Comparison of the Impact of GDP on the Efficiency of Chinese and British Commercial Banks Based on Experimental and Mathematical Statistics Analysis

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Abstract—China's banking industry is developing very fast, but the instability of global economic development makes its development full of risks. Previous studies mostly take the internal factors of banks as the factors affecting bank efficiency, and rarely consider the impact of external economic factors. Therefore, this paper uses the unexpected dynamic easing measurement model under the exogenous model, takes the growth of GDP as the exogenous factor, makes a mathematical statistical analysis on the bank efficiency of China and the UK from 2016 to 2019, and makes an empirical analysis on this basis. This paper holds that under the control of other influencing variables, GDP growth has a significant positive impact on bank efficiency. The average efficiency of Chinese commercial banks is higher than that of British commercial banks, but it fluctuates greatly.

Keywords:commercial bank; Bank efficiency;GDP growth

1 INTRODUCTION

Banking is the main body of China's financial system and plays an important role in promoting high-quality economic growth and stable financial development. It is obvious that businesses (such as a bank) play an important role in all economies and are the main creators of jobs and income, innovation, and growth at regional level.[1] Economic theory teaches us to expect a link between macroeconomic fluctuations and the performance of financial intermediaries.[2] financial globalization affects the rapid development of banking, and reveals the great influence of the banking sector on other institutions. [3] By the first quarter of 2019, the total assets of China's banking industry had exceeded 270 trillion yuan, ranking first in the world. However, with the slowdown of global economic growth, the downward pressure on China's. economic development has increased. Therefore, based on the current situation of macroeconomic development, this paper studies bank efficiency by taking GDP as an exogenous variable, hoping to make the banking industry develop continuously in the

complex external economic environment, promote financial stability and financial innovation, and develop the national economy healthily. At the same time, Britain's banking industry is in a leading position in the world's financial development. By comparing the efficiency of Chinese and British banks, this paper aims to study the shortcomings of the development of Chinese commercial banks, learn from the development experience of British commercial banks, and put forward suggestions for the stable development of Chinese commercial banks.

In recent years, relevant scholars have done a lot of research and discussion on the theory and practice of banking development. The early studies on the financial performance of commercial banks show that bank-specific factors like board size, bank size, capital ratio, funding cost, revenue diversification, and bank age are the major factors which determine the financial performance of the firms.[4] Peter Nderitu Githaiga [5] found that human capital and income diversification significantly influence bank performance. Although the current research has made a lot of analysis on the internal influencing factors of bank efficiency, there are not many literatures on the impact of macroeconomic environment on bank development. At the same time, in the context of economic globalization, it is particularly important to compare the development of domestic and foreign banks. Therefore, the main contributions of this paper are as follows. First, this paper takes GDP as an exogenous variable to measure the efficiency of commercial banks, which increases the overall average efficiency of banks and more accurately reflects the efficiency of commercial banks. Second, this paper compares the efficiency of British commercial banks with that of Chinese commercial banks, so as to draw experiences and lessons for the development of Chinese commercial banks.

2 MATERIALS AND METHODS

2.1 Materials

Excluding incomplete or missing data, this paper takes 48 Chinese commercial banks and 16 British commercial banks as the research object, and all the data reflect the annual data from2016 to 2019.

2.2 Methods

Second order dynamic shared SBM model with non consensual production under the influence of exogenous variables: suppose N banks are expressed as [DMU]_ J (J = 1, ..., n), each DMU is divided into k departments (k = 1,..., K), and t periods (t = 1,..., t). Each DMU has inputs and outputs in time period T, and period connection variables to the next T + 1 time period.

Based on the concept of common boundary, the sample data of the two countries are made into the common relative optimal efficiency value of the two countries:

Assuming that the research object is composed of G banks (n = N1 + N2 +... + ng), there are n DMUs (J = 1,..., n). There are input and output items in period T, and the period T + 1 is connected by connecting variables.

All manufacturers (n) are composed of decision-making units of G groups (n = N1 + N2 +... + ng), including n DMUs (J = 1,..., n). Each DMU is divided into k departments (k = 1,..., K)

and t periods (t = 1,..., t). Xij and YRJ respectively represent the i-th input (I = 1, 2,..., m) and r-th final output (r = 1, 2,..., s) of the j-th unit (J = 1, 2,..., n), E is an exogenous variable not outside a given economic model, which usually affects the results of the model. Under the common boundary, the decision-making unit K can choose the most favorable final output weight to maximize its efficiency. Therefore, the efficiency of decision-making unit K under the common boundary can be solved by the following linear programming program. The following is an unguided model:

