

Analysis of Economic Benefits of China's Joint-Stock Commercial Banks based on Two-Stage Network DEA and DEA-Malmquist

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Abstract:

Commercial banks are both financial institutions and independent economic entities. Therefore, commercial banks need to pay attention to their own operating efficiency while serving the real economy. On the one hand, it is responsible to all shareholders to ensure their investment interests; On the other hand, it is necessary to safeguard the survival and development of the enterprise. Objective evaluation of commercial banks' economic benefits is of great practical significance in promoting China's commercial banks to improve their capital operation efficiency, improve corporate governance, enhance the level of financial system services to the real economy, and promote their own healthy development. Based on super-efficient DEA and DEA-Malmquist method, this paper establishes a new network DEA model. By measuring some indicators of 10 commercial banks in China from 2017 to 2020, it is found that the network DEA model can better measure the economic benefits of commercial banks in China than the single-stage DEA model. The study found that China's commercial banks have been groping for development in the process of reform, but have not yet reached the optimal scale of operation. The overall scale efficiency is low and the operating efficiency needs to be improved.

Keywords: Commercial banks, Economic efficiency, Two-stage network DEA, DEA-Malmquist.

I. INTRODUCTION

The business of commercial banks in our country is particularly suitable for digitalization. However, in reality, the technological development and application of banks are far less than the latest developed technologies. Data Envelopment Analysis (DEA) is an interdisciplinary science that integrates operations research, economics and management. It is a powerful tool for solving multi-input and multi-output optimization problems. At present, there is no unified conclusion on the selection of efficiency value analysis indicators of commercial banks in the academic community. Based on the actual situation of China's commercial banks, this paper divides the bank's operating process into two stages: deposit and profit, analyzes multiple indicators, and uses the two-stage network DEA model to find out the reasons for its low efficiency.

Many literatures study the impact and impact of bank investment indicators on the economic efficiency of the entire banking industry and commercial banks from the perspectives of labor force, staff salaries payable, net loans and total bank assets. Scholar Xue Jianhan (2021) thinks that the level of pure technical efficiency and scale efficiency are the main factors that affect the economic efficiency of commercial banks, among which the selected indicators include operating personnel, investment in fixed assets and management expenses [1]. Wang Meiqiang et al. (2021) analyzed the bank's overall operating efficiency using indicators such as return on assets, asset size, capital adequacy ratio and handling fee and Commission expenses, and reasonably measured the operating efficiency of China's commercial banks [2]. Liu Yi (2020) introduced the input factor price to construct the Malmquist index model of total factor productivity under the framework of cost efficiency and allocation efficiency. The research found that the low cost efficiency of commercial banks is mainly due to the change of technical efficiency and allocation efficiency [3].

Referring to its five indicators of staff number, fixed assets, operating expenses, taxes payable and total loans as input indicators, and three indicators of total deposits, net profit and operating profit as output variables, this paper studies and analyzes the economic benefits of some listed banks and joint-stock commercial banks in China by using super-efficiency DEA and DEA-Malmquist.

The structure of this paper is as follows: The first section introduces the research background motivation, research process and relevant literature. The second section is the research method, which introduces the relevant theories of super-efficient DEA and DEA-Malmquist. The third section is about the selection of variables and data sources, introducing the variables and the reasons for the selection of variables. The fourth section is empirical analysis, which introduces the empirical process and analysis results. The fifth section is conclusion and suggestion, introduction and summary, and contribution of the paper.

II. METHODS

2.1 Sample Description

This paper selects the data of 10 banks from 2017 to 2020. The 10 commercial banks are Bank of Communications, Industrial and Commercial Bank, China Construction Bank, Agricultural Bank, Bank of China, China Merchants Bank, Huaxia Bank, China Everbright Bank, Pudong Development Bank and China CITIC Bank in turn. As shown in TABLE I, the selected indicators and indicator settings are as follows:

TABLE I. Province codes

Each bank code	
serial number	bank
one	Bank of Communications

two	Industrial and Commercial Bank of China (ICBC)
three	Construction Bank
four	agricultural bank
five	Bank of China
six	China Merchants Bank
seven	Huaxia Bank
eight	Everbright Bank
nine	Shanghai Pudong Development Bank
ten	China Citic Bank

The input/output variable settings of the two-stage network DEA are shown in TABLE II.

