Evaluation on FinTech Capability of Municipal Commercial Banks in China

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Keywords: FinTech, Municipal Commercial Bank, Fermatean Fuzzy Sets, TOPSIS.

Abstract: This paper refers to the FinTech development index and related research published by the People's Bank of China, this paper selects 28 listed municipal commercial banks as the research object, based on the 2020 annual report of 28 listed municipal commercial banks, establishes the FinTech capability evaluation index system, uses Fermat fuzzy set for 3 evaluations, uses Fermat fuzzy weighted geometric operator method to obtain comprehensive evaluation, uses AHP method to weight, and then uses TOPSIS method to obtain score. The study found that the commercial banks in the listed cities in East China are generally in the leading position in terms of FinTech capability, and the banks in the leading position in terms of various first-level indicators of FinTech capability are also mostly in East China. Summing up the characteristics of the banks and regions that rank first in FinTech capability, the following inspirations are drawn: Strengthen the FinTech resources investment, service capability, risk control capability, basic capability, research and application capability of municipal commercial banks. The most important of these is research capability. The government should formulate relevant policies and pay attention to the coordinated development of banking FinTech among regions.

1 INTRODUCTION

The core of FinTech is that licensed financial institutions can perfect and innovate financial products, business models and business processes with modern scientific and technological achievements on the premise of complying with the law, so as to improve the quality and efficiency of financial development. In August 2019, the People's Bank of China issued the FinTech Development Plan (2019-2021). It is pointed out that in order to deepen the structural reform on the financial supply side, strengthen the economic capacity of financial service entities and prevent and resolve major financial risks, we must adhere to the innovation-driven development and speed up the deployment of FinTech strategies and the safe application.

The continuous deepening of the development of FinTech in commercial banks has brought unprecedented opportunities as well as huge potential risks. Commercial banks play an important role in the economy. Once risks occur, they will bring huge

impact to the regional or national economy. Therefore, the development of FinTech of commercial banks needs to be paid great attention. Among the listed commercial banks, the six state-owned banks and the ten national joint-stock banks are relatively large in size and complete in FinTech. The rural commercial banks are relatively weak in FinTech due to their different clients. The municipal commercial banks are not only relatively moderate in size but also relatively moderate in FinTech. Municipal commercial banks also play a very important role in their respective regions.

Therefore, this paper takes China's listed municipal commercial banks as the research object, based on the indicators of institutional FinTech development in the Financial Industry Standard of the People's Republic of China issued by the People's Bank of China on October 22nd, 2020, comprehensively considering comprehensiveness, operability and timeliness, and constructs the FinTech capability evaluation system of China's listed municipal commercial banks. After three

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evaluations of the indicators by Fermat fuzzy set, Using Fermat's fuzzy weighted geometric operator method, the three evaluations are aggregated into one comprehensive evaluation. After weighting by AHP, the scores of each index and the scores of each bank are calculated by TOPSIS method. Select 30 indicators to construct the evaluation system of FinTech capability of commercial banks in listed cities in China, and make a micro-evaluation of FinTech capability of commercial banks in listed cities in China.

2 RELEVANT RESEARCHES

With the research of Burrell and Morgan (Burrell, Morgan, 1979) as the combing frame, the research on FinTech can be divided into four categories according to the nature of society and science, namely, order change and objective subjectivity: functional form-objective order, radical structural form-objective change, interpretive form-subjective order, radical humanistic form-subjective change. Haddad et al. (Haddad, et al, 2019) discussed the technological determinants of FinTech enterprises in their initial stage and the framework and strategies of FinTech platform, which belongs to functional research. The main research issue is to discuss what FinTech is; Yang (Yang, 2018) proposed to add a science and technology dimension as a supplement to the traditional supervision, and to conduct supervision from two dimensions, and the science and technology supervision dimension should focus on data supervision, which belongs to a radical structural research, mainly discussing how to develop a new FinTech system and provide a set of solutions to practical problems; Li et al. (Li, et al, 2020) studied FinTech from the perspective of innovation, and examined the function and influence mechanism of FinTech on enterprise innovation of China's new third board listed companies, which belongs to the hermeneutic research, mainly discussing the function mechanism and logic of FinTech; Wang and Huang (Wang, Huang, 2018) based on tools such as sentiment analysis and news analysis, build a FinTech evaluation system, obtain data from public platforms such as social media and news reports for processing, measure the sentiment of the market and its investors, and predict relevant trends. It belongs to radical humanistic research, which is mainly conducted from the aspect of human behaviour.

