

Impact of Digital Inclusive Finance on Household Formal Credit: Evidence from China Household Finance Survey

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Abstract: In this paper, whether and how digital inclusive finance affects households' formal credit are discussed. Based on the data of China Household Finance Survey from 2013 to 2017 and the province-level DFI index, we find that compared with traditional financial services, digital inclusive finance has higher flexibility, which can effectively reduce information asymmetry and transaction costs, and digital payment channels also significantly improve households' access to formal credit. However, it is found that the government intervention has a negative impact on household formal credit, which may be due to policy differences or regional discrimination. Therefore, when deepening the development strategy of digital inclusive finance, it is necessary to strengthen the construction of digital financial infrastructure, especially in rural areas and the central and western regions, so as to improve the underdeveloped situation of digital financial services. Additionally, it is necessary to develop tailored policy measures for different households when a comprehensive approach that considers various factors, such as education level, income level, and geographic differences.

Keywords: Digital Inclusive Finance, Household Formal Credit, Credit Availability, Government Intervention

1 Introduction

On a global scale today, the rapid development of digital technology is changing the way people live and the way economies operate. As an application form of Digital technology, Digital Financial Services (DFS) provides more convenient and efficient financial services for individuals and enterprises through mobile payment, Internet banking, electronic wallet and other tools. Among them, Digital Inclusive Finance (DIF) has attracted attention for its potential in promoting financial inclusion.

There are many limiting factors in the traditional financial system, such as geography, economic and social conditions, which lead to a part of the population being unable to access formal financial services. These groups are often referred to as “unbanked” or “financially marginalized” groups. However, with the emergence of digital financial inclusion, these groups can access financial services through tools such as mobile payment, E-wallets, mobile banking, etc., thereby solving their exclusion in the financial sector.

Financial inclusion policies aim to provide affordable financial services to all levels of society. Since the 2016 G20 Hangzhou Summit¹, the development of financial inclusion with the power of “digital” has attracted much attention. It not only provides people with basic financial functions such as daily payment and transfer, but also provides them with more financial choices and opportunities. For example, through digital financial inclusion, individuals can obtain small loans to start a business or expand their operations; farmers have access to agricultural insurance and disaster risk management services; poor families can receive social welfare funds, etc.

¹ The 2016 G20 Hangzhou summit was the eleventh meeting of the Group of Twenty (G20). It was held on 4–5 September 2016 in the city of Hangzhou, China.

Through formal credit, households can obtain additional funds for investment, consumption and risk management, thus promoting the development of economic activities, indicating that household formal credit is of great significance to household economic growth and social development. However, it is still unclear whether digital inclusive finance can improve households' formal credit availability and its impact on household credit risks.

Although digital inclusive finance has made some achievements in providing financial inclusion, there is less empirical research on its specific impact on household formal credit. Household formal credit is of great significance to household economic growth and social development. Through formal credit, households can access additional funds for investment, consumption and risk management, which in turn drives economic activity.

Therefore, this paper aims to fill the research gap in the impact of digital inclusive finance on household formal credit, and deeply explore the mechanism and factors of the impact of digital inclusive finance on households. We review the literature on digital financial inclusion and formal credit to households in Section 2. Section 3 describes the data and empirical strategy. Section 4 presents the results, and Section 5 provides conclusions and discussion based on the results. It is hoped that this study will provide more empirical evidence for understanding the role of digital financial inclusion on household financial inclusion, and provide useful references and suggestions for policy makers and practitioners.

2 Literature review and theoretical analysis

2.1 Role of digital inclusive finance

By using digital technology and innovative financial products and services, it reduces the cost and increases the availability of financial services, helping individuals and enterprises who have difficulty in accessing services in the traditional financial system, illustrating that digital inclusive finance plays an important role in providing financial inclusion. It not only provides convenient payment and transfer methods, but also helps individuals and enterprises to more easily access loans and credit services, promoting household economic growth and enterprise development. In addition, digital inclusive finance utilizes ABCD² technologies to provide accurate risk assessment and management tools, reducing lending and investment risks. At the same time, it also provides financial education and consulting services to help people improve financial literacy and better manage their finances.

Since the development of digital inclusive finance, many scholars have explored the development of digital inclusive finance. Many empirical literatures have verified that the development of digital inclusive finance has a promoting effect on narrowing the income gap between urban and rural residents (Song 2017; Zhang et al. 2019; Zhao 2020). Zhang and Tan (2018) conclude that digital inclusive finance plays a significant role in improving the coverage breadth, depth of use and degree of digital service use, which is conducive to narrowing the income gap between urban and rural areas in China. Ren and Li (2019) believe that the development of digital inclusive finance can effectively promote the improvement of the level of economic development in rural areas of China. More in-depth research shows that the development of digital financial inclusion can effectively improve the level of household consumption, and the impact varies depending on

² The ABCD technologies is a part of emerging tech. It is a set of 4 emerging technologies: (A) Artificial Intelligence, (B) Blockchain, (C) Cloud and (D) Data (big and small).

the level of regional development (Zou and Wang 2020).

