Appraisal and Categorization of Commercial Banks Group Customers

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Abstract: This paper first constructs an evaluation system based on the customer value theory and the distinguished features of group customers of commercial banks. Then establishes an Interval-valued Fuzzy Evaluation Model based on Fuzzy Multiple Attribute Decision Making Theory to evaluate and classify the group customers of commercial banks. The empirical study shows that, this classification method can better reflect the profit-oriented operating principle of commercial banks, besides; the comprehensive value assessment result and its intermediate calculation data provide a clear guidance to the differential marketing activities of commercial banks which is helpful to improve the efficiency of CRM.

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1. Introduction

With the rapid development of information technology, many companies have accumulated huge amounts of customer data in the process of daily production and operation. Understanding how to mine on massive data for useful information is thus important to practitioners and academics alike (e.g., Alex, Stephen and Kurt, 2001). Among the most important tasks is to evaluate customers. With the deepening research of customer relationship management (CRM), Customer Value is beginning to play a vital role in supporting the decision-making process. As Kincaid (2003) and other authors emphasized in their studies, CRM approach firstly started to take place in company's agenda when they had discovered that all the customers did not have the same value and profitability. To efficiently conduct value-based customer segmentation in turn to design distinct products and services arenow the common concerns of many businesses including commercial banks (e.g., Zhang and Zhao, 2012). According to the 80/20 law put forward by Italian economist Pareto, 80% of the profit is created by 20% of the customers in a company. Since profit increasing is the basis of customer value (Berry and Linoff, 2004), commercial banks usually tend to focus on superior customers especially Group Customers (or Key Customers). In accordance with this trend, the operation philosophy of commercial banks is gradually changing from "product-centric" to "customer-centric". Effective Group Customer Relationship Management becomes the final key to survive the fierce competition. However, Group Customers varies a lot incore business, scale, organization structure etc. Therefore, it becomes a hot research topic in the academic circle to establish an effective set of classification philosophy. The current customer segmentation method applied by Chinese commercial banks is simply to classify Group Customers by their business coverage area, dividing them into two categories, namely, cross-regional Group Customers and in-area Group Customers. Although this classification method can facilitate the daily operation of all bank branches, it cannot reflect the concrete value of each Group Customer. This paper combines customer value with customer segmentation and proposes a value-based method to conduct CRM with Group Customers. This paper mainly has two components. First we develop a customer value assessment frame work which contains three levels of indicators to examine the all-round value of Group Customers, from both the historical and future perspectives. Second, we construct an evaluation model based on Fuzzy Multiple Attribute Decision Making Theory, and conduct an empirical example to test the effectiveness of this model.

2. Literatures Review

The idea of this paper relates to several branches of literature. First, by presenting a framework relating customer value, this paper adds to the theoretical literature on customer value. Second, by constructing a value assessment system of Group Customers in commercial banks, this paper relates to other evaluation systems such as Anderson, Jolly and Fairhurst (2007) and Verhoef, Franses and Hoekstra (2001). Third, by empirically setting up fuzzy

assessment model to evaluate group customers, this paper draws on the experience of Wang (2005) and Zhang, Wang et al. (2006). In what follows, we describe each of these branches of literature. Our paper is mostly related to two customer value theories. Ravald and Grouroos(1996) put forward the customer relationship value theory. They started from the perspective of Relation Marketing, point out that customers tend to pay attention to the mutual relation in addition to the products and services of the company when they perceive the value. Reichheld (1996) put forward the finance-based calculation method of Customer Lifetime Value (CLV), and in the same year Bob. Stone (1996) present a RFM model to calculate customer value with 3 indicators, namely Recency, Frequency and Monetary. Using SEM theory and PLS parameter estimation method, Blocker, (2011) studied the main factors that affect customer value, and concluded that profit contribution, customer satisfaction, marketing cost and customer acquisition costs are the four most significant factors. Hasnelly and Yusuf (2012) find that the key factor that affects the customer value is customer loyalty. Chiang, (2011) seeks to study the factors that affect the customer value in the distribution channel by using modified RFMD model, he also present a new method to mine association rules.

