Digital Financial Inclusion and Inclusive Growth

—Empirical evidence based on the China Household Panel Survey

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Abstract

As an innovation in traditional inclusive finance, digital inclusive finance is an important way to coordinate the income gap between urban and rural areas, popularize financial products and services, and promote the digitalization process. Therefore, this study matches the digital inclusive finance index with the Chinese household tracking survey, uses a panel data econometric model, a mediation effect model, and a moderation effect model to control for the characteristics of heads of households and families, and explores the impact mechanism of the development of digital inclusive finance on inclusive growth in urban and rural areas in China, with a view to providing a scientific basis and policy suggestions for promoting inclusive growth. The study finds that: First, digital inclusive finance has a significant income-increasing effect on both urban and rural households, among which it has a greater impact on rural households, which is conducive to narrowing the income gap between urban and rural areas; Second, digital inclusive finance improves rural household income and narrows the income gap between urban and rural areas by promoting rural household entrepreneurship and business activities and alleviating the formal credit constraints of rural households; Third, digital inclusive finance can generally promote families with access to the Internet, a strong ability to use digital tools, and small information constraints to start businesses and obtain formal credit. This study innovatively incorporates entrepreneurial quality into the research of the transmission mechanism; three theories of the "digital divide" are put forward and tested. Research value: Clarifying the transmission mechanism of digital inclusive finance to promote inclusive growth, and providing policy suggestions for the development of digital inclusive finance.

1. Introduction

Inclusive growth, as a new development concept, was originally put forward by the Asian Development Bank in 2007. It emphasizes the dual dimensions of fairness and efficiency, and its core is equal opportunity and achievement sharing, so as to ensure that all people can participate in the economic growth process equally and share the development achievements. Although my country has achieved remarkable results in promoting inclusive growth, the urban-rural income ratio has shrunk from 3.03:1 in 2013 to 2.39:1 in 2023, and the Gini coefficient has also dropped by 4.9% during this period. However, we still need to face the fact that China still faces the challenges of unfair income distribution and unequal coverage of financial services, which is still

far behind the goal of inclusive growth. In order to eliminate the exclusiveness of financial services and solve the "paradox" of traditional inclusive finance, digital inclusive finance provides low-threshold and easy-to-access financial services for small and micro enterprises and low-income groups through digital technologies such as blockchain and cloud computing, narrowing the inequality of urban and rural financial services, so as to give consideration to fairness and efficiency and achieve inclusive growth. Although the development history of digital inclusive finance in China is short, it has been deeply integrated into all fields of the economy and society. The launch of Yu'ebao in June 2013 opened the first year of China's digital inclusive finance. Since then, China's digital inclusive finance has begun to develop rapidly and attracted widespread attention from the party, the government, and all sectors of society. The 2016 "Plan for Promoting the Development of Inclusive Finance (2016-2020)", the 2022 "14th Five-Year National Informatization Plan", and the 2024 Central Document No. 1 all emphasize the need to focus on building a digital inclusive finance service system to better promote rural revitalization and common prosperity. Since its development, the digital inclusive finance platform represented by Alipay has a registered user base of more than 1.3 billion, showing extensive coverage and inclusiveness. Extensive domestic practice shows that digital inclusive finance is an important force to promote inclusive economic growth, but it faces practical challenges such as the digital divide and financial fraud. In view of this, this article aims to provide more reliable empirical support and decision-making references for government departments, and help policies accurately meet actual needs, with a view to promoting the inclusive development of China's rural economy and achieving common prosperity under the strong empowerment of digital inclusive finance. Contribute to the goal of prosperity.

2. Literature Review

Inclusive Finance and Financial Exclusion are two contradictory aspects. Inthe1990s, Leyshorn and Thrift (1993) introduced the concept of financial exclusion, arguing that mainstream financial services exhibit a certain degree of exclusivity, making it difficult for impoverished and vulnerable populations in remote areas to access financial institutions, thus excluding them from the financial service system. Financial exclusion is widespread in China, hindering farmers and small and micro-enterprises from accessing local financial resources (Xu et al., 2008; Wang et al., 2010). To overcome financial exclusion, the United Nations formally proposed the establishment of an "Inclusive Financial System" in 2005. Inclusive Finance represents an innovative financial model that enables financial services to reach all social strata and groups equally and broadly. In rural areas, the development of inclusive finance exhibits unbalanced regional development (Du et al., 2016; Wang et al., 2024), while facing a "paradox" between "inclusiveness" and "commercial sustainability" in practice (Lu, 2014), manifested by high service costs, severe enterprise homogenization, and imbalanced resource allocation (Wu & Gu, 2018; Tang, 2024). With the proliferation of the Internet and advancements in digital technology, the focus of inclusive finance has gradually shifted from traditional inclusive finance to digital inclusive finance (Digital Inclusive Finance). The world's financial system has undergone electronic and internet-based transformations, now entering a digital era centered on digital technologies such as artificial intelligence, big data, and cloud computing. Supported by digital technologies, inclusive finance not only promotes equal access to financial services but also enhances financial risk control capabilities and resource allocation efficiency. Digital inclusive finance leverages advanced technologies such as the Internet, big data, and cloud computing to break information constraints, reduce transaction costs and service thresholds, thereby facilitating financial deepening and broadening, potentially achieving a win-win situation between inclusiveness and commerciality

