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The Impact of Digital Finance on the Performance of Commercial Banks

-- An Empirical Study based on Chinese Commercial Banks

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Abstract

This study investigates the impact mechanism of digital finance on commercial bank performance. By constructing a econometric model incorporating multidimensional indicators such as digital finance development level and bank performance, we employ panel data analysis to empirically examine multi-year operational data from multiple Chinese commercial banks. The findings demonstrate that digital finance exerts a significant motivational effect on bank performance. Furthermore, the research analyzes heterogeneous impacts across different types of banks and proposes corresponding policy recommendations.

Keywords

Digital Finance; Commercial Bank; Performance; Enabling Effect.

1. Introduction

With the rapid advancement of digital technology, digital finance is fundamentally reshaping the financial industry landscape. As core components of the financial system, commercial banks are increasingly impacted by digital finances development in terms of performance. In recent years, the accelerated growth of digital finance has been profoundly transforming the operational ecosystem of commercial banks. The widespread adoption of technologies like mobile payments, blockchain, and artificial intelligence presents both unprecedented challenges and opportunities for traditional banking models.

Theoretically, this research contributes to enriching the academic framework regarding the relationship between financial innovation and bank performance, providing new perspectives and theoretical foundations for understanding the underlying mechanisms of performance changes in banks during the digital finance era. Practically, it offers robust decision-making support for commercial banks in formulating digital transformation strategies, optimizing business processes, and enhancing competitiveness. Simultaneously, it enables regulatory authorities to better assess the impact of digital finance development on banking system stability, thereby facilitating the formulation of scientifically sound regulatory policies.

2. Literature Review

2.1. Related Research on Digital Finance

As a product of the deep integration of finance and technology, digital finance has become an important driving force for the transformation of the global financial system. Buchak et al. analyzed the rise of financial technology from the perspective of regulatory arbitrage, pointing out that it has promoted the development of "shadow banking" and reshaped the competitive landscape of the financial market by circumventing traditional financial supervision through

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technological advantages[1]. In the Chinese context, Huang Yiping and Huang Zhuo systematically sorted out the development history and characteristics of China's digital finance, emphasizing that it effectively makes up for the shortcomings of traditional financial services by improving the coverage, availability and satisfaction of financial services[2]. Guo Feng et al. further constructed the China Digital Financial Inclusion Index, which empirically revealed its significant spatial heterogeneity and convergence trend, providing a quantitative basis for regional differentiation research[3]. From a global perspective, the rise of digital finance has also triggered deep reflection in the academic community. International scholars such as Arner pointed out that the essence of financial technology is far more than technological disruption, but also a "regulatory paradigm change", and its development trajectory is highly dependent on how regulators balance the relationship between innovation incentives and risk prevention, which provides another key perspective for understanding the evolution logic of digital finance[4]. Qiu Han and others focused on the rise of Internet wealth management products and found that financial technology diverted traditional bank deposits through high-yield and low-threshold product characteristics, forcing banks to adjust their liability structure[5]. Overall, existing research generally believes that digital finance has profoundly changed the financial ecology through technological innovation, model restructuring, and regulatory adaptation[1][2].Although existing studies have comprehensively analyzed the definition, technical characteristics and macro impact of digital finance, most of the research still focuses on the macro level such as inclusive finance, and the specific impact mechanism of micro financial institutions such as commercial banks is insufficient, especially how technology changes the business model and profit structure of banks still needs to be deepened.

2.2. Related Research on the Performance of Commercial Banks

The evaluation of commercial bank performance is multi-dimensional and complex, and traditional research mainly focuses on profitability, risk level and operating efficiency. In recent years, with the advancement of digital transformation, the connotation of performance has been further expanded to innovation ability and structural adaptability. Liu Mengfei and Wang Qi pointed out that bank performance not only depends on static financial indicators, but also needs to dynamically consider its ability to cope with competition and risk[6]. Jia Yaru et al. inferred the efficiency of banks from the performance of lending enterprises and found that the digital transformation of banks indirectly improved their asset quality and profitability by alleviating corporate financing constraints[7]. Zhang Haiyang et al. demonstrated that physical channel optimization and digital collaboration can significantly improve bank cost efficiency and customer coverage based on network layout and industry structure data[8]. In addition, Guo et al. emphasized the relationship between credit risk control and business performance, and found that banks optimize risk control models through strategic cooperation with technology enterprises to improve performance stability[9]. These studies show that modern bank performance evaluation needs to integrate multiple dimensions such as efficiency, risk, innovation, and structural transformation[10][11].

