credit	Intermediate business income ratio
		Bank advance ratio

3. The solution of commercial bank credit management model based on fuzzy comprehensive evaluation

The construction of commercial bank credit management index system, not only must accurately reflect the internal of commercial bank credit management level but also reflect the whole process of credit management to ensure operability, comparability and continuity [5].

3.1 Commercial bank credit management index system and sampling data

Commercial bank credit management refers to all the credit business of commercial banks to concentrate, to conduct an overall comprehensive and multiple, system management, so as to achieve the safety liquidity and profitability management target.

According to the functions of commercial bank credit business, commercial bank credit management can be divided into asset credit management, debt credit management and intermediate business credit management those three subsystems [6].

Each index with explanation is as follows:

The asset credit management refers to commercial bank uses its centralized currency capital, loans and investments and other asset businesses to take the necessary measures to guard against and defuse the risks, to ensure the safety and benefits of bank assets [7] .

1. Overdue loan ratio: The ratio of overdue loan final balance to the end all kinds of loan balance, that is:

$$\text{Overdue loan ratio} = \frac{\text{Overdue loan final balance}}{\text{All kinds of loan balance}} \times 100\%$$

2. Single loan ratio: The ratio of the total loans for the same loan customer to total bank capital, that is:

$$\text{Single loan ratio} = \frac{\text{Total loans for the same loan customer}}{\text{Total bank capital}} \times 100\%$$

3. Single group client credit concentration ratio：The ratio of largest group client credit total to bank net capital, that is:

$$\text{Single group client credit concentration ratio} = \frac{\text{Total for the same loan client lending}}{\text{Bank net capital}} \times 100\%$$

Among them: The largest group client credit total refers to the credit total of the highest credit total amount of a group client at the reporting final.

4. Non-performing asset ratio: The ratio of bad credit risk assets to credit risk assets total, that is:

$$\text{Non-performing asset ratio} = \frac{\text{Bad credit risk assets}}{\text{Credit risk assets total}} \times 100\%$$

Among them: Credit risk assets refer to those in bank asset balance sheet and those assets bear credit risks which off the sheet. Mainly include: loans, inter-bank deposits, inter-bank offers and buying back the sale of assets, the bond investment of bank accounts, interest receivable, other receivables, commitment and contingent liabilities.

Bad credit risk assets refer to the credit risk assets classified as non-performing assets category part.

5. Bad loan ratio: The ratio of bad loans to all kinds of loans final balance, that is:

$$\text{Bad loan ratio: } = \frac{\text{Subprime loans} + \text{Doubtful loans} + \text{loss class loans}}{} \times 100\%$$

$$\text{All kinds of loans balance}$$

Among them: the normal kind of loan is defined as the borrowers will be able to fulfill the contract, there is no sufficient reason to doubt the principal and interest of loans cannot be repaid on time and in full. Special mention loan is defined as though borrowers now have the ability to repay the loan principal and interest, but some may have adverse effect factors on repayment. Subprime loan is defined as obvious problems for the borrower's repayment ability, relying on its normal business revenues is not able to repay the loan in full, even if with collateral may also cause some loss. Doubtful loan is defined as borrowers cannot repay the loan in full, even if with collateral, certainly will cause a greater loss. Loss class loan is defined as after taking all possible measures and all the necessary legal procedures, still unable to recover the principal and interest, or only a small portion can be recovered. To classify the loans, the followed three kinds of loans all together is bad loan [9].

The loans refer to the banking industry financial institution assets formed by borrower's monetary funds. Include loans, trade financing, bill financing, lease financing, from non financial institutions buying back the sale of assets, overdraft, the advances etc.

6. All correlation: The ratio of all related parties credit total to the bank net capital, that is:

$$\text{All correlation} = \frac{\text{All related parties credit total}}{\text{Bank net capital}} \times 100\%$$

Among them: The all related parties credit total refers to all commercial banks related parties credit balance, deduct margin deposits and pledged bank certificates of deposit and treasury amount provided by the related credit parties when granting credit.

Debt credit management refers to commercial banks rely on bank credit, to carry out debt business (such as deposits, interbank, borrowing from the central bank etc.), raise funds and debt credit business ,to meet the needs of the development of commercial banks and the demand for liquidity, liquidity risk prevention and control[10].

Cash reserve ratio: The ratio of cash reserve of people's bank and deposit cash to all kinds of deposits, that is:

$$\text{Cash reserve ratio} = \frac{\text{(Cash reserve of people's bank + Deposit cash) Average daily balance}}{\text{Average daily balance of all kinds of deposits}} \times 100\%$$

2. Liquidity ratio: The ratio of liquidity assets to liquidity liabilities, that is:

$$\text{Liquidity ratio} = \frac{\text{Liquidity assets}}{\text{Liquidity liabilities}} \times 100\%$$

Among them: The liquidity assets include: cash, gold, excess reserve deposits, the asset side net after one month maturity interbank payments netting, one month maturity interest receivable and other receivables, one month maturity eligible loan, one month maturity bond investment, in China secondary market can be readily realizable bond investment, the other one month maturity realizable assets (excluding the bad assets) [11].

