

# The Influence of Digital Inclusive Finance on the Non-performing Loan Ratio of Commercial Banks

Jingyi Zhang

zhangjingyi555@126.com

Renmin University of China Beijing, China, 100872

**Abstract**—The commercial bank serves as a crucial part in developing digital, inclusive finance, so it is important to figure out the influence between them. From the perspective of bank risk, this paper empirically tests the influence mechanism of digital inclusive finance on the non-performing loan ratio of commercial banks based on the panel data of 87 Chinese commercial banks from 2014 to 2019, using the methods of fixed panel model and dynamic panel model. The findings show that the relationship between the development of digital inclusive finance and the non-performing loan ratio of commercial banks presents an inverted U-shaped curve, and there are heterogeneities in the critical point according to different bank types and regions. The restraining effect of digital inclusive finance on the non-performing loan ratio of commercial banks is more likely to occur in urban commercial banks and commercial banks in eastern China. The empirical results of this paper provide a more comprehensive perspective for the bank to control and prevent risks, which are of great significance for commercial banks to perfect the performance of their non-performing loan ratio and improve their operations.

**Keywords**-Digital inclusive finance; non-performing loan ratio; commercial bank; heterogeneity

## 1 INTRODUCTION

The provision of appropriate and effective financial services at a reasonable cost to a diverse range of social groups in need of financial assistance is referred to as inclusive financial. The concept of inclusive finance was put forward by the United Nations in 2005, and it officially entered China's development strategy at the Third Plenary Session of the 18th CPC Central Committee in 2013. Inclusive finance strives to deal with financial exclusion, aims to enhance access to financial services, and plays a positive role in promoting poverty alleviation and revitalization. Therefore, in order to ease the financing difficulties of micro, small and medium-sized enterprises, meet the requirements of financial service of all social strata and achieve the goal of establishing a moderately prosperous society, the development of an inclusive financial system has already become a crucial part of China's strategic layout.

Recently, fintech has flourished in China. With the development of big data, cloud computing, blockchain and other advanced technologies, digital finance is gradually penetrating the traditional financial industry. Previous limitations of traditional inclusive finance have been

effectively solved by the integration of digital technologies, which successfully copes with the disadvantages of inclusive finance such as insufficient branches, difficult customer acquisition, cumbersome transaction procedures etc. Therefore, the emergence of digital inclusive finance is of great significance to solving the imbalance and disharmony of financial development. Up to now, digital inclusive finance has become the mainstream of China's current inclusive finance development.

Banks and insurance institutions are the main force in the development of inclusive finance. So how would digital inclusive finance influence the operation of commercial banks? This is a worthwhile issue to focus on. China's traditional banking industry is now in the stage of digital transformation, and the inclusive finance business is in its early stage as well. The development of digital inclusive finance could be regarded as both an opportunity and a challenge for the risk management of commercial banks. On one hand, since commercial banks are in the early stages of digitization, the incomprehensive control over digital technologies brings great potential risks for banks to develop their digital inclusive finance business. On the other hand, the commercial bank could tap its potential by taking advantage of the development of digital inclusive finance, which instills innovation and vitality into its risk control management as well as lowers its potential risk in its future operations. Therefore, this paper takes the perspective of the non-performing loan ratio of the commercial bank and explores the influential mechanism of digital inclusive finance on the non-performing loan ratio of the commercial bank.

## **2 THEORETICAL MECHANISMS AND HYPOTHESIS**

Recently, the digital economy has continued to develop. The traditional banking industry is facing technological transformation in the context of fintech, and the promotion of inclusive finance is also boosting the business transformation and structural optimization of traditional commercial banks [1] [2]. Nowadays, digital inclusive finance is gradually integrated into the traditional business activities of commercial banks. The continuous development of digital inclusive finance will inevitably have an impact on the risk management of commercial banks, and the non-performing loan ratio of a commercial bank is an important indicator to reflect such risks.