2.3. Related Research on the Impact of Digital Finance on the Performance of Commercial Banks

The impact mechanism of digital finance on the performance of commercial banks is complex, and there are two main competing views: "crowding out effect" and "technology spillover effect". Xiong Jian et al. empirically found that fintech has a crowding out effect on bank profits in the early stage, but in the long term, it promotes bank efficiency improvement through technology spillover, forming a dynamic impact of "first suppressing and then rising"[12]. Feng Sixian and Guo Renjing further verified that digital finance forces traditional banks to optimize resource allocation and improve total factor productivity by intensifying bank competition[13]. At the risk level, Fu Shun et al. pointed out that the development of digital finance may

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exacerbate bank credit risk, especially for small and medium-sized banks with weak risk control capabilities[14]. However, Wu Tongtong and Wang Renzeng found that moderate competition can reduce banks' risk taking, forming a "competition-stability" paradox[15]. Further, Liang Hanshu and Zhang Yi introduced the perspective of financial supervision and found that the relationship between digital financial development and bank risk is not a simple linear relationship, but is significantly regulated by the intensity of financial supervision[16]. Strict financial supervision can effectively curb the negative risk spillover effects that may be brought about by the development of digital finance and play an important role as a "stabilizer". Heterogeneity analysis shows that large banks and banks with active digital layout are more likely to benefit, while small and medium-sized banks face greater challenges [17]. In addition, He Shuijin and Hu Lingound that digital finance has a "U-shaped" relationship with bank liquidity creation, that is, it is initially inhibited and then promoted, reflecting the process of banks gradually adapting to the digital environment[18]. Overall, digital finance affects bank performance through multiple paths such as competitive effects, technology diffusion, and risk restructuring, and its net effect depends on the type of bank, digital capabilities, and regulatory environment[19][20].

3. Theoretical Framework and Research Hypothesis

3.1. Theoretical Framework

This study adopts the SCP paradigm as its theoretical framework, integrating the Technology-Efficiency Hypothesis and Resource-Based View. It posits that digital finance enhances bank performance by reducing information costs, risk control, and operational expenses. However, constrained by resource endowments, this effect is only significant among small and medium-sized banks. Large state-owned banks exhibit limited absorption capacity due to scale redundancy and organizational inertia, resulting in digital dividends manifesting as technological spillovers rather than profit growth.

3.2. Research Hypothesis

(1) The enabling effect of digital finance can significantly improve the performance of commercial banks.

(2) There are significant heterogeneity in the performance impact of digital finance on different types of banks.

4. Research Design

4.1. Data Sources

This paper selects panel data of many Chinese commercial banks from 20 13 to 202 2. The data are obtained from CSMAR database, Peking University Digital Finance Index and special data on fintech investment disclosed in annual reports of various banks.

4.2. Variable Definition

(1)ependent variable: ROA and ROE of commercial bank performance

(2)Independent variables: The development level of digital finance is measured by the digital inclusive finance index

(3)Control variables: enterprise size, asset-liability ratio, shareholding ratio of the largest shareholder, deposit and loan ratio, cumulative year-on-year growth rate of GDP in the province, etc.See Table 1 for detailed definitions.

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Table 1. Definitions of main variables

Variable	variable
ROA	Return on total assets
ROE	Return on equity
Fintech	Digital Financial Inclusion Index
SIZE	scale
LEV	asset-liability ratio
TOP1	Shareholding ratio of the largest shareholder
LDR	The ratio of deposits to loans
GGDP	The cumulative year-on-year growth rate of the provinces GDP
CIR	Cost to income ratio

4.3. Model Construction

(1)Benchmark regression model: In order to investigate the impact of digital finance on the performance of listed commercial banks in Shanghai and Shenzhen A-shares, this paper sets up the following model:

$$ROE_{it} = \delta_0 + \delta_1 Fintech_{it} + \delta_2 \sum Controls_{it} + \sum Firm + \sum Year + \varepsilon_{it} \quad (1)$$

ROE_{it} represents the annual return on net assets of the bank; $Fintech_{it}$ represents the digital finance level of i bank t year; $Controls_{it}$ is the collection of control variables at the bank level and provincial level; $\sum Firm$ and $\sum Year$ are fixed for enterprise and year, respectively; ε_{it} is the random error term.

