An AHP-fuzzy Approach for Evaluating the Commercial Bank Credits

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Abstract—**Microfinance in China has entered the phase of rapid development and it has become one of the most important businesses in commercial banks. According to the principals of low carbon economy and the characteristics of farmer microfinance of Chinese commercial bank, this paper designed the performance evaluation system and evaluated the performance of small and micro businesses microfinance. In combination with the AHP and fuzzy comprehensive evaluation method, this paper analyzed the performance of microfinance of Harbin Bank and got a better evaluation results.**

Keywords-microfinance; performance evaluation; AHP; fuzzy

I. INTRODUCTION

After the commercialization of Chinese microfinance in 2005, microfinance entered a high-speed development stage. The large-scale commercial banks tend to offer loans to large enterprises who have good credit and complete accounting records and they are not willing to offer loans to small and micro businesses who have incomplete accounting records and poor credit. Although the amount small and micro businesses need is small, the number of these businesses is very large and the market prospect is enormous. Now, Microfinance is regarded as an opportunity to expand by small and medium-sized banks.

Many performance evaluation systems can be used to evaluate banks' performance, such as "CAMEL" rating system, the standard & poor's bank rating system, EVA and BSC. Gao Li, Fan Weidong [1] designed a performance evaluation system based on EVA to evaluate the performance of Chinese banks and found that listed banks were better than non-listed banks. Li Jianjun [2] evaluated the performance of top 85 banks in the world from scale, operating performance, security and development and found that improvement of operating performance, security and development can enhance Chinese banks' competitiveness. Stan, Tom [3] pointed out that BSC can improve financial performance and the performance of BSC is much better than traditional performance model. Yang Xuefeng [4] hold the view that commercial banks should design performance evaluation model based on BSC and KPI should be designed based on strategy from BSC's four dimensions. Liu Lei [5] thought that BSC can help small and medium-size banks break development bottleneck and build a management system which is designed based on bank's individual situation. Zhang Lijing [6] designed a performance evaluation system based on BSC and used it to evaluate the performance of a commercial bank in Hebei province. Prasad, Reddy, Cha [7] used "CAMEL" to evaluate the performance of India's public banks. Wang Zheng, Wang Hao [8] pointed out that although BSC introduced non-financial indicators, these indicators did not reflect the shareholder value maximization. Therefore EVA should be used in BSC to compensate for its insufficiency.

This paper establishes a four dimension performance evaluation system for microfinance of commercial bank, and Fuzzy mathematics and AHP are used in the empirical analysis of performance of commercial bank microfinance to get a better evaluation results.

II. PERFORMANCE EVALUATION SYSTEM FOR MICROFINANCE

This paper evaluates the performance of microfinance of commercial bank from four dimensions which are finance, customers, internal process, learning and growth. "Table 1" is the performance evaluation system.

III. COMPREHENSIVE EVALUATION MODEL BASED ON THE COMBINATION OF FUZZY MATHEMATICS AND AHP

A. AHP is used to determine the indicator weight

To determine indicator weight, we issue questionnaires to experts. Experts establish the judgment matrix by comparing every level's indicator. After that, we calculate the indicator weight according to the theory of AHP.

We use comparison rating scale method to establish the judgment matrix. This method uses the ratio of the degree of importance of two factors to show the relative materiality (expressed by number of 1–9).

The score which a factor responses in the feature vector is the single ranking value of the importance to the upper level. To conduct the consistency check of the single ranking, the consistency indicator CI need to be calculated. In this formula, n is the number of matrix dimensions, λ_{max} is the maximum characteristic root. If the random consistency CR<0.10, it means that the result of the level single ranking meets the consistency. If not, the judgment matrix should be adjusted.

TABLE I. PERFORMANCE EVALUATION MODEL.

First Class Indicator	Second Class Indicator	Third Class Indicator
Finance	Security	RAROC x_1
		The impairment loss x_2
		Asset quality x_3
		Non-performing loan ratio x_4
	Development	Profit growth rate x_5
		EVA x_6
		Percentage of revenue in total revenue x_7
		Importance of microfinance x_8
		Growth rate of loan x_9
		Loan concentration x_{10}
	Profitability	Return on total assets of microfinance x_{11}
		Return on equity of microfinance x_{12}
		Net interest rate x_{13}
		Net profit rate x_{14}
	Efficiency	Before tax profit per person x_{15}
		Cost to revenue x_{16}
		Net profit to cost x_{17}
		Amount of lending per person x_{18}
		Amount of lending per Sub-branch x_{19}
Customer	Satisfaction	Growth rate of customers x_{20}
		Percentage of the regular customers x_{21}
		Retention rate x_{22}
	Coverage	Share of the stock market x_{23}
		Share of the new market x_{24}
		Business success rate x_{25}
	Improvement	Customer income growth rate x_{26}
		Customer accession rate x_{27}
Internal process		Percentage of professionals x_{28}
		Growth rate of professionals x_{29}
		Customers to staff x_{30}
		Approval time x_{31}
		Efficiency of process improvement x_{32}
		Corrective rate x_{33}
Learning and growth		Training investment rate x_{34}
		Average training hour x_{35}
		Knowledge level of staff x_{36}
		Staff turnover rate x_{37}
		Staff induction rate x_{38}
		Quantity of service innovation x_{39}
		Products utilization rate x_{40}

The ranking value of the relative importance of all factors to the top level is called the top level ranking. To calculate it, the calculation should be conducted level by level. For example, if the upper level has m factors which are b_1, b_2, …, b_m, weights are w_1, w_2, …, w_m, and the lower level has n factors and their single ranking weights to b_j are c_{1j}, c_{2j}, …, c_{nj}, the importance to the upper level can be calculated by weighting.