For one thing, the development of digital inclusive finance has led to an increase in the non-performing loan ratio of commercial banks. First, the rapid development of the digital economy does not match the governance capacity and risk prevention ability of commercial banks in the early stages of digital transformation. The commercial bank needs to adapt to its burgeoning digital transformation. Undoubtedly, it would be a new attempt by commercial banks to switch their offline deposit and loan business to online platform operations. Due to the imperfection of their digital risk management, unskilled technology, and the lack of experience in digital innovation, there would be a short-term rise in the non-performing loan ratio of commercial banks at first [3]. Second, the state's regulatory requirements for the commercial bank's digital inclusive finance business make it difficult to balance its loan tasks and loan supervision. In order to enhance the service of inclusive finance, the state has put forward explicit requirements for commercial banks in terms of their loan quantity and loan interest rate. Under strict regulations, commercial banks are likely to lower the audit requirements for lenders in order to fulfill the task of providing inclusive finance services. Therefore, aiming to promote the development of

inclusive finance business and benefit micro, small and medium-sized enterprises, commercial banks have to temporarily sacrifice the control of their non-performing loan ratio in the early stage of its digital development [4].

For another, the development of digital inclusive finance can restrain the increase in non-performing loans of commercial banks. First, the development of digital technology activates innovation and motivates the revolution of the commercial bank. In addition, the application of digital technology can improve the governance capacity and risk prevention ability of commercial banks [5]. The commercial bank employs big data technologies, constructs graph networks, and portrays users' traits to identify the risk level of their loan business. It also extracts risk characteristics and builds an intelligent risk control system [6] to curb the growth of non-performing loan ratios. Second, the development of digital inclusive finance effectively promotes regional economic development and residents' income level [7] [8]. The growth of economic level and the improvement of residents' disposable income can strengthen the repayment ability of enterprises and individuals. In the long term, digital inclusive finance service invigorates enterprise operations and regional economic development. Capital supply and liquidity injection boost economic growth, which helps to reduce the non-performing loan ratio of the commercial bank. Finally, the development of digital inclusive finance is gradually changing the risk characteristics of the environment in which commercial banks are located and improving individual credit awareness. With the enhancement of credit consciousness of enterprises and individuals, the non-performing loan ratio in commercial banks will present a declining trend. Therefore, this paper proposes the following hypothesis:

H1: The development of digital inclusive finance and the commercial bank's non-performing loan ratio have an inverted U-shaped relationship.

Since the development of digital inclusive finance officially entered the national development strategy in 2013, various financial institutions show differences in the development degree of digital inclusive finance. In 2017, in the government work report, Premier Li Keqiang pointed out that large state-owned banks were responsible for taking the lead in setting up inclusive finance businesses, then the large and medium-sized commercial banks should follow suit to carry out inclusive finance services. Digital inclusive finance presents a developing trend from top to bottom. The regional economic level and high popularity of branches are beneficial for city commercial banks, which make it much easier to launch digital, inclusive financial services than rural commercial banks. Obviously, there is a transition from large commercial banks to small and medium-sized commercial banks, and from urban commercial banks to rural commercial banks in the process of developing and constructing a digital inclusive finance system. Besides, there are differences in fintech development and digital technology levels among different banks. Due to the lagging technological development and Internet popularization in the region where they are located, it is more difficult for rural commercial banks to promote the development of digital inclusive finance. It can be considered that there is heterogeneity in developing digital inclusive finance in different types of commercial banks. Therefore, this paper proposes the following hypothesis:

H2: There is bank heterogeneity in the development of digital inclusive finance. For rural commercial banks, the critical value of the influence of the development level of digital inclusive finance on the non-performing loan ratio of commercial banks is higher.

Based on the popularization of the Internet and the application of advanced technology, the development of digital inclusive finance can break through geographical limitations to some extent. However, the digital inclusive finance business largely relies on the real economy and the traditional financial industry. Consequently, regional differences and spatial aggregation still exist in its development process [9]. There have been regional differences in China's economic market for a long time. Therefore, this paper considers regional heterogeneity. First, the eastern part of China presents a well-developed economic environment. It has a high urbanization level, a mature financial system, and abundant technical personnel, which all contribute to a higher degree of development of digital inclusive finance. A favorable market environment and technical support enable commercial banks to better equip themselves to prevent risks. Second, market competition is common in the eastern area of China. Fierce market competition drives commercial banks to innovate and optimize their business models, and motivates them to reform in the context of digital finance, thus enhancing their governance capacity and risk-resistance ability. Third, the eastern region has advanced financial concepts, while people in the central and western regions are still faithful to traditional financial business. They need a lot of time to accept the emerging digital inclusive finance business. Differences in residents' acceptance cause that the restraining effect of digital inclusive finance on the non-performing loan ratio of commercial banks is delayed in the central and western region. Therefore, this paper proposes the following hypothesis:

H3: There is regional consistency in the development of digital financial inclusion. Compared with the non-eastern region, the critical value of the influence of the development level of digital inclusive finance on the non-performing loan ratio of commercial banks in the eastern region is lower.

