

# A FAHP-FUZZY Approach of Evaluating Banking Service Quality

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Received: May 4, 2013 Accepted: June 13, 2013 Online Published: June 26, 2013

doi:10.5539/ijbm.v8n14p158

URL: <http://dx.doi.org/10.5539/ijbm.v8n14p158>

## Abstract

With the development of the interest rate liberalization in China, the narrowing of spreads has great influence on China's commercial banks operating income, the commercial banks "innovation" pressure is increasingly urgent. The electronic bank, as the main means of innovation, was being developed rapidly in recent years, which played an important role in reducing the constantly increasing intermediary business income during operation. The electronic banks promote the business innovation, and it is very convenient for the customer service. The purpose of innovation is to improve the quality of service. Bank service quality is an important factor to affect the bank's reputation and an important means of competition among banks. Based on the model of service quality of commercial banks, according to Chinese current situation, the paper puts forward an evaluation method using the FAHP-FUZZY model of service quality evaluation, in order to promote the continuous improvement of commercial banking service quality.

**Keywords:** commercial bank, service quality, FAHP, FUZZY, evaluation

## 1. Introduction

Since the year of 2012, because of the economic downturn and the People's Bank of China (PBC) adjustment of the floating range of interest rate by midyear, one research has shown that the Interest Expense is the most important operating expense for banks (about 85%), the narrowing of spreads creates a huge challenge for bank management, also the interest rate liberalization will impact on the profitability of commercial banks. By the end of April, the 2012 annual report of listed banks had showed that the Industrial and Commercial Bank of China, the Agricultural Bank of China, the Bank of China, the China Construction Bank and the Bank of Communications those assets scale was nearly 50% of the total Chinese banking, and the five banks had realized a net profit of 774.6 billion Yuan, increased 14.9 percent at the same period of last year. The average growth rate of 2012 fell behind the year of 2011 by more than 30 percent. A number of phenomena show that banking has turned into the market-oriented and low-growth industry from the semi-monopolistic and high-growth industry. In the process of declining growth, banks are facing the functional restructuring and the business transformation, that is, banks whose customers are mainly large enterprises begin to serve small businesses. Under the constraints of competition intensifies in the domestic and international interbank, banks will have to adjust customer structure and improve service quality in order to seek for new sources of profit.

Banks' service quality plays an important role in their reputation, which is a main approach during competition among banks as well as the core competence of banks' sustainable development. Therefore, how to improve banks' service quality and the structure of asset quality is an urgent subject in the background of market-oriented interest rate in China.

A lot of researches have proved that the service quality determines the Customer Satisfaction (Fornell, C., Michael, D. J., et al, 1996), and the Customer Satisfaction determines Customer Loyalty (Chunxiao, W., Xiaoyun, H., et al, 2003), which directly or indirectly brings in the profit increase. For example, if the customer loyal rises by 5%, the company's net profit will increase by 25%~95% (Reichhdd, F. F., 1996). As above, the logic is concluded: Service Quality→Customer Satisfaction→Customer Loyalty→Profit.

## 2. Literature Review

The research of service quality began in the 1970s. All researches indicate that the evaluation of service quality largely depends on the customers' psychological cognition because of the characteristics of the service, such as intangibility, heterogeneity, human contact, the process and so on. Perceived Service Quality by Raval

Grouroos, the representative of Nordic service quality school, embodies the idea of customers on Service Quality, and thus it can be called “market-oriental quality of service”. Grouroos also suggested that the quality of service should be classified into Outcome or Technical Quality and Process Quality (Gronroos, C., 1984). The former highlights the objectivity of the evaluating while the latter emphasizes the subjectivity of the evaluating. Fomell classified the quality of service into Customization (the degree of suppliers’ meeting the customers’ demands) and Reliability (the stability and accessibility of service from service providers) (Fornell, C., Michael, D. J., et al, 1996), which are similar to Ravalld Grouroos’s Outcome or Technical Quality and Process Quality. According to Ms. Wen Yanbi’s and Mr. Wang Xiaochun’s researches, the overall quality of service not only includes hardware quality and software quality but also contains contact fairness, result fairness and procedural fairness; the above-mentioned three fairness and two service qualities equally make up the sub-factors of the overall quality of service (Biyao, W., & Chunxiao, W., 2005). However, the evaluating process of service quality is the process of the subjective perception of value, during which contact fairness and procedural fairness have a high correlation with Process Quality or Software Quality while result fairness with Technical Quality or Hardware Quality. Hence, the evaluating of service quality remains two main means of Process Quality (or Software Quality) and Technical Quality (or Hardware Quality).