Wang, Zhang and Chi (2006) analysis the factors that affect customer loyalty of commercial banks, and find that it is the ability to provide customized services and products that count, and banks need to be customer-centered to survive the fierce competition. Zheng (2006) find that the purchasing behavior of customers shows obvious feature of individuation and intermittence, so he uses Markov chain theory to estimate the remaining lifetime value of customers, his research on the one hand, provides an effective way of customer segmentation and resource allocation, on the other, can be used to evaluate the effectiveness of various marketing strategies of a company. Zou, Li and Hao (2009) introduce the Support Vector Machine (SVM) as a classification tool under the Cost Sensitive learning mechanism, set error cost function based on the customer value to evaluate the effectiveness of the classification result. American Cybernetics expert, mathematician Zadeh (1965) first put forward the concept of fuzzy math and presents Fuzzy set Theory. Supported by computer technology, fuzzy math experiences a rapid development, in which Fuzzy clustering and Fuzzy comprehensive evaluation theory has been applied in the field of economics & management, environment science, transportation, medical science etc. Fuzzy theory has developed in the meantime; Bass and Kwakernaak (1997) put forward the fuzzy Multi-Attribute Decision Making Theory, and other researchers have extended this model, such as Zhang, Guan, and Meng (2001) and Wang (2005).

Value assessment system: Many scholars hold the view that the balance between perceived benefits and perceived loss is the core concern of Customer Value theory (e.g., Valarie, 1988; Ulaga and Chacour, 2001; Flint, Woodruff and Gardial, 1997). While Frederich (1993) defined customer value as the net cash flow that the customer create during a specific period. There exist two methods when it comes to assess customer value: the quantitative method and subjective evaluation method. The former adopts Activity-Based Costing (ABC) to measure customer cost, then analyses the profitability of a certain customer on the position of enterprise (Quan, Qi and Shu, 2004; Liu,2001). While the subjective evaluation method is to design an index system to indirectly assess the customer value. Based on the previous research, this paper sets up a value assessment system as mentioned above, which contains indicators from two dimensions: the historical value and the future value of group customers in commercial banks. The Group Customer value assessment system is described in Table1.

Fuzzy assessment model

Approach: The following study applies Fuzzy Mapping theory and Maximum Membership Principle in the Uncertainty Mathematics to the assessment of the performance of each subject (Group Customer) on each indicator in the value assessment system, then taking the calculated weight of each indicator into consideration to evaluate group customers. There is one detail here, since the value assessment system contains both quantitative and qualitative indicators, we must transform the qualitative data into calculable numbers before the assessment process. The most frequently used method to handle this problem is subjective grading; however it increases the distortion probability. In this paper, we use interval numbers to express the measurement of customer's performance on each indicator, which can better reflect the complex fuzzy information and the fuzziness and uncertainty of the feature of human reasoning. Following is the research route of this paper:

- Weight the indicators in the value assessment system by entropy method;
- Fuzzy mapping of indicators. Convert the value of each index into interval numbers within [0,100], and grade the assessment value on each indicator into fivedegrees: low(L), between low and medium(BLM), medium(M), between medium and high(BMH), high(H).
- Define the membership function for each of the five degree.
- Use the interval numbers obtained in step2 and the membership function defined in step 3 to calculate the assessment matrix.
- Use the weight matrix obtained in step1 and

the assessment matrix in step4 to calculate the final customer evaluation result.