### 3 RESEARCH DESIGN

#### 3.1 Data Source

This paper selects the panel data of 87 commercial banks nationwide from 2014 to 2019 as research samples, including 53 city commercial banks and 34 rural commercial banks. The operation data of commercial banks comes from CSMAR, Wind, and BankFocus, some missing data are collected and supplemented manually on the official websites of various banks. Inclusive financial data comes from “The Peking University Digital Financial Inclusion Index of China (PKU-DFIIC)” [10], which is jointly compiled by Peking University and Ant Group Research Institute. The macro-level data comes from CSMAR. Variables used in the model are defined and described in Table 1.

#### 3.2 Variables

TABLE 1. VARIABLES DEFINITION AND DESCRIPTION

Variable Type	Variable Name (Symbol)	Variable Meaning and Calculation Method
Explained Variable	Non-performing Loan ratio (NPL)	Non-performing loans/loans

Explanatory Variables	Level of Digital Financial Inclusion Development (INDEX)	Digital financial inclusion index of prefecture-level cities where commercial banks are located
	Square of Level of Digital Inclusive Finance Development (INDEX2)	Square of digital financial inclusion index of prefecture-level cities where commercial banks are located
	Cube of Level of Digital Inclusive Finance Development (INDEX3)	The third power of digital financial inclusion index of prefecture-level cities where commercial banks are located
Bank Characteristic Variables	Capital Adequacy Ratio (CAR)	Year-end capital adequacy ratio
	Net interest margin (NIM)	Return on interest-bearing assets of commercial banks
	Loan-to-Deposit Ratio (DELN)	Total ending loans/total ending deposits
	Asset SIZE (SIZE)	The natural log of ending assets
	Capital structure (FRAME)	Ending liabilities/Ending assets
Macro-control Variables	Type of Commercial Bank (CLASS)	The value of rural commercial bank is 1 and that of city commercial bank is 0
	Place where commercial banks are located (PLACE)	The value is 1 in the eastern region and 0 in the non-eastern region
Macro-control Variables	Regional Economic Development Level (GDPRATE)	The increment rate of gross domestic product of the prefecture-level city where the commercial bank is located
	Number of Industries by Region (INDNUM)	Number of industrial enterprises in prefecture-level cities where commercial banks are located
	Regional Population (PEOPLE)	The total population at the end of the term of the prefecture-level city where the commercial bank is located
	Money Supply (M2)	The natural log of quasi money

### 3.3 Model design

#### 3.3.1 The verification of the inverted U-shaped relationship

In order to verify hypothesis one, this paper constructs the following model according to the pervious empirical research [11].

$$NPL_{i,t} = \alpha_0 + \alpha_1 INDEX_{i,t} + \alpha_2 Character_{i,t} + \alpha_3 Control_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$NPL_{i,t} = \beta_0 + \beta_1 INDEX_{i,t} + \beta_2 INDEX2_{i,t} + \beta_3 Character_{i,t} + \beta_4 Control_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$NPL_{i,t} = \gamma_0 + \gamma_1 INDEX_{i,t} + \gamma_2 INDEX2_{i,t} + \gamma_3 INDEX3_{i,t} + \gamma_4 Character_{i,t} + \gamma_5 Control_{i,t} + \varepsilon_{i,t} \quad (3)$$

In the expressions above,  $\alpha_0, \beta_0$  and  $\gamma_0$  are constant terms,  $\varepsilon_{i,t}$  is random disturbance term and obeys standard normal distribution,  $\text{Character}_{i,t}$  is the characteristic variable of bank and  $\text{Control}_{i,t}$  is the control variable of macro level.

Regression fitting is applied in examining expressions above. If the result shows that both coefficient  $\beta_1$  and  $\beta_2$  are significant in Model (2) and are more significant than coefficient  $\alpha_1$  in Model (1), meanwhile, goodness of fit of model (2) is better than that of Model (1), the non-linear relationship between digital inclusive finance and non-performing loan ratio of commercial banks could be effectively verified. The negative  $\beta_2$  could further confirm the inverted U-shaped relationship. Besides, Model (3) includes the cube term of digital inclusive finance in order to rule out the possibility of a high-dimensional power function relationship, which improves the reliability and accuracy of hypothesis one.