Brands and distribution are very important in the purchase and consumption of tangible products because in most cases consumers cannot have an acquaintance with manufacturers and can only infer from brands and distribution for what manufacturers are like, whereas corporate images (rather than tangible products or brands) are very important to service enterprises in service industry where consumers can see service enterprises themselves as well as the sources of service businesses and the way of operation without the shelter of brands and distribution. Berry found that the corporate image was the driving factor of the successful service enterprises through researching 14 high-performance service businesses (including banks); he also suggested that positive images should be shaped by means of increasing customers’ experiences of service and put forward the ways of constructing corporate images by boosting the reputation enterprises, establishing emotion relationship with customers, internalizing brands (which is to deepen the idea of brands in the staff) and so on (Berry, L. L., 2000). Mr. Liu Jun found that the images and service quality of Chinese-funded banks and foreign-invested banks equally affected the cognition of service value. Corporate images, which affect Technical Quality and Process Quality, are accumulated consequences after customers’ long-term service experiences (Jun, L., 2004). For this reason, corporate images and quality cognition affect each other.

Scholars construct the measure of service quality largely from the above-mentioned three dimensions (that is Technical Quality, Process Quality and Corporate images). For instance, in the 10 variables of SERVQUAL by Parasuraman, Competence (the staff’s knowledge and technique as well as their ability of organization, research and development) and Tangibility (service entities) are relevant to Technical Quality; Credibility (the reliability of service enterprises and the consideration of customers) is associated with Corporate Images; Process Quality relates to Professionalism (the efficiency of the staff’s completing service), Responsiveness (the willingness of the staff’s providing service), Accessibility (the accessible and convenient contact), Courtesy (politeness, respect, consideration and kindness), Communication (the effective expression and listening), Security (zero risk and privacy) and Empathy (the ability of understanding customers) (Parasuraman, A., Zeithaml, V. A., & Berry, L. L., 1985). The excellent quality of service can bring customer satisfaction and customer loyalty. Economists like Fornell classify customer satisfaction into overall satisfaction, the satisfaction resulting from the comparison between experience and expected quality as well as the satisfaction resulting from the comparison between experience and ideal quality. Therefore, customer satisfaction results from customers’ psychological comparison whose benchmark is expectation. The formation of expectation originates from the previous experience of the application and from the judgment of competitors and ideal status. Customer intentions or behavior loyalty can be measured by repeated purchase. Economists like Gremler think customer satisfaction has a close relationship with the four kinds of customer loyalty (the loyalty of cognition, the loyalty of emotions, the loyalty of intentions and the loyalty of behavior) (Gremler, D. D, Brown, S.W., Bitner, M. J., & Parasuraman, A., 2001). In order to make a quantitative measurement of the bank’s service levels, Mr. Xu Jun and his colleagues made an evaluating from the perspective of factor analysis. They conducted a survey of service levels targeting CMBC and CCB as research objects and preliminarily designed the comparatively overall evaluating system of commercial banks including 8 primary indicators, which are Tangibility, Sensibility, Trust, Reactivity, Assurance, Professionalism, Humanity and Accessibility, and 30 secondary indicators and so on (Jun, X., & Jiong, Y., 2008).

