

Research on the Impact of Fintech on the Profitability of Commercial Banks

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Abstract: Based on the realistic background of the deepening development of fintech, this paper selects the panel data of 67 commercial banks in China from 2011 to 2019 and uses the digital financial inclusion index to measure the development level of fintech to study the impact of fintech on the profitability of commercial banks. The empirical study shows that there is a significant "inverted U-shaped" relationship between fintech and the profitability of Chinese commercial banks. In addition, fintech development has a significantly greater impact on the profitability of large medium- sized commercial banks than small banks. Finally, corresponding policy suggestions are given according to the results to enhance the profitability and competitiveness of commercial banks.

1. Introduction

Nowadays, the fourth industrial revolution characterized by digitalization and intelligence is coming, and the wave of digital economy has a profound impact on all walks of life. Among them, the banking industry, as the core of modern economy, is the first to face a series of major challenges and opportunities. As the mainstay of the financial system, commercial banks are not only the "old" representatives of traditional finance, but also the "new" subjects pursuing the development of fintech in the new era. The overall layout of fintech development strategy to realize the industry transformation into a commercial bank's general trend. In May 2019, ICBC established a wholly-owned subsidiary, ICBC Technology, in Xiongan, Hebei Province, becoming the seventh commercial bank to set up a fintech subsidiary. Many scholars believe that the establishment of fintech subsidiaries of banks will be the general trend [1,2].

Table.1. Banks' FinTech Strategy

Bank	Strategy	FinTech Strategy Details
CCB	TOP+	"T" stands for Technology, which stands for technology-driven financial innovation; "O" stands for Open, which stands for Open capabilities, including the group's financial services and data; "P" is Platform, which stands for Platform ecology to jointly build user ecology. "+" is Plus, which stands for the mechanism and corporate culture that encourages and tolerates innovation.
ZBB	Super Platform	By opening up all existing businesses and radiating new businesses in all directions, the "super platform" will become the entrance of customer flow, the place for business transactions and the gathering place for capital precipitation, forming a multilateral network effect, and realizing the diversification of business models based on ecological continuous self-iteration and extension.
BJBANK	Jingjiang Engineering	With the construction of "Jingjiang Engineering" ten project groups as the starting point, we will comprehensively comb the product and service process, and realize end-to-end optimization and improvement from the perspective of customers and user experience. By making every effort to build a more agile front desk, energy-gathering middle stage and stable background, further consolidate the scientific and technological strength.

Source: official website of each bank, annual report

With the continuous popularization and application of fintech technology, commercial banks have also begun to increase investment in fintech in order to improve business performance and reduce business risks. Some nations are listed in table.1 to CCB, Bank of Beijing and Zhongbang Bank as a representative of banking and finance technology development strategy, it can be seen that, in the digital economy era, both state-owned banks and joint-stock banks with first-mover advantages, and urban banks or private banks trying to achieve breakthrough development, are actively competing in the fintech market and comprehensively practicing digital transformation and operation. The digital transformation of banking, which is based on the emerging science and technology, digital marketing, digital operation, risk control and other fields, by reshaping organization and the relationship between people, build data-driven ability comes from inside and outside to change, to the external customer service run by the internal management, expand marketing channels, improve customer experience.

The development of fintech has brought uncertainty to commercial banks and posed new challenges to the deepening reform of commercial banks. In this context, an open question is whether the vigorous development of fintech can improve the profitability of the business bank. Theoretically, commercial banks mainly take deposit and loan spreads as the main source of their profits, and the structure of their assets and liabilities is highly correlated with interest rate changes. Previous studies have shown that fintech actually accelerates the process of interest rate liberalization and increases interest rate fluctuations substantially [3]. The development of fintech may affect the profitability of banks. Therefore, in the process of the booming development of fintech, will the profitability of the banks in China get promoted or lower? How does this influence differ in different types of commercial banks? The answers to the above questions are important practical problems for commercial banks to adapt to the changes in the external environment, improve the performance of banks, and deepen the supply side reform of commercial banks to strengthen financial services to the real economy. Based on this, this paper takes commercial banks as the analysis object to discuss the impact of fintech on bank profitability.