Table 1: Group Customer value assessment system

First-class indicator	Second-class indicator	Third-class indicator	Number of indicator	Indicator type	Data type
Historical value（0.4）	Asset business(B_1)（0.2415）	Average loan amount	C_1（0.4847）	Positive	Point value
		Compound loan period	C_2（0.5153）	Positive	Point value
	Liability business(B_2)（0.0856）	Average deposit amount	C_3（0.4416）	Positive	Point value
		Compound deposit period	C_4（0.3823）	Positive	Point value
		Standard deviation of deposit	C_5（0.1761）	Negative	Point value
	Intermediate business(B_3)（0.2237）	Total commission	C_6（0.7904）	Positive	Point value
		Transaction frequency	C_7（0.2096）	Positive	Point value
	Risk assessment(B_4)（0.4492）	Credit rating	C_8（0.6271）	Positive	Interval number
		Affiliate transaction	C_9（0.3729）	Positive	Interval number
Potential value（0.6）	Customerloyalty(B_5)（0.5749）	Business event duration(in years)	C_{10}（0.4133）	Positive	Point value
		Customer satisfaction	C_{11}（0.1487）	Positive	Interval number
		Business dependence	C_{12}（0.2369）	Positive	Interval number
		Reference tendency	C_{13}（0.1256）	Positive	Interval number
		Price tolerance	C_{14}（0.0755）	Positive	Interval number
	Customer life expectancy(B_6)（0.4251）	Prospect of the industry	C_{15}（0.1903）	Positive	Interval number
		Group scale	C_{16}（0.5443）	Positive	Interval number
		Policy orientation	C_{17}（0.2654）	Positive	Interval number

Fuzzy assessment model based on interval numbers: This paper has construct a 3-layer indicator system to assess the customer value, in that follows, we set up a level 2 interval-valued model for fuzzy comprehensive evaluation on the basis of the level 1 interval-valued model. This model suits the case of multi-factors. The model and its operation law are as follows:

Step1: Group the set of indicators ($X=\{x_1,x_2,\cdots,x_n\}$) into small teams $X=\{X_1,X_2,\cdots,X_k\}$ where $X_i=\left\{x_1^{(i)},x_2^{(i)},\cdots,x_{n_i}^{(i)}\right\}$ ($i=1,2,\cdots,k$). Here, $X=\{X_1,X_2,\cdots,X_k\}$ is called the first level factors set, and $X_i=\left\{x_1^{(i)},x_2^{(i)},\cdots,x_{n_i}^{(i)}\right\}$ is called the second-level factors set.

Step2: Given the comment set as $Y=\left\{y_1,y_2,\cdots y_m\right\}$, given A as an object. First, assess the first level of factors, and then we have this Interval-valued fuzzy mapping:

$$\begin{cases} x_1^{(i)} \mapsto f_i\left(x_1^{(i)}\right) \triangleq \left(\left[r_{11}^{(i)-},r_{11}^{(i)+}\right],\left[r_{12}^{(i)-},r_{12}^{(i)+}\right],\cdots,\left[r_{1m}^{(i)-},r_{1m}^{(i)+}\right]\right) \\ x_2^{(i)} \mapsto f_i\left(x_2^{(i)}\right) \triangleq \left(\left[r_{21}^{(i)-},r_{21}^{(i)+}\right],\left[r_{22}^{(i)-},r_{22}^{(i)+}\right],\cdots,\left[r_{2m}^{(i)-},r_{2m}^{(i)+}\right]\right) \\ \cdots \\ x_{n_i}^{(i)} \mapsto f_i\left(x_{n_i}^{(i)}\right) \triangleq \left(\left[r_{n_i1}^{(i)-},r_{n_i1}^{(i)+}\right],\left[r_{n_i2}^{(i)-},r_{n_i2}^{(i)+}\right],\cdots,\left[r_{n_im}^{(i)-},r_{n_im}^{(i)+}\right]\right) \end{cases} \quad (1)$$

And we get the fuzzy assessment matrix $R_A^{(i)}$ of the first level indicators:

$$R_A^{(i)} = \begin{bmatrix} \left[r_{11}^{(i)-}, r_{11}^{(i)+}\right] & \left[r_{12}^{(i)-}, r_{12}^{(i)+}\right] & \cdots & \left[r_{1m}^{(i)-}, r_{1m}^{(i)+}\right] \\ \left[r_{21}^{(i)-}, r_{21}^{(i)+}\right] & \left[r_{22}^{(i)-}, r_{22}^{(i)+}\right] & \cdots & \left[r_{2m}^{(i)-}, r_{2m}^{(i)+}\right] \\ \vdots & \vdots & \vdots & \vdots \\ \left[r_{n_i1}^{(i)-}, r_{n_i1}^{(i)+}\right] & \left[r_{n_i2}^{(i)-}, r_{n_i2}^{(i)+}\right] & \cdots & \left[r_{n_im}^{(i)-}, r_{n_im}^{(i)+}\right] \end{bmatrix} \quad (2)$$

Given that the weight matrix of the first level factor set is $w^{(i)} = \left(w_{i1}, w_{i2}, \cdots, w_{in}\right)$. Where $\sum_{j=1}^{n} w_{ij} = 1$.