### **3. Methodology**

#### *3.1 Constructing the Evaluating Indicator System*

Constructing the comprehensive evaluation indicator system is the vital foundation of the fuzzy comprehensive

evaluation meanwhile the choice of the evaluating indicator directly affects the evaluating conclusion. In this paper, the author refers to the above-mentioned relevant literature, employs the 10 variables of SERVQUAL by Parasuraman, reconstructs Mr. Xu Jun's theory and establishes the evaluating indicator system, which includes three layers, that is to say, the target layer, the main criteria layer and the sub-criteria layer. The target layer is "the comprehensive evaluation of listed banks' service quality"; the main criteria layer is the primary evaluating indicator including technical quality, corporate images and process quality; the sub-criteria layer is the secondary and tertiary evaluating indicator, which is the detail of the main criteria layer. It is shown in Table 1.

Table 1. The comprehensive evaluation indicator system of listed banks' service quality

Target	The Primary Evaluating Indicator	The Secondary Evaluating Indicator	The Tertiary Evaluating Indicator
The Comprehensive evaluation of Listed Banks' Service Quality (A)	Technical Quality (B <sub>1</sub> )	Competence (C <sub>11</sub> )	1 Service staff is well-trained and provide service in a normative way. (P <sub>111</sub> )
			2 Service staff enables to clearly and logically answer the questions of customers using their knowledge. (P <sub>112</sub> )
		Tangibility (C <sub>12</sub> )	1 Banks are equipped with modern technology and equipment. (P <sub>121</sub> )
	2 Banks should have a comfortable and elegant environment and attractive facilities with a fully functional resting area. (P <sub>122</sub> )		
	3 Service staff is neatly and properly dressed. (P <sub>123</sub> )		
	Corporate Images (B <sub>2</sub> )	Credibility (C <sub>21</sub> )	1 Banks' charges are reasonable, open and transparent. (P <sub>211</sub> )
			2 Banks have a good reputation of quality and each bank has the same level of service quality. (P <sub>212</sub> )
			3 Service staff is reliable. (P <sub>213</sub> )
		Professionalism (C <sub>31</sub> )	1 Banks records their service accurately. (P <sub>311</sub> )
			2 Banks provide the precise service for customers and give an early reply. (P <sub>312</sub> )
3 Banks promptly provide reliable service within promised time and effectively handle complaints and troubles. (P <sub>313</sub> )			
4 Service staffs receive a deposit, handle a loan and complete a withdrawal within a limited period of time. (P <sub>314</sub> )			
Responsiveness (C <sub>32</sub> )		1 Service staffs promptly correct the mistakes and compensate for the loss in service. (P <sub>321</sub> )	
		2 Service staffs understand customers' demands and offer service. (P <sub>322</sub> )	
		3 Banks offer help to customers and make every effort to eliminate their concerns when customers are in trouble. (P <sub>323</sub> )	
Accessibility (C <sub>33</sub> )		1 ATM can easily meet customers' demands. (P <sub>331</sub> )	
		2 The number of bank work windows is enough for customers. (P <sub>332</sub> )	
		3 The time of waiting for service is not long. (P <sub>333</sub> )	
	4 Customers receive the messages of new products and service in the shortest time and frequency. (P <sub>334</sub> )		
Process Quality (B <sub>3</sub> )	Courtesy (C <sub>34</sub> )	1 Service staffs are polite to make customers feel at home. (P <sub>341</sub> )	
		2 Service staffs are always willing to help customers. Even if busy, they promptly respond to customers' request for help. (P <sub>342</sub> )	
		1 Banks enable to adjust the service time according to different customers' demands and communicate with customers sufficiently and efficiently. (P <sub>351</sub> )	
Communication (C <sub>35</sub> )	2 Banks take customers' benefit into account and attach much importance to their feedback. (P <sub>352</sub> )		
	3 Service staffs enable to inform customers of the exact time of providing service. (P <sub>353</sub> )		
	1 Customers feel safe in the process of service. (P <sub>361</sub> )		
Security (C <sub>36</sub> )	2 Banks themselves are reliable and secure. (P <sub>362</sub> )		
	3 Business environment is safe, pleasant and comfortable. (P <sub>363</sub> )		
	4 Banks enable to guarantee customers' personal privacy. (P <sub>364</sub> )		
	Empathy (C <sub>37</sub> )	1 Service staffs pay special attention to customers in the principle of customer orientation. (P <sub>371</sub> )	
2 Bank's staffs enable to inform customers of preventative measures and the handling of some similar issues. (P <sub>372</sub> )			