### 3.3.2 Heterogeneity in bank types

The development of digital inclusive finance causes different impact on the non-performing loan ratio of different types of commercial banks. This paper introduces the interaction term  $\text{INDEX}_{i,t} \times \text{CLASS}$  to figure out the heterogeneity in bank types.

$$\begin{aligned} \text{NPL}_{i,t} = & \beta_0 + \beta_1 \text{INDEX}_{i,t} + \beta_2 \text{INDEX}_{i,t}^2 + \beta_3 \text{INDEX}_{i,t} \times \text{CLASS} \\ & + \beta_4 \text{Character}_{i,t} + \beta_5 \text{Control}_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (4)$$

The dummy variable  $\text{CLASS}$  stands for bank types. If the variable is zero, then it represents the city commercial bank. Otherwise, it represents the rural commercial bank.

### 3.3.3 Heterogeneity in regions

The dummy variable  $\text{PLACE}$  is introduced to test the heterogeneity in different regions. For commercial banks in the non-eastern region of China, the value of  $\text{PLACE}$  is equal to zero, while for commercial banks in the eastern region of China, the value of  $\text{PLACE}$  is one. The eastern region refers to ten provinces or municipalities which are Hebei, Beijing, Tianjin, Shandong, Jiangsu, Zhejiang, Shanghai, Guangdong, Hainan and Fujian. Data sample is divided into two groups according to the value of Model (2) is used for regression analysis respectively to compare the regression results and further explore the impact of regional heterogeneity.

## 4 EMPIRICAL TEST AND RESULT ANALYSIS

### 4.1 Variable Description and Related Test

#### 4.1.1 Descriptive statistics

In order to avoid the influence of abnormal data on the regression results, the data sample is winsorized by 1%. Data reveal that there are distinct differences between the non-performing loan ratios in different banks and between the index of digital inclusive finance in different regions, which increase the reliability of the data sample.

### 4.1.2 Model testing

This paper tests the correlation between variables. Results show that the correlation coefficients between core variables are all less than 0.5, which can rule out the existence of multicollinearity. Besides, if directly use the non-stationary data to construct the model, chances are that it would end up with a spurious regression, and the accuracy of regression results would be affected. Therefore, this paper carries out a unit root test. The null hypothesis is the non-stationary series of variables. The results of the unit root test are significant at 1% or 5% level, then the null hypothesis is rejected and there is no non-stationary series of variables.

### 4.2 Regression Results and Analysis

The data used in this paper are short and wide panel data with multiple periods. The purpose of this research is to explore the impact of digital inclusive finance on the non-performing loan ratio. However, reverse causality between variables is highly likely. In fact, the decline of the non-performing loan ratio will help improve the sustainable development of the commercial bank, enhance its strength and competitiveness, and further promote the development of digital inclusive finance. Therefore, there are endogeneity problems in the model, which will affect the accuracy and reliability of the regression. In order to eliminate endogenously, this paper selects the first-order lag term of the development level of digital inclusive finance, as well as the square and cube term of the first-order lag term of the development level of digital inclusive finance as proxy variables [12]. Generalized method of moments (GMM) [13] is used to conduct regression of the aforementioned models (1), (2) and (3), which ensures the validity of parameter estimation. Results are shown in Table 2. What's more, AR (2) test proves that there is no second-order autocorrelation of residuals, and Hansen test confirms that all instrumental variables are valid.