a) Total efficiency

$$
\theta_0^* = \min \frac{\sum_{t=1}^{T} W^t \left[\sum_{k=1}^{K} W^k \left[1 - \frac{1}{m_k + linkin_k + ninput_k} \left(\sum_{g=1}^{G} \sum_{i=1}^{m_k} \frac{S_{iok}^{t-}}{x_{iokg}^t} + \sum_{g=1}^{G} \sum_{(kh)_i=1}^{linkin} \frac{S_{o(kh)_i in}^t}{z_{o(kh)_i ing}^t} + \sum_{g=1}^{G} \sum_{k_i}^{ngood} \frac{S_{okinput}^{(t,t+1)}}{z_{okinput}^{(t,t+1)}} \right) \right] \right]}{\sum_{t=1}^{T} W^t \left[\sum_{k=1}^{K} W^k \left[1 + \frac{1}{r_{1k} + r_{2k}} \left(\sum_{g=1}^{G} \sum_{r=1}^{r_{1k}} \frac{S_{rokgood}^{t+}}{y_{rokggood}^t} + \sum_{g=1}^{G} \sum_{r=1}^{r_{2k}} \frac{S_{rokbad}^{t-}}{y_{rokgbad}^t} \right) \right] \right]}
$$

(1)

b) Stage efficiency

$$
\partial_0^* = \min \frac{\sum_{k=1}^{K} W^k \left[1 - \frac{1}{m_k + linkin_k + ninput_k} \left(\sum_{g=1}^{G} \sum_{i=1}^{m_k} \frac{S_{iok}^{t-}}{x_{iokg}^t} + \sum_{g=1}^{G} \sum_{(kh)_i=1}^{linkin} \frac{S_{o(kh)_i in}^t}{z_{o(kh)_i ing}^t} + \sum_{g=1}^{G} \sum_{k_i}^{ninput} \frac{S_{okinput}^{(t,t+1)}}{z_{okginput}^{(t,t+1)}} \right) \right]}{\sum_{k=1}^{K} W^k \left[1 + \frac{1}{r_{1k} + r_{2k}} \left(\sum_{g=1}^{G} \sum_{r=1}^{r_{1k}} \frac{S_{rokgood}^{t+}}{y_{rokgood}^t} + \sum_{g=1}^{G} \sum_{r=1}^{r_{2k}} \frac{S_{rokbad}^{t-}}{y_{rokgbad}^t} \right) \right]}
$$

(2)

c) Itemized efficiency

$$
\phi_0^* = \min \frac{\sum_{t=1}^{T} W^t \left[1 - \frac{1}{m_k + linkin_k + ninput_k} \left(\sum_{g=1}^{G} \sum_{i=1}^{m_k} \frac{S_{iok}^{t-}}{x_{iokg}^t} + \sum_{g=1}^{G} \sum_{(kh)_i=1}^{linkin} \frac{S_{o(kh)_i in}^t}{z_{o(kh)_i ing}^t} + \sum_{g=1}^{G} \sum_{k_i}^{ninput} \frac{S_{okinput}^{(t,t+1)}}{z_{okginput}^{(t,t+1)}} \right) \right]}{\sum_{t=1}^{T} W^t \left[1 + \frac{1}{r_{1k} + r_{2k}} \left(\sum_{g=1}^{G} \sum_{r=1}^{r_{1k}} \frac{S_{rokgood}^{t+}}{y_{rokgood}^t} + \sum_{g=1}^{G} \sum_{r=1}^{r_{2k}} \frac{S_{rokbad}^{t-}}{y_{rokgbad}^t} \right) \right]}
$$

(3)

From the above formula, we can get the total efficiency, stage efficiency and itemized efficiency. The efficiency of input variables and output variables (including expected output and unexpected output) is calculated as follows:

Input efficiency value=Actual input value/Target input value   (4)

Expected output efficiency value=Target expected output value/Actual expected output (5)

Unexpected output efficiency value=Actual unexpected output value/Target unexpected output value   (6)

3 RESULTS AND ANALYSIS

3.1 data description

Under the exogenous model, using the unexpected dynamic udsbm (undesired slack based measurement) model, the research is divided into two stages: capital accumulation stage and profit stage. In the capital accumulation stage, operating expenses and the number of employees are input indicators. Customer deposits are an acceptable output indicator. In the profit stage, the input indicators are operating expenses, number of employees, customer deposits and loan impairment reserves. Interest income and non interest income are desirable output indicators, and non-performing loans are undesirable output indicators. In addition, this paper selects the stock of fixed assets as the carry forward variable and the GDP growth rate as the exogenous variable. As shown in Table 1.

