Examination of the Mechanism of Fintech Empowerment in Commercial Banks Based on Text Mining

Jingyu Gao [1,†], Yongqi Li [2,*,†]

[1] School of Computing and Artificial Intelligence, Southwestern University of Finance and Economics, Chengdu, China

[2] School of Law, Southwestern University of Finance and Economics, Chengdu, China

* Corresponding Author Email: 42022046 smail.swufe.edu.cn

† These authors contributed equally.

Abstract. Against the backdrop of financial technology empowering the transformation of commercial banks, this paper uses panel data from 38 commercial banks in China between 2012 and 2020, and constructs a financial technology index using text mining techniques, to investigate the mechanism of fintech empowerment in commercial banks. The study found a significant positive "U" -shaped relationship between the level of bank fintech and profitability. The results of the examination indicate that fintech has a stronger positive impact on the profitability of small and medium-sized local state-owned banks, and that fintech affects bank profitability through risk-bearing, capital structure, and operational capabilities. This paper takes the risk-bearing ability, capital structure, and operational level of commercial banks as intermediate variables in the model, and controls for variables through macroeconomic environment and policy, and internal factors of commercial banks, to make the research results more convincing. This provides new research ideas for the study of systematic fintech theory and financial risk theory.

Keywords: Financial Technology, Text Mining, Profitability, Positive "U" Shape.

1. Introduction

Financial technology (fintech) was first proposed by John Reed, Chairman of Citigroup, in the 1990s, referring to the behavior of financial enterprises using digital information technologies such as big data and artificial intelligence to provide digital information services for traditional financial ecosystems. As fintech is still in its development stage, there is no standard definition. Therefore, scholars, international organizations, and governments have given reference definitions based on their own research and perspectives. Currently, research on fintech mainly focuses on the following areas: (1) research on the basic research paradigm of fintech, including concept definition, development positioning, market positioning, and functional positioning; (2) analysis of theoretical foundations related to fintech [1]; (3) research on the channels, business, and performance of traditional financial institutions affected by fintech [2]; and (4) research on the impact of fintech on financial services for the real economy and monetary policy transmission mechanism [3]. While fintech shapes a new vitality for the financial industry, it also brings many potential risks. Therefore, changes in technology must be considered in the context of changes in existing financial regulatory thinking, and the main risks it faces should be incorporated into the corresponding financial regulatory system [4].

The contribution of this study is twofold: firstly, it explores the theoretical mechanism of how fintech enhances the operational performance of commercial banks, providing new research ideas for academic research in systematic fintech theory and financial risk theory. Secondly, this paper takes the risk-bearing ability, capital structure, and operational level of commercial banks as intermediate variables in the model, and controls variables through macroeconomic environment and policy, and internal factors of commercial banks, making the research content more complete and the research results more convincing. At the same time, this paper also performs endogeneity processing and robustness tests on the regression model to further verify the conclusions of the model, and further explores the impact of fintech development on banks of different types and different corporate natures through heterogeneity analysis.

2. Literature Review

In the research on the impact of fintech on the operational performance of commercial banks, Jichang Dong et al. [5] used factor analysis to construct financial and comprehensive performance indices and found that the development of fintech has a positive impact on the profitability, safety, and growth of commercial banks, but a negative impact on their liquidity. Fintech can improve the operational, service, and risk management capabilities of banks and thus enhance their operational performance [6]. However, some scholars believe that fintech has an inverted U-shaped effect on the operational performance of commercial banks, and the changes in risk-taking induced by fintech are an important reason for the nonlinear effect [7].

In addition, regarding the impact of fintech on the risk-taking behavior of commercial banks, some scholars believe that fintech can help banks identify, quantify, and price risks, thereby reducing losses from non-performing loans and increasing their expected income [9]. Moreover, the impact of fintech on the risk-taking behavior of commercial banks exhibits a "U"-shaped trend, and its impact on the risk-taking behavior of different types of commercial banks is heterogeneous. In terms of capital structure, the analysis using the PLSR model shows that variables such as net interest margin and asset quality have a significant positive impact on the operational performance of commercial banks [10].