2. Literature Review

2.1 The Concept of Fintech

The term "Fintech" first appeared in the "Financial Services Technology Consortium" initiated by Citibank in the early 1990s. With the comprehensive transformation trend of technology enabling traditional financial institutions, it is becoming increasingly fierce. For fintech, there is no unified definition at home and abroad. Different scholars have different expressions on its definition, but the same is true. The essence of fintech is the integration of finance and technology, which requires not only the accumulation of technology, but also the understanding and practice of financial business [4]. Currently, the definition widely accepted by the academic community comes from the Financial Stability Board (FSB), that will fully apply emerging cutting-edge technologies such as big data, blockchain, cloud computing and artificial intelligence to payment and settlement, loan financing, wealth management, Retail banking, insurance, transaction settlement and other financial fields [5]. On this basis, the "FinTech Development Plan (2019-2021)" issued by the People's Bank of China pointed out that FinTech is a technology-driven financial innovation, which aims to use modern scientific and technological achievements to transform financial products, business models and business processes.

Fintech differs from Internet finance and technology finance. Liu Yuan et al. believe that "Fintech" and "Tech-finance" have different footing. The former emphasizes the innovative effect of technology on finance, while the latter focuses on the promotion of finance on the development of technology-based enterprises [6]. The essence of Internet finance is still finance, which is only the combination of traditional financial services and Internet technology. However, the foothold of fintech is science and technology, which emphasizes the application of new technology in financial products and services. It is a science and technology industry serving the financial industry [7]. It can be said that fintech is a

mature stage of Internet finance, and the technologies and problems it uses are more advanced than Internet finance. Such improvement is gradual, but it cannot be ignored.

2.2 Fintech and Commercial Bank Performance

Some scholars have carried out research on the impact of fintech on the performance of commercial banks. Wang Na and Wang Zaiquan believe that the development of fintech will have an adverse impact on the bank's deposit and loan business and intermediary business, thereby reducing the bank's performance level [8]. The results of Yu Bo's research are similar. He uses the data of 138 commercial banks from 2009 to 2017, and uses the social cognition index of fintech as an indicator to measure fintech. Based on the dynamic panel GMM model, he studies the development of fintech and the profitability of banks. The impact of fintech on bank performance is explored from the perspective of "competitive effect" and "technology spillover effect", and the final conclusion is drawn by comparing the level of positive and negative influences: the development of fintech has a negative impact on bank profitability [9]. Liu Mengfei and Wang Qi studied the fintech index synthesized by the text mining method as the core explanatory variable, and found that there was an obvious "inverted U-shaped" relationship between the development of fintech and the performance of Chinese commercial banks. That is, in the early stage, the development of fintech improved the performance level of commercial banks, but with the further application and development of fintech, the relationship between the two gradually reversed, and in the later stage, it turned to reduce the performance of commercial banks [10]. Li Xiangqian and He Zhuoyi came to the opposite conclusion. They found that the deepening of the application of technology in the financial field will significantly improve the operating performance of large state-owned commercial banks and national joint-stock banks [11].

To sum up, the current literature studies at home and abroad mostly focus on the qualitative analysis of fintech and the impact of fintech on the banking industry, and systematic theoretical results have been obtained. However, there are few literatures on the impact of fintech on China's commercial banks, especially the quantitative empirical analysis of fintech on the profitability of commercial banks. Based on this, this paper collected the data of 83 Chinese listed commercial banks from 2011 to 2019, including 5 state-owned commercial banks, 11 joint-stock commercial banks and 67 urban commercial banks. This paper mainly uses the fixed effect model to empirically analyze the impact of fintech on the profitability of traditional commercial banks in China and explore the influencing factors and degrees.

3. Study Design

3.1 Sample Selection and Data Sources

Considering the comprehensiveness of the research and the availability of data, this paper takes the data of 83 commercial banks from 2011 to 2019 as the research object, including 5 large commercial banks (ICBC, ABC, BOC, CCB, COMM), 11 joint-stock commercial banks led by HXBANK and CEB, and 67 urban commercial banks led by Bank of Beijing and Bank of Ningbo.

