

Research on the Influence of Digital Finance on Commercial Banks' TFP

Xiaoxian Yang, Cisheng Wu
xxyang97@163.com, 1400724555@qq.com

School of management, Hefei University of Technology Hefei, China

Abstract: With the iteration of digital technology, an emerging financial industry based on the Internet platform - digital finance - has been formed, and the vigorous rise of digital finance has continuously eaten into the market share of commercial banks, forming a drastic impact on their profitability. However, it also forces commercial banks to change their business philosophy, adjust their business strategies and optimize their resource allocation to enhance operational efficiency. Meanwhile, the technology spillover of digital finance also provides an opportunity for commercial banks to change their business model and upgrade their technology transformation. At present, the role of digital finance for commercial banks has become an issue of close attention in the industry. Based on this, this paper takes digital finance as a starting point to promote competition and bring technological spillover in the financial industry, and explores the impact of digital finance on commercial banks' TFP and the transmission mechanism, so as to provide a basis for decision making to promote digital transformation and sustainable development of commercial banks.

Key words: Digital Finance; Commercial Banks' TFP; Diversification; Risk-Taking

1 Introduction

By the end of 2021, the number of commercial bank branches in China has been on a downward trend for many years, and behind the closure of bank branches is the shrinking scale of business, one of the reasons for this phenomenon is that the traditional financial business is subject to the dramatic impact of digital finance. Digital finance emphasizes the deep integration of digital technology and the financial industry^[1], and its advantages such as data integration, high efficiency and low cost will undoubtedly bring serious challenges to the business models of traditional financial service providers. In this regard, commercial banks are not stagnating and resting on their laurels, but are bravely exploring new development paths to improve operational efficiency by transforming their business management model, adjusting their resource allocation structure and exploring new profit growth points. On the other hand, they are investing more in information technology, using digital technology to reshape various aspects of strategy, operations, product services, channels and risk control, and gradually transforming towards mastering the initiative of the digital financial market. Studies have shown that the deepening of digital finance will inevitably have a significant impact on the organizational management, technological progress, and innovation capabilities of commercial banks, which in turn will affect their total factor productivity^[2]. However, academic research on the impact mechanism of digital finance on total factor productivity of commercial banks is still inconclusive, and there is a lack of examination of the transmission channels and the moderating effect of strategic-

level factors between the two in the existing literature. Based on the above background, this paper intends to theoretically explore the impact channel between digital finance and commercial banks' TFP, and select 131 commercial banks from 2011-2019 as a sample for empirical testing.

2 Theoretical Basis and Research Hypothesis

2.1 Digital finance and banks' TFP

Digital finance can drive productivity improvements in traditional financial institutions by disrupting the competitive landscape of the traditional banking industry and exerting competitive effects. The degree of market competition in the financial industry is an important influence on the efficiency of commercial banks. As traditional financial intermediaries, commercial banks dominated the market before the rise of the Internet and could obtain more monopoly rents, thus their management was sloppy and their efficiency level was low^[3]. The rise of digital finance, however, has changed the competitive landscape of the traditional financial industry and dismantled the profitability advantage of commercial banks relying on the interest differential between deposits and loans, forcing commercial banks to change their mindset, service consciousness, and management style, gradually getting rid of the inefficiency and high cost of traditional sloppy management, and continuously optimizing the efficiency of resource utilization and improving market competitiveness^[4].

Digital finance can bring scale risk control, scale customer acquisition, standardized business processes and low-cost financial services to commercial banks through the technology spillover effect, helping commercial banks to achieve cost reduction and efficiency increase, and then improve efficiency. Based on technology spillover theory, involuntary and unconscious technology diffusion by leading digital financial technology companies will bring technology spillover to commercial banks through demonstration, personnel flow and business contacts, etc. Commercial banks can achieve technology catch-up through continuous technology absorption and technology learning, and can realize transformation and upgrading of service models and technology^[5], which in turn will bring improvement in operational management efficiency. First, traditional commercial banks are gradually strengthening their integration with emerging technologies, to reduce information asymmetry in the process of credit approval and improve the utilization rate of funds. Second, empowered by digital technology, commercial banks can reduce costs and increase efficiency by providing convenient services and standardized business processes. Third, digital technology enables commercial banks to reach previously unreachable customer groups and expand the coverage of financial services.