Do interval matrix multiplication, $w^{(i)} R_A^{(i)} = \left(\left[d_1^{(i)-}, d_1^{(i)+}\right], \left[d_2^{(i)-}, d_2^{(i)+}\right], \cdots, \left[d_m^{(i)-}, d_m^{(i)+}\right]\right)$, where,

$$\left[d_j^{(i)-}, d_j^{(i)+}\right] = \sum_{l=1}^{n_i} w_{il}\left[r_{lj}^{(i)-}, r_{lj}^{(i)+}\right] = \left[\sum_{i=1}^{n_i} w_{il} \cdot r_{lj}^{(i)-}, \sum_{i=1}^{n_i} w_{il} \cdot r_{lj}^{(i)+}\right], \quad j = 1, 2, 3..n \quad (3)$$

Denote $\Delta_A^{(i)} = \sum_{j=1}^{m}\left[d_j^{(i)-}, d_j^{(i)+}\right] \triangleq \left[\Delta_A^{(i)-}, \Delta_A^{(i)+}\right]$, Do interval division, we have

$$\left[d_j^{(i)-}, d_j^{(i)+}\right] \div \left[\Delta_A^{(i)-}, \Delta_A^{(i)+}\right] \triangleq \left[h_{ij}^{-}, h_{ij}^{+}\right], \quad (i = 1, 2, \cdots, k) \quad (4)$$

Step 3: Conduct the comprehensive evaluation of the second level of factors. Denote the weight matrix of $X = \{X_1, X_2, \cdots, X_k\}$ as $W = \{w_1, w_2, \cdots, w_k\}$, and then we have the final evaluation matrix,

$$R_A^{(i)} = \begin{bmatrix} H_{1A} \\ H_{2A} \\ \vdots \\ H_{kA} \end{bmatrix} = \begin{bmatrix} \left[h_{11}^{-}, h_{11}^{+}\right] & \left[h_{12}^{-}, h_{12}^{+}\right] & \cdots & \left[h_{1m}^{-}, h_{1m}^{+}\right] \\ \left[h_{21}^{-}, h_{21}^{+}\right] & \left[h_{22}^{-}, h_{22}^{+}\right] & \cdots & \left[h_{2m}^{-}, h_{2m}^{+}\right] \\ \vdots & \vdots & \vdots & \vdots \\ \left[h_{k1}^{-}, h_{k1}^{+}\right] & \left[h_{k1}^{-}, h_{k1}^{+}\right] & \cdots & \left[h_{km}^{-}, h_{km}^{+}\right] \end{bmatrix} \quad (5)$$

$$W \cdot R_A = \left(\left[d_1^{-}, d_1^{+}\right], \left[d_2^{-}, d_2^{+}\right], \cdots, \left[d_m^{-}, d_m^{+}\right]\right) \quad (6)$$

$$\left[d_j^{-}, d_j^{+}\right] = \sum_{l=1}^{k} w_l\left[h_{lj}^{-}, h_{lj}^{+}\right] = \sum_{l=1}^{k}\left[w_l h_{lj}^{-}, w_l h_{lj}^{+}\right] = \left[\sum_{l=1}^{k} w_l \cdot h_{lj}^{-}, \sum_{l=1}^{k} w_l \cdot h_{lj}^{+}\right], \quad j = 1, 2 \cdots m \quad (7)$$

Denote $\Delta_A = \sum_{j=1}^{m}\left[d_j^{-}, d_j^{+}\right] \triangleq \left[\Delta_A^{-}, \Delta_A^{+}\right]$ and given $\Delta_A^{-} > 0$, do interval division, $\left[d_j^{-}, d_j^{+}\right] \div \left[\Delta_A^{-}, \Delta_A^{+}\right] \triangleq \left[h_j^{-}, h_j^{+}\right]$, we have the final comprehensive evaluation result:

$$H_A = \left(\left[h_1^{-}, h_1^{+}\right], \left[h_2^{-}, h_2^{+}\right], \cdots, \left[h_m^{-}, h_m^{+}\right]\right) \quad (8)$$

If there is $\left[h_k^{-}, h_k^{+}\right] = \max_{1 \le j \le m}\left\{\left[h_j^{-}, h_j^{+}\right]\right\}$, then the object A belongs to the comment y_k.