Table 1 Input output variable.

Stage	Variable		Unit
Capital accumulation stage	Input	Operating expenses	th USD
		Number of employees	People
	Output	Total customer deposi	th USD
Profit stage	Carry-over	Logarithm of bank assets	th USD
	Input	Operating expenses	th USD
		Number of employees	People
		Total customer deposi	th USD
		reserves for impaired loans	th USD
	Output	Total interest income	th USD
		Non-interest income	th USD
		Non-performing loan	th USD
Exogenous Variable		GDP growth	%

This paper studies nine variables from 2016 to 2019, including GDP growth rate, operating expenses, number of employees, customer deposits, stock of fixed assets, provision for loan impairment, interest income, non interest income and non-performing loans of 48 Chinese commercial banks and 16 British commercial banks. The maximum, minimum, mean and standard deviation of 9 variables were calculated respectively. Table 2 and table 3 show the details.

Table 2 Statistical Description of Inputs and Outputs (Capital accumulation stage)

Variable	Mean	Min	Max	Std. Dev.
Operating expenses (th USD)	4231548.70	5998.41	32103334.46	7249755.68
Number of employees(People)	41945.48	31.00	496698.00	96621.28
Total customer deposi (th USD)	293962717.60	1639.99	3288629567.00	293962717.60
Logarithm of bank assets (th USD)	34843491.73	33208.25	411652429.60	34843491.73
GDP growth (%)	0.054	0.013	0.069	0.021

Table 3 Statistical Description of Inputs and Outputs (Profit stage)

| Variable	Mean	Min	Max	Std. Dev.
Operating expenses (th USD)	4231548.70	5998.41	32103334.46	7249755.68
Number of employees(People)	41945.48	31.00	496698.00	96621.28
Total customer deposi (th USD)	293962717.60	1639.99	3288629567.00	293962717.60
Total interest income (th USD)	15211292.53	1712.213257	148583654	28068634.14
Non-interest income (th USD)	3393113.23	82775.66161	28868755.99	5938511.729
reserves for impaired loans (th USD)	6396881.22	930.9427032	77369113.34	13694789.76
Non-performing loan (th USD)	3956888.96	13529.32809	34376269.89	7239577.127

3.2 Total efficiency comparison

In order to ensure the scientificity of the research, in this section, we calculate the bank efficiency in two cases with or without GDP growth rate as an exogenous variable. As shown in Table 4, in the absence of exogenous variables, the total efficiency of banks is generally about 0.5, but when considering exogenous variables, the total efficiency of banks is mostly 0.6-0.7, the operation effect of banks is good, and the difference of efficiency among banks is also reduced. Considering the actual situation, the macroeconomic environment will have an important impact on the operation of commercial banks. The revised model can better evaluate the total efficiency of commercial banks. Therefore, it is scientific to take GDP as an exogenous variable.

Specifically, the total efficiency of Chinese banks is greater than that of British banks. Under the influence of China's economic system reform and government policy guidance, China's economy has developed well, and the operation effect of Bank of China is also good. However,

China's macro environment is complex and changeable, market competition intensifies, the profit space of commercial banks needs to be increased, and the level of risk management also needs to be improved.

Figure 1 shows the total efficiency radar chart of Chinese (blue) and British (red) banks in 2016-2019 with exogenous variables. The total efficiency of Chinese banks is high, generally higher than 0.7. The total efficiency of British banks fluctuates greatly, and there is much room for improvement.
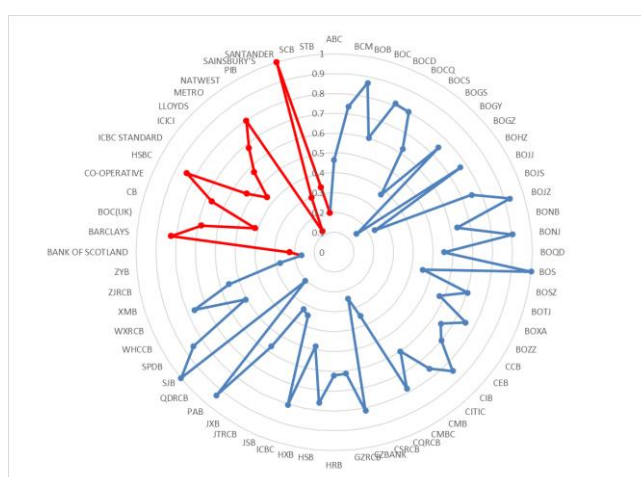
Figure 1. Radar chart of total efficiency of banks with exogenous variables from 2016 to 2019

