Study on the Impact of Digital Finance on Non-Performing Loan Rate of Chinese Commercial Banks

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Abstract. Affected by COVID-19, global economic growth is in recession, geopolitical conflicts are continuing, commercial banks' credit risk is climbing and profitability is facing severe changes. There are new opportunities in the crisis. Recently, with the development of the digital economy, digital finance is increasingly used in commercial banks, which can better meet regulatory needs and information needs, and effectively improve the bank's ability to control risks. Based on the development of digital technology and commercial banks, we collect panel data from 30 provinces and cities from 2011-2020 and use a two-way fixed effects model to explore the impact of digital finance on commercial banks' NPL rate. The results show that modern technology can effectively suppress the credit risk of China's commercial banks. In addition, due to the existence of financial exclusion and development differences between the east and west, there is a heterogeneity of fintech in different dimensions and power points in different regions. Based on the research results, we put forward relevant suggestions on how to create a good financial environment, increase the supply of financial technology and grow the advantages of it, which are of great practical significance to reduce systemic financial risks and build up a good financial ecological environment.

Keywords: Digital Finance; Non-Performing Loan Rate; Commercial Bank; Financial Security.

1. Introduction

Since the reform and opening up, China has gone through a difficult journey of 40 years, achieving glorious achievements that have attracted worldwide attention. Recently, China's economy is resilient and full of potential, the overall financial risks are converging, the financial system is generally sound, and the long-term fundamentals will not change. However, with the development of the economy, commercial banks' daily operations are increasingly affected by the NPL problem, which regularly triggers banking crises. Data from the end of 2021 indicate that the NPL rate of Chinese commercial banks is heading towards the high water mark of 2%, and this phenomenon is not promising. As a hinge factor affecting the sustainable development of commercial banks, the NPL rate will directly affect their asset quality and induce crises in profitability, solvency, and liquidity levels. What is more, it may simulate the occurrence of systemic risks, ultimately harming social stability and national economic development.

Nowadays, the scale of China's digital economy industry has steadily ranked second in the world, accounting for more than 40% of GDP. As the core of our economy, Finance digitalization is surging forward. The digital RMB pilot navigated digital finance to accelerate changes, big data technologies are widely used, and digital financial products and derivatives are booming. Throughout future development, the financial industry, as a booster of China's economic growth, must be more deeply integrated into the tide of digital economic development. Based on the boom of various industries in the national economy moving towards the digital era, this paper focuses on the main business of commercial banks and empirically analyzes the impact of digital finance on the bank's NPL rate, so as to provide some reference for effectively reducing the operational risks of commercial banks and deepening the structural reform on the supply side.

The theories and literature related to this paper mainly include the following: one is about the factors influencing the credit security of commercial banks. From an economic cycle perspective, Williamson (1985) and Li (2009) use the economic cycle theory to explain the relationship between the macroeconomic environment and non-performing loans. When the economy is in an upward cycle,

business conditions improve, repayment capacity increases, and commercial banks increase credit supply to stimulate continued economic expansion. When the economy is in a downward cycle, enterprises' business conditions deteriorate, their repayment ability decreases, commercial banks' non-performing loans increase, and the credit scale shrinks, making economic recovery difficult. From the government's point of view, Lin(1998)believes that China's high non-performing loan rate is mainly due to the guidance of the national policy of banks to invest loanable funds in low-efficiency industries and enterprises. Ba et al. (2005) argue that local governments can only establish a positive interaction between local governance and banking reform by strengthening functional transformation and local supervision, promoting reform of the investment and financing system, and improving the way officials' performance is assessed. Using panel data of 31 provinces from 2005-2014, Sun et al. (2017) analyzed the impact of excessive government intervention on the loan quality of commercial banks, arguing that the direct effect is to reduce the efficiency of financial operations and cause inefficient use of credit resources, and the indirect effect is to lead to overcapacity. In addition, the impact of commercial banks' own internal bank characteristics on NPL rate has received increasing and sufficient attention from scholars in recent years (Zhang and Han, 2016; Liang et al., 2017; Ding,2018). One of the more notable topics is that Zhang and Han (2016) used a panel data model to investigate the relationship between the equity structure of commercial banks and non-performing loans and found that an increase in the shareholding of private major shareholders and a decrease in the shareholding of foreign capital both reduce the credit risks of financial industry, while state-owned shares, investment shares of private financial institutions and outstanding corporate shares have no significant.