The number of high-level academic journals searched on the title of bank and FinTech on CNKI is only 103. Among them, there are 22 articles whose titles contain impact, mainly studying the impact of FinTech on banks (Qiu, et al, 2018, Sun, 2018); The title of 14 articles includes transformation, which mainly studies the transformation of banks under the background of FinTech (Xie, et al, 2018, Wang & Wang, 2017). Other articles are mostly focused on these two aspects, and for the evaluation of the bank's FinTech capability, only one article, such as Lin Sheng, was retrieved. Lin et al. (Lin, et al, 2020) took 29 globally systemically important banks as the research object, constructed the FinTech evaluation system from 7 aspects, evaluated the FinTech capability with the analytic hierarchy process, carried out comparative analysis, and put forward corresponding suggestions for the development of banking FinTech based on the results of comparative analysis. It can be seen that at present, the research on the evaluation of banks' FinTech capability is still very scarce, while the research on the evaluation of China's listed local commercial banks' FinTech capability still has certain deficiencies. Therefore, the research in this paper has certain theoretical and innovative significance.

3 FERMATEAN FUZZY SETS

Definition: Let X be a universe of discourse. A Fermatean fuzzy set F in X is an object having the form F={<x, αF(x),βF(x)>:x∈X}, where αF(x):X→[0,1] and βF(x):X→[0,1],including the condition $0 \leqq (\alpha F(x))3+(\beta F(x))3 \leqq 1$, for all x ∈ X. The numbers αF(x) and βF(x) denote, respectively, the degree of membership and the degree of non-membership of the element x in the set F. For any FFS F and x∈X, πF(x)= $\sqrt[3]{1 - [\alpha_F(x)]^3 - [\beta_F(x)]^3}$ is identified as the degree of indeterminacy of x to F (Senapati & Yager 2020).

Fermatean fuzzy sets is an improvement on the traditional fuzzy set (Atanassov 1986, Yager 2013), which expands the scope of fuzzy set on the original basis. As shown in Figure 1, its advantages are more intuitive.
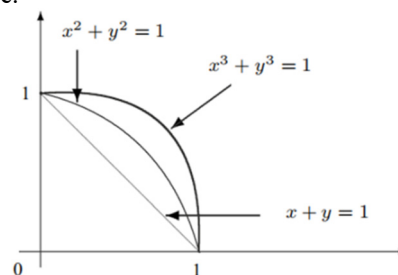

Figure 1: Fermatean fuzzy sets.

4 RELEVANT RESEARCHES

In this paper, Fermatean fuzzy TOPSIS method is mainly applied, and preference aggregation is combined with Pythagorean fuzzy weighted geometric operator (Yang, et al, 2019). Hesitant fuzzy language is an effective form of information expression, which can well reflect people's qualitative and hesitant decision-making information (Wu, et al, 2021).

The specific calculation process is as follows:

Firstly, three evaluations are carried out by using Fermatean fuzzy sets.

$$R = (C_j(S_i))_{m \cdot n} = \begin{pmatrix} & C_1 & C_2 & \cdots & C_n \\ S_1 & (u_{11},v_{11}) & (u_{12},v_{12}) & \cdots & (u_{1n},v_{1n}) \\ S_2 & (u_{21},v_{21}) & (u_{22},v_{22}) & \cdots & (u_{2n},v_{2n}) \\ \vdots & \vdots & \vdots & \ddots & \cdots \\ S_m & (u_{m1},v_{m1}) & (u_{m2},v_{m2}) & \cdots & (u_{mn},v_{mn}) \end{pmatrix} \quad (1)$$

Where u is satisfaction degree, v is disappointment degree, m is evaluation object, n is evaluation index.

After three evaluations, the three evaluation values are combined into one preference by using Fermatean fuzzy weighted set operator. The Fermatean fuzzy weighted geometry (FFWG) operator is defined according to the Pythagorean fuzzy weighted geometry (PFWG) operator (Yager & Abbasov 2013, Yager 2014, Peng & Yang 2015) and the Fermatean fuzzy sets, the formula is as follows:

$$FFWG(\alpha_1, \alpha_2, \cdots, \alpha_n) = (\prod_{i=1}^{n} u_i^{w_i}, \sqrt[3]{1 - \prod_{i=1}^{n}(1-v_i^3)^{w_i}}) \quad (2)$$

Among them, the proportion of three evaluations w_i is 0.4, 0.3 and 0.3 respectively.