TABLE II. Input/output indicators of stage network DEA

Indicator type	index	variable	maximum	minimum value
invest	Number of employees	HC	496698	38948
invest	fixed assets	PPE	25352500	1137200
invest	revenue expenditure	NBE	49128300	3790600
invest	Taxes payable	TAX	10960100	450100
intermediate variable	total deposits	CIB	248667.85	13683
invest	Total loans	LOANS	186243.08	12166.54
output	net profit	NP	31768500	1975600
output	trading profit	POT	39138200	2611700

The input/output variable settings of DEA-Malmquist are shown in TABLE III.

TABLE III. Input/output of DEA-Malmquist

Indicator type	index	variable	maximum	minimum value
invest	Number of employees	HC	496698	38948
invest	fixed assets	PPE	25352500	1137200
invest	revenue expenditure	NBE	49128300	3790600
invest	Taxes payable	TAX	10960100	450100
output	total deposits	CIB	248667.85	13683
invest	Total loans	LOANS	186243.08	12166.54
output	net profit	NP	31768500	1975600
output	trading profit	POT	39138200	2611700

2.2 Two-Stage Network DEA

Liu Qian (2020) through the establishment of a new network DEA model. Based on the actual situation of commercial banks in China, the operation process of commercial banks is divided into two stages: deposit obtaining and profit making, and the reasons for their low efficiency are found [4]. By measuring the overall efficiency of 15 banks in China in 2017, it is found that the network DEA model can better distinguish the efficiency of China's banks than the single-stage DEA model. Therefore, this paper also divides the business process of commercial banks into deposit stage and profit stage, and studies its operating efficiency.

The specific model of the two-stage network DEA is constructed as follows: assuming that there are d influencing factors, each influencing factor has m inputs and m outputs and f intermediate outputs, among which: X_i is the input of the I influencing factor (DMU), $X_i = (x_{i1}, x_{i2}, \dots, x_{im})^T$ is the number of employees of commercial banks, fixed assets and operating expenses of commercial banks, etc.; Z_i is the output of the first stage of decision unit I and the input of the second stage, i.e. total commercial bank deposits; $Z_i = (z_{i1}, z_{i2}, \dots, z_{if})^T$; Y_i is the output of the second-stage capital allocation system, $Y_i = (y_{i1}, y_{i2}, \dots, y_{im})^T$ is the operating profit and net profit of commercial banks, $R = (r_1, r_2, \dots, r_m)$, $S = (s_1, s_2, \dots, s_n)$, $H = (h_1, h_2, \dots, h_f)$ respectively represent the weights of input, intermediate and output indicators.

$$\left\{ \begin{array}{l} R \geq \varepsilon e, S \geq \varepsilon e, T \geq \varepsilon e \\ X_0 R^T = 1 \\ H^T Z_i - R^T X_i \leq 0 \\ \text{s. t. } P^T Z_i - R^T X_i \leq 0 \\ H^T Y_i - S^T Z_i \leq 0 \end{array} \right.$$

Where: ε is a non-Archimedean infinitesimal, $e = (1, 1, \dots, 1)$. If R^*, S^*, H^* is the optimal solution of the model, then the efficiency of the DMU as a whole and sub-processes are respectively, where E_0 is the integral stage, E_1 and E_2 are the first and second stages respectively, and $E_0 = E_1 \times E_2$. $E_0 = H^* \times T \times Y_0 \times R^* \times T \times X_0$, $E_1 = H \times T \times Z_0 \times R^* \times T \times X_0$, $E_2 = H^* \times T \times Y_0 \times R^* \times T \times Z_0$

2.3 DEA-Malmquist

Scholars Lin Yu et al (2020) used the mining method to construct the technology and finance index, combined with the DEA-Malmquist index analysis to measure the total factor productivity, technological progress efficiency and technological efficiency change index of 19 commercial banks in China from 2011 to 2018, and established a multiple regression model to explore the impact mechanism of financial technology on the efficiency of commercial banks in the era of big data [5]. This paper uses this method for reference to study which factors and indicators can improve the operating efficiency of commercial banks.