### 3.2 Determining the Weight of Each Indicator by Fuzzy Analytic Hierarchy Process (FAHP) Method

Analytic Hierarchy Process (AHP) is a system analysis method of combining qualitative analysis with quantitative analysis, which was put forward by Professor A.L.Saaty in 1970s, who was an American operational researcher of the University of Pittsburgh. The key process of AHP is to establish judgment matrix, whether the judgment matrix is reasonable or not, it will directly affect the effect of APH. This method can effectively analyze non-sequential relationship between the level of objective criteria system and comprehensive measurement by the decision maker's judgment and comparison. It is widely used in the fields of society, economy and management etc. because the system is simple and practical (Jibin, L., Yang, X., Liangan, H., & Jiazhong, L., 2006). However, it has the following disadvantages (Jijun, Z., 2000): Firstly, it is difficult to test and judge the consistency of judgment matrix; secondly, there is a significant difference between the consistency of judgment matrix and that of human beings; thirdly, the criteria of the consistency of judgment matrix:  $CR < 0.1$  lacks the scientific evidence; fourthly, when the judgment matrix is not consistent, its adjustment will be very difficult. Nevertheless, FAHP can overcome the above-mentioned disadvantages and it is simpler and more scientific than the traditional AHP.

FAHP firstly constructs a fuzzy consistent matrix by pairwise comparison of the elements of the same layer. In this paper, if Table 2 is used to scale and  $r_{ij} = 1 - r_{ji}$  is true, the constructed judgment matrix  $R = (r_{ij})$  will be fuzzy consistent matrix, that is to say, it is unnecessary to test the consistency of matrix. Then according to the character of fuzzy consistent matrix, the weight of the element in each layer  $w_i$  can be measured as follows.

$$w_i = \frac{1}{n} - \frac{1}{2a} + \frac{1}{na} \times \sum_{k=1}^n r_{ik}, i \in \Omega \quad (1)$$

Where,  $n$  is the order of  $R$ ,  $\Omega = \{1, 2, \dots, n\}$ ,  $a = (n-1)/2$ .

Table 2. 0.1~0.9 quantity scale (Yanmei, Z., & Weihua, L., 2008)

Scale	definition	Description
0.5	Equally important	Compared with each other, two elements are equally important.
0.6	Slightly important	Compared with the other, one element is slightly more important than the other.
0.7	Obviously important	Compared with the other, one element is obviously more important than the other.
0.8	Much more important	Compared with the other, one element is much more important than the other.
0.9	Extremely important	Compared with the other, one element is extremely more important than the other.
0.1,0.2,0.3,0.4	Converse comparison	If comparing the element $a_i$ with the element $a_j$ concludes the judgment $r_{ij}$ , then the compared element $a_j$ concludes the judgment $r_{ji} = 1 - r_{ij}$

### 3.3 Evaluating the Object by Fuzzy Comprehensive Evaluation Method

The advantage of AHP is that it enables the evaluating indicators which are difficult to quantify by other means to be quantitatively analyzed by pairwise comparison, under the condition of the complex structure of judgment targets and the shortage of necessary data. Then it can take the complex evaluating indicators into a clear and easy hierarchical structure which will effectively determine the relative importance of various factors in the evaluating of multi-factor, and to make a further evaluating. However, the disadvantage of APH is the shortage of a unitive and specific indicator quantifying method in the process of judging the targets as a whole. Therefore, in practice, the fuzzy analytic hierarchy process and the fuzzy comprehensive evaluation should be combined together to evaluate the bidding units. Namely, first of all, use the fuzzy analytic hierarchy process to calculate the various indicator weights, and then use the comprehensive evaluation in fuzzy mathematics to make a

comprehensive evaluation.