In summary, existing domestic and foreign studies have mainly explored the impact of fintech on the operational performance of commercial banks from the perspectives of risk-taking, capital structure, competition, and specific effects. However, most studies ignore the specific scale of commercial banks, neglect the heterogeneity of commercial banks in different regions, and have insufficient research on the intermediary transmission mechanism of fintech on the operational performance of commercial banks. Based on the above considerations, this paper constructs a financial technology index to verify the impact of financial technology on the operational performance of commercial banks, and uses a multiple mediation model to explore the mediating mechanism of financial technology on the operational performance of commercial banks. Additionally, this paper investigates the heterogeneity of the impact of financial technology on large and small commercial banks by categorizing all banks into these two groups.

3. Theoretical Analysis and Research Hypotheses

Given the controversy surrounding the impact of financial technology on bank performance, this paper proposes different hypotheses and draws conclusions through empirical analysis.

Firstly, banks can enhance asset allocation efficiency, reduce operating costs, strengthen risk control to some extent, and optimize customer service processes by leveraging financial technology, thereby achieving an overall increase in bank total factor productivity. Furthermore, the development of financial technology will increase non-interest income, affecting total assets. Based on this, this paper proposes hypothesis H1a:

H1a: Financial technology has a positive impact on the operational performance of commercial banks.

The development of banks from traditional finance to financial technology involves four dynamic stages: market perception, resource investment, utility realization, and marginal revenue decline. In the market perception stage, banks face competition from external financial technology companies. In the resource investment stage, banks begin to increase their investment in financial technology, and at this stage, investment exceeds output. In the utility realization stage, banks begin to receive positive effects from financial technology, including reduced total costs, increased revenue, and improved total factor productivity [1]. Overall, the first three stages are revenue-generating stages for banks. However, in the marginal utility decline stage, the risk exposure increases, which will affect bank performance. Therefore, this paper believes that the development of financial technology in banks and profitability show a nonlinear relationship of increasing and then decreasing. Based on the above analysis, this paper proposes hypothesis H1b:

H1b: Financial technology will affect the profitability of commercial banks, exhibiting an inverted "U" shape with an initial increase and then a decrease.

The impact of financial technology on banks is mainly reflected in the technology squeeze-out effect and the technology spillover effect. With regard to the technology squeeze-out effect, firstly, financial technology will cause serious loss of long-tail customers for commercial banks, thereby negatively affecting their performance [11]. Secondly, after obtaining control over the "low-end market," financial technology will use low-cost business models to gradually penetrate the mainstream market from the bottom up, intensifying market competition.

With regard to the technology spillover effect, technology has significant externalities, and owners of advanced technology consciously or unconsciously transfer or disseminate their technology, which may have a positive impact on other competitors in the same industry. In the current stage of the development of financial technology, the deep integration of finance and technology means that commercial banks will be more proactive in collaborating with financial companies to absorb advanced technology and experience. Based on the above analysis, this paper proposes hypothesis H1c:

H1c: Financial technology will have an impact on the profitability of commercial banks, exhibiting a positive "U" shape with an initial decrease followed by an increase.

4. Research Design

4.1. Sample and Data Sources

This study examines data from 38 commercial banks in China between 2012 and 2020, including 5 large state-owned commercial banks, 9 joint-stock commercial banks, 16 city commercial banks, and 8 rural commercial banks, by referring to Bank Focus database and the annual reports of various commercial banks in China.

4.2. Variable Definitions

1) Dependent Variable

As a commonly used indicator to measure the profitability of financial institutions, the return on assets (ROA) is used in this study to assess the observed operational performance of commercial banks, following previous studies [8]. It can objectively demonstrate the horizontal differences in operational performance among banks.

2) Independent Variable

Given the lack of standardized and comprehensive statistical data in the field of financial technology, this study constructs a financial technology index based on the "text mining method" proposed by previous research to effectively measure the changes in the level of financial technology development in recent years. Specifically, we first construct a keyword library for the financial technology index (Table 1), which mainly includes the underlying technologies of financial technology development, the implementation paths of financial technology, and practical applications. Second, we conduct text mining on the financial technology keywords in the annual reports of 38 commercial banks between 2012 and 2020, calculate the frequency of keywords, eliminate words with extremely low frequency, and select effective words as the basis for constructing the financial technology index. Third, we use factor analysis to estimate the score coefficient matrix, and use the variance percentage of each factor as the weight to obtain the standardized financial technology index.