Then calculate the score.

$$score(C_j(S_i)) = u_{ij}^3 - v_{ij}^3 \quad (3)$$

Confirm the optimal scheme S+ and the worst scheme S-.

$$S^+ = \begin{cases} \max_i score(C_j(S_i)), C_j positive \\ \min_i score(C_j(S_i)), C_j negative \end{cases} = \{(u_1^+,v_1^+) \quad (u_2^+,v_2^+) \quad \cdots \quad (u_n^+,v_n^+)\} \quad (4)$$

$$S^- = \begin{cases} \min_i score(C_j(S_i)), C_j positive \\ \max_i score(C_j(S_i)), C_j negative \end{cases} = \{(u_1^-,v_1^-) \quad (u_2^-,v_2^-) \quad \cdots \quad (u_n^-,v_n^-)\} \quad (5)$$

Calculating the distance from each evaluation to S+ and S- and summing up.

$$D(S_i,S^+) = \frac{1}{2}\sum_{j=1}^{n} w_j \sqrt{\frac{1}{2}\left[(u_{ij}^3-(u_j^+)^3)^2+(v_{ij}^3-(v_j^+)^3)^2+(u_{ij}^3+v_{ij}^3-(u_j^+)^3-(v_j^+)^3)^2\right]} \quad (6)$$

$$D(S_i,S^-) = \frac{1}{2}\sum_{j=1}^{n} w_j \sqrt{\frac{1}{2}\left[(u_{ij}^3-(u_j^-)^3)^2+(v_{ij}^3-(v_j^-)^3)^2+(u_{ij}^3+v_{ij}^3-(u_j^-)^3-(v_j^-)^3)^2\right]} \quad (7)$$

w_j is the weight of each index, calculated by using analytic hierarchy process (AHP).

Finally get a score.

$$RC(S_i) = \frac{D(S_i, S^-)}{D(S_i, S^-) + D(S_i, S^+)} \quad (8)$$

5 INDEX SYSTEM

Based on the institutional FinTech development indicators in the "Financial Industry Standard of the People's Republic of China" issued by the People's Bank of China on October 22, 2020, combined with the relevant research of Lin Sheng and others, and considering comprehensively the comprehensiveness, representativeness, scientificalness, operability and timeliness, this paper constructs the FinTech level evaluation system of China's listed commercial banks. As shown in Table 1, a total of 6 first-level indicators and 30 second-level indexes are used as the evaluation basis for the FinTech level of China's listed commercial banks.

Table 1: Index system of FinTech capability.

First-level index	Second-level index
Resource input	FinTech focus
	FinTech development function
	Percentage of investment in FinTech
	Percentage of FinTech personnel
	FinTech-related training attention
Service capability	Number of mobile banking users
	Bank staff
	Total turnover
	Total profit
	Ratio of mobile banking users to total users
	Ratio of mobile banking users to bank employees
	Average employee profit
	Average turnover of employees
	Banking attention
	Number of bank branches
	Bachelor degree rate of banking staff
	Graduate and above proportion of bank staff
Risk control capability	Tier 1 capital rate
	Non-performing loan rate
	Capital adequacy ratio
	Risk exposure ratio
Basic capability	Asset size

First-level index	Second-level index
	Net profit
	Net profit growth rate
	ROA
	ROE
Research capability	Number of patents
	IPC patents
Application capability	FinTech related awards
	Information technology development

FinTech focus refers to the frequency of FinTech in the annual report. The FinTech development function refers to whether relevant departments are established. FinTech-related training attention refers to the frequency of training in the annual report. Banking attention refers to the frequency of service in the annual report. FinTech related awards refer to the number of FinTech related awards received in the annual report. Information technology development refers to the frequency of information technology in the annual report.

The data in this paper are mainly from the 2020 annual report published by various banks, supplemented by internet search, in which patent-related data are from the State Intellectual Property Office and refer to the patent applications after January 1, 2020. The missing values are evaluated by approximate values.