In 1994, Rolfar et al. combined a nonparametric linear programming method of the Malmquist index theory with the theory of data envelopment analysis, which made the Malmquist index widely used in the

world. The specific formula is as follows:

Suppose (x_t, y_t) represents the input and output of stage T, (x_{t+1}, y_{t+1}) represents the input and output of stage t+1, and $D_0(x_{t+1}, y_{t+1})/D_0(x_t, y_t)$ represents the change in technical efficiency from stage T to stage T+1 under the technical conditions of stage T; Where subscript 0 indicates constant return on scale. The Malmquist index can be expressed by the following formula:

$$\frac{D_0(x^{t+1}, y^{t+1})}{D_0(x^t, y^t) \times D_{0t}(x^{t+1}, y^{t+1})} \times \frac{D_{0t+1}(x^{t+1}, y^{t+1})}{D_{0t+1}(x^t, y^t)^{\frac{1}{2}}} = M_0(x^t, y^t, x^{t+1}, y^{t+1})$$

Malmquist can also be divided into two parts: technical efficiency and change. The specific formula is as follows:

$$\frac{D_{0t+1}(x^{t+1}, y^{t+1})}{D_0(x^t, y^t)} = EC$$

$$\frac{D_{0t}(x_0^{t+1}, y_0^{t+1})}{D_0(x_0^{t+1}, y_0^{t+1})} \times \frac{D_{0t+1}(x_0^{t+1}, y_0^{t+1})}{D_0(x_0^t, y_0^t)} = TC$$

$$M = TC \times SEC \times PEC = TC \times EC$$

TC mainly reflects the degree of influence of technological progress on DMU. If $TC > 1$ indicates technological progress and $TC \leq 1$, it indicates that there is no progress or retrogression in technology and technology needs to be further improved; SEC reaction scale efficiency, if $sec > 1$, indicates optimal scale, $SEC \leq 1$ indicates deviation from optimal scale; The pure technical efficiency of PEC reaction, if $PEC > 1$, indicates that the pure technical efficiency is increasing, and $PEC \leq 1$, indicates that the technical efficiency is decreasing.

III. VARIABLE SELECTION AND DATA SOURCES

3.1 Input Variables and Intermediate Variables

According to the characteristics of China's commercial banks and the research method of scholar Liu Juan (2021) [6], we select the number of employees, fixed assets, operating expenses, taxes payable and total loans as input variables. Staff is the labor input of banks, and the number of staff is the capital to measure the labor input of commercial banks; Fixed assets are the foundation and premise of bank operation, and are important physical inputs in business activities. Operating expenses are the expenses in the business process of commercial banks, which specifically include operating expenses, management expenses and financial expenses, and are indicators used to measure the operating conditions of commercial banks. Due taxes and fees are the fees that commercial banks have to pay for their operations. Because banks of different natures will have different national preferential policies, therefore, this paper

takes due taxes and fees as one of the variables. Total loans are a major part of the business segment of commercial banks. The size of total loans indicates the asset business of commercial banks and is linked to operating risks.

In this paper, the total deposit as an intermediate variable, deposit is a kind of trust behavior of the public to deposit funds in the bank based on the trust of the bank. The deposit business is the foundation of commercial banks and the premise and foundation of realizing other business. It directly determines the future spread income and economic benefits of commercial banks.

3.2 Output Variables

Net profit and operating profit are selected as output variables.

Operating profit reflects the business activities of commercial banks. It is the revenue obtained by commercial banks from lending, settlement and leasing, trust investment and securities trading. It can timely reflect the problems reflected in the operating table of commercial banks. For this reason, this paper takes operating profit as one of the output variables.

Net profit is the net income of commercial banks after paying income tax on the total profit, which can reflect the preferential policies of the state for banks of different natures and better explain the difference between the earnings of listed banks and those of joint-stock banks.