Table 1. Keywords library for the financial technology index

Underlying Technology	Artificial intelligence	Artificial Intelligence, business intelligence, image understanding, investment decision support system, intelligent data analysis, sharing, machine learning, deep learning, semantic search, biometric technology, facial recognition, speech recognition, identity verification, user profiling, precise matching, customization, agility
	Blockchain	Blockchain, digital currency, distributed ledger, distributed computing, differential privacy technology, smart financial contracts
	Cloud computing	Cloud computing, stream computing, graph computing, in-memory computing, multi-party secure computing, neuromorphic computing, green computing, cognitive computing, integrated architecture, billion-level concurrency, exabyte-level storage, IT, Internet of Things (IoT), Cyber-Physical Systems (CPS), private cloud, public cloud
	Big data	Big data, data mining, information technology, text mining, data visualization, heterogeneous data, credit reporting, augmented reality, mixed reality, virtual reality, data analysis
Practical application		Internet finance, mobile banking, app, NFC payment, mobile payment, phone payment, third-party payment, e-commerce, private banking, B2B, B2C, C2B, C2C, O2O, internet finance, platform, intelligent supervision, intelligent risk control, intelligent transportation, intelligent customer service, intelligent investment advisory, intelligent counter, regulatory technology, digital marketing, digital finance, fintech, financial technology, quantitative finance, open banking, API, scenario, supply chain finance, digital inclusive finance

3) Mediating Variables

Considering that FinTech affects bank performance through its impact on risk-taking, capital structure, and operational efficiency, this study selects performance indicators such as non-performing loan ratio (NLP), capital adequacy ratio (CAR), and cost-to-income ratio (CTI) as variables to measure the mediating effects mentioned above.

4) Control Variables

Table 2. Variable Definition and Description

Variable Type	Variable Name	Symbolic Representation	Variable Definition.
Dependent Variable	Return on Assets	ROA	Net Income / Total Assets
Independent Variable	Fintech Index	FinTech	—
Mediator Variable	Non-performing Loan Ratio	NLP	Total Non-performing Loans / Total Loans
	Capital Adequacy Ratio	CAR	Capital (Core Capital + Supplementary Capital) / Risk-weighted Assets
	Cost-to-Income Ratio Logarithm	CTI	ln(Operating Costs / Operating Income)
Control Variable	GDP Growth Rate	GDP	(Current Period GDP - Previous Period GDP) / Previous Period GDP
	Money Supply Growth Rate	MSR	(Current Period Money Supply - Previous Period Money Supply) / Previous Period Money Supply
	CPI Index	CPI	—
	Unemployment Rate	UR	Number of Unemployed Persons / Total Labor Force
	Total Assets Logarithm	ASSET	ln(Total Assets Value)
	Loan-to-Deposit Ratio Logarithm	DL	ln(Total Deposits / Total Loans)
	Net Income Ratio Logarithm	FCP	ln(Net Income / Operating Income)
	Net Interest Margin	NIM	Interest Income - Interest Expense

In selecting control variables, following previous literature [12], micro and macroeconomic variables may have significant impacts on bank operational efficiency. Therefore, this study controls for internal factors of commercial banks, including total asset size, loan-to-deposit ratio, net fee and commission income ratio, and net interest margin. This study also controls for macroeconomic

variables, including GDP growth rate, money supply growth rate, CPI index, and unemployment rate. Other control variables include bank fixed effects and time fixed effects. The definitions and descriptions of the main variables are shown in Table 2.

4.3. Model Specification

1) Baseline Model

To examine how financial technology development affects the profitability of banks, this paper constructs the following fixed effects multivariate linear model for empirical analysis:

$$ROA_{it} = \alpha_0 + \alpha_1 FinTech_{it} + \alpha_2 Control_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

$$ROA_{it} = \alpha_0 + \alpha_1 FinTech_{it} + \alpha_2 FinTech_{it}^2 + \alpha_3 Control_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

Among them, ROA_{it} is the dependent variable, representing the profitability of bank i in year t; $FinTech_{it}$ is the core explanatory variable, representing the FinTech index of bank i in year t, and its squared term ($FinTech_{it}^2$) is introduced in the equation to test for the nonlinear impact of FinTech on bank profitability. $Control_{it}$ is the control variable, including macro-level and bank-level characteristics. μ_i is the bank-specific fixed effect, and δ_t is the time fixed effect. ε_{it} is the error term. α_1, α_2 are the coefficients of primary interest in this study.