The second is the assessment of the impact of digital technology on economic operations. From macroscopic aspect, existing scholars mainly conduct research from two perspectives: technological innovation and economic growth. Wang et al. (2022) used a spatial joint cubic equation model to argue that there is a mutually reinforcing effect of digital inclusive finance, technological innovation and economic growth. Chen et al. (2022) found that financial technology can stimulate innovative R&D activities by alleviating firms' innovation financing constraints, which indirectly affects the quality of economic growth through a mediating effect model. In addition, digital finance, through technology-driven and technology-enabled, can comprehensively and effectively present the business status and credit standing of enterprises, reduce adverse selection, and help banks reduce information search and risk control costs.

In summary, the existing literature provides a more detailed study of the causes of commercial banks' NPL rate, the economic growth effect and the innovation effect of digital finance. However, few scholars have explored the relationship between financial technology and commercial banks' NPL rate, ignoring digital finance’s impact on financial risk and economic security. Based on this, the contribution of this paper may be: first, based on the digital inclusive finance indicators compiled by the Peking University Institute of Inclusive Finance and the relevant data provided by the China Statistical Yearbook, we use a two-way fixed effects model to empirically test the transmission mechanism of the multi-dimensional and multi-indicator dynamic development history of digital finance acting on the NPL rate. It not only makes the influence path between digital finance and commercial bank NPL rate more convincing but also provides some reference for the subsequent related research. In addition, the variables are divided into eastern and central-western regions according to the provinces where they are, which provides a financial-level solution to study the current problem of unbalanced regional economic growth and promote the coordinated development of regional innovation. In our research, we found that digital finance can significantly reduce the credit risks and effectively guide them to improve digitalization in their operations, strengthen internal governance and risk control, thus effectively avoiding systemic financial risks and creating a safe financial environment, and ultimately promoting the development of the digital economy and the economy.

2. Empirical Design

2.1 Model Setting

To analyze the relationship between the digital finance, the breadth of digital finance coverage, the depth of digital finance usage and the degree of digitalization of inclusive finance and the commercial banks NPL's rate, we use a two-way fixed effects model, controlling for the year as well as regional effects. The specific model is as follows:

$$NPLR_{it} = \alpha + \beta Difin_{it} + \gamma X_{it} + \theta_i + \varphi_t + \epsilon_{it}$$

The detailed explanation of the variables in the model is shown in Table 1. Among them, the explanatory variable is the non-performing loan rate of commercial banks in province i in year t; there are four explanatory variables, which are the digital finance (DF), the breadth of digital finance coverage (Wid), the depth of digital finance use (Dep), and the degree of digitalization of financial inclusion (Dig) in province i in year t. The relevant control variables affecting the NPL rate of commercial banks include fiscal factor, urbanization rate, technology factor, trade factor, financial development level, and tertiary sector share. θ_i is a province-fixed effect, θ_i is a time-fixed effect and ϵ_{it} is a random error term.

2.2 Variable Description

2.2.1 Core Explained Variables: NPLR

Considering the availability of data and the representativeness of the variables, this paper draws on the China Financial Statistics Yearbook and uses the commercial banks' NPL rate in 30 provinces and cities in China from 2011 to 2020 as the descriptive variable to measure loan quality. The higher the NPL rate, the lower the quality of commercial banks' credit assets and the higher the credit risk and credit losses they face.