3.3 Data Sources

Based on the completeness and availability of the data, 10 listed commercial banks are selected as the research object, among which 5 are joint-stock commercial banks. The data are extracted from the banks' annual reports from 2017 to 2020 in WIND database.

IV. EMPIRICAL ANALYSIS

Scholar Zhao Fu et al. (2021) measured and analyzed the operating efficiency of city commercial banks by selecting the relevant data of four major large city commercial banks in a province and using DEA data envelopment analysis method. This paper studies the operation efficiency of a commercial bank in a certain province and puts forward some countermeasures to improve the operation efficiency of the bank [7]. This paper studies the impact of various input factors on the overall operating efficiency of banks by using the empirical analysis method of the paper.

4.1 Two-Stage Network DEA

TABLE IV. Two-stage Network DEA Results

Year	DMU	Score	Year	DMU	Score
2017	one	0.7977	2019	one	0.7585
2017	two	0.8180	2019	two	0.9996
2017	three	0.9047	2019	three	0.9327
2017	four	0.7927	2019	four	0.7817
2017	five	0.9713	2019	five	0.8027
2017	six	0.7005	2019	six	0.9521
2017	seven	0.8048	2019	seven	0.6875
2017	eight	0.7128	2019	eight	0.7072
2017	nine	1.0096	2019	nine	0.9176
2017	ten	0.9231	2019	ten	0.6717
2018	one	0.7245	2020	one	0.8432
2018	two	0.8513	2020	two	1.0660
2018	three	0.8635	2020	three	0.9670
2018	four	0.7356	2020	four	0.7939
2018	five	0.7482	2020	five	0.8721
2018	six	0.9659	2020	six	0.9491
2018	seven	0.6316	2020	seven	0.7776
2018	eight	0.6573	2020	eight	0.7628
2018	nine	0.8234	2020	nine	0.9586
2018	ten	0.6476	2020	ten	0.7385

As can be seen from TABLE IV, the operating efficiency of the 10 banks in 2017-2020 showed an overall upward trend in 2017-2020, but the efficiency of many banks decreased in 2018; Among them, the efficiency of Bank of China, Huaxia Bank, Pudong Development Bank and CITIC Bank in 2020 was lower than that in 2017, and only the operating efficiency of ICBC was increasing every year; In addition, the efficiency of CITIC Bank in 2018 was 0.6476, representing a 30% decrease as compared with that of 2017. The efficiency of Bank of China in 2018 was 0.7482, representing a 23% decrease as compared with that of 2017. The efficiency of ICBC and China Merchants Bank in 2018 were 0.8513 and 0.9659 respectively, representing a 4% and 38% increase as compared with that of 2017.

TABLE V. Two-stage Network DEA Results

Year	Node	DMU	Score	Year	Node	DMU	Score
2017	one	one	0.6862	2019	one	one	0.7402
2017	one	two	0.7793	2019	one	two	0.9992
2017	one	three	0.8566	2019	one	three	0.8786