H1: The full competitive effect and technology spillover from digital finance improves total factor productivity of commercial banks.

2.2 The mediating mechanism of risk taking

The development of digital finance can inhibit commercial banks' risk-taking by enhancing risk transfer incentives and improving risk management capabilities. From a risk transfer perspective, Akins et al. (2016) test results show that higher competition reduces moral hazard and adverse selection^[6], and when faced with a change in the competitive landscape and a narrowing of

profit margins brought about by digital finance, commercial banks will be more inclined to adopt a conservative investment strategy and reduce their allocation to risky assets, with a corresponding reduction in the level of risk-taking^[7]. Based on the risk management perspective, by effectively absorbing the technological spillover from digital finance, commercial banks can significantly improve their risk identification and risk management capabilities, improve the quality of credit assets and reduce the likelihood of problem loans without changing their risk tolerance, thus curbing the rise in default risk.

The "bad luck" and "mismanagement" hypothesis proposed by Berger and De Young predicts that excessive risk-taking by banks will lead to a large number of non-performing loans and thus lower operational efficiency because banks must provide more reserves for risky assets and spend more to screen for credit risk^[8]. Both the high-risk tolerance of commercial banks at the time of loan disbursement and the low-risk management capability after disbursement lead to an increased likelihood of non-performing loans, and banks have to spend extra management effort and capacity to deal with problematic loans, thus making their operations less efficient. The above analysis shows that digital finance reduces the credit risk of commercial banks by strengthening their risk management level and risk transfer motive, and there is a close correlation between credit risk and efficiency, the lower the credit risk of banks, the higher the efficiency.

H2: Digital finance has a dampening effect on commercial bank risk-taking.

H3: Commercial bank risk-taking has a mediating effect between digital finance and its total factor productivity.

2.3 The regulating mechanism of diversified operation

Commercial banks that diversify their operations will be more sensitive to the impact of digital finance and respond accordingly, thus strengthening the positive effects of digital finance^[9]. According to asset portfolio theory, innovative business models and innovative business varieties brought about by diversification and cross-selling with traditional businesses can enrich banks' income sources, effectively share the risks brought about by changes in the external environment, and reduce the volatility of banks' earnings. Based on the internal capital market theory^[10], diversification can create internal resource flow and resource allocation, so that resources can be transferred from inefficient and low-yielding business sectors to efficient and high-yielding business sectors, thus improving the efficiency of internal resource allocation. Therefore, diversification of commercial banks on the basis of digital finance can accelerate the transfer of internal excess capital and resources and improve the utilization of capital and resources. Secondly, the technology absorption capacity of individual commercial banks determines the extent to which the technology spillover effect of digital finance works. Diversification of commercial banks can accelerate the absorption and integration of technology spillover from digital finance, and the implementation of diversification of commercial banks can enhance their absorption capacity of technology spillover from digital finance and accelerate the accumulation and application of internal technology resources through sharing and reducing the development and application costs of technology resources by generating economies of scale, thus enhancing the total factor productivity of digital finance on their Positive effects^[11].

H4: Diversification positively moderates the impact of digital finance on banks' total factor productivity.

Based on the above theoretical analysis, a theoretical theory model for this study can be constructed, as shown in Figure 1.