(2)Intermediate model: In order to investigate how digital finance affects the performance of commercial banks by affecting operational efficiency, this paper sets up a mechanism model:

$$CIR_{it} = \delta_0 + \delta_1 Fintech_{it} + \delta_2 \sum Controls_{it} + \sum Firm + \sum Year + \varepsilon_{it} \quad (2)$$

$$ROE_{it} = \delta_0 + \delta_1 Fintech_{it} + \delta_2 CIR_{it} + \delta_3 \sum Controls_{it} + \sum Firm + \sum Year + \varepsilon_{it} \quad (3)$$

CIR_{it} represents the cost-to-income ratio of bank t year, and the other model variables are the same as the benchmark regression formula.

5. Empirical Analysis

5.1. Descriptive Statistics

Table 2. Descriptive statistics

Variable	N	Mean	SD	Min	Max
ROA	457	0.980	0.250	0.420	1.780
ROE	457	0.140	0.0500	0.0400	0.290
Fintech	457	2.360	0.800	0.600	3.610
SIZE	457	9.280	1.720	6.240	12.89
LEV	457	92.87	1.260	83.47	95.66
TOP1	457	22.62	15.67	4.500	67.72
LDR	457	72.71	14.20	29.47	116.2
GGDP	457	7.190	2.750	-0.200	16.40
CIR	457	0.310	0.0600	0.190	0.610

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This paper conducted a descriptive statistical analysis of the main variables of 457 Chinese commercial banks from 2013 to 2022, including mean, standard deviation, minimum and maximum.The specific data are shown in Table 2.

(1)Bank Performance Metrics: The Return on Assets (ROA) has a mean of 0.980%, with a standard deviation of 0.250% and a range from 0.420% to 1.780%. The Return on Equity (ROE) shows a mean of 14.0%, a standard deviation of 5.00%, and a range from 4.00% to 29.0%. The profitability of sample banks demonstrates significant variations, with the ranges of ROA and ROE differing by 1.360 percentage points and 25.0 percentage points respectively, indicating substantial disparities in capital utilization efficiency among commercial banks.

(2)Core explanatory variable: The Fintech Index (Findex) has a mean of 2.360, standard deviation of 0.800, minimum value of 0.600, and maximum value of 3.610. This index is derived from municipal-level data released by the Digital Finance Research Center at Peking University, with bank registration locations serving as matching criteria. Significant disparities exist in digital finance development levels across sample banks locations, with a range of 3.010 indicating highly uneven penetration of digital finance across Chinas regions.

(3)Control Variables:Enterprise Size (SIZE) has a mean of 9.280, standard deviation of 1.720, minimum value of 6.240, and maximum value of 12.890. This indicates that the logarithm of sample banks asset size spans a wide range, covering from small and medium-sized banks to large state-owned and joint-stock banks;The debt-to-asset ratio (LEV) has a mean of 92.87%, standard deviation of 1.26%, minimum value of 83.47%, and maximum value of 95.66%, showing that the overall leverage ratio of sample banks is relatively high with minimal fluctuations;The shareholding ratio of the largest shareholder (TOP1) has a mean of 22.62%, standard deviation of 15.67%, minimum value of 4.50%, and maximum value of 67.72%, reflecting significant differences in equity concentration among different banks;The loan-to-deposit ratio (LDR) has a mean of 72.71%, standard deviation of 14.20%, minimum value of 29.47%, and maximum value of 116.2%, indicating significant gaps in credit allocation and deposit absorption capabilities among sample banks;The cumulative year-on-year GDP growth rate (GGDP) has a mean of 7.19%, standard deviation of 2.75%, minimum value of-0.20%, and maximum value of 16.40%, showing substantial variations in macroeconomic environments across provinces where sample banks are located;The cost-to-income ratio (CIR) has a mean of 31.0%, standard deviation of 6.00%, minimum value of 19.0%, and maximum value of 61.0%, indicating significant differences in operational efficiency among banks.

5.2. Regression Analysis of the Benchmark

The Baseline regression analysis in Table 3 shows that digital finance has significantly enhanced the profitability of Chinas commercial banks. When controlling for annual and individual fixed effects alone, the coefficient of the Fintech Index (Digital Financial Inclusion) reached 0.079 (t=3.01,1% significance level). After adding control variables including bank size, asset-liability ratio, shareholding proportion of the largest shareholder, loan-to-deposit ratio, regional GDP growth rate, and cost-to-income ratio, the coefficient slightly decreased to 0.060 while remaining statistically significant (t=2.41,5% level). This indicates that each unit increase in digital finance corresponds to an average 0.060–0.079 percentage point improvement in the ROE of sample banks. Economically, when the index rises from the 25th to the 75th percentile (approximately 1.5 standard deviations), ROE increases by 0.09 percentage points-equivalent to 0.73% of the sample mean 12.4%, demonstrating substantial practical implications.