2.2 Connection between digital inclusive finance and formal credit

Digital financial inclusion serves as a powerful catalyst in seamlessly connecting individuals and businesses to the world of formal credit, revolutionizing the way loans and credit are accessed. Gone are the days of towering requirements that traditional formal credit demanded. Instead, digital financial inclusion provides borrowers with more flexible and personalized loan options by using big data analysis and emerging evaluation models. Besides, digital financial inclusion also reduces waiting time and red tape for borrowers by reducing the application and processing time of loans and credit, enabling them to quickly access financial support.

Previous studies have shown that a good financial environment can provide convenient financial services for households, alleviate the constraints of household formal credit, and promote household participation in the financial market (Yin et al. 2015; Yin and Zhang 2018). In the literature of the mechanism, Zhang et al. (2019) believe that digital inclusive finance relies on the customer information big data technology accumulating so as to provide financial products and services accurately, which greatly improves the availability and convenience of household credit services. Therefore, improving the availability of formal credit for households is necessary.

2.3 Current situation of formal credit under the development of digital inclusive finance

In the wake of digital inclusive finance's meteoric ascent, formal credit has showcased a newfound and unprecedented status of development. Digital inclusive finance provides more convenient and efficient financial services, making it easier for borrowers to obtain formal credit. Traditional formal credit usually requires borrowers to meet a series of strict requirements and conditions, while digital inclusive finance provides borrowers with more flexible and personalized loan options by using big data analysis and emerging evaluation models. Moreover, digital inclusive finance platforms can also connect borrowers with multiple formal financial institutions, increasing borrowing channels and opportunities, thus promoting the development of formal credit. However, formal credit also encounters a wave of challenges under the development of digital inclusive finance, such as how to ensure loan compliance and risk control.

Yan (2020) pointed out that digital inclusive finance formed an information network through identity recognition, life payment, capital exchange and other information, effectively screening users and ensuring controllable risks. It has created a good digital information foundation for promoting the formal credit business under digital inclusive finance. However, there is also a typical information asymmetry in the inclusive finance market. Wang and Liu (2020) take non-Ricardian households as the research object and finally conclude that moderate household debt is conducive to the development of the real economy, while the deleveraging through credit tightening may increase the risk of economic downturn. Therefore, China's formal credit business is facing a major challenge.

After reviewing the existing literature, we find that most of the scholars in this field focus on promoting consumption, narrowing income gap and influencing path, and few research from the perspective of credit access. Therefore, this article will start from this research gap and study the impact and impact path of the development of digital financial inclusion on household formal credit. Specifically, we will explore the following aspects:

Firstly, we will study the impact of digital inclusive finance on households' formal credit availability. In the traditional financial system, households often cannot obtain formal credit

services due to geographical, economic or other factors. The emergence of digital inclusive finance provides new opportunities for these households excluded from the traditional financial system. Through the analysis of data, we will explore whether digital inclusive finance can improve households' formal credit accessibility, and further analyze the influencing factors.

Secondly, we will study the impact of digital inclusive finance on household credit risk, which refers to the possibility of households defaulting or overdue repayment in the process of lending. In the context of digital inclusive finance, households may face higher credit risks when borrowing through non-traditional financial service providers. Through empirical analysis, we will explore whether digital inclusive finance will have an impact on household credit risk, and further study the mechanisms and factors involved.

Theoretical in essence, we illuminate the elusive impact of digital financial inclusion on household formal credit. While some literatures have tangentially explored the role of digital financial inclusion in promoting overall financial inclusion, the specific ramifications on household formal credit remain shrouded in mystery. With empirical analysis at its core, this paper aims to provide a rich tapestry of empirical evidence, unraveling the mechanism of digital financial inclusion in empowering households with access to formal credit.

Beyond the realm of theory, the tangible results of this study hold immense value for policy makers, financial institutions, and practitioners alike. Serving as both a compass and a treasure trove of insights, the findings will furnish these stakeholders with invaluable references and practical suggestions. In the face of the rapid growth of digital financial inclusion, comprehending its influence on household formal credit becomes paramount in crafting effective policies and devising winning strategies. Armed with the revelations of this study, financial institutions will be fortified to seize the day, fostering the development of digital financial inclusion products and services, and propelling the remarkable actualization of financial inclusion for all.

3 Data, variables and model

3.1 Data

This paper selects samples³ of three rounds of household tracking surveys in 2013, 2015 and 2017 from the data of the China Household Finance Survey (CHFS), extracts data on household credit and characteristics of family and mutual assistance, and combines it with the Peking University Digital Financial Inclusion Index of China (PKU_DFIIC) for follow-up research⁴. The PKU_DFIIC is an index system compiled by the Institute of Digital Finance, Peking University, whose authority and credibility have been recognized in previous research. The index mainly evaluates the development level of inclusive finance in China from four aspects: the total index of inclusive finance, the coverage breadth index, the digitalization degree index and the depth of use index.

One, the digital financial inclusion index takes into account factors such as financial institutions, financial products, financial services and financial markets, reflecting the overall development level of inclusive finance. Two, the breadth of coverage measures the breadth of financial inclusion in different regions and among different populations. It takes into account factors such as the

³ For the universality of the study, the sample of the study is the general family of the country, including both urban families and rural families.