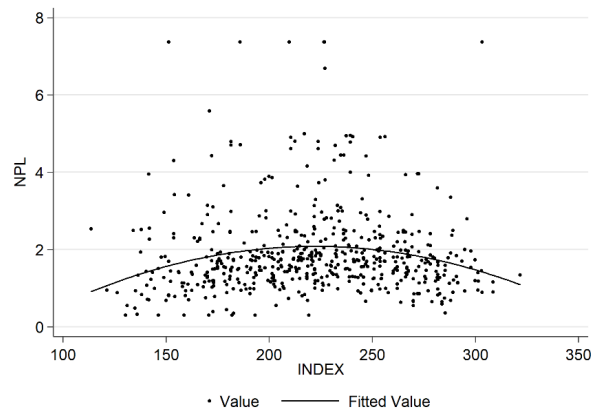
TABLE 2. REGRESSION RESULTS

Variable	(1) NPL	(2) NPL	(3) NPL
INDEX	0.0059* (0.003)	0.0306*** (0.011)	0.0814 (0.082)
INDEX2		-0.0001** (0.000)	-0.0003 (0.000)
INDEX3			0.0000 (0.000)
CAR	-0.1695*** (0.047)	-0.1701*** (0.046)	-0.1726*** (0.047)
NIM	-0.0173** (0.007)	-0.0157** (0.007)	-0.0161** (0.007)
DELN	0.6904* (0.409)	0.6949* (0.422)	0.6858 (0.428)
SIZE	-0.7562*** (0.166)	-0.7773*** (0.163)	-0.7853*** (0.168)
FRAME	13.0715*** (4.968)	13.2615*** (4.892)	13.3868*** (4.951)
GDPRATE	0.0010 (0.001)	-0.0001 (0.001)	-0.0000 (0.001)
INDNUM	-0.0001**	-0.0001***	-0.0001***

	(0.000)	(0.000)	(0.000)
PEOPLE	0.0002**	0.0003**	0.0003**
	(0.000)	(0.000)	(0.000)
M2	1.6058	0.7477	0.8645
	(1.469)	(1.345)	(1.329)
Constant	-13.3775	-10.7780	-14.9664
	(11.325)	(10.821)	(12.535)
Observations	342	342	342
R-squared	0.300	0.317	0.318
Area FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: Parameter estimation results based on GMM. The robust standard deviations of each variable are listed in parentheses. \*, \*\* and \*\*\* represent significant at the statistical level of 10%, 5% and 1% respectively. The same is below.

The significance of coefficients of core variables are improved after the square term of digital inclusive finance index is added to Model (1). Besides, the goodness of fit of the model is also improved. Both improvements prove that there is a non-linear relationship between the development degree of digital inclusive finance and the non-performing loan ratio of commercial banks. What's more, the significance of coefficients of core variables decreases after the cube term is added, and the explanatory power of the model is weakened, which further confirms the validity of the hypothesis one.



**Figure 1.** Sample scatter plot and regression fitting curve

Figure 1 depicts the relationship between digital inclusive finance and the non-performing loan ratio of commercial banks visually and effectively. In the early stage of the development of digital inclusive finance, the imperfect digital system of banks causes the upward trend of its non-performing loan ratio. With the further development of digital inclusive finance, the complete intelligent risk control system, the optimization of digital technology of commercial banks, the



improvement of the capital strength of enterprises, and the enhancement of credit consciousness could restrain the further rise of the non-performing loan ratio of commercial banks, which effectively alleviates their non-performing credit business.

### 4.3 Heterogeneity Analysis

#### 4.3.1 Bank types

The differences of banks make digital inclusive finance present different development trends. A rural commercial bank is usually located in poor areas, its digital technology level is relatively basic. It is hard for them to promote digital inclusive finance services and the related cost is quite high. Thus, digital inclusive finance business of a rural commercial bank is carried out late and is not mature enough. Accordingly, the critical value of the influence of the development level of digital inclusive finance on the non-performing loan ratio of rural commercial banks arrives later than city commercial banks. A rural commercial bank needs to wait until the development of digital inclusive finance reaches to a higher stage before it can effectively cope with its regional difficulties and technological backwardness.

In order to verify hypothesis two the interaction term of dummy variable stands for bank types and index of digital inclusive finance is added to Model (4) [14]. Results are shown in Table 3 (The following table lists only the regression results of core variables). The first column shows the results of Model (2) and the second column shows the results of Model (4) which includes the interaction term.