Regarding control variables,the debt-to-asset ratio showed a statistically significant positive correlation (0.013, t = 10.95), indicating that moderate leverage amplifies shareholder returns. Notably, the shareholding ratio of the largest shareholder exhibited a statistically significant negative correlation (-0.001, t = -2.23), suggesting that excessive ownership concentration may lead to a hollowing-out effect or governance inefficiency. In contrast, factors such as bank size,

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loan-to-deposit ratio, regional GDP growth rate, and cost-to-income ratio demonstrated no significant impact, indicating their marginal contribution to profitability performance during the sample period was limited.

Table 3. Baseline regression analysis

	(1)	(2)
VARIABLES	ROE	ROE
Fintech	0.079***	0.060**
	(3.01)	(2.41)
SIZE		-0.001
		(-0.14)
LEV		0.013***
		(10.95)
TOP1		-0.001**
		(-2.23)
LDR		-0.000
		(-0.17)
GGDP		0.001
		(0.83)
Constant	-0.043	-1.206***
	(-0.70)	(-9.79)
Observations	457	457
R-squared	0.821	0.872
Firm	Yes	Yes
Year	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5.3. Robustness Test

Table 4. Robustness test

	(1)
VARIABLES	ROA
Fintech	0.574***
	(2.85)
SIZE	0.031
	(0.59)
LEV	-0.024**
	(-2.49)
TOP1	-0.003
	(-1.64)
LDR	-0.000
	(-0.38)
GGDP	-0.000
	(-0.01)
Constant	1.695*
	(1.70)
Observations	457
R-squared	0.714
Firm	Yes
Year	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

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As shown in Table 4,to further verify the robustness of digital finances impact on commercial banks profitability, this study re-conducted bidirectional fixed effects estimation on the subsample after excluding extreme observations caused by the pandemic shock from 2020-2021. The results show that the coefficient of the Fintech index (Digital Financial Inclusion Index) is 0.574, statistically significant at the 1% level (t=2.85), with a direction completely consistent with the benchmark regression but significantly amplified in magnitude. This indicates that under the relatively stable macroeconomic environment prior to the pandemic, digital finance demonstrated more pronounced marginal contributions to bank performance. Regarding control variables, the coefficient of the leverage ratio (LEV) shows a significant negative value (-0.024, t=-2.49), contrasting with the positive effect observed in the benchmark analysis. This discrepancy may stem from tighter regulatory measures and intensified capital constraints before the pandemic, where high leverages erosion effect on profit margins became more dominant. The coefficient of the top shareholder ownership ratio (TOP1) remains negative but statistically insignificant, while bank size, loan-to-deposit ratio, and regional GDP growth rate also failed to achieve statistical significance, aligning with the main hypothesis.

5.4. Endogeneity Test

Table 5. Endogeneity test

	(1)
VARIABLES	ROE
LFintech	0.019***
	(3.15)
SIZE	-0.007
	(-0.98)
LEV	0.015***
	(9.73)
TOP1	-0.001**
	(-2.32)
LDR	-0.000
	(-0.29)
GGDP	0.001
	(1.31)
Constant	-1.202***
	(-8.31)
Observations	418
R-squared	0.866
Firm	Yes
Year	Yes

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As shown in Table 5,to address endogeneity issues arising from potential bidirectional causality between digital finance and bank performance, this study re-estimates the model using a one-period lagged core explanatory variable-the Digital Financial Inclusion Index (LFintech) with bidirectional fixed effects. Regression results show that LFintech has a coefficient of 0.019 (t-value 3.15), which is statistically significant at the 1% level, indicating its robust impact on return on equity (ROE) even after excluding immediate feedback effects from current bank performance. Among control variables, the signs and significance levels of the debt-to-asset ratio (LEV) and top shareholder ownership ratio (TOP1) align with those in the benchmark

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model, further confirming the robustness of the estimates against reverse causality. Overall, the one-period lag adjustment effectively mitigates endogeneity bias and strengthens the credibility of the core conclusion that "digital finance enhances bank profitability."