B. Fuzzy comprehensive evaluation model

Fuzzy comprehensive evaluation model combines the AHP and fuzzy calculation. It uses AHP to determine the weight of each dimension and indicator of the performance evaluation system of microfinance, and the fuzzy calculation to determine the degree of membership, and at last, evaluates the performance of microfinance of commercial bank.

Step 1: Establish the comment set

We assume that $U = \{u_1, u_2, u_3, …, u_n\}$ is the set of n elements of describing the evaluated object (indicators).

$G = \{g_1, g_2, g_3, …, g_m\}$ is the set of m judgments of describing the status of each element.

Comment set G is the set of possible results that given by the appraiser. G_j is evaluation result, m is the number of total possible evaluation results. Usually the comment set is divided into 3 to 5 levels.

Step 2: Determine the degree of membership

First level fuzzy comprehensive evaluation is to evaluate indicators of one dimension.

Step 3: First level fuzzy comprehensive evaluation

The comment set of the first level fuzzy comprehensive evaluation of dimension is:

$$g_i = w_i \times f_i \qquad (1)$$

At the same time, the comment sets of the first level fuzzy comprehensive evaluation of other dimensions should be calculated.

Step 4: Second level fuzzy comprehensive evaluation

Second level fuzzy comprehensive evaluation is calculated based on the results of first level fuzzy comprehensive evaluation results. We can use following equation to get the result. According to the maximum membership principle, the evaluation result which has the maximum numerical value is the final evaluation result of the company.

$$G = w(g_1, g_2, ……, g_n)^T \qquad (2)$$

IV. EMPIRICAL RESULTS OF THE PERFORMANCE EVALUATION

We use the AHP to calculate the weight of indicators of the performance evaluation system of farmer microfinance. We use the data from HARBIN Bank as the analytical samples, and evaluate the performance of microfinance.

A. Determine the comment set

We set five evaluation results which are: "excellent," "very good," "good," "general," "poor." The comment set is:

$M = \{m_1, m_2, m_3, m_4, m_5\} = \{$excellent, very good, good, general, poor$\}$

Four dimensions which affect the performance evaluation of microfinance are: "finance," "customer," "internal process," "learning and growth." Therefore, the factor set is:

$V = \{v_1, v_2, v_3, v_4\} = \{$finance, customer, internal process, learning and growth$\}$.

B. Empirical results

When calculating the degree of membership, the actual value of each indicator of the two branches will compare with the standard value which has five levels. We use their relative distance and the membership function to determine the degree of membership. According to the data of Harbin Bank from 2013, the degree of membership of each indicator is in "Table II."

According to the above results, the second level fuzzy comprehensive evaluation is shown in "Table III," and the first level fuzzy comprehensive evaluation is shown in "Table IV."

TABLE II. DEGREE OF HARBIN BANK.

	g1	g2	g3	g4	g5
X_1	0	0.43	0.57	0	0
X_2	0	0.95	0.05	0	0
X_3	0	0	0	0	1
X_4	0	0	0	0.6	0.4
X_5	1	0	0	0	0
X_6	0.464884	0.535116	0	0	0
X_7	0	0	0	1	0
X_8	0	0.715	0.285	0	0
X_9	0	0	0.131	0.869	0
X_{10}	0	0	0.72625	0.27375	0
X_{11}	0	0	0.545	0.455	0
X_{12}	0	0	0	1	0
X_{13}	0	0.52	0.48	0	0
X_{14}	0	0.345	0.655	0	0
X_{15}	0	0.327187	0.672813	0	0
X_{16}	0	0	0	0	1
X_{17}	0	0	0	0.16533	0.83467
X_{18}	0	0.41133	0.58867	0	0
X_{19}	0.099964	0.900036	0	0	0
X_{20}	0	0.214439	0.785561	0	0
X_{21}	0	0	0	0.875451	0.124549
X_{22}	1	0	0	0	0
X_{23}	0.404492	0.595508	0	0	0
X_{24}	0	0.322438	0.677562	0	0
X_{25}	0	0	0.72925	0.27075	0
X_{26}	0.54827	0.45173	0	0	0
X_{27}	0	0	0.561675	0.438325	0
X_{28}	0	0.381099	0.618901	0	0
X_{29}	0	0.414783	0.585217	0	0
X_{30}	0	0.298237	0.701763	0	0
X_{31}	0.875225	0.124775	0	0	0
X_{32}	0	0.485714	0.514286	0	0
X_{33}	0	0	0	0.761905	0.238095
X_{34}	1	0	0	0	0
X_{35}	0	0.624647	0.375353	0	0
X_{36}	0	0	0.225915	0.774085	0

TABLE III. FIRST LEVEL FUZZY COMPREHENSIVE EVALUATION RESULTS.

Dimension	Weight	g_1	g_2	g_3	g_4	g_5
Finance	0.47	0.082	0.276	0.253	0.215	0.171
Customer	0.23	0.140	0.164	0.354	0.304	0.036
Internal process	0.21	0.172	0.201	0.275	0.266	0.083
Learning and growth	0.09	0.087	0.372	0.268	0.241	0

TABLE IV. SECOND LEVEL FUZZY COMPREHENSIVE EVALUATION RESULTS.

	g_1	g_2	g_3	g_4	g_5
Total results	0.1152	0.2433	0.2827	0.2491	0.1068

According to the calculation results, we can get the degree of membership of the second level of fuzzy comprehensive evaluation. In combination with the comment set $M = \{$excellent, very good, good, general, poor$\}$, the possibility of "good."

V. CONCLUSIONS

This paper established the performance evaluation system of microfinance of commercial bank. In combination with the AHP and fuzzy comprehensive evaluation method, we analyzed the performance of microfinance Harbin Bank and got the conclusions. The performance of microfinance in 2013 is "good."

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