2) Mediation effect model

To further investigate the channels through which the development of financial technology affects bank profitability, this study constructs a multiple mediation effect model for testing. The model is set as follows:

$$ROA_{it} = \alpha_0 + \alpha_1 FinTech_{it} + \alpha_2 FinTech_{it}^2 + \alpha_3 Control_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (3)$$

$$NLP_{it} = \beta_0 + \beta_1 FinTech_{it} + \beta_2 Control_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (4)$$

$$CAR_{it} = \gamma_0 + \gamma_1 FinTech_{it} + \gamma_2 Control_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (5)$$

$$CTI_{it} = \varphi_0 + \varphi_1 FinTech_{it} + \varphi_2 Control_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (6)$$

$$ROA_{it} = \theta_0 + \theta_1 FinTech_{it} + \theta_2 FinTech_{it}^2 + \theta_3 NLP_{it} + \theta_4 CAR_{it} + \theta_5 CTI_{it} \quad (7)$$
$$\theta_6 Control_{it} + + \mu_i + \delta_t + \varepsilon_{it}$$

Among them, NLP_{it}, CAR_{it} and CTI_{it} are the intermediate variables, which are the ratios of non-performing loans, capital adequacy ratio, and cost-to-income ratio for bank i in year t. The significant estimation coefficients α_1 and α_2 are the pre-requisites for the existence of the intermediate effect, so the significance of these two coefficients in equation (3) needs to be tested first. Secondly, the significance of the coefficients β_1, γ_1 and φ_1 for the intermediate variables, and the coefficients θ_3, θ_4 and θ_5 in equation (7) need to be tested for the effect of the financial technology index. If one of the two coefficients corresponding to the intermediate variable is not significant, the significance of the product of the intermediate variable coefficients will be directly tested. If the product of the coefficients is significant, it indicates that the intermediate effect does not exist if both are not significant. Finally, the significance of θ_1 and θ_2 in equation (7) is tested. If significant, it indicates a direct effect of the financial technology index on profitability. If not significant, it means that, in addition to the intermediate transmission pathway, the financial technology index does not have a direct impact on its profitability.

5. Empirical Results

5.1. Overall Impact of FinTech on Bank Performance

As shown in Table 3, without introducing micro-level bank characteristics, the estimated coefficient of FinTech is significantly negative at the 5% level of significance, but gradually becomes insignificant with the introduction of related micro-level characteristics. This contradicts hypothesis

H1a, and the negative coefficient cannot indicate that the development of FinTech has a single inhibitory effect on bank performance. To ensure the validity of the experimental results, this study introduces the quadratic term of FinTech into the model to further verify hypotheses H1b and H1c.

Table 3. Baseline Model Regression Results: Overall Impact

Variable	(1) ROA	(2) ROA	(3) ROA	(4) ROA	(5) ROA
FinTech	-0.0071**	-0.0065**	-0.0072**	-0.0038	-0.0041
	(0.0032)	(0.0032)	(0.0032)	(0.0030)	(0.0030)
GDP	0.0484***	0.0366***	0.0446***	0.0434***	0.0424***
	(0.0083)	(0.0116)	(0.0121)	(0.0112)	(0.0112)
MSR	0.0411***	0.0311***	0.0386***	0.0314***	0.0310***
	(0.0044)	(0.0081)	(0.0087)	(0.0082)	(0.0082)
UR	-0.3440**	-0.2542***	-0.2763	-0.1687	-0.1948
	(0.1657)	(0.1765)	(0.1755)	(0.1636)	(0.1646)
CPI	-0.0666	-0.0339	-0.0577	-0.0489	-0.0482
	(0.0445)	(0.04979)	(0.0506)	(0.0470)	(0.0470)
LNSIZE		-0.0784	-0.0515	0.0641	0.0515
		(0.0541)	(0.0550)	(0.0541)	(0.0548)
LNDL			0.1553**	0.0537	0.0536
			(0.0706)	(0.0674)	(0.0674)
NIM				0.1686***	0.1799***
				(0.0263)	(0.0275)
LNFCP					0.0316
					(0.0216)
Constant term	2.0345***	3.9088**	2.5319	-1.1193	-0.7403
	(0.7744)	(1.5052)	(1.6195)	(1.6066)	(1.6278)
Industry	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Observation	296	296	296	296	295
AdjustedR2	0.6671	0.6699	0.6763	0.7226	0.7249

Note: Standard errors are reported in parentheses. Statistical significance is denoted by *** for p<0.01, ** for p<0.05, and * for p<0.10. The same format applies to the table below.