⁴ This study uses the Peking University Digital Financial Inclusion Index (2011-2018).

geographic distribution of financial services, the spread of financial products, and the spread of financial institutions. Three, the level of digitalization evaluates the digitalization of financial inclusion, which refers to the ability to provide financial services using tools such as information technology and the Internet. It focuses on the degree of digital technology application in the financial sector and the popularity of digital financial services such as electronic payment and mobile finance. Four, the depth of usage reflects the degree and depth of financial inclusion usage. It takes into account factors such as the frequency of financial service use, the scope of financial product use, and the trading activity of financial market.

These indicators comprehensively evaluate the development level of digital inclusive finance in China, and provide financial institutions and research institutions with reference and analysis basis for the development of inclusive finance. By monitoring the changes of these indicators, the effectiveness of Chinese inclusive finance policies can be evaluated, and macro guidance can be provided for further promoting the development of inclusive finance.

From the perspective of macro-level control variables, this paper finds data such as GDP, urbanization rate, government intervention, and population density from the yearbooks of 31 provinces, autonomous regions and municipalities to match the CHFS data.

One, the CHFS provides data on household income sources, assets and liabilities, which can be used to analyze income inequality and wealth distribution. Two, the survey collected data on household financial behavior, including holdings of financial assets such as bank deposits, stocks, bonds and funds, as well as household borrowing behavior and investment decisions. Three, the CHFS provides data on the use of different financial products by households, which can be used to assess the availability of financial services and financial inclusion. Four, the survey also collected data on household financial education, financial knowledge level and financial awareness, which can be used to study the effect of household financial literacy and financial education policies.

Since CHFS surveys the sample households in the previous year, in order to minimize the endogeneity, this paper selects the data of China Digital Inclusive Finance Index in 2012, 2014 and 2016, which are lagged by one year, and the relevant data of statistical yearbooks of various provinces and cities.

Next, in order to study the impact of digital inclusive finance on household formal credit, data processing and matching are needed.

Firstly, the household credit access is processed in the CHFS. This step includes collecting and collating information about household credit access, such as loan amount, interest rate, borrowing purpose, etc. These data provide a detailed description of households' formal credit access. Secondly, samples with missing values need to be removed. This step can ensure the reliability of the analysis results. In addition, the household assets and household income are also processed with levels of 1% winsorization. This means that extremes are adjusted to avoid their deviation impact on the analysis results. Through such processing, the actual financial status of households can be better reflected. Finally, the digital inclusive finance-related indicators and macroeconomic indicators are matched to the CHFS micro-household data. This means that the information from different data sources is integrated to establish the link between household formal credit and digital inclusive finance. This data matching can provide more comprehensive information, thus more accurately evaluating the impact of digital inclusive finance on household formal credit.

3.2 Variables

3.2.1 Dependent variable

The *household formal credit* is obtained. Start with the seven questions “does your family have unpaid agricultural production/business operations/housing purchase/car purchase/children’s education/medical care/credit card loans”. Seven aspects of business, housing purchase, car purchase, children’s education, medical care and credit card loans are used to judge whether the family has obtained formal credit. If the household has obtained corresponding financial services in one of these aspects, the variable takes the value of 1, otherwise it takes the value of 0.

3.2.2 Explanatory variables

The *digital financial inclusion* includes the digital financial inclusion index, the *breadth of coverage*, the *level of digitalization* and the *depth of usage*, in which the credit part has been removed. The *breadth of coverage* refers to how many people are covered by digital financial inclusion. The *depth of usage* is mainly measured by the actual use of Internet financial services, including the number of transactions per capita in various banks and mobile payments. Additionally, the *digital financial inclusion* index also includes business classification indexes such as payment, credit, insurance, and credit.

3.2.3 Control variables

Control variables can help rule out the influence of other factors on the research results. By controlling for some basic characteristics of the head of household and households, we can more precisely analyze the impact of digital financial inclusion on formal credit. For instance, the marital status of the head, the gender of the head, the age of head, the education of the head and other factors may have an impact on the ability to obtain formal credit. By controlling these variables, we can more accurately assess the impact of digital financial inclusion on formal credit. Family features can reflect the family's economic strength and consumption behavior. Factors such as family size, household assets, and household gift money spending may be related to formal credit needs. By controlling these variables, we can better understand the impact of digital financial inclusion on different types of households.

Macroeconomic indicators can reflect the impact of the overall economic environment on formal credit. For example, macroeconomic indicators such as GDP growth rate, unemployment rate, and inflation rate may affect banks’ lending policies and market interest rates, which in turn have an impact on formal credit. By controlling for these variables, we can more sensitively grasp the relationship between digital financial inclusion and formal credit, and exclude the interference of macroeconomic factors.

The summary table is shown in Table 1. This paper selects three levels of control variables. One, the *head of household features* include the *marital status* of the head of household, the *gender* of the head of household, the *age* of the head of household, the *education background* of the head of household, whether the head of household purchases *health insurance*, and the *risk preference* of the head of household. Two, *family features*, including *family size* and *family assets*. Three, *macroeconomic indicators*. In this paper, the provincial *GDP per capita*, the rate of *urbanization*, the intensity *government intervention* and *population density* in the place where the family are located are taken as the control variables of regional economy and finance.