2.2.2 Core Variables: Digital Finance

Table 1. Variable Description

Variables	Sign	Variable interpretation	properties
Non-performing loan rate of commercial banks	NPLR	China Financial Statistical Yearbook	Explained Variable
Digital finance	DF	Digital Finance Research Center of Peking University	Independent variables
Coverage of digital finance	Wid	Digital Finance Research Center of Peking University	Independent variables
the depth of digital financial use	Dep	Digital Finance Research Center of Peking University	Independent variables
Digitalization degree of digital finance	Dig	Digital Finance Research Center of Peking University	Independent variables
Financial factors	Gov	Expenditure/GDP	Control variable
Urbanization rate	City	Urban population/Total population	Control variable
Technical factors	Tec	R&D/GDP	Control variable
Trade factors	Trade	Import and Export trade/GDP	Control variable
Financial development level	Fin	Balance of deposits and loans of banking financial institutions/GDP	Control variable
Proportion of tertiary industry	Third	Output value of tertiary industry/GDP	Control variable

This paper draws on the digital financial inclusion index system of 30 provinces in China from 2011 to 2020 compiled by the Digital Finance Research Center of Peking University, and selects the digital financial (DF), the breadth of coverage (wid), the depth of digital financial use (dep) and the digitalization degree of digital finance (dig) as measures for the overall metrics. The index is a relatively scientific index system in the field of financial technology in China based on the transaction data of Alibaba's affiliate Ant Financial Services, which has been adopted by many scholars and relevant studies.

In addition, drawing on existing scholarly studies, we also added some control variables, as shown in Table 1.

2.3 Description of Data

In this paper, we select panel data from 30 Chinese provinces and cities from 2011-2020 for regression analysis. To ensure the reliability of the regression results, we did the following processing of the data: (1) exclude the data of Hong Kong, Macao, and Taiwan; (2) exclude Tibet where the sample data are missing; (3) convert the import and export trade to RMB caliber at the exchange rate of RMB to USD; (4) some of the missing values of the variables are filled based on the mean, and finally, 3300 observations are obtained. The data on digital finance is obtained from China's Digital Inclusive Finance Index compiled by the Digital Finance Research Center of Peking University, and other data are obtained from China Statistical Yearbook, China Financial Statistical Yearbook, and China Science and Technology Statistical Yearbook.

The results of descriptive statistics for each variable are shown in Table 2.

Table 2. Descriptive statistics for each variable

	Total	Mean	SD	Min	Max
NPLR	300	1.690	1.133	0.35	8.7
DF	300	217.246	96.968	18.33	431.93
Gov	300	0.264	0.114	0.120	0.758
City	300	0.590	0.122	0.350	0.896
Tec	300	0.017	0.011	0.004	0.065
Trade	300	96.566	156.661	0.186	887.148
Fin	300	3.319	1.058	1.688	7.522
Third	300	0.492	0.090	0.327	0.837

3. Empirical Results and Discussion

3.1 Full Sample Analysis

Table 3. Mian Regression results

	NPLR (1)	NPLR (2)	NPLR (3)	NPLR (4)
DF	-0.038 *** (-5.42)	-0.038*** (-5.08)	-0.036*** (-4.31)	-0.036*** (-4.29)
Gov		-1.532 (-0.65)	-1.095 (-0.46)	0.597 (0.20)
City		0.817 (0.23)	2.411 (0.61)	2.743 (0.68)
Tec			-0.561 (-1.08)	-0.662 (-1.25)
Trade			0.002 (0.93)	0.003 (1.01)
Fin				-0.267 (-0.83)
Third				-0.962 (-0.29)
Constant	2.556 *** (7.96)	2.489 (1.13)	-1.226 (-0.30)	-1.086 (-0.26)
R2	0.442	0.444	0.448	0.450
N	300	300	300	300

This paper first analyzes the results obtained from regressions using all sample data and finds that digital finance has a significant negative relationship with commercial banks' NPL rate. Considering the effects of macro and micro factors on the core variables, we apply the distribution regression method to gradually add six control variables and find that the coefficients of digital finance remain largely consistent, all significantly negative at the 1 percent level. It is a good indication that the development of digital technology can help reduce the commercial bank's credit risks, improve their resilience to risk, and reduce the occurrence of systemic financial risks.