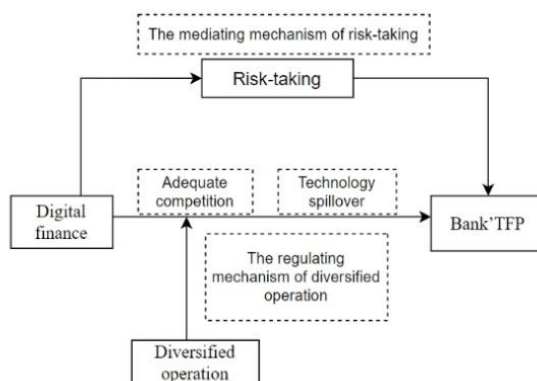


Figure 1 Theoretical Model

3 Research Design

3.1 The data source

The empirical data in this paper are mainly obtained from CSMAR database and Wind database, excluding policy banks and foreign banks, excluding samples with missing data needed to calculate total factor productivity of commercial banks, and finally obtaining unbalanced panel data of 131 commercial banks from 2011-2019 as the research object.

3.2 Variable selection

3.2.1 Commercial banks' TFP

Solow defines the "residual value of growth" left in industrial growth after deducting factor inputs such as capital, labor and land as technological progress, also known as TFP, which is used to measure the role of pure technological progress in production. In this paper, the DEA-Malmquist index is used to measure banks' TFP, and total deposits, interest expenses and operating expenses are selected as input variables, while total loans, interest income and net non-interest income are output variables, following the practice of CAI Yuezhou ^[12].

3.2.2 Digital finance

Drawing on Zhang Xun et al. (2019), the China Digital Financial Inclusion Index was used as a proxy variable for the degree of digital financial development^[13], provincial-level data of the Digital Financial Inclusion Index were matched to a sample of banks based on the location of commercial banks' headquarters.

3.2.3 Degree of diversification

According to the practice of Liu Mengfei et al., the Herfindahl index of income structure (HHI) is selected to measure the degree of diversification ^[14].

3.2.4 Risk-taking

With reference to Haifeng and Yu (2019) ^[15], the bank risk-taking is first measured using the non-performing loan ratio (Risk), which measures the percentage of loans with default risk.

3.2.5 Control variables

Both bank micro characteristics variables and macroeconomic variables have a significant impact on total factor productivity of commercial banks, and the control variables selected based on the relevant research are shown in Table 1.

Table 1 Variable definition table

The Control variables	Variable symbol	Variable description
Bank size	LnSize	Log of total assets
Resource allocation	Ltd	Total loans to total deposits
The capital structure	Eta	Equity assets to total assets
Ability to manage	Cta	Operating expenses to total assets
Capital adequacy ratio	Car	Capital adequacy ratio
Bank listing	Ipo	Virtual variable
Macroeconomic level	Gdp	The growth rate of GDP
Stock Market development	Gs	Total stock market value to GDP

3.3 Econometric model

In order to test the impact of digital finance on commercial banks' TFP, this paper constructs the following model (1).

$$Be_{i,t} = \beta_0 + \beta_1 Df_{k,t} + \sum_{j=1}^n \beta_j Control_{j,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (1)$$

In order to verify the moderating effect of diversification, this paper constructs the following model (2)

$$Be_{i,t} = \gamma_0 + \gamma_1 Df_{k,t} + \gamma_2 Hhi_{i,t} + \gamma_3 Hhi_{i,t} * Df_{k,t} + \sum_{j=1}^n \beta_j Control_{j,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (2)$$

In order to explore the mediating role of risk taking, a regression model of digital finance, risk taking and bank efficiency was constructed.

$$Be_{i,t} = \beta_0 + \alpha_1 Df_{k,t} + \sum_{j=1}^n \alpha_j Control_{j,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (3)$$

$$Risk_{i,t} = \theta_0 + \theta_1 Df_{k,t} + \sum_{j=1}^n \theta_j Control_{j,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (4)$$

$$Be_{i,t} = \beta_0 + \beta_1 Df_{k,t} + \beta_2 Risk_{i,t} + \sum_{j=1}^n \beta_j Control_{j,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (5)$$