3.3 Stage efficiency comparison

Next, this paper begins to study the average total efficiency, average efficiency in capital accumulation stage and average efficiency in profit stage of commercial banks in the two countries from 2016 to 2019. Overall, the overall efficiency of commercial banks in the two countries has little change, generally fluctuated slightly between 0.7-0.8. The average total efficiency of Chinese banks reached the maximum value of 0.82 in 2018 and that of British banks reached the maximum value of 0.73 in 2017. See Table 5 for details. In addition, the average efficiency of Chinese commercial banks and British commercial banks in the capital accumulation stage is generally higher than that in the profit stage, and the efficiency value fluctuates around 0.7, so the development level can be further improved.

Table 4 Average efficiency of sample banks in the two countries from 2016 to 2019

stage	country	2016	2017	2018	2019
Average total efficiency	China	0.73	0.73	0.82	0.79
	British	0.70	0.73	0.72	0.72
Average efficiency of capital accumulation stage	China	0.82	0.85	0.86	0.79
	British	0.64	0.62	0.79	0.79

Average efficiency of profit stage	China	0.72	0.73	0.75	0.70
	British	0.67	0.74	0.68	0.75

After calculation, the average efficiency in the capital accumulation stage is 0.80 and the average efficiency in the profit stage is 0.71. The development level of capital accumulation stage of Bank of China and Bank of England is better than that of profit stage. In addition, the efficiency of Chinese banks in the two stages is generally higher than that of British banks in the two stages. The two-stage efficiency distribution of each sample bank is shown in Figure 2.
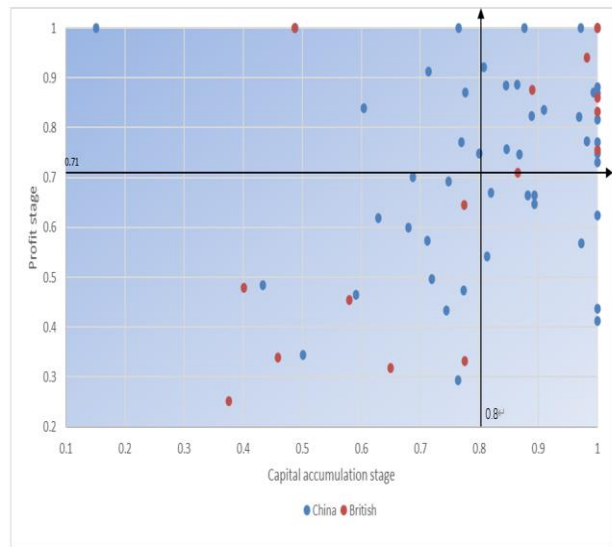
Figure 2. Radar chart of total efficiency of banks with exogenous variables from 2016 to 2019

4 CONCLUSION AND SUGGESTIONS

4.1 Conclusion

Based on the non desirable dynamic udsbm model under the exogenous model, this paper analyzes the overall efficiency and stage efficiency of Chinese and British commercial banks in detail. The main conclusions are as follows:

a) As a macro influencing factor, GDP growth rate plays an important role in bank efficiency. GDP growth is negatively correlated with non-performing loans and positively correlated with interest income and non interest income. When the macro-economy develops stably, maintains a good state, and the GDP is at a high level and grows steadily, commercial banks can adapt to economic development and improve profitability and operating efficiency.

b) The average total efficiency of Chinese commercial banks is higher than that of British commercial banks, but the average total efficiency of Chinese commercial banks fluctuates

greatly, with a difference of 0.9. There is a "financial and economic" relationship between China's economic growth and bank efficiency.

c) From the two stages, the efficiency of the capital accumulation stage of Chinese and British banks is higher than that of the profit stage. It can be seen that the commercial banks of the two countries have strong capital absorption ability, but poor capital operation ability and profitability.

4.2 Suggestions

a) commercial banks must pay attention to the level of inflation while paying attention to macroeconomic changes. High economic growth rate is usually accompanied by inflation. When controlling the overall credit scale and risk control level, commercial banks should consider social price factors, make reasonable estimates of the current raw material cost and labor cost of enterprises, and have a certain understanding and expectation of the future operating profit and cash flow of enterprises.

b) In the context of global economic integration, China's commercial banks need to expand international business, enrich financial products and develop diversified financial services.

c) governments should establish and improve the measurement and supervision mechanism for the operation and management risks of commercial banks, understand the impact of macro-economy on the stability and development of commercial banks, systematically prevent the adverse consequences of macroeconomic fluctuations on the safety and stability of commercial banks, and stabilize the order of financial markets.

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