The fuzzy comprehensive evaluation is to make a comprehensive evaluation of something using the tool of fuzzy mathematics during taking the effect of various factors into consideration (Tao, Z., 2006). We assume that  $U = \{u_1, u_2, u_3, \dots, u_m\}$  is the set of  $m$  elements of describing the evaluated object, and  $V = \{v_1, v_2, v_3, \dots, v_n\}$  is the set of  $n$  judgments of describing the status of each element.

The evaluating indicator to determine the target are decided by  $n$  factors, and can be uniquely defined by  $U$ ,  $U = \{u_1, u_2, u_3, \dots, u_m\}$ ,  $u_i (i = 1, 2, \dots, m)$ , the influence degree of each  $u_i$  is difference for determining the level of critical objects. i.e., their weights are difference, Which distribute the weight is one fuzzy subset of  $U$ , and can be uniquely defined by  $\tilde{W}, \tilde{W} = \{w_1, w_2, \dots, w_m\}$ , where  $w_i$  is the weight of  $u_i$ ,  $w_i \geq 0$ ,  $\sum_{i=1}^m w_i = 1$ . By evaluating the each single fuzzy factor, the fuzzy comprehensive evaluation matrix can be obtained as follows.

$$R = \begin{pmatrix} R_1 \\ R_2 \\ \vdots \\ R_n \end{pmatrix} = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \vdots & \vdots & & \vdots \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix} \tag{2}$$

Where  $R_i = (r_{i1}, r_{i2}, \dots, r_{in})$  is the  $i$ th single factor evaluating of  $u_i$ , so  $r_{ij}$  indicates that the frequency distribution of  $i$ th factor ( $1 \leq i \leq m$ )  $u_i$  in the  $j$ th judgment  $v_j$  ( $1 \leq j \leq n$ ), and generally make it normalization to satisfy with  $\sum_{j=1}^n r_{ij} = 1$ .

The results of comprehensive evaluation can be obtained by the complex calculating as follows.

$$\tilde{G} = \tilde{A} \bullet \tilde{R} = (G_1, G_2, \dots, G_n) \in F(V) \tag{3}$$

Where  $G_j$  indicates that the level of evaluated subject for the set of judgments. i.e., the membership degree of  $v_j$  for fuzzy sets  $\tilde{G}$ . Then starting from the principle of maximum membership degree, in  $G = (G_1, G_2, \dots, G_n)$ ,

Takes its maximum value as the level of evaluating object, and also may according to the formula of fuzzy vector or the principle of weighted averages, each grade were assigned to a certain score, and normalization (Yonghong, H., & Sipin, H., 2001).

#### 4. Comprehensive Evaluations of Banks' QOS

##### 4.1 Determining the Weight of Each Indicator by FAHP

According to the hierarchy structure model in Table 1, make a level's indicator which is relative to previous level's indicator to pairwise comprise by the importance degrees, obtain the fuzzy consistent judgment matrix, the importance degrees of indicator pairwise comprise to determine by the 0.1~0.9 Quantity Scale in Table 2. Then make a level's indicator that relative to previous level's indicator to sort by the importance degrees, obtain the relative weights among all indicators as follows (table 3~table 16).

Table 3. The fuzzy consistent judgment matrix and weight of first evaluating indicator A

Indicator	A	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	w <sub>A</sub>
B <sub>1</sub>		0.5	0.4	0.25	0.217
B <sub>2</sub>		0.6	0.5	0.35	0.317
B <sub>3</sub>		0.75	0.65	0.5	0.467

Table 4. The fuzzy consistent judgment matrix and weight of second evaluating indicator  $B_1$ 

Indicator $B_1$	$C_{11}$	$C_{12}$	$WB_1$
$C_{11}$	0.50	0.40	0.404
$C_{12}$	0.60	0.50	0.596

Table 5. The fuzzy consistent judgment matrix and weight of second evaluating indicator  $B_2$ 

Indicator $B_2$	$C_{11}$	$WB_1$
$C_{11}$	0.50	1

Table 6. The fuzzy consistent judgment matrix and weight of second evaluating indicator  $B_3$ 