Due to the banking stock market reform and the separation of non-performing assets before 2008, these measures had a great impact on China's banking industry. In addition, the actual large-scale growth of fintech in China started late, and the time range of data is relatively short. Based on the consistency of data, the sample data are from the annual data of commercial banks from 2011 to 2019. The data of commercial banks come from China Statistical Yearbook, China Financial Yearbook, annual reports of commercial banks and WIND.

3.2 Variable Selection

3.2.1 Explained Variable

The main indicators to measure the profitability of commercial banks are return on total assets (ROA) and return on equity (ROE). ROE reflects how banks operate their own capital to generate income, while ROA reflects the efficient of banks using all their assets to generate income. The main

income of commercial banks is deposit and loan interest rates, so ROA can better reflect the profitability of banks. Therefore, referring to the research ideas of previous studies [12–14], this paper selects return on total assets (ROA) as the explained variable to measure the profitability of banks. At the same time, return on equity (ROE) was selected for robustness test.

3.2.2 Core Explanatory Variable

The core explanatory variable of this paper is fintech index (FI), but the development of fintech in China has not yet formed a unified measurement index. At present, when scholars select indicators to measure the development level of China's fintech, some scholars adopt the "text mining method" to construct fintech development indicators by counting the number of keywords related to fintech. Representative studies include Shen Yue, Guo Pin [15], Liu Zhonglu [16], etc. The other is "substitution method". For example, Qiu Han et al [3] used the China Digital Inclusion Index compiled by the Research Center for Digital Finance of Peking University as a proxy variable to measure the development level of fintech.

Refer to the indicators used by Guo Feng [17], and Qiu Han [3], this paper adopts the Digital Financial Inclusion Index compiled by The Digital Finance Research Center of Peking University to measure the development degree of fintech in the provinces where commercial banks are registered. The Digital Financial Inclusion Index, which is based on the underlying data of Ant Financial's trading accounts, measures the level of fintech development across provinces, cities and counties. Reference Qiu Han [3], this paper selects the financial coverage of science and technology to measure the degree of fintech development. The coverage of specific indicators includes pay treasure account number per ten thousand people, pay treasure to users binding bank card in proportion, and the average tied card number of each account. These indicators are not affected by the influence of bank profitability, so it helps to avoid endogenous effects to a certain extent. In the empirical study, the relevant indexes corresponding to the cities where the headquarters of commercial banks are located are selected as the variables of fintech development.

3.2.3 Control Variables

Table.2. Variable Design

Variable	Indicators	Symbol	Variable Definitions
Explained variable	Return on total assets	ROA	Net profit/Total assets
	Return on equity	ROE	Net profit/average net assets
Core explanatory variable	Fintech Index	FI	Fintech coverage is broad
Control variables	Total assets	SIZE	Log of total assets
	Capital adequacy ratio	CAR	Equity capital/total assets
	Non-performing loan ratio	NPL	Non-performing loans/various loans
	Equity ratio	ETA	Shareholders' equity/total assets
	Cost-income ratio	INF	(Operating expenses + administrative expenses)/ operating income
	loan-to-deposit ratio	LDR	Total bank loans/total deposits
	Net interest rate	NIR	(Interest income - interest expense)/average balance of interest-bearing assets
	The GDP growth rate	GGDP	(GDP of this year - GDP of last year)/ GDP of last year
	Consumer price index	CPI	Changes in the price level of consumer goods and services related to people's life

The control variables in this paper are mainly considered from internal and external perspectives. From the internal perspective of the bank, this paper adds (1) the bank's total assets at the end of the period to measure the size of the bank(SIZE); (2) Capital Adequacy Ratio (CAR), reflecting the asset quality of commercial banks; (3) Non-performing loan ratio (NPL), reflecting the quality of bank loans; (4) Shareholder equity ratio (ETA), reflecting the level of the bank's own capital; (5) Cost-

income ratio (INF); (6) The loan-to-deposit ratio (LDR), reflecting bank liquidity; (7) Net interest rate of return (NIR) as control variable.

From the external perspective of the bank, GDP and price index are important indicators to measure the financial system of a country, and the bank, as the core of the financial system of a country, will also be directly affected by these two aspects. Therefore, GDP growth rate and consumer price index are selected as control variables.