6 RESULTS AND ANALYSIS

Establishing a matrix according to the formula (1) to obtain three evaluation matrixes, synthesizing the three evaluation matrixes into one evaluation matrix according to the formula (2), calculating the scores of each index of each bank by using the formula (3), determining the optimal scheme and the worst scheme by using the formula (4) and the formula (5) according to the score situation, calculating the distance from each evaluation value to the optimal scheme and the worst scheme by using the formula (6) and the formula (7) and summing up, and finally calculating the scores of each bank by using the formula (8) and ranking, the results are shown in Table 2.

Table 2: Score and ranking of FinTech capability.

Bank	Score	Ranking
Shanghai	0.509358	1
Chongqing	0.491643	2
Zhongyuan	0.489337	3
Hangzhou	0.442895	4
Beijing	0.416211	5
Ningbo	0.415359	6
Nanjing	0.410792	7
Huishang	0.408684	8
Jiangsu	0.407023	9
Jiangxi	0.403569	10
Luzhou	0.401217	11
Changsha	0.394509	12
Chengdu	0.388694	13
Guiyang	0.381703	14
Qingdao	0.381655	15
Gansu	0.378831	16
Xian	0.378459	17
Xiamen	0.372064	18
Suzhou	0.372017	19
Tianjin	0.364058	20
Zhengzhou	0.363532	21
Weihai	0.361962	22
Guizhou	0.360259	23
Haerbin	0.356358	24
Jiujiang	0.35547	25
Jinshang	0.349468	26
Jinzhou	0.348694	27
Shengjing	0.345607	28

Among the 28 listed municipal commercial banks, the bank of Shanghai scored the highest, 0.5094; The bank with the lowest score was Jiangyin Bank, with 0.3456, and the extremely poor score was 0.1638. On the whole, the scores are clearly distinguishable.

The average score of 28 listed municipal commercial banks is 0.3946, with a median of 0.3817. The banks closest to the median are Bank of Guiyang and Bank of Qingdao, with the corresponding ranking of 14 and 25 among the 28 banks respectively. The average score is 0.0129 points higher than the median, and the difference is small, which indicates that the overall distribution of scores is relatively uniform.

The variance of the scores of 28 listed municipal commercial banks is 0.0018 and the standard

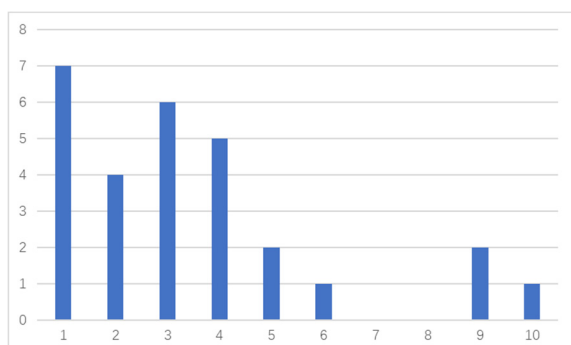deviation is 0.0427, which indicates that the dispersion of the scores is more appropriate.

Figure 2: Ranking chart of FinTech capability.

According to the score range of 0.1638, the scores of 28 listed local commercial banks are divided into 10 grades. The number of banks falling within these 10 grades is: 7, 4, 6, 5, 2, 1, 0, 0, 2 and 1 respectively. As shown in Figure 2, the scores of the vast majority of banks are concentrated in another 1-4 grades, which shows that the vast majority of banks have relatively low FinTech capability.

Generally speaking, listed municipal commercial banks have low FinTech capability; By region, the listed city firms in East China rank ahead in FinTech. Among the top 10 banks with FinTech capability of listed municipal commercial banks, there are 7 in East China and 1 each in Southwest, North and Central China. The highest ranked bank in the northeast is Harbin Bank, which ranks 24th. The highest ranked bank in the Northwest is Bank of Gansu, which ranks 16th.

The outstanding performance of FinTech capability of listed municipal commercial banks in East China reflects the leading advantages of East China in FinTech. East China, especially the Jiangsu, Zhejiang and Shanghai regions, is represented by a large number of listed local commercial banks and a well-developed regional economy. It is the economic centre of China. In terms of policy, since the economic opening policy is also relatively open, FinTech innovation is encouraged on the premise of risk prevention; In terms of science and technology, the regional economy is developed, there are many universities and colleges, and there are many talents. They are actively exploring in the research and development and application of many emerging technologies, and have certain advantages in starting first. In the market, the regional market is open and has a high acceptance of FinTech-related service innovation, and there is a huge space for financial market expansion. Listed municipal commercial banks in other regions can refer to the development experience in East China to improve their FinTech capability.