5.2. Nonlinear Effect of FinTech on Banking Performance

Table 4 presents the benchmark regression results of the relationship between a bank's FinTech level and its profitability, with the introduction of a quadratic term to explore the possibility of nonlinear effects. Columns (1) to (5) show the estimated results with the gradual addition of micro-level variables, while all regressions control for macro-level variables and bank-specific and time-fixed effects. The results show that the FinTech index is significant at the 1% level and negative in all specifications, while the quadratic term is significant at the 1% level and positive, indicating a significant positive "U-shaped" relationship between a bank's FinTech level and its profitability. Specifically, when the FinTech index is less than 21.4, the total asset return decreases with an increase in the index, while when the index is greater than 21.4, the total asset return increases with an increase in the index. This finding is consistent with prior studies (8), suggesting that FinTech exerts an inhibitory effect on banks' profitability in the early stage, but in the later stage, the positive effect of technological innovation will generate more opportunities for banks, weaken the crowding-out effect, and enhance the technology spillover effect. The inhibitory effect of the FinTech index on bank profitability will then be reduced or even reversed, resulting in a nonlinear effect on bank performance. Thus, hypothesis H1b is rejected, and H1c is supported.

The sample banks selected in this study are of significant importance in the banking system, and their FinTech development levels are representative. According to the descriptive statistics, the mean value of the calculated FinTech index is 16.825, which is still far from the critical value of 21.4, indicating that Chinese commercial banks are generally in the early stage of needing to increase investment in FinTech and facing an inhibitory effect on profitability. More investment is needed to surpass the critical value and achieve the positive effects of FinTech.

Table 4. Results of the Baseline Model Regression: Nonlinear Effect

	(1) ROA	(2) ROA	(3) ROA	(4) ROA	(5) ROA
FinTech	-0.0437***	-0.0410***	-0.0471***	-0.0393***	-0.0419***
	(0.0153)	(0.0155)	(0.0155)	(0.0144)	(0.0145)
$FinTech^2$	0.0010**	0.0009**	0.0010***	0.0009**	0.0010***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
GDP	0.0489***	0.0395***	0.0493***	0.0476***	0.0468***
	(0.0082)	(0.0116)	(0.0121)	(0.0112)	(0.0112)
MSR	0.0385***	0.0307***	0.0394***	0.0322***	0.0318***
	(0.0044)	(0.0080)	(0.0086)	(0.0081)	(0.0081)
UR	-0.3629**	-0.2905	-0.3217*	-0.2112	-0.2433
	(0.1642)	(0.1758)	(0.1743)	(0.1628)	(0.1636)
CPI	-0.0621	-0.0364	-0.0645	-0.0551	-0.0544
	(0.0441)	(0.0494)	(0.0501)	(0.0465)	(0.0464)
LNSIZE		-0.0622	-0.0284	0.0823	0.0686
		(0.0541)	(0.0551)	(0.0540)	(0.0545)
LNDL			0.1805**	0.0780	0.0800
			(0.0704)	(0.0674)	(0.0673)
NIM				0.1653***	0.1778***
				(0.0261)	(0.0271)
LNFCP					0.0365*
					(0.0214)
Constant term	2.4672***	3.9267***	2.3287	-1.2294	-0.7914
	(0.7869)	(1.4927)	(1.6023)	(1.5902)	(1.6080)
Industry	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Observation	296	296	296	296	295
AdjustedR2	0.6750	0.6767	0.6851	0.7295	0.7327

5.3. Endogeneity Handling and Robustness Checks

Based on the above analysis, this study finds that there is a positive "U"-shaped relationship between bank FinTech development and its profitability. However, this result can be easily influenced by endogeneity issues because there may exist endogenous relationships between bank FinTech development and profitability as well as bank attribute variables. Here is a further explanation of this relationship: on the one hand, banks may use more FinTech to improve their profitability, thereby promoting the development of FinTech in banks; on the other hand, profitability may be highly autocorrelated with past performance, and therefore current profitability may be affected by past profitability. In order to address these issues, this study employs instrumental variables. Following the approach of Cheng and Qu et al. [12], this study uses the weighted number of FinTech companies in each province where the bank's branches are located as the instrumental variable for bank FinTech development, with city commercial banks and rural commercial banks using the weighted number of FinTech companies in the province where their headquarters are located. Two-stage least squares (2SLS) regression is used to estimate the model. The results of the two-stage regression are shown in Table 5.