**TABLE 3.** REGRESSION RESULTS OF HETEROGENEITY

	(1)	(2)	(3)	(4)
	NPL	NPL	NPL	NPL
INDEX	0.0273*** (0.010)	0.0232** (0.010)	0.0173 (0.012)	0.0339** (0.016)
INDEX2	-0.0001** (0.000)	-0.0001** (0.000)	-0.0000* (0.000)	-0.0001* (0.000)
CLASSINDEX		0.0016*** (0.000)		
Constant	-21.3399** (8.891)	-30.3940*** (9.051)	-40.3631*** (13.558)	-17.3757 (32.303)
Observations	376	376	280	96
R-squared	0.305	0.328		
Area FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

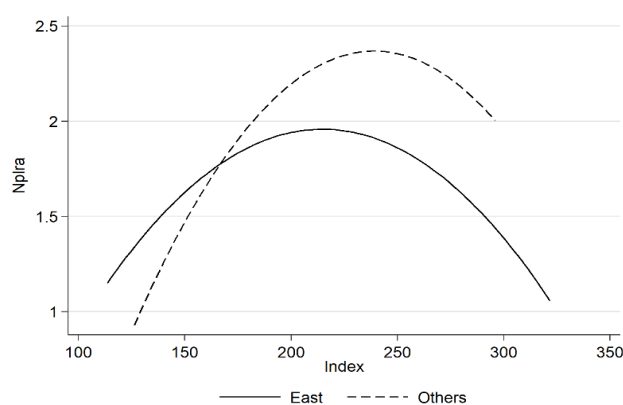
The coefficient of interaction term is significant at 1% statistical level, which points out there is an obvious heterogeneity of bank types. The positive coefficient means when is equal to one, the critical value is higher than when is zero. So, the turning point related to rural commercial banks arrives later than city commercial banks, which strongly supports hypothesis two There is the

reason. The region rural commercial banks located in usually has poor economic development, the scarcity of offline branches is hard to promote the development of digital inclusive finance. Besides, rural commercial bank lacks enough talented people and technological skills, its customers generally reluctant to accept the concept of digital economy. Therefore, the negative impact on non-performing loan ratio of rural commercial banks would be gradually alleviated only when digital inclusive finance develops to a higher level.

### 4.3.2 Regions

According to the value of dummy variable, the data sample is divided into two sub-samples. The first one stands for the eastern region and the second one stands for the central and western region, and these two subsamples are respectively brought into the model (2) for empirical test. The results are shown in Table 3. The third column shows the results of the Eastern region and the fourth column shows the results of central and western region.

According to the empirical test, it can be calculated that the critical value of the impact of digital inclusive finance development on the non-performing loan ratio of commercial banks in eastern China appears earlier than that in central and western China, which supports hypothesis three<sup>3</sup>. Figure 2 shows the relationship between digital financial inclusion index and non-performing loan ratio of commercial banks in the eastern and non-eastern region of China. The digital inclusive financial index corresponding to the curve critical value in the eastern region is smaller than that in the central and western region, and the overall non-performing loan ratio in the eastern region is lower than that in the central and western region, which meets the fact that the eastern region has a higher level of economic development, a more developed level of technology, and a more perfect risk control system of commercial banks.



**Figure 2.** Regression fitting curve in different area

### 4.4 Robustness Test

This paper conducts the robustness test in order to test the reliability of empirical results. Data of banks in the four major municipalities are removed from the sample, and robust OLS regression,

fixed effect model and dynamic panel model are used to test the new sample [15]. The results obtained by different test methods are consistent, indicating that the research conclusion is robust.

## 5 CONCLUSION

In the era of digital economy, inclusive finance is gradually integrated with the Internet. Digital inclusive finance is booming, and commercial banks are the main force in the development of digital inclusive finance. Digital inclusive finance aims to improve financial accessibility, solve financial exclusion, alleviate the financing difficulties of micro, small and medium-sized enterprises etc. It plays a great role in promoting enterprise operation and economic growth. But how does the development of digital inclusive finance affect the operation of commercial banks? From the perspective of risk management, this paper selects panel data of 87 Chinese commercial banks from 2014 to 2019 as samples to theoretically analyze and empirically test the influence mechanism of digital inclusive finance on non-performing loan ratio of commercial banks. Limited by layout, experimental data can be obtained by contacting the author. The findings are as follows: First, the relationship between the development of digital inclusive finance and the non-performing loan ratio of commercial banks presents an inverted U-shaped curve. Second, the critical point at which the impact of digital inclusive finance on the non-performing loan ratio of commercial banks turns from promotion to inhibition shows heterogeneity in bank categories, and rural commercial banks need a higher development degree of digital inclusive finance to effectively alleviate its negative impact. Third, compared with the commercial banks in the central and western region, the suppression effect of digital inclusive finance on the non-performing loan ratio of commercial banks in the eastern region of China is more likely to occur.

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