

Research on the Influence of Financial Technology Development on the Operational Efficiency of Commercial Banks

-- Taking China's Listed Commercial Banks as an Example

Guangxin Pan*, Yanping Xia, Kang Peng

Anhui University of Finance and economics, Bengbu City, Anhui Province, 233030, China

*1960147052@qq.com

Abstract

In recent years, China's financial technology has developed rapidly. As an important pillar of the financial industry, banking industry is gradually applying financial technology to all aspects of its own operation. Thus, it is of great importance to study the relationship between financial technology and bank operation efficiency. This paper takes China's listed commercial banks from 2013 to 2019 as the research object, uses Malmquist index model to measure the efficiency indicators of the listed commercial banks in this period, introduces financial technology index, and uses System GMM model to empirically analyze the relationship between financial technology and commercial banks. Based on the research results, corresponding strategies are proposed to improve the operational efficiency of commercial banks, improve the efficiency of financial services and promote the stability of financial markets.

Keywords

Financial Technology; Commercial Bank; Operating Efficiency; GMM Model.

1. Research Background and Significance

In August 2019, the people's Bank of China issued the "fintech development plan (2019-2021)", which clearly put forward the guiding ideology, basic principles, development goals, key tasks and safeguard measures of fintech work in the next three years. The document points out that financial technology is technology driven financial innovation. The financial industry should take Xi Jinping's new socialist ideology with Chinese characteristics as the guide, fully implement the nineteen spirit of the party, and give full play to the role of financial technology in promoting the high quality development of China's financial industry, in accordance with the requirements of the national financial work conference. The banking industry is an important pillar of China's financial industry, and the listed commercial banks are the typical representatives of China's banking industry. Their operating efficiency has a significant impact on the financial system and economic operation. Therefore, it is of great significance to study the relationship between financial technology and the operational efficiency of listed commercial banks and put forward suggestions.

2. Journals Reviewed

Based on the operating data of 13 commercial banks from 2000 to 2004, Zhu Chao (2006) calculated the total factor productivity index (TFPI), which reflects the inter period dynamic efficiency change, and made a sensitivity analysis on it. The results show that the sample banks have the situation of waste of input resources and low scale efficiency, and this situation has a significant impact on the overall efficiency of banks. Based on the data of China's commercial

banks from 1990 to 2003, Wang Cong and Tan Zhengxun (2017) used the random frontier method to measure the profit, scale, scope, efficiency and dynamic changes of China's banking industry, and analyzed the influence degree and mechanism on the efficiency level from macro factors, property rights system and market structure factors. Geng Hongyan (2012) and Duan Yongrui (2016) used data envelopment analysis to evaluate the efficiency of 14 commercial banks and 16 commercial banks in China from 2006 to 2013, and concluded that the efficiency of joint-stock banks is higher than that of state-owned banks. Guan renrong et al. (2014) and cangming et al. (2016) calculated the efficiency of commercial banks based on the traditional DEA model and studied some listed banks. They found that Internet finance can significantly promote the improvement of total factor productivity of commercial banks. To sum up, at present, scholars have some research on the evaluation of commercial banks' operating efficiency and the measurement of relevant indicators, but there is less research on the impact of financial technology on commercial banks' operating efficiency. Considering that financial technology is an important technology driver for the development of commercial banks in the future, this paper introduces financial technology index, takes China's listed commercial banks from 2013 to 2019 as the research object, uses Malmquist index model to measure the efficiency indicators of listed commercial banks in this period, and uses System GMM model to analyze the impact relationship between financial technology and listed commercial banks.

3. Calculation of the Operational Efficiency of Commercial Banks in China

At present, data envelopment analysis (DEA) is a commonly used efficiency measurement method, but it can not effectively reflect the dynamic changes of relative efficiency and has the defects of single index. Therefore, this paper uses the improved Malmquist index model based on DEA method to measure the operational efficiency of commercial banks.

3.1. Index Selection of Input Output Variables

The core problem in the calculation of Malmquist productivity index is the selection of input index and output index. In this paper, combined with the relevant research results of scholars all over the world in recent years, and combined with the operating characteristics of China's banking industry and the constraints of the model used, we select the input-output indicators as shown in Table 1.