Table 1 Variable introduction

| | Variable | Description | Alias |
|----------------------------|-----------------------------|--|----------|
| Dependent variable | Household formal credit | Yes=1; No=0 | Y |
| Explanatory variables | Digital financial inclusion | Province-level indicator | $DIFI_1$ |
| | Breadth of coverage | Province-level indicator | $DIFI_2$ |
| | Level of digitalization | Province-level indicator | $DIFI_3$ |
| | Depth of usage | Province-level indicator | $DIFI_4$ |
| | Marital status | Married=1; Others=0 | X_1 |
| Head of household features | Age | Years | X_2 |
| | Gender | Male=1; Female=0 | X_3 |
| | Education background | High education=1; low education=0 | X_4 |
| | Health insurance | Yes=1; No=0 | X_5 |
| | Risk preference | Scores | X_6 |
| | Size | Number of permanent residents | X_7 |
| | Assets | Sum of nonfinancial and financial assets | X_8 |
| Macroeconomic indicators | Government intervention | Government fiscal expenditure at the end of the year/GDP | X_9 |
| | GDP per capita | Province-level indicator (Yuan) | X_{10} |
| | Urbanization | Proportion of urban population at the end of the year | X_{11} |
| | Population density | Province-level indicator (Person per square kilometer) | X_{12} |

From the analysis in Table 2, it can be seen that the average value of household formal credit is 0.769, which can explain that the individuals with household formal credit behavior account for the majority. The corresponding average value of digital financial inclusion is 175.204, indicating that the overall development of digital financial inclusion in my country is relatively good, but the range is large, indicating that the gap between different regions is still large. Among them, the heads of households are mostly risk-averse middle-aged men. In the government intervention data, there is a large value, indicating that there are policy differences, and the degree of control in each region is different, which may have different impacts on the development of the credit industry.

Table 2 Descriptive statistics

| Variable | N | Mean | SD | Min | Max |
|-----------------------------|--------|---------|--------|--------|---------|
| Household formal credit | 84,357 | 0.769 | 0.422 | 0.000 | 1.000 |
| Digital financial inclusion | 84,357 | 175.204 | 59.046 | 61.470 | 286.370 |
| Breadth of coverage | 84,357 | 169.618 | 52.103 | 51.850 | 281.480 |
| Level of digitalization | 84,357 | 159.556 | 60.530 | 47.120 | 285.650 |
| Depth of usage | 84,357 | 237.033 | 86.845 | 32.590 | 404.000 |
| Marital status | 84,357 | 0.856 | 0.351 | 0.000 | 1.000 |
| Age | 84,357 | 59.804 | 14.011 | 7.000 | 121.000 |
| Gender | 84,357 | 0.777 | 0.417 | 0.000 | 1.000 |
| Education background | 84,357 | 0.196 | 0.397 | 0.000 | 1.000 |
| Health insurance | 84,357 | 0.418 | 0.493 | 0.000 | 1.000 |

| | | | | | |
|-------------------------|--------|---------|----------|--------|----------|
| Risk preference | 84,357 | 0.221 | 0.415 | 0.000 | 1.000 |
| Size | 84,357 | 1.605 | 1.139 | 1.000 | 16.000 |
| Assets | 84,357 | 930128 | 1894099 | 0.000 | 30000000 |
| Government intervention | 84,357 | 0.206 | 0.090 | 0.100 | 0.712 |
| GDP per capita | 84,357 | 716.744 | 1012.620 | 7.935 | 5244.000 |
| Urbanization | 84,357 | 0.769 | 0.422 | 0.000 | 1.000 |
| Population density | 84,357 | 175.204 | 59.046 | 61.470 | 286.370 |

3.3 Model building

$$P(Y = 1|DIFI_{i,t}, X_{i,t}) = \Phi(\beta_0 + \beta_1 DIFI_{i,t} + \beta_2 X_{i,t})$$

In this model, Y represents the credit acquisition status of family i in period t (1 represents yes, 0 represents no). $DIFI_{i,t}$ represents the digital financial inclusion index of family i in period t ; $X_{i,t}$ represents the control variables, including the *head of household features*, *family features* and *macroeconomic indicators*.

4 Results

4.1 Stationarity test

In economic models, it is very critical to assume that variables are stationary, which means that the mean and variance of variables are constant in time and are not affected by external factors. In this way, when conducting empirical analysis, we can better control other factors that may interfere with the results, and thus draw more accurate conclusions.

Through the stationarity test, we confirmed that the explanatory variable household formal credit acquisition, the core explanatory variable digital financial inclusion index and each control variable are in line with the stationarity assumption, which allows us to further explore the impact of digital financial inclusion on household formal credit, and carry out relevant empirical analysis and statistical inference.

Therefore, in the future, we can use a variety of economic methods and models, such as regression analysis, panel data analysis, etc., to study the mechanism and extent of the impact of digital inclusive finance on household formal credit, while controlling other potential influencing factors, such as family Income, education level, etc. to ensure the accuracy and reliability of the research results.

4.2 Impact of digital financial inclusion on households' access to formal credit

From the analysis in Table 3, it can be seen that digital financial inclusion has a significant positive correlation with household formal credit, indicating that digital financial inclusion plays a positive role in improving the ability of households to obtain formal credit.