2017	one	four	0.8003	2019	one	four	0.6876
2017	one	five	0.9426	2019	one	five	0.7598
2017	one	six	0.7240	2019	one	six	0.9042
2017	one	seven	0.8092	2019	one	seven	0.6832
2017	one	eight	0.7041	2019	one	eight	0.6723
2017	one	nine	1.0000	2019	one	nine	0.9577
2017	one	ten	0.9773	2019	one	ten	0.6938
2017	two	one	0.9092	2019	two	one	0.7768
2017	two	two	0.8568	2019	two	two	1.0000
2017	two	three	0.9529	2019	two	three	0.9868
2017	two	four	0.7851	2019	two	four	0.8758
2017	two	five	1.0000	2019	two	five	0.8456
2017	two	six	0.6769	2019	two	six	1.0000
2017	two	seven	0.8005	2019	two	seven	0.6917
2017	two	eight	0.7216	2019	two	eight	0.7421
2017	two	nine	1.0000	2019	two	nine	0.8775
2017	two	ten	0.8689	2019	two	ten	0.6497
2018	one	one	0.7055	2020	one	one	0.9067
2018	one	two	0.7598	2020	one	two	1.0000
2018	one	three	0.8221	2020	one	three	0.9991
2018	one	four	0.6435	2020	one	four	0.7791
2018	one	five	0.7040	2020	one	five	0.9156
2018	one	six	0.9319	2020	one	six	0.8982
2018	one	seven	0.6302	2020	one	seven	0.9151
2018	one	eight	0.6368	2020	one	eight	0.8089
2018	one	nine	0.8720	2020	one	nine	1.0000
2018	one	ten	0.6832	2020	one	ten	0.8353
2018	two	one	0.7435	2020	two	one	0.7797
2018	two	two	0.9428	2020	two	two	1.0000
2018	two	three	0.9050	2020	two	three	0.9349
2018	two	four	0.8277	2020	two	four	0.8087
2018	two	five	0.7923	2020	two	five	0.8287
2018	two	six	1.0000	2020	two	six	1.0000
2018	two	seven	0.6330	2020	two	seven	0.6401
2018	two	eight	0.6777	2020	two	eight	0.7167
2018	two	nine	0.7749	2020	two	nine	0.9171
2018	two	ten	0.6120	2020	two	ten	0.6417

As shown in TABLE V, the overall effect of the operation efficiency of the first stage banks in the period of 2017-2019 is not as good as that of the second stage, although all of them exceed 0.5, but many

of them are below 0.8. The efficiency of the second stage is relatively good, and many of them are close to 1 and reach 1, indicating that the first stage is the one that causes the overall efficiency of the bank operation to be poor; Among them, the operating efficiency of China Merchants Bank reached 1 in the second stage from 2018 to 2020, the operating efficiency of Pudong Development Bank reached 1 in both stages of 2017 and reached 1 in the first stage of 2020, the operating efficiency of Industrial and Commercial Bank of China reached 1 in both stages of 2020 and reached 1 in the second stage of 2019, and the operating efficiency of Bank of China reached 1 in the second stage of 2017; In addition, the efficiency in the first stage of 2017-2020 showed an upward trend, indicating that the overall efficiency of banking operations is gradually improving.

4.2.DEA – Malmquist

Scholar Wang ChiaNan (2021) Real estate management and its operation play a crucial role in supporting the operation of the company. With the rapid growth of enterprises, the real estate investment portfolio has expanded dramatically, attracting a large number of domestic and foreign investors. This paper takes the top 12 real estate companies listed on the Vietnamese stock market as the research object, and uses the method of combining the grey method and the data envelopment analysis (DEA) Malmquist model to forecast and evaluate their performance in the two periods of 2015-2018 and 2019-2022 [8]. This paper analyzes the input factors by learning the method of evidence-based analysis, so as to obtain the impact of each factor on the bank's operating efficiency.

TABLE VI. DEA-Malmquist results

t(Period)	DMU	MI(t-1, t)	PEC(t-1, t)	SEC(t-1, t)	TC(t-1, t)
2017	one	0.9671	1.0000	1.0000	0.9671
2018	one	1.3887	1.0000	1.0000	1.3887
2019	one	0.7750	1.0000	1.0000	0.7750
2020	one	1.2413	1.0000	1.0000	1.2413
2017	two	0.9292	1.0000	1.0000	0.9292
2018	two	0.9492	1.0000	1.0000	0.9492
2019	two	0.9367	1.0000	1.0000	0.9367
2020	two	0.9820	1.0000	1.0000	0.9820
2017	three	0.9547	1.0000	1.0000	0.9547
2018	three	0.9151	1.0000	1.0000	0.9151
2019	three	0.9582	1.0000	1.0000	0.9582
2020	three	0.9879	1.0000	1.0000	0.9879
2017	four	0.8053	1.0000	1.0000	0.8053
2018	four	0.9252	1.0000	1.0000	0.9252
2019	four	0.9636	1.0000	1.0000	0.9636
2020	four	1.0354	1.0000	1.0000	1.0354