Table 1. Input output index table of commercial banks

Input index	Net value of fixed assets	Output indicators	Interest income
	Total operating expenses		Non-interest income

3.2. Data Sources

In the selection of research objects, this paper selects the input-output index data of 24 listed commercial banks from 2013 to 2019. During this period, China's banking industry began to develop financial technology on a large scale, so it is more reasonable to choose the data during this period. These commercial banks include 5 state-owned commercial banks such as China Construction Bank and Bank of China, 10 city commercial banks such as Bank of Beijing and Bank of Nanjing, and 9 joint-stock commercial banks such as Huaxia Bank. The data used in this paper come from the official website of the National Bureau of statistics, China Financial Yearbook, resset financial research database and the annual reports of commercial banks.

3.3. Calculation Process

This paper uses Malmquist index to measure the trend of total factor productivity of listed commercial banks. Assuming that in year t, the input and output of bank I are x_i^t and y_i^t , in turn, the calculation formula of Malmquist index can be obtained.

$$M = \left[\frac{D^t(x_i^{t+1}, y_i^{t+1}) D^{t+1}(x_i^t, y_i^t)}{D^t(x_i^t, y_i^t) D^{t+1}(x_i^{t+1}, y_i^{t+1})} \right]$$

3.4. Calculation Results

Based on the Malmquist index formula, this paper estimates the total factor productivity and its decomposition efficiency of 24 listed commercial banks in China from 2013 to 2019. The calculation results are shown in Table 2.

Table 2. Changes of total factor productivity and its decomposition index of sample banks from 2013 to 2019

	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	The average
Changes in total factor productivity	1.018	1.095	1.055	0.918	0.961	0.986	1.005
Changes in the level of technology	1.026	1.144	1.013	1.110	0.822	0.923	1.006
Changes in pure technical efficiency	1.008	0.963	1.026	0.994	1.021	1.008	1.003
Changes in scale efficiency	0.985	1.003	1.016	0.850	1.157	1.148	1.027

Note: the mean value in the table is the simple arithmetic mean value of all sample banks

According to the estimation results in Table 2, the total factor productivity and its decomposition efficiency of the listed commercial banks in the whole sample have improved (the average is greater than 1). Among them, the pure technical efficiency and the change of technical level are in a steady state, with an average annual improvement of 0.3% and 0.6%, respectively. The average annual improvement of total factor productivity is 0.5%, and the average annual improvement of technical level is 2.7%. It can be seen that the improvement of the overall efficiency of banks mainly comes from the improvement of the change of scale efficiency.

4. Measurement of Financial Technology Index

Firstly, according to the financial technology business classification of Basel bank, this paper divides financial technology into four categories: investment management, payment and settlement, deposit and loan and capital raising, and market facilities. This paper takes ccnd as the data source, first selects 17 initial keywords, counts the total number of press releases in 2013-2019, and gets the annual word frequency of each initial keyword. Finally, the efficiency of the commercial bank is calculated.

Then, factor analysis method is used to reduce dimension, and factor analysis is performed on the annual word frequency of the 12 effective initial keywords selected in the previous step from 2013 to 2019, and three main factors are extracted. Then, the variance contribution rate of the extracted factors is taken as the weight, and the weighted sum of the factors is carried

out, and finally the financial technology index is obtained. In order to simplify the process of empirical test, it is standardized from 0 to 1 between. As shown in Table 3, figure 1 depicts the changes in the financial technology index.

Table 3. Financial technology index

Year	2013	2014	2015	2016	2017	2018	2019
Financial technology index	0.000	0.531	0.667	1.000	0.982	0.968	0.987