Table 3 Model regression results

| Variable | Whether to obtain formal credit (Yes=1; No=0) | | |
|-----------------------------|---|-----------------------|-----------------------|
| | (1) | (2) | (3) |
| Digital financial inclusion | 0.0038*** (0.0001) | 0.0018*** (0.0001) | 0.0025*** (0.0001) |

| | | | |
|-------------------------|---------------------------|----------------------------|----------------------------|
| Marital status | | -0.0049 (0.0157) | 0.0025 (0.0158) |
| Age | | -0.0389*** (0.0125) | -0.0256** (0.0126) |
| Gender | | -0.0075*** (0.0004) | -0.0074*** (0.0004) |
| Education background | | 0.1989*** (0.0129) | 0.1337*** (0.0131) |
| Health insurance | | 0.2396*** (0.0149) | 0.2057*** (0.0149) |
| Risk preference | | -0.3069*** (0.0121) | -0.2609*** (0.0123) |
| Size | | | 0.0411*** (0.0050) |
| Assets | | | 0.1026*** (0.0033) |
| Government intervention | -0.1833** (0.0859) | -0.1142 (0.0877) | -0.1954** (0.0887) |
| GDP per capita | 0.0289*** (0.0108) | 0.0310*** (0.0110) | 0.0403*** (0.0111) |
| Urbanization | -0.7066*** (0.0536) | -0.3613*** (0.0551) | -0.2831*** (0.0553) |
| Population density | -0.0119** (0.0056) | -0.0270*** (0.0057) | -0.0282*** (0.0058) |
| Constant | 0.7920*** (0.1177) | 0.6110*** (0.1241) | 1.7478*** (0.1316) |
| Wald test | $\chi^2(5)=1776.38^{***}$ | $\chi^2(11)=3654.97^{***}$ | $\chi^2(13)=4566.24^{***}$ |
| Observations | 84,357 | 84,357 | 84,357 |

Notes: Robust standard errors are in parentheses.

† *p< 0.1; **p<0.05; ***p< 0.01.

Specifically, digital financial inclusion makes it easier for households to access formal credit support by reducing the cost of financial services, increasing accessibility, and providing personalized lending options. Furthermore, digital financial inclusion platforms can also connect borrowers with multiple formal financial institutions, expanding borrowing channels and opportunities, and further promoting the development of formal credit.

Therefore, it is proved that the promotion and application of digital financial inclusion can help solve the credit problems existing in the traditional financial system and provide families with more financing options and opportunities. By increasing households' access to formal credit, digital financial inclusion is expected to promote household economic growth and social development, and improve households' living conditions. Also, digital financial inclusion can help families better cope with risks and emergencies, improving their financial security.

From the control variables, it can be seen that the *head of household features*, *family features* and *macroeconomic indicators* have a significant impact on the family's formal credit availability.

There is a significant positive correlation between the *educational background* of the head of household and whether to purchase *health insurance*, which shows that higher education level and better risk awareness can make families more willing to obtain loans through formal channels, and the importance of education level for family health protection.

First, higher education is generally associated with higher income and occupational status. This makes household heads with higher education more able to purchase insurance and bear the corresponding costs. In contrast, household heads with low education may face financial constraints, be unable to pay for insurance or tend not to purchase it.

Secondly, highly educated household heads tend to have better health awareness and knowledge, and it is easier for them to understand the importance of medical insurance and its role in family protection. Therefore, they are more inclined to take the initiative to purchase medical insurance to deal with potential medical risks and expenses.

The significance of the analysis is that through the improvement of education, people's awareness and understanding of medical insurance can be improved, and they can be more actively purchased insurance, thereby reducing the burden of family medical expenses and improving the level of family health protection. Prompts and related organizations need to pay attention to education, publicity and popularization when promoting medical insurance, so as to improve public awareness and acceptance of medical insurance. Through strengthening education and publicity, the willingness of low-education families to purchase medical insurance can be increased, thereby promoting the realization of universal health protection.

The family *size* and *assets* have a significant positive correlation with the family's formal credit availability, which shows that the family size and wealth level have an important impact on the formal credit access. Larger households generally mean higher incomes and greater economic resources, making it easier for them to obtain formal credit from banks or other financial institutions. Further, higher asset levels can also act as collateral or collateral, improving households' access to credit.

Government intervention is significantly negatively correlated with access to formal credit, which means that government-organized interventions have had an adverse effect on households' access to formal credit. This intervention may include legal, policy, or institutional restrictions, such as for certain groups of people or regions credit discrimination, and restrictions on certain types of loans by financial institutions. What's more, the intervention may destabilize credit markets or increase credit risk, causing financial institutions to scrutinize loan applications more carefully, thereby reducing the supply of formal credit. Such interventions can hinder households' ability to access formal credit, limiting their opportunities for economic development and investment.

This is not a small conflict with the conclusion in the previous literature that government intervention promotes the balance between supply and demand of household credit (Zhang and Liu 2020). Therefore, the negative relationship between the intervention and access to formal credit may indicate some institutional problems or policy barriers that require further research and improvement.