2017	five	0.9402	1.0000	1.0000	0.9402
2018	five	1.0717	1.0000	1.0000	1.0717
2019	five	0.7916	1.0000	1.0000	0.7916
2020	five	1.0160	1.0000	1.0000	1.0160
2017	six	0.9080	1.0000	1.0000	0.9080
2018	six	0.9869	1.0000	1.0000	0.9869
2019	six	0.9080	1.0000	1.0000	0.9080
2020	six	0.9296	1.0000	1.0000	0.9296
2017	seven	0.9338	1.0000	1.0064	0.9278
2018	seven	0.9128	1.0000	0.9636	0.9472
2019	seven	0.9511	1.0000	1.0651	0.8930
2020	seven	0.9002	1.0000	1.0424	0.8636
2017	eight	0.9341	1.0000	1.0000	0.9341
2018	eight	0.9035	1.0000	0.9984	0.9049
2019	eight	0.9263	1.0000	1.0016	0.9248
2020	eight	0.9676	1.0000	1.0000	0.9676
2017	nine	0.9392	1.0000	1.0000	0.9392
2018	nine	0.9433	1.0000	1.0000	0.9433
2019	nine	0.9746	1.0000	1.0000	0.9746
2020	nine	0.9535	1.0000	1.0000	0.9535
2017	ten	0.8550	1.0000	1.0000	0.8550
2018	ten	1.2171	1.0000	1.0000	1.2171
2019	ten	0.7794	1.0000	1.0000	0.7794
2020	ten	0.9280	1.0000	1.0000	0.9280

As shown in TABLE VI, the MI values of Bank of Communications, Bank of China and China Merchants Bank showed a downward trend from 2018 to 2020, and decreased significantly in 2019, mainly affected by the TC value. However, the MI values of Bank of Communications and Bank of China exceeded 1 in 2018 and 2020, and the operating efficiency showed an upward trend; Industrial and Commercial Bank of China and China Construction Bank showed an upward trend in MI value from 2017 to 2020, but the MI value was less than 1, and the operating efficiency showed a downward trend. The decrease in MI value of Industrial and Commercial Bank of China in 2019 and the decrease in MI value of China Construction Bank in 2018 were both affected by TC value; The MI value of Agricultural Bank showed an upward trend, mainly affected by TC value; The MI value of Huaxia Bank showed a downward trend in 2018 and 2020, while that of China Everbright Bank showed a downward trend in 2018, mainly affected by TC value and SEC value; PDB's MI value showed an upward trend from 2017 to 2019, mainly affected by TC value; CITIC Bank's MI value showed an upward trend in 2018 and 2020, and a downward trend in 2019, mainly affected by the TC value, and the bank's operating efficiency showed an upward trend when the MI value was greater than 1 in 2018.

V. CONTRIBUTION

Contribution of this paper: Commercial banks not only serve the real economy, but also need to pay attention to their own operating efficiency. In order to ensure their investment interests and safeguard the survival and development of enterprises, it is very important to correctly understand the main factors affecting the performance of commercial banks. scholarFeng Qing et al.(2021) The concept of output scale was mentioned [9]. Appropriate investment in various factors, accurate grasp of the number of employees, fixed assets, operating expenses, taxes payable and the proportion of the total amount of loans and their respective inputs, to achieve economies of scale, that is, the most appropriate inputs to obtain the highest output. Through this article, the bank can learn from which aspects and which aspects can be implemented to improve the bank's operating efficiency, which is beneficial to the improvement of the bank's overall operating efficiency.

Only by stabilizing its own management skills and resource allocation ability can it stand firm in the ever-changing financial market environment.

Scholar An Bo Wen (2021) proposed to optimize the bank's asset scale [10], strengthen the integration of existing resources and make full use of them, and further strengthen the adjustment of institutions, so as to reduce the bank's operating costs, thus improving the bank's scale efficiency and improving the overall efficiency.