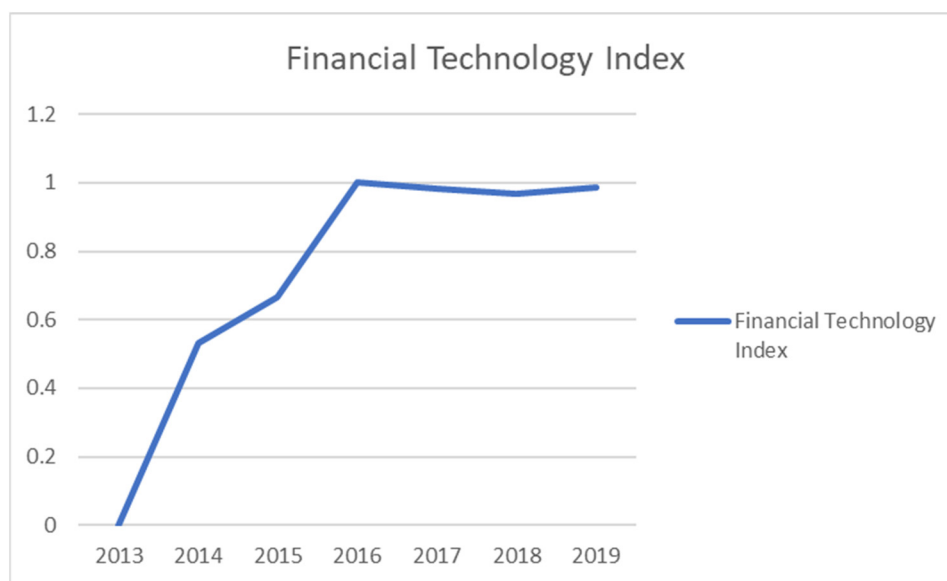


Figure 1. Changes in financial technology index

5. An Empirical Analysis of the Impact of Financial Technology on the Operational Efficiency of Banks

5.1. Variable Selection

For variable selection, variables are divided into explained variables, explanatory variables and control variables. In this paper, the total factor productivity change and its decomposition efficiency change index are taken as the explained variables to represent the dynamic situation of bank operating efficiency. The explanatory variables are represented by financial technology index, which quantitatively shows the development level of financial technology in different years. The selection of control variables, this paper from the following three levels. At the macro level, the real GDP growth rate is chosen to represent the level of macroeconomic development, and the development of stock market to represent the level of capital market development; At the industry level, we choose industry concentration and industry openness; at the bank level, we choose asset capital ratio and deposit loan ratio to represent bank risk-taking and bank resource allocation level respectively. The higher the ability of risk resistance and resource allocation, the better the efficiency of banks. The specific definitions of empirical variables are shown in Table 4.

Table 4. Variable definition table

Variable type	Variable name	Symbol	Variable definition
Explained variable	Total factor productivity	Y	Malmquist index
	Changes in technical level	TC	Measurement of the level of technological progress
	Change of pure technical efficiency	PTEC	Measurement value of management level
	Scale efficiency change	SEC	Measurement of scale economy
Explanatory variable	Financial technology index	I	Development level of financial technology
control variable	Real GDP growth rate	GDP	Real GDP growth
	Stock market development	GS	Ratio of GDP to GDP
	Industry concentration	CR5	Growth rate of assets proportion of five state owned banks
	Industry openness	FR	Growth rate of number of foreign funded institutions in China
	Bank risk taking	AE	Ratio of bank assets to capital
	Bank liquidity level	LDR	Ratio of bank's liquid assets to total assets

5.2. Model Establishment

In order to test the impact of financial technology development on the operating efficiency of listed businesses, this paper uses the following econometric equation based on the relevant research results:

$$Y_{it} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 I_t + \sum_{j=3}^8 \beta_j \gamma_{jit} + \mu_i + \varepsilon_{it}$$

In the above formula, *i* is the sample bank, *t* is the year, and the explained variable Y_{it} is the total factor productivity of commercial banks; The core explanatory variable is financial technology index *I*, the control variable is γ_{jit} , μ_i is the fixed effect of commercial banks, ε_{it} is the random error term, β_2 describes the impact of financial technology on the total factor productivity of listed commercial banks.

At the same time, due to the further decomposition of TFP in this paper, in order to further test the impact of financial technology on the decomposition rate of listed commercial banks, the following regression equations are designed (TC, PTEC, SEC are the technical level change index, pure technical efficiency change index and scale efficiency change index of sample banks respectively).

$$\begin{cases} TC_{it} = \beta_0 + \beta_1 TC_{i,t-1} + \beta_2 I_t + \sum_{j=3}^8 \beta_j \gamma_{jit} + \mu_i + \varepsilon_{it} \\ PTEC_{it} = \beta_0 + \beta_1 PTEC_{i,t-1} + \beta_2 I_t + \sum_{j=3}^8 \beta_j \gamma_{jit} + \mu_i + \varepsilon_{it} \\ SEC_{it} = \beta_0 + \beta_1 PTEC_{i,t-1} + \beta_2 I_t + \sum_{j=3}^8 \beta_j \gamma_{jit} + \mu_i + \varepsilon_{it} \end{cases}$$