3.2 Sub-dimensional Analysis

Also, we include the breadth of digital financial coverage, depth of use, and degree of digitization in the estimation process separately, and the results in Table 4 show that their depth and degree of digitization are significantly negative at the 1% level, except for the coefficient of breadth of digital financial coverage, which is not significant and can effectively reduce the commercial NPL rate, indicating that different dimensions of digital finance have different effects on the NPL rate of commercial banks.

We deduce that this is because there is still a certain degree of financial exclusion in China, and this phenomenon has led to the phenomenon of the "two-eight principle" in financial services, that is, to serve 20% of high-end customers, while the remaining 80% of the disadvantaged and low-income people are excluded. On the one hand, due to their income level, physical and mental characteristics, knowledge structure, ideology and other factors, they have a long adaptation process to digital finance; on the other hand, the services provided by financial technology are homogeneous and do not take into account the special needs of this group, resulting in their resistance and giving up further understanding and learning.

Table 4. Multidimensional regression results

	NPLR (1)	NPLR (2)	NPLR (3)
Wid	-0.018 (-1.55)		
Dep		-0.016*** (-3.32)	
Dig			-0.013*** (-4.23)
Gov	1.936 (0.63)	0.436 (0.14)	1.214 (0.40)
City	11.839** (3.09)	1.627 (0.36)	2.679 (0.66)
Tec	-1.370* (-2.65)	-0.967* (-1.84)	-0.827 (-1.59)
Trade	0.001 (0.20)	0.002 (0.73)	0.003 (1.09)
Fin	-0.150 (-0.45)	-0.153 (-0.47)	-0.249 (-0.78)
Third	-2.58 (-0.76)	-0.968 (-0.29)	-2.130 (-0.65)
Constant	-9.636*** (-2.65)	-2.735 (-0.65)	-2.365 (-0.60)
R2	0.416	0.435	0.449
N	300	300	300

3.3 Sub-regional Inspection

To test the impact of digital technology on different regions, we divide the sample into two subsamples, the eastern, and the mid-western, and conduct regressions separately, and find that the coefficient of digital finance in the east is significantly negative at 1% level, while the mid-western

is significantly negative at 10% level. It indicates that financial technology can reduce the NPL rate of commercial banks in different regions. In comparison, the absolute value of the coefficient of digital finance is larger and the significance level is higher in the eastern, which has a more significant inhibitory effect on the NPL rate of commercial banks.

We believe this may be the result of uneven development in different regions. With a favorable policy environment, relatively full capital market development and a lower level of financial inhibition in the eastern, digital inclusive finance can have a more significant improvement effect on commercial banks' NPL rate. In addition, the economic development of the mid-western areas is slower, and digital finance is still in the initial development stage due to the limitations of infrastructure, technology level, and education level.

Table 5. Regional Regression

	East(1)	Mid-West(2)
DF	-0.084***	-0.020*
	(-5.69)	(-1.72)
Gov	8.746	2.043
	(1.28)	(0.51)
City	-2.346	8.628
	(-0.39)	(1.03)
Tec	-1.104	-0.466
	(-0.87)	(-0.78)
Trade	0.004	-0.023**
	(1.14)	(-2.14)
Fin	-2.115***	-0.214
	(-3.64)	(-0.53)
Third	16.080**	-5.530
	(2.12)	(-1.37)
Constant	0.196	-1.866
	(0.02)	(-0.31)
R2	0.554	0.536
N	110	190