From the first-stage regression results, although the Cragg-Donald Wald F-statistic and the Stock-Wright LMS statistic are not significant, indicating that the instrumental variable is weakly related to the endogenous explanatory variable, the Anderson LM statistic is highly significant and enough to reject the null hypothesis of "instrumental variable identification failure," indicating that the selected instrumental variable is effective to some extent. The second-stage regression results in Table 5 show that even after controlling for endogeneity issues, the FinTech index and its squared term still have significant impacts on bank profitability.

Table 5. First and Second Stage Regression Results Using Instrumental Variable to Address Endogeneity Issue

Variable	(1)		(2)
	FinTech	$FinTech^2$	ROA
FinTech			-0.1172*
			(0.0690)
$FinTech^2$			0.0031*
			(0.0018)
Fin_Comp	-0.0005**	-0.0143*	
	(0.0002)	(0.0080)	
Fin_Comp^2	1.01e-08***	3.39e-07**	
	(3.84e-09)	(1.52e-07)	
Control variable	Yes	Yes	Yes
Individual effects	Yes	Yes	Yes
Year effects	Yes	Yes	Yes
Observations	295	295	295
F-statistic	4.09**	3.92**	40.76***
Anderson LM statistic	8.00***		
Cragg-Donald Wald F statistic	3.90		
Stock-Wright LMS statistic	3.37		

In addition, there may be measurement errors in the indicators used to measure the level of bank FinTech and bank profitability. To address this issue, this study conducted a robustness check by replacing the dependent and independent variables with alternative indicators. Specifically, the study constructed a digitalization index by multiplying the proportion of a bank's network branches in each province by the province's digital inclusive finance index. The study then replaced the ROA with the ROE as the dependent variable, and replaced the FinTech index with the digitalization index as the independent variable. The results show that the coefficient of the FinTech index is significantly negative at the 1% level, while the coefficient of its quadratic term is significantly positive at the 1% level. The coefficient of the digitalization index is negative at the 10% level, while the coefficient of its quadratic term is significantly positive at the 1% level. These results confirm the robustness of the baseline regression and support the existence of a significant positive "U"-shaped relationship between bank FinTech development and profitability. For detailed results, please contact the author due to space constraints.

5.4. Heterogeneity Analysis

Due to the influence of various factors, different types of banks are at different stages of financial technology development, and the impact on their profitability may also differ. Therefore, this study classified the sample banks in two ways. The first way is based on bank size, dividing them into large banks and small and medium-sized banks. The estimated results for large banks and small and medium-sized banks are shown in columns (1) and (2) of Table 6, respectively. The second way is based on ownership type, dividing them into three categories: central state-owned enterprises, local state-owned enterprises, and public enterprises. The estimated results for these three categories are shown in columns (3) to (5) of Table 6, respectively.

The results show that the coefficient of financial technology development is not significant in large banks and public enterprises, but significant in small and medium-sized banks, central state-owned enterprises, and local state-owned enterprises. This indicates that the positive "U"-shaped effect of financial technology development on the profitability of small and medium-sized banks, central state-owned enterprises, and local state-owned enterprises is valid. Small and medium-sized banks face more pain points in traditional business, but they have a smaller size and can adapt more quickly to changes brought about by new technologies, giving them a late-mover advantage. Local state-owned enterprise banks, compared to central state-owned enterprise banks, also have the advantages of small banks. Compared to small and medium-sized banks, they are more likely to obtain support from

various policies due to their state-owned enterprise characteristics, which enables them to apply financial technology more quickly.