Total assets, fintech index, NPL provision coverage, loan-to-deposit ratio, PER capita GDP and CPI should be logarithmic.

3.3 Descriptive Statistics

The descriptive statistical results of the main variables in this paper are shown in Table.3. As can be seen from Table.3, the maximum value, minimum value and standard deviation of ROA are 0.0311, -0.0054 and 0.0037, indicating that there are great differences in profitability of different commercial banks. The maximum value, minimum value and standard deviation of FI, which measures the fintech development degree of the city where the bank headquarters is located, are 5.9524, 2.6919 and 0.4766, indicating that there is a gap in fintech development level in different regions.

Table.3. Variable Descriptive Statistical Results

Variable	Mean	Median	Max	Min	Std	obs
ROA	0.0093	0.0090	0.0311	-0.0054	0.0037	746
FI	5.1601	5.2651	5.9524	2.6919	0.4766	746
LNSIZE	26.2849	25.8145	31.0359	22.1936	1.7747	746
CAR	13.0724	12.6600	47.5000	5.5800	2.4209	746
NPL	1.3828	1.3300	13.2500	0.0100	0.8865	746
ETA	6.9753	6.7358	21.7599	3.5023	1.6589	746
INF	33.2783	32.4100	71.1400	14.8300	7.5615	746
LDR	4.1789	4.2075	4.8156	3.1839	0.2017	746
NIR	2.6957	2.5700	7.1453	-0.2010	1.0095	746
GGDP	7.3444	7.0000	9.6000	6.0000	0.9692	746
LNCPI	4.6299	4.6260	4.6578	4.6191	0.0108	746

3.4 Unit Root Test

This paper uses panel data model to analyze. Before regression, it is necessary to check whether there is unit root in panel data to test the stability of data and avoid false regression or spurious regression. Panel data model can only be applied to stationary time series data, if non-stationary time series data, variables may have the same trend, which will lead to unreliable results of the model. The most common method of testing data stationarity is the unit root test. There are many kinds of unit root test methods, including the same root unit test and different root unit test. LLC test (for the same root) and Fisher-ADF test (for different roots) are selected in this paper. The results are as follows:

Table.4. Unit Root Test Results

Variable	LLC	Fisher-ADF
ROA	0.0000	0.0032
LNFI	0.0000	0.0000
SIZE	0.0000	0.0000
CAR	0.0000	0.0000
NPL	0.0000	0.0045
ETA	0.0000	0.0000
INF	0.0000	0.0000
LDR	0.0000	0.0017
NIR	0.0000	0.0524
GGDP	0.0000	0.0000
CPI	0.0000	0.0000

According to the unit root test results in Table.4, the P-values of all variables show that they all pass the unit root test at the significance level of 10%. Therefore, the original hypothesis is rejected and the alternative hypothesis is accepted, that is, the sequence of variables is stable.

4. Analysis of Empirical Results

This paper mainly studies the impact of fintech on banks' profitability, so the econometric model is constructed as follows:

$$ROA_{i,t} = \alpha_1 FI_{i,t} + \alpha_2 FI_{i,t}^2 + \sum_{j=1} \beta_j control_{i,t}^j + \varepsilon_{i,t}$$

In the formula, “control” represents a series of control variables, α_1 represents the estimated coefficient of the core explanatory variable FI, β represents the estimated coefficient of the control variable, and ε is the random disturbance term subject to normal distribution.

In this paper, the balanced panel data of N=83 and T=9 are used to carry out F-test, LM test and Hausman test respectively. The results showed that all the models passed F-test, LM test and Hausmann test at 1% significance level, and the fixed-effect model should be selected for empirical analysis.