5.3. Model Checking

In order to avoid the multicollinearity problem, we first test the correlation between explanatory variables and control variables before regression. According to the correlation test results, the correlation between the relevant variables is basically less than 0.5, so there is no obvious correlation. In order to further eliminate the problem of multiple collinearity, this paper conducts multiple collinearity test for each related variable. As shown in Table 6, the mean Vif value is 4.62, which is far less than the reasonable value 10. The results show that the correlation coefficient between explanatory variables is small, which means that there is no serious multiple collinearity problem.

Table 5. Multicollinearity test

Variable	VIF	1/VIF
gdp	9.72	0.1029
I	9.46	0.1057
gs	3.45	0.2899
fr	3.02	0.331
cr5	2.65	0.3778
ae	2.11	0.4735
ldr	2.02	0.4947
Mean VIF	4.62	

In order to prevent the "pseudo regression", we carry out the stationarity test around the variables of total factor productivity change (y), technical level change (TC), pure technical efficiency change (PTEC), scale efficiency change (SEC), bank risk-taking (AE) and bank liquidity level (LDR) at the bank level. The results are shown in Table 6. Therefore, there is no "pseudo regression" problem in the regression analysis process.

Table 6. Stationarity test

variable	Statistics	P-value	Smoothness
Y	-16.159	0	Smooth
TC	-19.094	0	Smooth
PTEC	-14.651	0	Smooth
SEC	-14.992	0.008	Smooth
AE	-11.91	0	Smooth
LDR	-4.376	0.0084	Smooth

5.4. Regression Results

Because the ratio of assets to capital, deposit loan ratio and other variables of commercial banks may have a causal relationship with the operational efficiency of banks, that is, there can be endogenous problems. The Dynamic Panel System GMM model is used to estimate the total factor productivity. According to the estimation results, the results show that the Dynamic Panel System GMM Estimation (sys-gmm) is significant, and the p value of AR (2) test is 0.779, which indicates that there is no second-order sequence correlation in the difference of the disturbance term; meanwhile, the p value of sargan test is 0.22, which also shows that all the instrumental variables are exogenous, which indicates that the selection of System GMM model and the selected instrumental variables are reasonable and effective. This paper decomposes the change of total factor productivity of commercial banks. In order to verify the influence mechanism of financial technology on the change of total factor productivity of commercial banks, TC, PTEC and SEC are regressed respectively. The regression results are shown in Table

7. The results of AR (2) test and sargan test show that the System GMM Estimation Model and the selected instrumental variables are reasonable and effective.

Table 7. Regression results of total factor productivity and decomposition efficiency of sample commercial banks

	Y	TC	PTEC	SEC
L.Y	-0.3404			
	0.1379			
I	-2.3631	-2.135	2.421	0.9816
	0.9728	0.7429	0.8481	1.0337
gdp	0.000	0.000	0.000	0.000
	0.0012	0	0.002	0
gs	-0.407	1.0958	-0.1384	0.2478
	1.4012	1.0704	0.0983	1.4994
cr5	0.8046	1.1531	-0.3443	-6.0716
	0.4001	0.2552	0.0315	0.5983
fr	-0.2674	0.2994	0.0542	0.6573
	0.0798	0.0609	0.0054	0.0853
ae	0.1058	0.1096	0.0033	-0.1488
	0.0732	0.0561	0.0049	0.0764
ldr	-0.0323	-0.0304	-0.0182	-1.6153
	0.0156	0.0092	0.0081	1.2563
L.TC		-0.2906		
		0.14		
L.PTEC			-0.3497	
			0.137	
L.SEC				-7.7702
				0.871
AR(2)	0.779	0.623	0.256	0.198
sargan	0.221	0.339	0.191	0.292