Table 6. Results of Heterogeneity Test Regression

Variable	Large commercial bank	Small/medium-commercial bank	Central state-owned enterprise	Local state-owned enterprise	Public enterprise.
FinTech	0.0001	-0.0483**	0.1015*	-0.0506**	-0.0106
	(0.0508)	(0.0187)	(0.0530)	(0.0220)	(0.0294)
$FinTech^2$	8.32e-06	0.0011**	-0.0031*	0.0012**	0.0002
	(0.0014)	(0.0005)	(0.0016)	(0.0005)	(0.0007)
GDP	0.0432***	0.0237 (0.0226)	0.0281* (0.0151)	0.0005	0.0977***
	(0.0140)			(0.0200)	(0.0282)
MSR	0.0264***	0.0151 (0.0183)	0.0172	-0.0116	0.0742***
	(0.0100)		(0.0106)	(0.0156)	(0.0217)
UR	-0.3116*	-0.0851	-0.1803 (0.1444)	-0.0059	-0.5514
	(0.1829)	(0.2750)		(0.2671)	(0.3423)
CPI	-0.0755	0.0124 (0.0811)	-0.0256 (0.0469)	0.0770	-0.1656
	(0.0528)			(0.0781)	(0.1005)
LNSIZE	0.0309	-0.0109 (0.1068)	-0.3172***	-0.1748*	0.3489***
	(0.0939)		(0.1149)	(0.0971)	(0.1310)
LNDL	-0.2334**	0.0963	0.0384	-0.2052*	0.2296*
	(0.0969)	(0.0966)	(0.1013)	(0.1203)	(0.1182)
NIM	0.1970***	0.1842***	0.0030	0.1809***	0.1801***
	(0.0362)	(0.0389)	(0.0377)	(0.0495)	(0.0464)
LNFCP	0.1436***	0.0273	-0.0831**	0.0288	0.0761**
	(0.0368)	(0.0283)	(0.0403)	(0.0367)	(0.0372)
_cons	1.2520	0.8460 (2.7180)	10.3096***	6.6074**	-8.5145**
	(2.5114)		(2.9855)	(2.8590)	(3.4913)
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Observation	124	171	63	132	100
Adjusted R2	0.8797	0.6775	0.9776	0.7738	0.6308

5.5. Mechanism Test

To investigate the mediating mechanisms through which FinTech affects the operational performance of commercial banks, this study employs a causal stepwise regression test to verify the proposed multiple mediation model. Table 7 reports the regression results of the multiple mediation model test. Columns (1) and (8) correspond to Equation (3) and (7) in the model setting, respectively. The regression coefficients of FinTech and FinTech2 in Column (1) are significant at the 1% and 5% level, respectively, which confirms the premise of testing the mediating effect. The impact of FinTech on the three intermediate variables, risk-bearing, capital structure, and operational ability, is further examined by introducing the three variables as dependent variables in Columns (2) to (4), respectively. The results show that the regression coefficients of FinTech on capital adequacy ratio and cost-to-income ratio are significant at the 1% and 10% level, respectively, while the regression coefficient on non-performing loan ratio is not significant. Columns (5) to (7) present the regressions of the three intermediate variables as independent variables, and the results show that the coefficients of all three intermediate variables are significant at the 1%, 1%, and 10% level, respectively. The regression results of the capital adequacy ratio and cost-to-income ratio satisfy the second test condition of the multiple mediation model. Therefore, both mediation mechanisms exist and contribute partially to the mediating effect. The Sobel test indicates that the mediating effect of non-performing loan ratio is significant. Column (8) introduces the three intermediate variables into the regression simultaneously, and the regression coefficients of both FinTech and FinTech2 are not significant, indicating that the FinTech index has no direct impact on the total asset return on investment other than the intermediate transmission path.

Table 7. Regression Results of the Impact of FinTech on Commercial Bank Performance and Its Mediating Effects

	(1) ROA	(2) NLP	(3) CAR	(4) CTI	(5) ROA	(6) ROA	(7) ROA	(8) ROA
FinTech	-0.0448***	0.0127	0.0864***	-0.0037*	-0.0157	-0.0426***	-0.0448***	-0.0190
	(0.0146)	(0.0080)	(0.0253)	(0.0021)	(0.0137)	(0.0143)	(0.0146)	(0.0137)
$FinTech^2$	0.0010**				0.0004	0.0009***	0.0010***	0.0004
	(0.0004)				(0.0003)	(0.0003)	(0.0004)	(0.0003)
NLP					-0.1618***			-0.1549***
					(0.0222)			(0.0222)
CAR						0.0211***		0.0156**
						(0.0073)		(0.0068)
CTI							-0.1499*	-0.0834
							(0.0902)	(0.0820)
Control Variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Annual effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observation	296	295	295	295	295	295	295	295
Adjusted R2	0.675	0.5284	0.6059	0.5368	0.7807	0.7415	0.7357	0.7868