Give full play to the advantages of the second stage. When the total deposits are fixed, the increase in total deposits absorbed by commercial banks will promote economic efficiency and resource allocation efficiency. However, with the expansion of scale, it will hinder the improvement of management technology efficiency. Therefore, this paper believes that promoting the high-quality construction of commercial banks in our country needs to adjust measures to local conditions.

The concrete measures are as follows:

1. Within the scope of improving economic benefits, China's commercial banks can appropriately increase the total investment in assets and expand the scale of operation. Considering the negative correlation between total asset size and management technology efficiency, blind expansion is not allowed.

2. To improve the ability to issue loans, we should continue to focus on the loan business. Actively respond to national policies, increase the amount of loans to small and medium-sized enterprises, and improve economic efficiency by transferring risks. 3. Improve innovation ability and pay full attention to the close relationship between science and technology and productivity. Improve the level of electronic technology and make scientific and technological innovations.

VI. CONCLUSIONS

This paper takes 10 commercial banks in our country as the research object, using two-stage DEA model for empirical research. Through the analysis of the table, the following conclusions can be drawn: as can be seen from TABLE IV, the overall operating efficiency of the 10 banks showed an upward trend from 2017 to 2020, but some of them showed a downward trend. This shows that the operating efficiency of our banks is still improving. As can be seen from TABLE V, the first stage is the main stage that results in the overall inefficiency of banking operations. The overall effect of the operating efficiency of the banks in the first stage is not as good as that in the second stage. I.e. the efficiency value at the deposit stage is relatively low. The input variables of the deposit stage include the number of employees, fixed assets, operating expenses and taxes payable. This shows that the commercial banks in our country have not achieved economies of scale. The arrangement of the various elements is not just right. Therefore, to sum up, China's commercial banks have been groping for development in the process of reform, but they still have not reached the optimal operating scale, which makes the overall scale efficiency low.

REFERENCES

- [1] Xue Jianhan(2021). An Empirical Study on the Factors Influencing the Comprehensive Efficiency of China's Commercial Banks in inclusive finance in the New Development Period-Based on DEA-Tobit Model Analysis. *Journal of Hubei Institute of Economics*, 19(06):26-37.
- [2] Wang Meiqiang, Chang Mei (2021). Analysis of the operating efficiency of China's commercial banks considering capital operation mode. *China Management Science*: 1-14.
- [3] Liu Yi (2020). Research on the efficiency of resource allocation and total factor productivity of commercial banks under the background of interest rate marketization-an empirical analysis based on the Malmquist model of cost efficiency and cost. *Contemporary financial research*:12-23.
- [4] Liu Qian (2020). New network DEA model and its application in bank efficiency evaluation. *Journal of Wenzhou University (Natural Science Edition)*, 41(04):1-9.
- [5] Lin Yu, Zhong Junbin, Li Zhennan (2020). The impact of financial technology on the efficiency of commercial banks in the era of big data-based on text mining and DEA-Malmquist index analysis. *Research on the development strategy of scientific and technological innovation*, 4(04):1-9.
- [6] Liu Juan (2021). Research on the Efficiency of Non-state-owned Listed Commercial Banks Based on Three-stage DEA Model. *Northern Finance*: 36-40. DOI: 10.16459/j. Cnki.15-1370/f.2021.04.007.
- [7] Zhao Fu, Zhao Jiyao (2021). Analysis and countermeasures of the problems in the operation efficiency of city commercial banks using DEA model. *Economist*, 2021(05):106-107+114.
- [8] Analyzing Operational Efficiency in Real Estate Companies: An Application of GM (1,1) and DEA Malmquist Model Mathematics Volume 9, Issue 3. 2021. PP 202-202
- [9] Fixed cost allocation considering the input-output scale based on DEA approach *Computers & Industrial Engineering* Volume 159, 2021.
- [10] An Bo Wen, Hou Zhen Mei, Li Chunyu (2021). Research on the economic benefits of China's commercial banks-efficiency measurement based on three-stage DEA-Tobit model and analysis of influencing factors. *Journal of Jiangnan University (Social Science Edition)*, 38 (01): 86-99+128. DOI: 10.16387/J.CN Ki.42-1867/C.2021.01.008.