4 The Empirical Analysis

4.1 Descriptive statistical analysis

The statistical characteristics of the variables in this paper are shown in Table 2. Due to missing data for some variables, the study sample is unbalanced panel data with slight differences in the observations between variables. Moreover, the observations with abnormal diversified business indicators have been excluded by preprocessing the sample data before conducting descriptive statistics. The mean value of TFP of the explanatory variable is 0.995. The maximum value is 1.271 and the minimum value is 0.739, which indicates that the commercial banks' TFP varies considerably depending on their size and nature of property rights, etc. The mean, maximum and minimum values of the explanatory variable digital finance index are 2.174, 3.990 and 0.297, respectively, and multiplying them by 100 for recovery clearly shows that the differences in development levels between regions lead to the same large regional variability in the degree of development of digital finance.

Table 2 Descriptive statistics of variables

variable	N	mean	sd	min	P50	max
Be	1167	0.995	0.0810	0.739	0.994	1.271
Df	1167	2.177	0.934	0.297	2.244	3.990
Risk	1149	1.420	0.726	0.120	1.370	4.310
Hhi	1167	0.274	0.139	0.0150	0.267	0.500
lnSize	1166	16.76	1.589	13.87	16.41	21.48
Ltd	1166	0.667	0.123	0.334	0.682	0.989
Eta	1166	0.0740	0.0160	0.0430	0.0720	0.122
Roa	1166	0.0100	0.0040	0.0020	0.0090	0.0210
Cta	1159	0.0090	0.0030	0.0040	0.0090	0.0210
Car	1133	0.133	0.0190	0.0980	0.130	0.206
Ipo	1167	0.160	0.367	0	0	1
Gdp	1167	0.0940	0.0620	-0.250	0.0910	0.299

4.2 Baseline regression and moderating effect regression

All regressions in this paper use a panel data model with individual fixed effects and time fixed effects. In addition, to control for the effects of autocorrelation and heteroskedasticity, Robust standard errors are used for the regressions. To test the above hypotheses, multiple regressions are conducted for model (1) and model (2), and the results are shown in Table 3.

The empirical results of model (1) show that the regression coefficient of digital finance (Df) is 0.1362 and significant at the 1% level, and hypothesis 1 holds. Digital finance, on the one hand, drives traditional financial service providers to improve their resource allocation structure, innovate business revenue sources and achieve productivity improvement by introducing full competition mechanism; Meanwhile, it brings technology spillover to traditional financial service providers, who achieve technological change and improve productivity by fully learning and absorbing technology.

Model (2) tested the moderating effect of conducting diversification. The results shows that the interaction term (Df*Hhi) is significantly positive (coef.=0.0682, $p<0.01$), and hypothesis 4 holds. Diversification of commercial banks in the context of digital finance can expand their

income sources to mitigate the competitive impact brought by digital finance, and diversification can form a market-oriented capital market internally, optimize resource allocation, diversify risks and reduce costs, thus improving operational efficiency. In addition, the diversification of commercial banks can enhance their ability to absorb and learn from the technology spillover brought by digital finance, and can accelerate the accumulation and application of digital technology through the sharing of internal institutional technology resources and reduce the development and application costs of technology resources by generating economies of scale, thus enhancing the positive effect of digital finance on their total factor productivity.

Table 3 Regression results of the impact of financial development on bank efficiency and the moderating effect of diversification

	(1)	(2)
	Be	Be
Df	0.1362*** (2.79)	0.1220** (2.47)
Hhi		-0.1049*** (-4.06)
Df*Hhi		0.0682*** (2.94)
Controls	Yes	Yes
_cons	2.0207*** (4.31)	1.9654*** (4.16)
N	1124	1124
r2	0.2222	0.2453
Individual/time	0.1362***	0.1220**

Note: ***, ** and * are significant at the level of 1%, 5% and 10% respectively. The t values of coefficient significance test are in parentheses. The following tables are the same.

