

## Judge of Personal Customers of Banks Based on Fuzzy Comprehensive Evaluation

### ファジィ包括評価法による銀行個人顧客の判別

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**Abstract** In this Article, the authors insist on the importance of personal business of banks. Among all the personal customers, only those who have purchasing power are the goal market of banks. To judge whether a customer is a valuable customer or not, the authors bring forward the means based on Fuzzy Comprehensive Evaluation. And two real examples are given. One is to judge of a single personal customer. The other is to compare among many personal customers. Every bank has its own evaluation indexes to the customers according to its own operation policies which are different from any other bank's. Although giving marks to every customer is a very tedious work, the means the authors bring forward is feasible.

#### 1. Introduction

The experiences of the world financial market indicate that the profit which the corporate clients (especially the large-scale corporate clients) can bring becomes small day by day. The banks relying mainly on large-scale company's business generally face surviving crisis. Compared with company's business, the income and profit on the personal business are comparatively steady. And the large-scale production and network function are more remarkable. Only when a bank has sites coverage to a great extent, can it attract personal users effectively and reduce the comprehensive fund cost. The requisition for network has improved the threshold of the personal business and limited the competition on the personal business accordingly.

The personal business makes profits more, increases comparatively fast and relatively steady. So, many banks put back center again to the personal business progressively. The banks all face the transition of profits at present. It means banks pay more attention to business of low risk than high risk (such as the personal housing loan). The service is more partial to individuals.

The personal customers can be subdivided into several

groups according to the age, the standards, income, individual character, educational level, hierarchy of consumption, consumption structure and idea, family's living standard, social class, etc. Different types of personal customer groups have different demands on financial products and services of the commercial banks and different satisfaction to financial services to some extent. And they obtain different interests from the commercial banks.

Among them only the type of customer groups or several types of customer groups who have purchasing power is the market which is suitable for the business development of the commercial banks. We call it goal market. And the goal market should have enough members so that commercial banks can get enough profits.

#### 2. The theory of Fuzzy Comprehensive Evaluation

Because an object has multiple attributes, affected by many kinds of factors, during the process of appraising it, a lot of relevant factors must be considered comprehensively and be evaluated overall. This kind of evaluating way is called Comprehensive Evaluation. And so-called Fuzzy Comprehensive Evaluation is a kind of way of Comprehensive Evaluation mainly utilizing fuzzy conversion and fuzzy relevant nature that distinguishes in fuzzy mathematics to judge synthetically.

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(1) Fuzzy theory summary

What is called "fuzzy" refers to the "indeterminate phenomenon" of the transition among the things differences. The fuzzy set theory is abandoned to traditional ways which divide things into two groups namely "belong to " or " not belong to ". The substitute is "belong to in a certain degree", represented by the index named grade of membership. Grade of membership shows the degree that something belongs to a fuzzy set.

(2) Basic conception of the fuzzy set

The concept of the traditional set is "belong to definitely ", but the fuzzy set is "relatively belong to". The relation changes from the "either A or B" to "also A also B ". The fuzzy theory expands the characteristic function of either 0 or 1 value, to the successive characteristic function  $\mu_A(u)$  whose data is within (0, 1). The extent that u belongs to the discussed region U is  $\mu_A(u)$ , its value within (0, 1) block. We call function  $\mu_A(u)$  membership function. The value of membership function shows the extent that u belongs to U. Thus, the value between "yes" and "no" is expressed.

(3) Membership degree of fuzzy set

The establishment of membership function is totally different according to the problem to be solved. The membership can be obtained by individuals according to subjectivism, or by experts and authorities. And we can get the membership function utilizing the Neural Network or the Genetic Algorithm. When the number of the sample is too large, through examining actually, utilizing the information feedback method, revising constantly, we can get the membership function reach a relatively stable state during the course of a kind of machine study.

The membership degree of a fuzzy set is decided by the standards that the essential attributes of objective things are reflected in the human brain. Some are subjective factors. Some are weighted averages. Some are the theoretical generalization and comprehensive evaluation. Some are the practical experience or the judge of the authority.

(4) Fuzzy Comprehensive Evaluation

The step of Fuzzy Comprehensive Evaluation is as follows:

- ① Set up evaluation indexes U

$$U = \{u_1, u_2, \dots, u_n\}$$

- ② Confirm evaluation results V

$V = \{v_1, v_2, v_3, \dots, v_m\}$ , for example,  $V = \{\text{better, good, ordinary, bad, worse}\}$ .