Liquidity liabilities include: Demand deposit (without fiscal deposits), one month maturity demand deposit (without fiscal deposits), the liability net after one month maturity interbank payments netting, one month maturity issued bonds, one month maturity interest payable and other payments, one month maturity central bank borrowings, other one month maturity liabilities.

3. Deposit fund ratio: The ratio of the deposit fund balance to all kinds of deposits balance, that is:

$$\text{Deposit fund ratio} = \frac{\text{Deposit fund balance}}{\text{All kinds of deposits balance}} \times 100\%$$

Lending fund ratio: The ratio of the lending fund balance to all kinds of deposits balance, that is:

$$\text{Lending fund ratio} = \frac{\text{Lending fund final balance}}{\text{All kinds of deposits final balance}} \times 100\%$$

The intermediate business credit management is generated based on bank assets and debt credit business, refers to the commercial banks do not use their own capital, relying business, technology, mechanism, reputation and talent advantage, in the identity of middlemen deputize for client undertake payments and other entrusted matters, provide a variety of financial services and collect the fees, establish effective risk control mechanism in the business operators to increase the income of banks[12].

1. Intermediate business income ratio: The ratio of intermediate business income to total bank income, that is:

$$\text{Intermediate business income ratio:} = \frac{\text{Total intermediate business income}}{\text{Total bank income}} \times 100\%$$

2. Bank advance ratio: The ratio of bank advances to the total amount of bank external business guarantee, that is:

$$\text{Bank advance ratio:} = \frac{\text{Total bank advances}}{\text{Total amount of bank external business guarantee}} \times 100\%$$

The three credit managements are not independent but mutual restriction and interaction. Debt credit provides stable supply of funds for asset credit expansion, asset credit via bank creating function, expanded its debt credit growth scale. The asset credit expansion and risk require timely capital replenish, the intermediate business profitability is directly related to the capital gains rate, so that made up an organic and inseparable bank credit system management.

3.2 The establishment of credit management index weight

This paper takes the credit management of China Construction Bank Henan Province branch as an example, takes China Construction Bank Henan Province branch employees, to public clients and to private clients as the investigation objects, designed questionnaire by using commercial bank credit management relevant evaluation indexes, The management evaluation index system for questionnaire design consists of 4 first level indexes and 12 secondary level indexes. The questionnaires use a self-administered questionnaire to collect data, questionnaires were granted to the investigation people randomly by using stratified sampling method, let them independently complete the questionnaires and review the validity of each questionnaire. Questionnaires were sent to 500, returned 485, the rate is 97%, valid questionnaires 470, the validity rate is 94%.

In this paper, the comprehensive evaluation of bank credit management is divided into 4 measurement grades: excellent, good, medium and poor. In order to facilitate the calculation, quantify subjective evaluation semantic scale and value in turn 4, 3, 2 and 1. Subjective measurement is to use four grades semantics scaling. The designed quantitative evaluation standard is shown as table 2.

Table 2 Quantitative evaluation of grading standards

Evaluation values	Comments	Grading
$x_i > 3.5$	excellent	$E1$
$2.5 < x_i \le 3.5$	good	$E2$
$1.5 < x_i \le 2.5$	medium	$E3$
$x_i \le 1.5$	poor	$E4$

Through collecting and statistical sampling survey data, totally identified the specific weights of 4 first level indexes and 12 secondary level indexes, specific data as follows:

First level indexes		Secondary level indexes	
Title	Weight	Title	Weight
Asset credit (A)	0.653	Overdue loan ratio	0.172
		Single loan ratio	0.158
		Single group client credit concentration ratio	0.157
		Non-performing asset ratio	0.175
		Bad loan ratio	0.176
Debt Credit (B)	0.251	All correlation	0.162
		Cash reserve ratio	0.308
		Liquidity ratio	0.292
		Deposit fund ratio	0.218
		Lending fund ratio	0.182
Intermediate business credit (C)	0.096	Intermediate business income ratio	0.457
		Bank advance ratio	0.543

3.3 The index weight solution AHP steps

1. Determine the evaluation object set. P = Commercial bank credit management system.

2. Create evaluation factor set. $u=\{u_1,u_2,\cdots\cdots,u_6\}$ = { Asset credit, Debt credit, Intermediate business credit }.