3.4 Robustness Tests

Table 6. Robustness estimation results

	Hysteretic Effect(1)	IV-SLS(2)	Replace Samples(3)
DF	-0.024**	-0.041**	-0.038***
	(-2.38)	(-3.16)	(-3.92)
Gov	-2.523	0.401	1.927
	(-0.74)	(0.13)	(0.55)
City	9.032*	4.126	0.162
	(1.93)	(0.88)	(0.02)
Tec	-1.015	-0.788	-0.288
	(-1.64)	(-1.32)	(-0.48)
Trade	0.001	0.003	0.003
	(0.30)	(1.16)	(0.96)
Fin	0.766**	-0.333	-0.278
	(2.18)	(-0.98)	(-0.77)
Third	-5.108	-0.717	-3.323
	(-1.41)	(-0.19)	(-0.89)
Constant	-6.815	2.768	2.435
	(-1.43)	(0.42)	(0.46)
Cragg f		171.142	
R2	0.430	0.577	0.453
N	270	270	260

To increase the reliability of the regression results, we use the following three methods to verify the robustness of the relationship between digital finance to reduce the NPL rate of commercial banks:

First, we lagged all variables by one order to observe the lagged effect of digital finance and found that the regression coefficient of digital technology is still significantly negative, indicating that the effect on the NPL rate is persistent;

Second, endogeneity is treated using the IV-2SLS. By lagging digital finance by one order as an instrumental variable and then regressing using two-stage least squares, we find that the coefficient on digital finance remains significantly negative after accounting for endogeneity;

Finally, considering Beijing, Tianjin, Shanghai, and Chongqing have more advantages in economic development, policy guidelines, financial environment, and innovation ability, we exclude these four cities for the regression and find that the inhibitory effect of financial technology on the non-performing loan rate is still very obvious.

By using the above three methods, we find that all the findings are mostly consistent with the results of the previous analysis, fully validating the robustness of the relationship between digital finance and the NPL rate of commercial banks.

4. Conclusion and Insights

We explored the impact of fintech on commercial banks' NPL rate from different perspectives using 30 provincial and municipal panel data from 2011-2020, combined with a two-way fixed effects model, and the empirical results are shown below.

(1)Digital finance can significantly curb the increase in commercial banks' NPL rate. Specifically, for every point increase in the digital finance, the NPL rate of commercial banks will decrease by 0.04 percentage points.

(2)Digital finance can significantly reduce the commercial banks' credit risks in both dimensions of the depth of use and digitalization of financial inclusion.

(3)Fintech reflects a significant suppressive effect on commercial banks' NPL rate in the eastern region, while it does not form a significant inverse relationship with the central and western areas.

Based on the development of digital technology and the current situation of the financial risks in China, this paper believes that we can further deepen the development of modern technology and maintain the security of commercial banks in the following three aspects.

In terms of financial environment, first, strengthen the policy environment to support the development of the financial industry, and improve the construction of fintech infrastructure and the building of digital financial platforms; Second, strengthen the credit environment and credit system, increase the penalties for breach of trust, to create a good atmosphere of honesty and trustworthiness, fair competition; Third, to create a judicial environment, we should actively carry out anti-monopoly and anti-unfair competition regulations in the financial sector.

On the financial supply side, first of all, we should actively introduce digital finance talents, strengthen digital finance R&D innovation, promote the theoretical research of digital finance in various institutions of higher learning, support the development and application of frontier technologies such as big data, cloud computing, and Internet of Things, promote the transformation of digital finance achievements. In addition, we should expand the application of fintech scenarios, and enhance services in areas such as government services, social security, education, and training, so that the fruits of digital financial development can benefit more people.

Last but not least, to better leverage the advantages of digital finance, first, we should organically combine information disclosure, capital monitoring, and risk warning, strengthen the monitoring of financial risks, carry out in-depth risk investigation and respond to unexpected situations on time. Second, the use of digitalization to promote financial information sharing, fully grasp the credit status and financial strength of customers, reduce the extra costs paid by financial institutions due to being on the disadvantaged side of information, and reduce moral hazard and adverse selection. Finally, through the application of big data, artificial intelligence, satellite remote sensing, and other financial

technology means, it is possible to carve an all-round and multi-angle picture of customers, develop personalized solutions for their credit line needs, repayment time and repayment ability, and to provide accurate and efficient credit services.

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