- ③ Confirm single factor fuzzy evaluation matrix R

$$R = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1m} \\ r_{21} & r_{22} & \dots & r_{2m} \\ \dots & \dots & \dots & \dots \\ r_{n1} & r_{n2} & \dots & r_{nm} \end{bmatrix}$$

$r_{ij}$  shows the membership degree that the object evaluated belongs to  $v_j$  in the index of  $u_i$ .

- ④ Confirm the evaluation weight A

That is to assign the weight according to the importance of every factor in the evaluation indexes.

Set evaluation weight value  $A = \{a_1, a_2, \dots, a_n\}$ , Express the importance of  $u_1, u_2, \dots, u_n$  in the evaluation indexes U.

- ⑤ Fuzzy Comprehensive Evaluation

Fuzzy comprehensive Evaluation is made according to the fuzzy mathematics model :

$$B = A \circ R = \{b_1, b_2, b_3, \dots, b_m\}, \circ \text{ is Zadeh operator.}$$

- ⑥ the principle of the most membership degree

Among  $b_1$  to  $b_m$ , if the most is  $b_r$ , then the final evaluation is  $v_r$ .

3. Real example

(1) Judge of a single personal customer

While a bank investigates the personal customers, the evaluation indexes to the personal customers is collected as  $U = \{\text{assets, credit history, loyal degree, unpredictable factor}\}$ . The value of the evaluation weight A is  $\{0.5, 0.3, 0.1, 0.1\}$ . The value of the weight has reflected the management theory of initiative marketing of the bank. So long as a customer has enough wealth and good credit history and loyal quality, the bank will try the best to train him to be a valuable customer.

The evaluation results V of the personal customers of the bank is  $\{\text{Very good, OK, general, relatively bad, very bad}\}$ .

There is a personal customer named X. He is appraised by the experts group including the personnel

from the sale department, the management department and the financial department of the bank and other credit evaluation organizations. The experts group gives marks

to X, thus the single factor fuzzy evaluation matrix R of X customer is confirmed as Table T1:

**Table T1 the single factor fuzzy evaluation matrix R of customer X**

Evaluation ndxes (weight)	Very good	OK	general	relatively bad	worse
assets 0.5	0.4	0.7	0.5	0.2	0.1
credit history 0.3	0.2	0.5	0.6	0.4	0.2
loyal degree 0.1	0.7	0.6	0.3	0.2	0.1
unpredictable factor 0.1	0.2	0.3	0.4	0.6	0.4

The final Evaluation is:  $B = A_0R = \{0.4, 0.5, 0.5, 0.3, 0.2\}$ . Through the normalization, we can get  $B = \{0.21, 0.26, 0.26, 0.16, 0.11\}$ . According to the principle of the most membership degree, the evaluation of customer X is OK.

**(2) Comparison among many personal customers**

We will compare the values of three customers x, y, z to the bank.

Regard the three customers as the evaluation results  $V = \{x, y, z\}$ . The values of customers' is divided into five grades: The first grade with value in (0.9,1) is the most valuable ;the second grade with value in (0.8, 0.9) is more valuable; the third grade with value in (0.7, 0.8) has an ordinary value; the fourth grade with value in (0.6, 0.7) has a bad value; the fifth grade with value in (0, 0.6) has the worse value.

The evaluation indexes, the single factor fuzzy evaluation Matrixes of customers' and weights are listed in table 1 to 5:

**Table 1 Evaluation index and weight of u<sub>1</sub>**

u <sub>1</sub>		Value of customers'		
		X	Y	Z
0.20				
u <sub>11</sub>	0.20	1.00	0.85	0.88
u <sub>12</sub>	0.25	0.85	0.80	1.00
u <sub>13</sub>	0.15	0.85	0.90	0.95
u <sub>14</sub>	0.10	0.85	0.85	0.85
u <sub>15</sub>	0.15	0.98	0.95	0.65
u <sub>16</sub>	0.15	0.90	0.90	0.90

**Table 2 Evaluation index and weight of u<sub>2</sub>**

u <sub>2</sub>		Value of customers'		
		X	Y	Z
0.25				
u <sub>21</sub>	0.30	0.85	0.75	0.90
u <sub>22</sub>	0.15	0.85	0.80	0.95
u <sub>23</sub>	0.20	0.80	0.85	0.90
u <sub>24</sub>	0.10	0.75	0.85	0.95
u <sub>25</sub>	0.25	0.95	0.60	0.85