Empirical example

Data: The data we use is provided by Company Business Department of Agricultural Bank of China (ABC). We collected the monthly transaction data of 100 Group Customers from manufacturing industry, within the period January 2011 to December 2012.Since the assessment system we constructed above contains both qualitative and quantitative indicator, it is necessary to conduct data standardization before the process of comprehensive assessment. In order to maintain the commensurability of each criterion measurement, we convert the measure of each criterion into interval numbers within the range of [0,100], then we divide the range into five degrees (L, BLM, M, BMH, H)whose ranges are [0,30], (30,55], (55, 75], (75,90] and (90,100] respectively. Following are the specific grading measure of each criterion.

According to the discussion above, take a Group Customer A as an example to deduce the specific calculation process.

Example deduction: Firstly, use Analytic Hierarchy Process (AHP) to determine the weight of each indicator. Take the second-class indicator "customer loyalty (B_5)" as an example. It has 5subordinate indicators: C_{10}, C_{11}, C_{12}, $C_{13}$and C_{14}.Table3 shows the decision matrix ofB_5.

Through some calculation, we have the weight of indicators C_{10}, C_{11}, C_{12}, C_{13}, C_{14}, namely: 0.4, 0.15, 0.25, 0.12 and 0.08.The consistency test shows the weighting result is reliable. Weights of other indicators can be calculated in the same way. Table 1 shows the specific weight of each indicator. Table 4 shows thescore of each indicator we worked out with Table 1 and Table 2.

According to the practice of commercial banks and the suggestions of professionals, we set the Membership Function of the five measure degrees as follows in equation (9) to (13):

Table 2: Grading measure standard value range of the value assessment system

First-class indicators	Second-class indicators		Third-class indicators		Grading measure standard value range				
					L [0,30]	BLM [30,55]	M [55,75]	BMH [75,90]	H [90,100]
Historical value	B_1	Asset business	C_1	Average loan amount (in 100 million)	<3.5	3.5-12	12-25	25-50	>50
			C_2	Compound loan period(in years)	<0.25	0.25-1	1-3	3-5	>5
	B_2	Liability business	C_3	Average deposit amount (in 100 million)	<1	1-5	5-10	10-20	>20
			C_4	Compound deposit period(in years)	<0.5	1	2	3	5
			C_5	Standard deviation of deposit(in 100 million)	>15	15-8	8-5	5-3	<3
	B_3	Intermediate business	C_6	Total commission(in 100 million)	<2	2-6	6-15	15-25	>25
			C_7	Transaction frequency(in times)	<3	3-5	5-8	8-12	>12
	B_4	Risk assessment	C_8	Credit rating	C	B	A,A^+	AA,AA^+	AAA,AAA^+
			C_9	Affiliate transaction amount (%)	>130%	80%-130%	50%-80%	20%-50%	<20%
Potential value	B_5	Customer loyalty	C_{10}	Business event duration(in years)	<1	1-3	3-5	5-8	>8
			C_{11}	Customer satisfaction	Very dissatisfied	Dissatisfied	Barely satisfied	Satisfied	Very satisfied
			C_{12}	Business dependence	Very low	low	Medium	high	Very high
			C_{13}	Reference tendency	Very weak	weak	Medium	Strong	Very strong
			C_{14}	Price tolerance	Very weak	weak	Medium	Strong	Very strong
	B_6	Life expectancy	C_{15}	Prospect of industry	Very bad	Bad	Moderate	Good	Very good
			C_{16}	Group scale (in 100 million)	<0.3	0.3-3	3-50	50-100	>100
			C_{17}	Policy orientation	Forbid	Discourage	Neutral	Encourage	Support