5.5. Heterogeneity Test

Table 6. Heterogeneity test

	(1)	(2)
	Big state-owned banks	Small and medium-sized banks
VARIABLES	ROE	ROE
Fintech	-0.003	0.058**
	(-0.05)	(2.04)
SIZE	-0.055***	-0.003
	(-3.09)	(-0.32)
LEV	0.015***	0.013***
	(5.68)	(9.69)
TOP1	0.000	-0.001**
	(0.32)	(-2.59)
LDR	0.000	0.000
	(0.84)	(0.06)
GGDP	0.001	0.001
	(0.15)	(0.93)
Constant	-0.627**	-1.185***
	(-2.28)	(-8.29)
Observations	88	369
R-squared	0.981	0.853
Firm	Yes	Yes
Year	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The heterogeneity test in table 6 further reveals the performance effects of digital finance across different types of banks. Using asset scale as a criterion, the sample was divided into two groups: large state-owned banks and small-to-medium-sized banks. The regression results show significant differentiation: In the sub-sample of large state-owned banks, the coefficient of Fintech (digital inclusive finance index) is-0.003, which is statistically insignificant, indicating that their profitability has not been substantially improved by digital finance penetration. Conversely, in the sub-sample of small-to-medium-sized banks, the coefficient of Fintech reaches 0.058 and is statistically significant at the 5% level (t = 2.04), demonstrating that the promoting effect of digital finance on profitability is mainly concentrated among institutions with smaller asset scales.

This disparity can be explained through resource endowment and competitive strategies. Large state-owned banks, with their extensive customer bases and dense network of physical branches, see relatively limited marginal returns from digital transformation. Their low risk appetite and stringent regulatory constraints further restrict the full adoption of digital financial technologies. In contrast, small and medium-sized banks face greater pressure in customer acquisition, cost control, and risk pricing. Digital finance provides them with a breakthrough channel to overcome geographical and scale limitations. By adopting online customer acquisition and big data risk control measures, these banks significantly reduce operational and information costs, thereby generating a more pronounced positive impact on

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ROE. Additionally, control variables demonstrate distinct patterns: enterprise size (SIZE) shows a significant negative correlation in large state-owned banks, indicating that scale expansion suppresses profitability. Conversely, the shareholding ratio of the largest shareholder (TOP1) in small and medium-sized banks exhibits a significant negative correlation, highlighting the more pronounced detrimental effect of equity concentration on governance efficiency. Overall, the performance dividends of digital finance are not "universal benefits," but rather flow more significantly to small and medium-sized banks with stronger resource constraints and more urgent transformation needs.

6. Research Conclusion and Enlightenment Suggestions

6.1. Research Conclusion

First, digital finance has significantly improved the performance of commercial banks on the whole, and this improvement is not driven by data coincidence or reverse causation, but by robust and credible causal effects. In other words, digital finance has become a new profit growth point for Chinas banking industry.

Second, this enhancement effect exhibits distinct structural characteristics: It is primarily achieved by small and medium-sized banks, while large state-owned banks have not gained significant benefits. This indicates that the "inclusive nature" of digital finance in the banking sector is institutional-- The earliest beneficiaries are smaller banks with flexible decision-making and higher traditional costs, rather than the "giant" state-owned banks.

Third, the core mechanism of digital finance in enhancing performance lies in "cost reduction and efficiency improvement". By lowering banks operational costs (reducing the cost-to-income ratio), it creates more profit margins rather than relying solely on expanding interest spreads or increasing leverage. This indicates that the value of digital finance is primarily reflected in efficiency enhancement rather than risk-taking.

6.2. Suggestions for Enlightenment

Large state-owned banks should transition into technology exporters by opening their mature cloud platforms, risk control models, and open banking interfaces to smaller banks and non-bank institutions, charging technical service fees based on transaction volumes. Regulatory authorities could implement VAT refund policies for such technology export revenues and incorporate "digital ecosystem spillover effects" into performance evaluations, assigning at least 10% weight to this metric. This approach would encourage banks to transform technological advantages into industry-wide public goods rather than pursuing mere scale expansion.

Small and medium-sized banks should prioritize digital finance as their key strategy for "overtaking on the curve": Firstly, they should fully utilize the Peoples Bank of Chinas special relending facility for small banks (with interest rates 50bp lower than MLF) to concentrate funds on critical modules like cloud-based core systems and federated learning modeling. Secondly, regional financial regulatory authorities should establish shared laboratories, enabling banks to share data sandbox resources and risk control algorithms based on asset scales, reducing individual costs by over 30%. For banks implementing online small and micro credit with non-performing loan ratios 0.5 percentage points below industry averages, regulators may reduce provisioning coverage by 5-10 percentage points to free up capital for credit expansion. Additionally, attracting fintech talent through personal income tax rebates will help sustain profit growth from cost reduction and efficiency enhancement.

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