**Table 3 Evaluation index and weight of u<sub>3</sub>**

u <sub>3</sub>			Value of customers'			
			X	Y	Z	
0.20						
u <sub>31</sub>	0.30	u <sub>311</sub>	0.25	0.65	0.80	0.90
		u <sub>312</sub>	0.20	0.95	0.85	0.92
		u <sub>313</sub>	0.20	0.95	0.75	0.90
		u <sub>314</sub>	0.20	0.75	0.90	0.85
		u <sub>315</sub>	0.15	0.70	0.85	0.95
u <sub>32</sub>	0.25	u <sub>321</sub>	0.25	0.60	0.75	0.92
		u <sub>322</sub>	0.25	0.60	0.75	0.92
		u <sub>323</sub>	0.25	0.50	0.75	0.95
		u <sub>324</sub>	0.25	0.65	0.75	0.90
u <sub>33</sub>	0.25	u <sub>331</sub>	0.25	0.95	0.95	0.85
		u <sub>332</sub>	0.35	0.70	0.70	0.85
		u <sub>333</sub>	0.40	0.80	0.85	0.90
u <sub>34</sub>	0.20	u <sub>341</sub>	0.25	0.85	0.70	0.90
		u <sub>342</sub>	0.25	0.85	0.70	0.90
		u <sub>343</sub>	0.20	0.85	0.85	0.90
		u <sub>344</sub>	0.20	0.75	0.75	0.85
		u <sub>345</sub>	0.10	0.85	0.85	0.90

**Table 4 Evaluation index and weight of  $u_4$**

$u_4$	Value of customers'		
	X	Y	Z
0.10			
$u_{41}$ 0.20	0.85	0.70	0.90
$u_{42}$ 0.16	0.80	0.75	0.65
$u_{43}$ 0.16	0.85	0.80	0.88
$u_{44}$ 0.16	0.85	0.75	0.78
$u_{45}$ 0.12	0.85	0.90	0.75
$u_{46}$ 0.10	0.90	0.80	0.85
$u_{47}$ 0.10	0.90	0.85	0.92

**Table 5 Evaluation index and weight of  $u_5$**

$u_5$	Value of customers'		
	X	Y	Z
0.25			
$u_{51}$ 0.15	0.85	0.50	0.95
$u_{52}$ 0.15	0.85	0.50	0.95
$u_{53}$ 0.25	0.80	0.50	0.90
$u_{54}$ 0.20	0.80	0.40	0.90
$u_{55}$ 0.125	0.95	0.90	0.70
$u_{56}$ 0.125	0.95	0.90	0.70

**①The first level Fuzzy Comprehension Evaluation**

The first level Fuzzy Comprehension Evaluation will be made to the  $u_{3i}$  indexes (  $i=1, 2, 3, 4$ ) of the values of customers'.

$$B_{31}=A_{310}R_{31}= (0.7975,0.8275,0.9015)$$

$$B_{32}=A_{320}R_{32}= (0.5875,0.7500,0.9225)$$

$$B_{33}=A_{330}R_{33}= (0.8025,0.8225,0.8700)$$

$$B_{34}=A_{340}R_{34}= (0.8300,0.7550,0.8900)$$

**②The second level Fuzzy Comprehension Evaluation**

The second level Fuzzy Comprehension Evaluation will be made to the  $u_i$  indexes (  $i=1, 2, 3, 4,5$ ) of the value of customers'.

$$B_1=A_{10}R_1= (0.9070,0.8675,0.8860)$$

$$B_2=A_{20}R_2= (0.8550,0.7500,0.9000)$$

$$B_3=A_{30}R_3= (0.7528,0.7924,0.8966)$$

$$B_4=A_{40}R_4= (0.8520,0.7810,0.8166)$$

$$B_5=A_{50}R_5= (0.8525,0.5800,0.8650)$$

**③The Third level Fuzzy Comprehension Evaluation**

The third level Fuzzy Comprehension Evaluation will be made to get the values of customers'.

$$B=A_0R= (0.8440,0.7426,0.8794)$$

The evaluation result indicates that the value of customer X is 0.8440; the value of customer Y is 0.7426; the value of customer Z is 0.8794; the customers X and Z are more valuable; the customer Y has an ordinary value. Among the three, Z has the greatest customer's value.

**4. Conclusion**

In this article, Fuzzy Comprehensive Evaluation is used to try to judge the personal customers of the bank. Because every bank has its own operation policies which are different from any other bank's, the evaluation indexes to the customer will be different to some extent. In addition, while using Fuzzy comprehensive Evaluation to judge the customers' value, a group of experts need to be made up to give the evaluation to the single index to the customer, forming the single factor fuzzy evaluation matrix, which is a very tedious job. But the Fuzzy Comprehensive Evaluation still can be regarded as a kind of feasible method to judge the personal customers of banks.

**References**

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