3. Determine reviews level domain. V={V_1,V_2, V_3, …Vn}= { Excellent, Good, Medium, Poor}.

4. First level index weight calculation. Use analytic hierarchy process method to work out the weight of 3 first level index weight. Constructing judgment matrix $S=(u_{ij})_{p\times p}$ that is:

$$S=\begin{bmatrix} 1 & 3 & 6 \\ 1/3 & 1 & 3 \\ 1/6 & 1/3 & 1 \end{bmatrix}$$

Use software Mathematica to calculate and get the greatest characteristic root of matrix S : λ max=3.018347. For the consistency test of the judgment matrix, need to calculate consistency index:

$$CI=\frac{\lambda_{\max}-n}{n-1}=\frac{3.018347-3}{3-1}=0.0091735$$

The average random consistency index $RI=1.24$,then:

$$CR=\frac{CI}{RI}=\frac{0.0091735}{0.52}=0.01764135<0.10$$

Therefore, the distribution of weight coefficient is reasonable.

The corresponding feature vector is:

$$A=(0.652991 \quad 0.250997 \quad 0.096011)$$

Secondary level index weight calculation. Again, use analytic hierarchy process method to work out the index weight, and construct the judgment matrix of each secondary level index, then use software Mathematica calculate the greatest characteristic root , do the consistency test. Get reasonable weight coefficient.

Asset credit management index weight: (0.172, 0.158, 0.157, 0.175, 0.176, 0.162)

Debt credit management index weight: (0.308, 0.292, 0.218, 0.182)

Intermediate business credit management index weight: (0.457, 0.543)

3.4 The multilevel fuzzy comprehensive evaluation of commercial bank credit management

Multilevel fuzzy comprehensive evaluation result vector

The credit management statistical data of China Construction Bank Henan Province branch sampling survey is substituted in the established model, calculate the fuzzy comprehensive evaluation vectors of all levels.

1. Asset credit management evaluation vector

$$A=\begin{bmatrix} 0.3 & 0.4 & 0.2 & 0.1 \\ 0.2 & 0.3 & 0.3 & 0.2 \\ 0.1 & 0.3 & 0.4 & 0.2 \\ 0.4 & 0.3 & 0.2 & 0.1 \\ 0.1 & 0.4 & 0.3 & 0.2 \\ 0.2 & 0.1 & 0.5 & 0.2 \end{bmatrix}$$

Normalized it, that is : $(0.255 \quad 0.257 \quad 0.257 \quad 0.231)$

2. Debt credit management evaluation vector

$$B=\begin{bmatrix} 0.3 & 0.4 & 0.2 & 0.1 \\ 0.3 & 0.2 & 0.3 & 0.2 \\ 0.2 & 0.2 & 0.3 & 0.3 \\ 0.1 & 0.3 & 0.2 & 0.4 \end{bmatrix}$$

Normalized it, that is : $(0.268 \quad 0.275 \quad 0.261 \quad 0.195)$

3. Intermediate business credit management evaluation vector

$$C=\begin{bmatrix} 0.2 & 0.3 & 0.3 & 0.2 \\ 0.4 & 0.3 & 0.3 & 0 \end{bmatrix}$$

Normalized it, that is : $(0.333 \quad 0.250 \quad 0.250 \quad 0.167)$

4. The overall evaluation vector

$$D=\begin{bmatrix} 0.255 & 0.257 & 0.257 & 0.231 \\ 0.268 & 0.275 & 0.261 & 0.195 \\ 0.333 & 0.250 & 0.250 & 0.167 \end{bmatrix}$$

Normalized it, that is : $(0.248 \quad 0.248 \quad 0.289 \quad 0.215)$

4. The comprehensive score rating

V_A =4*0.255+3*0.257+2*0.257+0.231=2.536

V_B =4*0.268+3*0.275+2*0.261+0.195=2.614

V_C =4*0.333+3*0.250+2*0.250+0.167=2.749

Comprehensive evaluation scores overall:

V=4*0.248+3*0.248+2*0.289+0.215=2.529

Illustrated China Construction Bank Henan Province branch credit management overall quality as "good", which belongs to $E2$ level.

4. Conclusion

Risk management is a key problem in commercial bank management and sustainable development, credit risk is one of the main risks of commercial banks [13]. Commercial banks in the credit management should constantly improve the credit management model construction, continue to absorb the advanced evaluation ways and methods of domestic and foreign bank credit management, improve the accuracy of credit risk prediction and evaluation, continue to promote the quality of bank loans enhance, take active measures to reduce Non-performing assets, improve the intermediate business credit management system, to promote the healthy, sustained, intermediate business credit good development.

In addition to the improvement of credit analysis method and technology, the establishment of credit risk evaluation model and the study of improving bank credit management system, we should enhance the construction of credit culture, change the traditional way of thinking, break the influence of old business philosophy[14], educate high quality risk management talents, enhance bank credit management team, increasing the external supervision, improve the effectiveness and pertinence of external supervision, improve the level of bank credit risk management, enhance banking information disclosure, improve the transparency and effectiveness of commercial bank information disclosure, guide the market to enhance the analysis of bank information, improve the market constraint force, to improve commercial bank credit risk management level in China[15].

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