4.1 Regression Analysis

Table.5 shows the regression results. It can be seen that the coefficient of fintech index (FI) is positive, while the coefficient of FI^2 is negative and significant at the level of 5% or 1%, regardless of the total sample or the sub-sample regression of banks into state-owned commercial banks, joint-stock commercial banks and urban commercial banks. It shows that there is an inverted U-shaped relationship between the development of fintech and the profitability of Chinese commercial banks. That is, in the early stage, the development of fintech improves the profitability of commercial banks, but with the further application and development of fintech, the relationship between the two gradually reverses and turns to reduce the performance of commercial banks in the later stage. In the later period when the development of fintech was relatively mature, fintech alleviated the information asymmetry in the credit market with the help of digital technologies such as big data and cloud computing, and effectively met the borrowing needs of ordinary financial consumers and long-tail groups such as small and micro enterprises. Narrowing the profit range of the bank's asset business will ultimately have a negative impact on the operating performance of the bank whose main source of income is the deposit and loan spread. In general, during the research period, as a kind of financial innovation, the rapid development of fintech has an obvious nonlinear effect on the performance of commercial banks, which is consistent with the findings of Hu Wentao et al. [18] and Liu Mengfei et al. [7]. This conclusion shows that under the background of the continuous deepening of fintech development, traditional commercial banks should actively integrate into the tide of fintech development, increase relevant investment, make full use of the development opportunities brought by fintech, enhance their own innovation and research capabilities, and form new business models. But at the same time, they should also pay attention to avoid the adverse effects of emerging technologies, prevent and resolve potential risks, so as to effectively improve their competitiveness and performance. In addition, the development of fintech has the greatest effect on the profitability of joint-stock banks, followed by large commercial banks, and city commercial banks have the least effect.

In addition, there is also a significant correlation between the control variables and the bank's profitability, which is mainly reflected in the following aspects. The estimated coefficient of the logarithm of total bank assets (LNSIZE) is positive, indicating that larger banks are more profitable, which is related to the economies of scale of assets. The estimated coefficient of the capital adequacy ratio CAR of city commercial banks is significantly negative at the level of 1%, indicating that the requirement of high capital adequacy ratio will limit the scale of its operable assets and inhibit the improvement of profitability. The increase in the non-performing loan ratio means that the risk of bank assets is aggravated. Non-performing loans are the main source of risk for commercial banks. Once the non-performing loan ratio is too high, banks will have a large number of bad debts. In this case,

banks have to withdraw a large number of profits to make up for non-performing losses, their main business income cannot be guaranteed, so bank profits will naturally decrease. Therefore, the non-performing loan ratio is significantly negatively correlated with bank profitability. Moreover, the larger the INF ratio is, the higher the operating expense is when the operating income remains unchanged, and the higher the cost will reduce the profitability. Therefore, the cost-income ratio is significantly negatively correlated with the profitability of the bank at the level of 1%.

Table.5. Regression Results

Variable	ROA			
	All samples	Large commercial bank	Joint-stock commercial bank	City Commercial Bank
FI	0.6488 ** (2.1909)	4.3507 ** (2.0855)	7.1868*** (5.3876)	0.7269*** (2.7164)
FI ²	-0.0824** (-2.5454)	-0.4016** (-2.0906)	-0.7023*** (-5.5963)	-0.0823*** (-2.9313)
LNSIZE	0.0342*** (4.5992)	0.1278** (2.6403)	0.0717*** (4.5670)	-0.0096 (-1.1952)
CAR	-0.0054 (-1.0320)	0.0057 (0.3096)	0.0241** (2.1550)	-0.0135*** (-2.9679)
NPL	-0.1117*** (-9.7529)	-0.0486 (-1.0950)	-0.0910** (-2.6084)	-0.1282*** (-11.4127)
ETA	0.0299*** (3.8703)	0.0084 (0.2363)	0.0793*** (4.2436)	0.0299*** (5.3355)
INF	-0.0119*** (-9.5677)	0.0075 (0.8968)	-0.0051** (-2.1178)	-0.0139*** (-13.4971)
LNLDR	-0.0310 (-0.5760)	0.0695 (0.3052)	-0.0448 (-0.3823)	-0.0692* (-1.8303)
NIR	0.1626*** (15.2757)	0.1836*** (2.9568)	0.1849*** (6.0371)	0.1240*** (13.5399)
GGDP	0.0270 (0.8332)	0.1209* (1.7001)	-0.0489 (-1.0416)	0.0402* (1.8866)
LNCPI	-1.592 (-0.9892)	-0.1915 (-0.0613)	10.2433*** (3.4430)	-0.7175 (-0.6588)

Note: Numbers with “*”, “**” and “***” are significant at the 10%, 5% and 1% levels respectively, the same below.