7 CONCLUSIONS

7.1 Resources Investment

In terms of investment in FinTech resources, Bank of Hangzhou and Bank of Beijing are significantly ahead of other banks, with five banks in East China in the top ten, and the municipal commercial banks in East China are generally ahead of other regions. Although the East China region as a whole has a leading edge, the Bank of Beijing ranks second, far ahead of other banks. The reason is that the Bank of Beijing owns its own FinTech company. Although Hangzhou Bank, which ranks first, does not have a FinTech company, its development in FinTech talents is far ahead of other banks.

Therefore, each bank can make reference to the experience of the two banks and make efforts in terms of strategy, capital and talents to increase the investment in FinTech resources and enhance their own FinTech Capability. In particular, we should pay attention to the investment in strategy and talents. FinTech companies should be established if conditions permit, and FinTech departments should be actively established if conditions do not permit, and professional management should be implemented. At the same time, we should actively introduce FinTech personnel.

7.2 Services

In terms of FinTech service capability, Bank of Shanghai is significantly ahead of other banks, with six banks in East China in the top 10, and banks in East China are generally ahead of other regions. As for the FinTech service capability of listed municipal commercial banks, East China has a clear leading advantage. The main reason why Shanghai Bank, which ranks first, came first is that it ranks first in all its indicators and has a strong comprehensive capability.

Banks can refer to the above banking experience and focus on the development of mobile banking to enhance service focus, expand service coverage while saving costs and improve service Capability. In the process of development, pay attention to efficiency, can optimize the personnel structure, improve the proportion of highly educated, enhance service at the

same time, reduce expenses, achieve the purpose of improving service capability.

7.3 Risk Control and Basic Capability

In terms of FinTech risk control capability, banks in Bank of Ningbo and Hangzhou are significantly ahead of other banks, and they are also on a ladder, while the gap between other banks is not big. There are 6 banks in East China in the top 10, and they are all in the top 3 with obvious advantages. In terms of basic FinTech Capability, the East China region as a whole is in the lead, with six of the top 10 banks all located in the East China region. In terms of FinTech, risk control and basic Capability, the listed municipal commercial banks in East China have obvious leading advantages.

The indicators under risk control and basic capability are both the basic indicators of banks and the foundation of banks. At the same time, they are also the necessary premise for banks to carry out FinTech. Only based on solid foundation can FinTech be carried out smoothly. However, attention should also be paid to the issue of efficiency. On the premise of ensuring safe risk control and basic Capability, FinTech should be actively developed to achieve high efficiency in resource allocation, instead of excessively concentrating large amounts of idle resources in risk control.

7.4 Research and Application

In terms of FinTech research and development capability, Zhong Yuan Bank's score is far ahead of other banks. Among the top 8 banks, there are 4 banks in East China, 2 banks in Southwest China and 2 banks in Central China, which shows that Southwest China and Central China pay relatively much attention to FinTech research and development to make up for their own shortcomings. On the whole, the banks in the Southwest, Central and East China regions have certain leading advantages over other regions in terms of FinTech research and development capability. In terms of FinTech application capability, the East China region ranks high, with five of the top 10 banks located in East China and ranking No.1 in Jiangxi having significant scoring advantages.

In terms of FinTech research and development and application Capability of listed municipal commercial banks, the East China region has obvious advantages. Among the research and development Capability, the Southwest region and the Central China region have excellent performance, which is mainly due to their attention to patents. The number of patents applied for has obvious advantages. The number of patents applied for by Zhong Yuan Bank is as high as 13, ranking first. Therefore, banks should strengthen their research and development Capability and increase the number of patent applications, so as to enhance the banking FinTech Capability. In terms of application, it should pay more attention to information technology, actively carry out relevant businesses, and actively innovate and research and develop under the premise of effective risk control, so as to obtain awards from relevant institutions or media, thus demonstrating the effectiveness of FinTech application.

Finally, the most important thing is the banks' own technical capability, and each bank should improve its technical capability most. In addition, the government should pay attention to the coordinated development among regions so as to formulate corresponding policies. The research in this paper still has some problems such as single sample, short time and no further analysis. In the future, the scope and time of the research can be expanded based on the research in this paper, so as to further increase the accuracy of the research and conduct more in-depth research.

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