4.3 Regression of mediating effects

The regression results in Table 4 show that the effect of digital finance on total factor productivity of banks is significant and satisfies the condition of the mediating effect test. Therefore, this section will directly conduct the test of the mediating effect in equations (4) and (5). The results show that the regression coefficient of digital finance (Df) on risk taking (Risk) is significantly negative (coef. = -1.7139, $p < 0.01$), which verifies hypothesis 2. Traditional commercial banks lack the ability to price and innovate high-risk and high-yield products, and therefore will actively seek their own reforms to cope with the impact of digital finance by optimizing the allocation of risky assets and strengthening risk management, thus reducing the level of risk-taking. At the same time, digital technology improves the transparency of information and thus improves the credit quality of banks. The regression results in column (2) show that the coefficients of θ_1 , β_2 and β_1 are significant, indicating that hypothesis 3 holds. That is, the development of digital finance will lead to savings in management costs and productivity gains by effectively reducing the likelihood of non-performing loans and the

subsequent costs of processing and disposing of problem loans, etc.

Table 4 Regression results of mediating effects

	(1)	(2)
	Risk	Be
Risk		-0.0137** (-2.10)
Df	-1.7139*** (-5.89)	0.1167** (2.31)
Controls	Yes	Yes
_cons	-13.2134*** (-4.63)	1.9385*** (4.01)
N	1110	1110
r ²	0.6691	0.2270
Individual/time	Yes	Yes

4.4 Robustness test

Given the time-lag effect of commercial banks' absorption of digital financial technology spillovers, this paper re-estimates commercial banks' TFP by lagging the digital finance index by one period, an approach that also attenuates the endogeneity problem caused by reverse causality to some extent. Second, this paper uses net non-interest income as a proxy for the Herfindahl index to measure the interaction and conducts robust regression analysis. In addition, z-values are chosen to measure banks' risk-taking to test the robustness of the mediating effect. The empirical results for all three variable substitutions are significant at the 5% level, which again validates the hypothesis of relevance. The results are not shown due to space limitations. Finally, this paper selects the number of Internet access ports (Port) in each province lagged by one period as an instrumental variable for digital finance to further control for endogeneity in measurement identification. The test results still indicate the robustness of the results in this paper.

5 Conclusion and Enlightenment

This paper takes the introduction of full competition mechanism and technology spillover effect of digital finance as the starting point, constructs an econometric model of the interaction effect between variables, selects 131 commercial banks as the research sample, and tests the research hypotheses using a two-way fixed-effect model. The empirical results are as follows: firstly, digital finance can drive the restructuring and technological upgrading of commercial banks by promoting market competition and generating technological spillover, which positively affects commercial banks' TFP. Second, commercial banks' risk-taking plays a partial mediating effect in the process of digital finance driving TFP improvement. Third, diversification reinforces the positive effect of digital finance on TFP.

Whether traditional commercial banks can successfully cope with digital disruption and grasp the opportunities will determine their future competitive market position. In response to the gradually intensifying competitive environment, commercial banks should take the initiative to carry out differentiated competitive strategies, accelerate the pace of digital transformation,

promote the conversion of old and new dynamics, and innovate and change financial product formats. Secondly, the deepening of financial liberalization, the development of digital information technology and the enhancement of public financial awareness and demand for financial diversity all urgently require traditional financial institutions to provide more diversified and higher quality financial services. Commercial banks should give full play to their own resource advantages, build a diversified business system with equal emphasis on deposit and loan business, market transactions and financial asset services with the help of digital technology and new infrastructure, innovate business income sources, accelerate information technology accumulation and generate synergistic effects to mitigate the impact of the external environment and accelerate the pace of transformation. In addition, relevant departments should improve relevant laws and regulations to support and protect the development of the financial industry, but how to balance the relationship between the innovative development of the financial industry and reasonable regulation is crucial, and relevant departments need to innovate regulatory tools and seek an effective measure to make regulation achieve the purpose of both protecting the rights and interests of users and avoiding regulatory transition so as to leave enough room for innovation in the financial industry.

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