Indicator $B_3$	$C_{31}$	$C_{32}$	$C_{33}$	$C_{34}$	$C_{35}$	$C_{36}$	$C_{37}$	$WB_3$
$C_{31}$	0.50	0.30	0.48	0.17	0.29	0.77	0.55	0.121
$C_{32}$	0.70	0.50	0.64	0.65	0.24	0.11	0.71	0.146
$C_{33}$	0.52	0.36	0.50	0.16	0.30	0.15	0.79	0.108
$C_{34}$	0.83	0.35	0.84	0.50	0.68	0.63	0.13	0.165
$C_{35}$	0.71	0.76	0.70	0.32	0.50	0.88	0.48	0.183
$C_{36}$	0.23	0.89	0.85	0.37	0.12	0.50	0.25	0.129
$C_{37}$	0.45	0.29	0.21	0.87	0.52	0.75	0.50	0.147

Table 7. The fuzzy consistent judgment matrix and weight of third evaluating indicator  $C_{11}$ 

Indicator $C_{11}$	$P_{111}$	$P_{112}$	$W_{c11}$
$P_{111}$	0.50	0.30	0.296
$P_{112}$	0.70	0.50	0.700

Table 8. The fuzzy consistent judgment matrix and weight of third evaluating indicator  $C_{12}$ 

Indicator $C_{12}$	$P_{121}$	$P_{122}$	$P_{123}$	$W_{c12}$
$P_{121}$	0.5	0.35	0.55	0.300
$P_{122}$	0.65	0.5	0.75	0.467
$P_{123}$	0.45	0.25	0.5	0.233

Table 9. The fuzzy consistent judgment matrix and weight of third evaluating indicator  $C_{21}$ 

Indicator $C_{21}$	$P_{211}$	$P_{212}$	$P_{213}$	$W_{c21}$
$P_{211}$	0.50	0.20	0.79	0.330
$P_{212}$	0.80	0.50	0.33	0.376
$P_{213}$	0.21	0.67	0.50	0.295

Table 10. The fuzzy consistent judgment matrix and weight of third evaluating indicator  $C_{31}$

Indicator $C_{31}$	$P_{311}$	$P_{312}$	$P_{313}$	$P_{314}$	$w_{c31}$
$P_{311}$	0.50	0.80	0.59	0.71	0.350
$P_{312}$	0.20	0.50	0.68	0.18	0.176
$P_{313}$	0.41	0.32	0.50	0.18	0.152
$P_{314}$	0.29	0.82	0.82	0.50	0.322

Table 11. The fuzzy consistent judgment matrix and weight of third evaluating indicator  $C_{32}$

Indicator $C_{32}$	$P_{321}$	$P_{322}$	$P_{323}$	$w_{c32}$
$P_{321}$	0.50	0.40	0.34	0.245
$P_{322}$	0.60	0.50	0.83	0.478
$P_{323}$	0.66	0.17	0.50	0.277

Table 12. The fuzzy consistent judgment matrix and weight of third evaluating indicator  $C_{33}$

Indicator $C_{33}$	$P_{331}$	$P_{332}$	$P_{333}$	$P_{334}$	$w_{c33}$
$P_{331}$	0.50	0.12	0.79	0.69	0.267
$P_{332}$	0.88	0.50	0.27	0.32	0.245
$P_{333}$	0.21	0.83	0.50	0.77	0.302
$P_{334}$	0.31	0.68	0.23	0.50	0.203

Table 13. The fuzzy consistent judgment matrix and weight of third evaluating indicator  $C_{34}$

Indicator $C_{34}$	$P_{341}$	$P_{342}$	$w_{c34}$
$P_{341}$	0.50	0.61	0.610
$P_{342}$	0.39	0.5	0.390

Table 14. The fuzzy consistent judgment matrix and weight of third evaluating indicator  $C_{35}$

Indicator $C_{35}$	$P_{351}$	$P_{352}$	$P_{353}$	$w_{c35}$
$P_{351}$	0.50	0.73	0.81	0.511
$P_{352}$	0.27	0.50	0.23	0.168
$P_{353}$	0.19	0.77	0.50	0.321