4.3 Influence mechanism of digital inclusive finance on households' access to formal credit

From the analysis in Table 4, it can be seen that the depth of use, the breadth of coverage, and the degree of digitization are all significantly positively correlated with the acquisition of formal credit by households. Depth, coverage, and degree of digitalization are significantly positively correlated with household formal credit acquisition, indicating that digital financial inclusion plays

a positive role in promoting household formal credit acquisition.

Table 4 Test the mechanism of digital inclusive finance on households' access to formal credit

| Variable | Whether to obtain formal credit (Yes=1; No=0) | | |
|----------------------------|---|----------------------------|----------------------------|
| | (1) | (2) | (3) |
| Depth of usage | 0.0034*** (0.0002) | | |
| Breadth of coverage | | 0.0019*** (0.0001) | |
| Level of digitalization | | | 0.0016*** (0.0001) |
| Head of household features | YES | YES | YES |
| Family features | YES | YES | YES |
| Macroeconomic indicators | YES | YES | YES |
| Constant | 2.1055*** | 1.7563*** | 1.2874*** |
| | 0.1340 | 0.1308 | 0.1321 |
| Wald test | $\chi^2(13)=4640.70^{***}$ | $\chi^2(13)=4422.82^{***}$ | $\chi^2(13)=4596.61^{***}$ |
| Observations | 84,357 | 84,357 | 84,357 |

Notes: Robust standard errors are in parentheses.

† *p<0.1; **p<0.05; ***p<0.01.

The *depth of usage* refers to the degree to which digital financial inclusion services fully utilize the financial resources provided by individuals or families. If digital financial inclusion services can provide more choices of financial products and services to meet the different borrowing needs of households, then the opportunities for households to obtain formal credit will increase. Therefore, the positive correlation between depth and household formal credit access suggests that the richness of digital financial inclusion services is important for improving households' ability to obtain formal credit.

The *breadth of coverage* pertains to their reach and popularity. If these services can be widely adopted by households across different regions and income levels, it will consequently increase their access to formal credit. Hence, the positive relationship between coverage and household formal credit access underlines the pivotal role of widespread adoption in enhancing households' ability to obtain formal credit.

The *level of digitalization* corresponds to the technology and informatization of digital inclusive financial services. By leveraging digital technology, financial services can be delivered to households more efficiently, reducing both time and cost. Consequently, the positive correlation between the degree of digitalization and household access to formal credit highlights the positive impact of technological innovation and convenience offered by digital financial inclusion. This ultimately improves households' access to formal credit.

4.4 Endogenous problems

Endogeneity mainly comes from two aspects of omitted variables and bidirectional causality. In terms of omitted variables, we try to select variables that may affect households' access to formal credit as control variables, including household income, education level, and employment status.

By introducing these control variables, the potential impact of omitted variables on the estimated results can be reduced. Additionally, we also used the data lagged by one year to ensure that the problem of endogeneity is reduced to some extent.

Regarding the two-way causality between household formal credit acquisition and the digital financial inclusion index, we observe that household formal credit acquisition represents micro data, while the digital financial inclusion index represents macro data. These two types of data possess a certain hierarchical relationship, emphasizing the distinction between individual-level and aggregate-level information. In essence, the relationship between household credit and digital financial inclusion is characterized by the limitations imposed by the disparity between micro and macro data. The hierarchical nature of these data types, coupled with their distinct origins, makes it challenging for individual-level credit acquisition to exert a direct influence on the aggregate-level digital financial inclusion index, which further reduce the likelihood of bidirectional causality.

Although we have tried our best to solve the endogeneity problem, the influence of other unknown factors on the research results cannot be completely ruled out. Therefore, when interpreting the results of the empirical analysis, out of careful consideration of other potential endogenous problems, we use the DID method for the next verification analysis.

Digital financial inclusion as a separate and complete concept was first proposed in the *G20 High-Level Principles for Digital Financial Inclusion* initiative adopted at the 2016 G20 Hangzhou Summit. This principle believes that digital financial inclusion refers to everything that uses digital financial services to Actions to Promote Financial Inclusion. Therefore, the family data after 2016 are selected as the experimental group, and the families that did not participate before 2016 are selected as the control group.

By introducing the interaction term of time and treatment variables, the baseline model is extended to obtain a DID estimate, which helps us evaluate the impact of digital financial inclusion on household formal credit, and controls the time trend and other potential confounding factors, and finally obtains Table 5 the result of.