From the regression results, the regression coefficient of financial technology to the technical level of commercial banks is significantly negative. The change of technology level measures the relative speed between the change speed of output level and the change speed of production technology frontier. If the change speed of output level is faster than the change speed of production technology frontier, it will lead to the improvement of technology progress rate. If the change speed of output level is slower than that of production technology frontier, it will lead to the decrease of technology progress rate. Technology level change mainly refers to the ability of commercial banks to use new technology for business and product innovation, including technology innovation and technology introduction. Here, the financial technology coefficient of the change of bank technology level is significantly negative, indicating that the application degree of financial technology of commercial banks is less than the overall development degree of financial technology, indicating that commercial banks should pay more attention to the application of financial technology and accelerate technological progress. The regression coefficient of pure technical efficiency change index is significantly positive, while the regression coefficient of scale efficiency change is not significant. The change of pure technical efficiency reflects the dynamic change of management level or management efficiency of commercial bank managers. It refers to the development and utilization of existing resources,

application and situation of technology, such as internal risk management and control, business process, etc. Here, the financial technology coefficient of pure technical efficiency of commercial banks is significantly positive, which indicates that the development of financial technology promotes the pure technical efficiency of commercial banks and the management efficiency of commercial banks. According to the relationship between total factor productivity of commercial banks and its decomposition efficiency, the negative change relationship between financial technology and total factor productivity growth of commercial banks is mainly due to the negative change relationship between financial technology and technical progress of commercial banks.

6. Conclusions and Suggestions

6.1. Conclusions

Based on the impact of financial technology on listed commercial banks, this paper selects the data of 24 listed commercial banks from 2013 to 2019 to further test the impact of financial technology development on total factor productivity and decomposition efficiency of listed commercial banks. According to the results, we can draw the following conclusions: the development of financial technology has obvious negative effect on the operational efficiency of listed banks, and this negative effect is mainly caused by the lack of technological innovation and technology introduction ability of banks. At the same time, financial technology has a significant positive impact on the management level or efficiency of bank managers, which indicates that financial technology promotes the improvement of bank management efficiency.

6.2. Recommendations

According to the test results, financial technology mainly affects the total factor productivity of banks through the changes of technology level (technological innovation, technology introduction ability) and pure technical efficiency (management level). Therefore, banks need to do the following:

6.2.1. Determine Strategic Support for the Development of Financial Science and Technology, and Focus on Promoting the Construction of Financial Science and Technology

On the one hand, banks can invest or form a consortium with other well-known investment institutions or financial institutions to jointly invest in financial technology enterprises. For banks, they should make full use of their strong capital advantages and make good use of the technology of financial technology enterprises through external cooperation to enhance their technological innovation and technology introduction ability. On the other hand, banks can strengthen cooperation with financial technology enterprises, and share resources and advantages by virtue of their advantages in various fields such as product provision and service provision, so as to jointly promote the application and improvement of financial technology, so as to enhance the bank's financial service and product innovation ability.

6.2.2. Build a Professional and Agile Financial Technology Team to Increase the Talent Pool in the Field of Financial Technology

On the one hand, financial technology talents can feel the impact of financial technology on the specific business of banks more quickly, which is convenient for banks to reflect the development and application of financial technology. On the other hand, adding financial technology talents to the bank team can enhance the bank management's understanding of financial technology, adapt to market changes, optimize the management system, improve the bank management efficiency, strive for more support for the development of the bank, create a better application development environment for the development and application of financial technology of the bank, and cultivate and endow the bank team with financial technology

talents The ability to strike. Only with sufficient financial technology knowledge accumulation and skills reserve, can we better cope with and promote the development of financial technology, so as to maintain long-term competitiveness in the context of rapid development of scientific and technological innovation.

6.2.3. We should Make Full Use of Our Position in the Financial Field to Improve the Efficiency of Financial Services and the Ability of Product Innovation

In response to the impact of the emerging financial business model, traditional banks have accumulated a large number of customer resources, more and more convenient online platform and intensive offline physical outlets, and accumulated corporate reputation for many years, which are a major advantage that many customers can not ignore when choosing financial services. In the application of financial technology, the use of financial technology to enhance the efficiency of existing financial services, enhance customer experience, enhance customer stickiness. At the same time, we should pay attention to the impact of financial innovation brought by financial technology. The business innovation of commercial banks should be combined with their own situation, such as the huge business scale characteristics of state-owned commercial banks, the flexible management characteristics of joint-stock commercial banks, etc. each bank should highlight its own advantages and determine its own business or key development direction.

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