Table 15. The fuzzy consistent judgment matrix and weight of third evaluating indicator  $C_{36}$

Indicator $C_{36}$	$P_{361}$	$P_{362}$	$P_{363}$	$P_{364}$	$w_{c36}$
$P_{361}$	0.50	0.15	0.17	0.48	0.134
$P_{362}$	0.85	0.50	0.29	0.84	0.331
$P_{363}$	0.83	0.71	0.50	0.35	0.314
$P_{364}$	0.52	0.16	0.65	0.50	0.221

Table 16. The fuzzy consistent judgment matrix and weight of third evaluating indicator  $C_{37}$

Indicator $C_{37}$	$P_{371}$	$P_{372}$	$w_{c37}$
$P_{371}$	0.5	0.42	0.420
$P_{372}$	0.58	0.5	0.580

## 4.2 Using Fuzzy Comprehensive Evaluation Method to Evaluate the Listed Banks' Service Quality

### 4.2.1 Determining the Estimation Scales

The evaluation scales were decided by the evaluation committee that includes 10 experts of technical and economic aspects, and given the set of judgments  $V = \{\text{best, better, good, bad, worse}\}$ .

### 4.2.2 Determining the Relation Matrix between the Criteria Layer of $C$ and $V$

Take  $C_{11}$  for example, we assume that  $P_{111} = \{0.2, 0.4, 0.2, 0.1, 0.1\}$  and  $P_{112} = \{0.2, 0.3, 0.2, 0.2, 0.1\}$ , where, Take  $P_{111}$  for example, means 20% of the experts of the evaluation committee determined the Banks' Service Quality is best. 40% are better, 20% are good, and 10% are bad; the rest of 10% are worse. So we can obtain the relation matrix  $R_{c11}$  between the criteria layer of  $C_{11}$  and  $V$  as follows.

$$R_{c11} = \begin{bmatrix} P_{111} \\ P_{112} \end{bmatrix} = \begin{bmatrix} 0.2 & 0.4 & 0.2 & 0.1 & 0.1 \\ 0.2 & 0.3 & 0.2 & 0.2 & 0.1 \end{bmatrix}$$

### 4.2.3 One-Stage Fuzzy Comprehensive Evaluation

As we have calculated the relative weights of  $A, B, C$  hierarchies by FAHP method before, so we can obtain the One-stage fuzzy comprehensive evaluation about  $C_{11}$  as follows.

$$\begin{aligned} C_{11} &= w_{c11} \cdot R_{c11} \\ &= \{0.296, 0.700\} \bullet \begin{bmatrix} 0.2 & 0.4 & 0.2 & 0.1 & 0.1 \\ 0.2 & 0.3 & 0.2 & 0.2 & 0.1 \end{bmatrix} \\ &= (0.20, 0.33, 0.20, 0.17, 0.10) \end{aligned} \quad (4)$$

Where, it means 20% of the experts of the evaluation committee determined the Banks' Service Quality is best. 33% are better, 20% are good, and 17% are bad; the rest of 10% are worse.

In a similar way, the other of one-stage fuzzy comprehensive evaluation about  $C$  hierarchy as follows.

$$C_{12} = (0.17, 0.40, 0.20, 0.13, 0.10)$$

$$C_{21} = (0.13, 0.40, 0.24, 0.17, 0.06)$$

$$C_{31} = (0.18, 0.42, 0.20, 0.17, 0.03)$$

$$C_{32} = (0.20, 0.40, 0.25, 0.13, 0.03)$$

$$C_{33} = (0.18, 0.41, 0.25, 0.13, 0.05)$$

$$C_{34} = (0.16, 0.40, 0.20, 0.14, 0.10)$$

$$C_{35} = (0.15, 0.40, 0.20, 0.18, 0.07)$$

$$C_{36} = (0.19, 0.42, 0.20, 0.14, 0.05)$$

$$C_{37} = (0.20, 0.44, 0.26, 0.10, 0.00)$$

### 4.2.4 Multi-Stage Fuzzy Comprehensive Evaluation

From the result of the previous step, we can obtain the fuzzy matrix between the criteria layer of  $C$  and the set of judgments  $V$  as follows.