Table 5 DID regression results

| Variable | Whether to obtain formal credit (Yes=1; No=0) | | |
|-----------------------------|---|-----------------------|-----------------------|
| | (1) | (2) | (3) |
| Digital financial inclusion | 0.0052*** (0.001) | 0.0003*** (0.001) | 0.0002*** (0.001) |
| Marital status | | -0.0040 (0.0354) | -0.0037 (0.383) |
| Age | | -0.0125*** (0.001) | -0.0099** (0.001) |
| Gender | | -0.0004*** (0.001) | -0.0038*** (0.001) |
| Education background | | 0.0153*** (0.001) | 0.0125*** (0.001) |
| Health insurance | | 0.0313*** (0.001) | 0.0279*** (0.001) |
| Risk preference | | 0.0689*** | 0.0573*** |

| | | | |
|------------------------------------|------------------------|-------------------------|-------------------------|
| | | (0.001) | (0.001) |
| Size | | | 0.0034*** (0.010) |
| Assets | | | 0.0001*** (0.0001) |
| Government intervention | 0.0608*** (0.002) | 0.0822*** (0.0001) | 0.0911** (0.001) |
| GDP per capita | 0.0001** (0.073) | 0.0001*** (0.0008) | 0.0001*** (0.002) |
| Urbanization | 0.0506*** (0.001) | -0.0053** (0.069) | -0.0262** (0.052) |
| Population density | -0.0001 (0.829) | -0.0001** (0.063) | -0.0001*** (0.032) |
| Digital financial inclusion × Time | | | -0.0007*** (0.0001) |
| Constant | 0.2377*** (0.001) | 0.1731*** (0.001) | 0.1765*** (0.001) |
| Wald test | $\chi^2(5)=581.71$ *** | $\chi^2(11)=389.94$ *** | $\chi^2(13)=394.93$ *** |
| Observations | 84,357 | 84,357 | 84,357 |

Notes: Robust standard errors are in parentheses.

† *p< 0.1; **p<0.05; ***p< 0.01.

By analyzing the results of DID regression, we can discern the implications of the interaction items' P values, all of which are less than 0.05. This indicates a statistically significant relationship between digital financial inclusion and household formal credit. In summary, the results of the double difference estimation provide compelling evidence for the positive impact of digital financial inclusion on household formal credit. By utilizing these services, households witness an enhanced access to formal credit, suggesting the transformative potential of digital financial inclusion in improving financial opportunities and economic well-being.

The premise of the double difference is that before the policy event occurs, the change trends of the treatment group and the control group should be the same. Drawing on the research methods of Liang and Li (2021), and taking 2016 as the base year, we further examine the changing trends of the experimental group and the control group. Figure 1 reports the analysis results. From the results, the coefficients for 2016 and after are all significant. Therefore, the sample passes the parallel trends test required for difference-in-differences estimation.

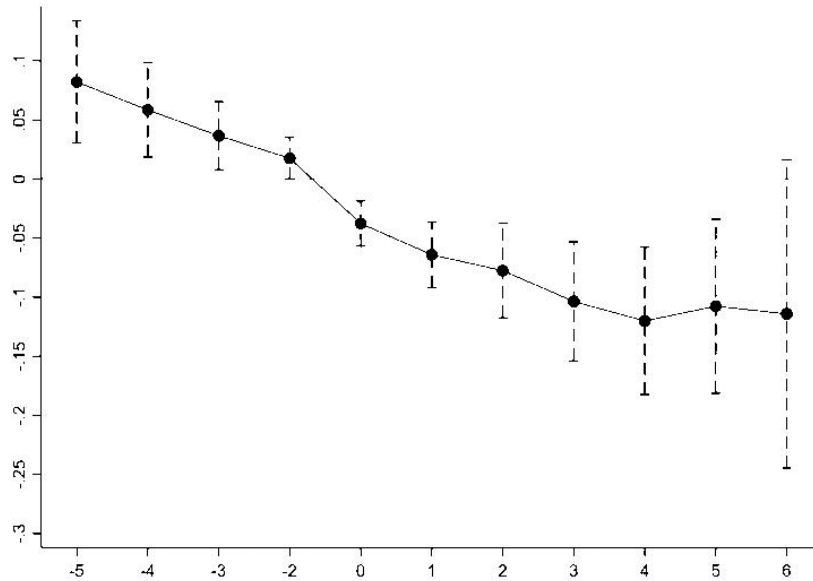


Figure 1 Parallel trend test

While digital financial inclusion demonstrates an overall positive impact on household formal credit, the DID analysis reveals the existence of potential heterogeneity. The extent to which household formal credit is influenced varies among different cases or groups.

Currently, research primarily centers around examining the short-term effects of digital financial inclusion on household formal credit. However, it is important to note that further investigation is necessary to fully understand the long-term effects. To delve deeper into the subject, future research can focus on tracking the households that utilize digital financial inclusion services and assessing the changes in their credit conditions over an extended period. This will provide valuable insights into the long-term impact of digital financial inclusion on household formal credit.

By acknowledging the presence of heterogeneity, delving into the long-term effects, and considering the dynamic nature of household credit conditions, we can gain a more comprehensive understanding of the relationship between digital financial inclusion and household formal credit. This knowledge will contribute to refining and advancing the field of financial inclusion research.

5 Conclusion and Discussion

Based on the data of the China Household Finance Survey (CHFS) in 2013, 2015 and 2017, combined with the data of the Digital Financial Inclusion Index, the Statistical Yearbook and the China Household Tracking Survey (CFPS), this paper establishes a Probit panel random effect model, and empirically tests the data of the Digital Inclusive Financial Inclusion Index. How Incentive Finance Affects Household Formal Credit Access.

Findings show that households using digital financial inclusion services have easier access to formal credit opportunities than households that do not. This shows that digital financial inclusion provides households with more convenient, flexible and transparent borrowing channels, helping them meet their diverse financial needs such as production, consumption and investment.