Table 3: Decision matrix for customer satisfaction of a Group Customer

	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}
C_{10}	1	5	2	3	3
C_{11}	1/5	1	1/3	3	2
C_{12}	1/2	3	1	3	2
C_{13}	1/3	1/3	1/3	1	3
C_{14}	1/3	1/2	1/3	1/3	1

Table 4: Scoring of each indicator in the value assessment system

Type of service	Score of indicators
Asset business B_1	$C_1=[80,84]$, $C_2=[72,80]$
Liability business B_2	$C_3=[86,94]$, $C_4=[76,83]$, $C_5=[72,80]$
Intermediate business B_3	$C_6=[17,25]$, $C_7=[56,65]$
Risk assessment B_4	$C_8=[82,86]$, $C_9=[97,99]$
Customer loyalty B_5	$C_{10}=[64,72]$, $C_{11}=[70,85]$, $C_{12}=[75,88]$, $C_{13}=[60,70]$, $C_{14}=[57,68]$
Customer life expectancy B_6	$C_{15}=[70,80]$, $C_{16}=[80,89]$, $C_{17}=[70,78]$

$$f_j^1(x)=\begin{cases}1 & x\in[0,30]\\ \dfrac{55-x}{25} & x\in[30,55]\\ 0 & x\in[55,100]\end{cases} \quad (9)$$

$$f_j^2(x)=\begin{cases}\dfrac{x}{30} & x\in[0,30]\\ 1 & x\in[30,55]\\ \dfrac{70-x}{15} & x\in[55,70]\\ 0 & x\in[70,100]\end{cases} \quad (10)$$

$$f_j^3(x)=\begin{cases}0 & x\in[0,30]\\ \dfrac{x-30}{25} & x\in[30,55]\\ 1 & x\in[55,75]\\ \dfrac{90-x}{15} & x\in[75,90]\\ 0 & x\in[90,100]\end{cases} \quad (11)$$

$$f_j^4(x)=\begin{cases}0 & x\in[0,55]\\ \dfrac{x-55}{20} & x\in[55,75]\\ 1 & x\in[75,90]\\ \dfrac{100-x}{10} & x\in[90,100]\end{cases} \quad (12)$$

$$f_j^5(x)=\begin{cases}0 & x\in[0,75]\\ \dfrac{x-75}{15} & x\in[75,90]\\ 1 & x\in[90,100]\end{cases} \quad (13)$$

Take the lower limit x_{ij}^- and upperlimit x_{ij}^+ of the score on indicator C_j into every membership function above, we get an interval-valued matrix of the degree of membership to each degree. For example, we take the subordinate indicators $C_1=[80,84]$, $C_2=[72,80]$ of into the above membership functions; we have the fuzzy assessment matrix $R_A^{B_1}$ on the indicator B_1"asset business":

$$R_A^{B_1}=\begin{bmatrix}0 & 0 & [0.24,0.40] & [1,1] & [0.33,0.60]\\ 0 & 0 & [0.4,1] & [0.85,1] & [0,0.33]\end{bmatrix}$$

According to the calculation above, we already have the weight of C1 and C2, donate as $w_1^{B_1}$ and $w_2^{B_1}$, then we have the weight matrix w^{B_1} of B_1. $w^{B_1}=\left(w_1^{B_1},w_2^{B_1}\right)=(0.5,0.5)$, and then use $M(\bullet,+)$ to calculate, we have,

$$w^{B_1}\cdot R_A^{B_1}=(0.5,0.5)\begin{bmatrix}0 & 0 & [0.40,0.66] & [1,1] & [0.33,0.60]\\ 0 & 0 & [0.66,1] & [0.35,1] & [0,0.33]\end{bmatrix}$$

$$=(0\quad 0\quad [0.533,0.833]\quad [0.675,1]\quad [0.167,0.467])$$

$$\Delta_A\triangleq[1.375,2.3]$$

$$H_A^{B_1}=(\ 0\quad 0\quad [0.232,0.606]\quad [0.293,0.727]\quad [0.072,0.339]\ )$$