6. Conclusion and Suggestions

This study examines the impact of FinTech on the operating performance of commercial banks by constructing a FinTech index based on the text mining technique of annual reports of 38 commercial banks from 2012 to 2020. The findings are as follows: first, there is a significant inverted U-shaped relationship between FinTech and bank profitability. FinTech has a restraining effect on bank profitability in the early stages, but after reaching the critical turning point, it can positively empower banks. This conclusion holds even after endogeneity and robustness tests. Second, the impact of FinTech development on the profitability of small and medium-sized banks is more significant than that of large banks. Third, FinTech development can increase the capital adequacy ratio and reduce the cost-to-income ratio, thus positively affecting profitability.

The implications of the study are as follows: First, traditional banks should enhance their financial technology application capabilities and leverage technology spillover effects to innovate inclusive financial products and services to mitigate the crowding-out effect. Second, small and medium-sized banks facing capital and scale disadvantages should proactively join the technology innovation wave and focus on specific market or supply chain segments. Third, the application of financial technology can empower traditional businesses and optimize credit risk management models to improve asset quality. Fourth, upgrading and innovating intermediary business can be an important profit growth point for future commercial banks. They should transition towards a "light capital and asset" direction and provide customers with a more comprehensive financial service system using financial technology. Fifth, the relationship between financial technology development and financial stability should be managed, and various financial risks should be monitored. Regulatory authorities should adopt a gradual strategy for the development of financial technology, strengthen top-level design and overall planning, improve the regulatory framework, coordinate the impact of financial technology on commercial bank's prudent operation, and ensure the healthy operation of the financial system.

References

[1] Li Jianjun, Jiang Shichao. Bank FinTech and the Business Sustainability of Inclusive Finance: Micro Evidence of Financial Enhancement Effect [J] (in Chinese). Economic Research Journal, 2021, 21(03): 889-908.

[2] Lee I, Shin Y J. Fintech: Ecosystem, business models, investment decisions, and challenges [J]. Business Horizons, 2018, 61.

[3] Song, M., Zhou, P., & Si, H. FinTech and Total Factor Productivity of Enterprises: Perspectives on "Empowerment" and Credit Allocation [J] (in Chinese). China Industrial Economics, 2021, 397(04), 138-155.

[4] Yang, D. Regulatory technology: regulatory challenges and dimension construction of financial technology. China Social Science, 2018(05): 69-91+205-206

[5] Jichang Dong, Lijun Yin, Xiaoting Liu, Meiting Hu, Xiuting Li, Lei Liu, Impact of internet finance on the performance of commercial banks in China, International Review of Financial Analysis [J], 2020, 72, 101579.

[6] Hu Jun, Li Qiang, Dai Jiacheng, Zeng Yong. Measurement of FinTech and Empirical Study of Its Empowerment Effect on Commercial Banks Based on Text Analysis [J] (in Chinese). China Management Science, 2022, 1-15

[7] Wang, Y., & Luo, S. FinTech and Commercial Bank Performance: An Analysis of the Intermediary Effect Based on Risk Bearing [J] (in Chinese). Financial Forum, 2022, 27(04), 19-30

[8] Xiong, J., Zhang, Y., & Dong, X. The impact of financial technology on the operational performance of commercial banks: Crowding-out effect or technology spillover effect? [J] (in Chinese). Economic Review, 2021, 229(03), 89-104.

[9] Wang, H., Zeng, B., Yang, H., & Wang, M. Can investment in FinTech enhance bank performance?—A perspective based on non-performing loan risk [J] (in Chinese). Foreign Economics & Management, 2022, 44(06), 94-109.

[10] Yan, Z. Empirical analysis of factors affecting commercial bank profitability: Based on partial least squares regression (PLSR) algorithm [J] (in Chinese). Finance Theory and Practice, 2022, 43(04): 10-17.

[11] Dinh Hoang Bach Phan, Paresh Kumar Narayan, R. Eki Rahman, Akhis R. Hutabarat, m Do financial technology firms influence bank performance? [J], Pacific-Basin Finance Journal, 2020, 62, 101210.

[12] Cheng Maoyong, Qu Yang. Does operational risk management benefit from FinTech [C]. Proceedings of China International Risk Forum, 2021, 23-25.