There is a significant positive correlation between family features and access to formal credit, indicating that family size and wealth have an important impact on access to formal credit. Formal credit is more readily available to households with larger household sizes and those with more

assets. This may be because larger households generally have higher income and repayment ability, while households with more assets can provide more collateral or collateral, which increases the confidence of banks to lend.

There exists a profound and undeniable relationship between government intervention and the availability to obtain formal credit. This correlation highlights potential institutional flaws and policy barriers that society must address. Regrettably, households endure numerous government interventions that obstruct their access to formal credit, thereby impeding financial inclusion and hindering household economic development. Therefore, relevant agencies should examine and eliminate interventions that may limit households' access to formal credit in order to promote financial inclusion and household economic development.

The above conclusions suggest the positive effect of digital financial inclusion on household formal credit acquisition, and emphasize the influence of factors such as family size, wealth level and policy intervention on household formal credit acquisition. At the same time, it also pointed out that financial institutions should take measures to promote the development of digital inclusive financial services and provide diversified financial products and services to meet the different borrowing needs of households. This can further promote financial inclusion and support the economic growth and social development of families. Based on this, this paper puts forward the following suggestions.

One, relevant departments should further promote the development of digital inclusive finance and increase support for relevant institutions and projects. Financial institutions can be encouraged to carry out digital inclusive financial services by providing tax breaks and loan guarantees. Then, a special fund can also be set up to support the research and development and promotion of digital financial inclusion innovation projects. These initiatives can promote the adoption and development of digital financial inclusion on a wider scale.

Two, financial institutions should actively explore digital inclusive financial model innovations to provide more flexible and convenient financial products and services. For instance, digital tools such as mobile payment and microfinance can be developed to facilitate household financing and repayment operations. Besides, financial institutions can also cooperate with technology companies to use technological means such as big data and artificial intelligence to improve the efficiency of risk assessment and credit approval. Through continuous innovation, financial institutions can better meet the formal credit needs of households.

Three, financial institutions can formulate differentiated policies and products based on the impact of factors such as family size and wealth level on access to formal credit. For families with a large population, you can consider launching a family joint guarantee loan or a joint repayment plan to reduce the risk of family loans. For families with less assets, more flexible collateral requirements or guarantee methods can be provided to help them obtain formal credit. Through tailored financial services, households can better leverage digital financial inclusion channels to obtain the financing support they need.

Four, financial regulatory authorities should strengthen the supervision and regulation of the digital inclusive financial market to ensure that financial institutions operate legally and their risks are controllable. Regulatory authorities can formulate relevant regulations and standards to clarify the access conditions and operating specifications for digital inclusive financial services. At the same time, strengthen the supervision and inspection of financial institutions to discover and solve potential risk problems in a timely manner. Effective supervision can maintain market order and

protect the legitimate rights and interests of families.

Five, interested scholars can continue to focus on this research direction to gain an in-depth understanding of the impact mechanism of digital inclusive finance on family formal credit acquisition, and provide a scientific basis for further optimizing policies and systems. Research institutions can jointly conduct research and evaluation, collect relevant data, and conduct in-depth analysis, so as to better understand the effects and potential problems of digital financial inclusion, and improve relevant policies and systems in a targeted manner. Through continuous research and evaluation, the operation mechanism of digital financial inclusion can be continuously improved so that it can better provide formal credit support for households.

Future research should optimize data collection and processing methods, consider regional differences and household heterogeneity, and expand the scope of research to long-term effects and social impacts, so as to further understand the impact mechanism of digital financial inclusion on household formal credit, and provide policy Develop and practice to provide more effective guidance. These improvements will allow for a more comprehensive assessment of the potential and role of digital financial inclusion.

In subsequent empirical tests, we can try to use more comprehensive and accurate data sets, including more samples and more dimensional indicators. For example, more data on household income, indebtedness, borrowing purpose, and repayment history could be collected to more fully assess the impact of digital financial inclusion on household formal credit. In addition, more advanced data processing techniques, such as machine learning algorithms and big data analysis methods, can be adopted to improve the quality and credibility of data. This will help to more accurately assess the impact of digital financial inclusion on household formal credit, and provide useful reference for policy formulation.

The impact of household formal credit and digital financial inclusion may vary by region and household characteristics. Future research can further consider regional differences and household heterogeneity to better understand their impact mechanisms and provide more targeted recommendations for policy-making. For instance, the development of digital financial inclusion services and the level of formal household credit in different regions can be compared to determine the needs and potential of specific regions. At the same time, the differential impact of factors such as family socioeconomic background, education level, and occupational status on the impact of digital financial inclusion on formal credit can also be considered.

This topic currently focuses on the short-term effects of household formal credit. Future research can be extended to long-term effects and social impacts to explore the potential impact of digital financial inclusion on household economic status, social development, and sustainable development. In particular, households using digital financial inclusion services could be tracked and long-term changes in their credit profile assessed to understand the contribution of digital financial inclusion to households' long-term welfare and economic growth. Moreover, the role of digital financial inclusion in reducing poverty, improving employment opportunities, and promoting social inclusion can also be studied to provide policymakers with a more comprehensive decision-making basis.

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