$$R_{B1} = \begin{pmatrix} 0.20, 0.33, 0.20, 0.17, 0.10 \\ 0.17, 0.40, 0.20, 0.13, 0.10 \end{pmatrix}$$

$$R_{B2} = (0.13, 0.40, 0.24, 0.17, 0.06)$$

$$R_{B3} = \begin{pmatrix} 0.18, 0.42, 0.20, 0.17, 0.03 \\ 0.20, 0.40, 0.25, 0.13, 0.03 \\ 0.18, 0.41, 0.25, 0.13, 0.05 \\ 0.16, 0.40, 0.20, 0.14, 0.10 \\ 0.15, 0.40, 0.20, 0.18, 0.07 \\ 0.19, 0.42, 0.20, 0.14, 0.05 \\ 0.20, 0.44, 0.26, 0.10, 0.00 \end{pmatrix}$$

The weight of the criteria layer of  $B$  have been calculated from the previous step by FAHP as follows:

$$w_{B1} = (0.404, 0.596) \quad (\text{see Table 4})$$

Based on  $B_1 = w_{B1} \bullet R_{B1}$ , we can calculate the Comprehensive Evaluation of the criteria layer of  $B$  as follows.

$$\begin{aligned} B_1 &= w_{B1} \bullet R_{B1} \quad (5) \\ &= (0.404, 0.596) \begin{bmatrix} 0.20, 0.33, 0.20, 0.17, 0.10 \\ 0.17, 0.40, 0.20, 0.13, 0.10 \end{bmatrix} \\ &= (0.18, 0.37, 0.20, 0.15, 0.10) \end{aligned}$$

In a similar way, the other fuzzy comprehensive evaluation about  $B$  hierarchy can be calculated as follows.

$$B_2 = (0.13, 0.40, 0.24, 0.17, 0.06)$$

$$B_3 = (0.18, 0.41, 0.22, 0.14, 0.05)$$

As above, we can obtain the fuzzy matrix between the layer of targets  $A$  and the set of judgments  $V$  as follows.

$$R_A = \begin{pmatrix} 0.18, 0.37, 0.20, 0.15, 0.10 \\ 0.13, 0.40, 0.24, 0.17, 0.06 \\ 0.18, 0.41, 0.22, 0.14, 0.05 \end{pmatrix}$$

The weights of the target layer of  $A$  have been calculated from the previous step by FAHP as follows.

$$w_A = (0.217, 0.317, 0.467)$$

Finally, we can obtain the result of fuzzy comprehensive evaluation by complex calculating as follow,

$$\begin{aligned} \tilde{G} &= \tilde{A} \bullet \tilde{R} = w_A \bullet R_A \quad (6) \\ &= (0.16, 0.40, 0.22, 0.15, 0.06) \end{aligned}$$

As above which indicated that 16% of the experts determined the bank's QOS are best; 40% are better, 22% are good, 15% are bad, the rest of 6% are worse. According to the maximum membership principle, the bank's QOS should be concluded as better.

## 5. Conclusion

From the analysis and examples of this paper, it is convenient and suitable for banks to apply the AHP and the fuzzy comprehensive evaluation to the evaluation of banks' QOS, which can help banks to make the evaluating more reasonable and largely reduce the effect of the judges' personal subjective factors. Thus the judges can make a more objective evaluating, which is of great significance to promote the fairness, the openness and the impartiality of evaluating.

Banks' QOS is the customers' value judgment. Through analyzing the indices and the factors of affecting banks' QOS, the paper indicates how banks improve their quality of service. Apart from the evaluating indices of banks' QOS, banks should systematically improve their QOS from the bank's product and service through constant innovation, so that banks' service can really meet customers' expectation and constantly enhance the attraction of customers in the increasingly fierce market competition.

## Acknowledgments

The work described in this paper is supported by a grant from the National Nature Science Foundation of Chinese (project no. NSFC 71272177/G020902) and the funds "Innovation Program of Shanghai Municipal Education Commission (project no.12ZS101).

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