Similarly, we can work out the assessment matrix ofB_2, B_3,B_4, $B_5$and B_6; the combined matrix is as follows:

$$R_A = \begin{bmatrix} H_A^{B_1} \\ H_A^{B_2} \\ H_A^{B_3} \\ H_A^{B_4} \\ H_A^{B_5} \\ H_A^{B_6} \end{bmatrix} = \begin{bmatrix} 0 & 0 & [0.232, 0.606] & [0.293, 0.727] & [0.072, 0.339] \\ 0 & 0 & [0.293, 0.727] & [0.339, 0.693] & [0.148, 0.489] \\ [0.408, 0.532] & [0.252, 0.571] & [0.102, 0.133] & [0.005, 0.067] & 0 \\ 0 & 0 & [0.085, 0.216] & [0.340, 0.487] & [0.340, 0.487] \\ 0 & [0.002, 0.148] & [0.265, 0.780] & [0.233, 0.693] & [0.233, 0.693] \\ 0 & 0 & [0.155, 0.568] & [0.363, 0.693] & [0.074, 0.430] \end{bmatrix}$$

Through calculation, we have the final weight vector of $B_1 \sim B_6$

$$W = \{w_1, w_2, w_3, w_4, w_5, w_6\} = \{0.096, 0.036, 0.088, 0.18, 0.36, 0.24\}$$

Using the assessment matrix and the converted weight vector to calculate the final comprehensive evaluation result by operator $M(\bullet, +)$,

$$W \circ R_A = \left([0.036, 0.047] \quad [0.023, 0.104] \quad [0.184, 0.542] \quad [0.273, 0.604] \quad [0.095, 0.405] \right)$$

$$\Delta_A \triangleq [0.611, 1.702]$$

$$H_A = \left([0.021, 0.077] \quad [0.013, 0.170] \quad [0.108, 0.888] \quad [0.160, 0.989] \quad [0.056, 0.664] \right)$$

Here, the vector H_A is the final assessment result of customer A.

Similarly, we can calculate the rest 99 Group Customers' value assessment, due to the space limit;we are not to set out the details of their calculation process.

3. Result analysis

The previous section gives a specific deduction of the value assessment process of Group Customers, according to the maximum membership principle and sequencing principle of interval numbers, we reach the conclusion that the value of Group Customer A is ranking the "BMH" level.The customer scores high on the indicator of "risk assessment"which implies a good credit record and low default risk, we regard A as a potential "superior customer".However, its score on the "intermediate business" indicator is low [17, 25] which will definitely shrinkitsprofit contribution to the bank. This is probably because the intermediate service provided by commercial bank cannot meet the special need of this customer, or that the commission fee is not competitive as competitors in the financial market. Through the statistical analysis of the value assessment result from 100 Group Customers, we find that most of them distribute on the "BMH" and ''medium" value levels, which are 33%and 34%respectively. The other 3 levels takes up about one-third of the 100 group customers, and the distribution on these three levels is relatively even, that is 11% on the "high" value level, 12% on the "between low and medium (BLM)" value level, and 10% on the "low" value level. The analysis of customer value distribution shows that these Group Customers show a relatively high overall customer value to this commercial bank, further analysis of the 22% low-value customers, we find that their profit contribution on liability business and intermediate business is weak, which are the main obstacle of the profit growth of this bank.Based on the above analysis and calculation result, commercial bank can develop customized marketing strategy to stimulate customers' purchasing intention and their profitability.

4. Conclusion

We develop and test a new method to assess the value of Group customers of commercial banks. Previous evaluation method tend to grade the customers on each indicator subjectively with a specific number, while our method allows the historical data to be fully reflect in the grading process by introducing interval numbers and membership function. The empirical example confirmed the effectiveness andsuperiority of this method. Using interval numbers to grade the performance of group customers on each indicator can fully reflect theirhistorical performance and avoid subjectivity deviation of the refereeas well. The fuzzy assessment model provides the membership degree to each of the five levels (Low, BLM, Medium, BMH, and High) which give clear description of the customer value features. A cohesive frame work is not only important to academics; it is proved to be valuable

to practitioners as well.The comprehensive calculation results facilitate the establishment of specialized marketing strategy. The goal of this work is to provide a useful and reliable tool to support the strategy-making process based on customer value, which will enhances the efficiency of Group Customer Relationship Management (GCRM) activities in commercial banks.

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