4.2 Robustness Test

In order to verify the robustness and significance of the empirical model, this paper will change the explained variables and use the ROE index to test the robustness of the model results. The regression results are shown in Table.6.

As can be seen from Table.6, after taking ROE as the explained variable, the primary term coefficient of the fintech index is positive, while the secondary term coefficient is negative and significant, indicating that the development of fintech and the performance level of commercial banks still presents an obvious "inverted U-shaped" relationship, which rises first and then falls. The coefficients of other control variables in the model are basically the same, and the positive and negative directions are basically unchanged, and the significance level is mostly the same. The regression results of the two groups of robustness tests are basically consistent with the above results. In general, the estimation results in this paper are robust and reliable.

Table.6. Robustness Test

Variable	(1)	(2)	(3)	(4)
	All samples	Large commercial bank	Joint-stock commercial bank	City Commercial Bank
FI	18.4002*** (4.1333)	60.7625 * (1.7559)	69.7066** (2.1676)	8.2430* (1.8753)
FI2	-2.1501*** (-4.4194)	-5.8143* (-1.8285)	-7.1113** (-2.3604)	-0.6628 (-1.2538)
LNSIZE	0.5624*** (5.0346)	-2.2973*** (-2.8426)	1.3382*** (3.3998)	-5.3710*** (-6.7761)
CAR	0.2754*** (3.5047)	0.2918 (0.9411)	0.2809 (1.1776)	0.1190 (1.3692)
NPL	-1.6366*** (-9.5072)	-0.6743 (-1.0501)	-2.5366*** (-3.1596)	-1.4066*** (-8.3345)
ETA	-1.4899*** (-12.8136)	-2.2051*** (-3.6909)	-1.3325*** (-2.8322)	-1.3188*** (-9.0035)
INF	-0.1818*** (-9.6673)	0.0630 (0.4572)	-0.0944* (-1.7463)	-0.2755*** (-9.2875)
LNLDR	-1.7038*** (-2.1043)	1.3109 (0.3450)	0.4911 (0.1624)	-1.8123* (-1.7158)
NIR	2.3557*** (14.7238)	3.6788*** (3.7027)	3.7832*** (5.9954)	0.9786*** (4.4967)
GGDP	0.4976 (1.0224)	0.8349 (0.6966)	-1.6963 (-1.3789)	0.8306 (1.2947)
LNCPI	-4.4982 (-0.1859)	18.0919 (0.3571)	134.5877* (1.8708)	-30.3824 (-1.2055)

5. Conclusion

This paper conducts an empirical test based on the balanced panel data of 87 Chinese commercial banks from 2011 to 2019. The results show that:

(1) On the whole, there is an inverted u-shaped relationship between the fintech development and the performance of Chinese commercial banks. In other words, the development of fintech in the early stage is conducive to improving the performance level of commercial banks, while it reduces the performance of banks in the later stage.

(2) The development of fintech has a greater impact on the profitability of large and medium-sized commercial banks (large state-owned banks and joint-stock banks) than small banks.

(3) Factors such as bank loan quality, capital structure, net interest margin, and cost control have a significant impact on the profitability of commercial banks.

In view of the above research conclusions, this paper puts forward the following policy suggestions: First, commercial banks, especially small local banks, should actively participate in the development trend of "Finance + Technology" integration, rationally use artificial intelligence and other scientific and technological achievements to improve the quality and efficiency of financial services, and obtain more space for performance growth. Second, gradually transform to an "asset-light" direction, such as using 5G technology, VR/AR and other technologies to create a remote interactive, highly accessible and physically aware financial scene environment, providing customers with multi-level online financial services, giving full play to customers agglomeration effect and reducing the marginal cost of financial services. Third, commercial banks should use fintech to build an inclusive and open cooperation platform, attract technology companies and scientific research institutes to participate in the design of scenarios, and create a comprehensive financial ecosystem. Fourth, use key technologies of fintech to optimize the risk monitoring system and improve the ability of commercial banks to identify, warn and deal with financial business risks. Fifth, the government should strengthen the top-level design of fintech and financial system reform to create a rational, benign, healthy and sustainable competitive environment for commercial banks to use fintech.

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