(Dong & Zhao, 2018). This not only represents an innovation and transcendence of the traditional inclusive finance model but also constitutes an important part of the modern financial system construction in socialism with Chinese characteristics for a new era. Regarding the definition of digital inclusive finance, the Consultative Group to Assist the Poor (CGAP, 2015) of the World Bank defines it as a means to provide appropriate and convenient financial services to excluded populations through digital channels. In 2016, the G20 Global Partnership for Financial Inclusion (GPFI) released a report providing a more representative explanation: "Any action or initiative aimed at leveraging digital financial services to advance the goals of inclusive finance falls within the scope of digital inclusive finance."

3. Theoretical analysis and hypothesis

3. 1 Analysis of digital inclusive finance to increase rural income

First of all, in recent years, more and more literature believes that digital inclusive finance has significantly improved residents' income (Zhang, 2019; Liu et al., 2019; Yang et al., 2020). Secondly, digital inclusive finance can significantly narrow the income gap between urban and rural areas (Song, 2017; Zhang & Bai, 2018; Zhou et al., 2020). Moreover, this influence has been confirmed by many scholars from macro and micro levels, respectively. However, most studies divide urban and rural areas according to the geographical boundaries of permanent residence, and this paper will divide urban and rural types according to household registration. Based on the above research and simple data charts, this paper puts forward the first hypothesis:

H1: Digital inclusive finance can promote farmers' income growth.
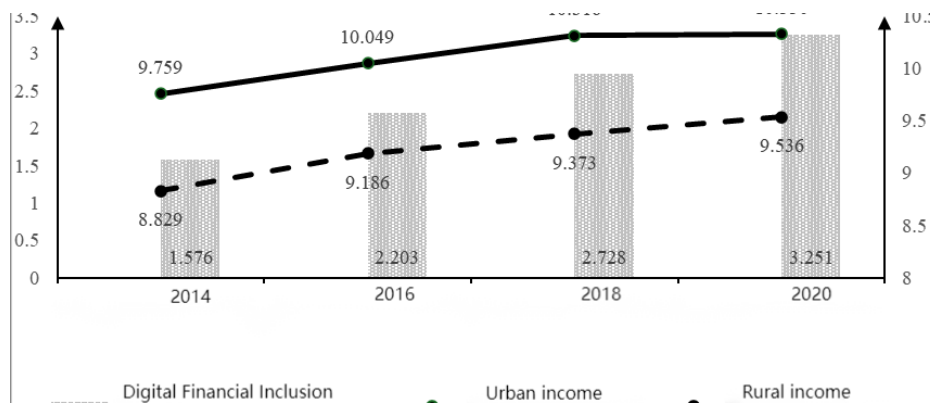

Figure 1.Empirical evidence of digital financial inclusion and revenue growth

3.2 Analysis of digital inclusive finance incentivizing rural families to start their own businesses

Regarding the theoretical aspects of entrepreneurship and management, Li et al. (2009) regarded private enterprises and self-employed individuals as entrepreneurship according to the connotation of entrepreneurship. Chen (1995) believes that the investment in the establishment stage of an enterprise is large, the construction period is long, and the enterprise enters the survival period after its establishment, so the human and financial resources are often weak, and the bankruptcy rate is high. Therefore, in addition to the activities of new ventures, the survival business activities after starting a business should also be included in the measurement scope of entrepreneurship.

Secondly, digital inclusive finance can promote family entrepreneurial activities and business activities. Specifically, on the one hand, digital inclusive finance directly provides entrepreneurial opportunities, and on the other hand, it indirectly promotes residents'

entrepreneurship by providing financial support, information integration, industrial structure optimization, and infrastructure construction services (Xie et al., 2018; Qian et al., 2020; Zhang et al., 2022; Huang et al., 2023). Regarding the research on digital inclusive finance to increase income by promoting entrepreneurship, Zhang et al. (2019) found that digital inclusive finance promotes family entrepreneurship from the perspective of new entrepreneurship behavior. Furthermore, Lu et al. (2023) believe that digital inclusive finance promotes household non-agricultural entrepreneurship to reduce income inequality. On the other hand, income inequality can be indirectly reduced through the "bundling effect" of non-agricultural entrepreneurship and employment increase. He & Li (2019) believe that digital inclusive finance only has an impact on non-agricultural entrepreneurship and survival entrepreneurship. In addition, the research on digital inclusive finance and entrepreneurial activities all measures entrepreneurship from the perspective of new start-ups, and few studies measure entrepreneurship from the perspective of entrepreneurial quality, thus ignoring the issues of "large quantity and low quality" and "catering policy." Lu et al. (2022) found that digital inclusive finance has significantly improved the quality of urban innovation and entrepreneurship, but few literatures discuss the impact of digital inclusive finance on the quality of rural entrepreneurship from the micro level.

Therefore, this paper follows the approach of Li et al. (2009) and defines entrepreneurial activity as the act of founding private enterprises and self-employed individuals. Astebro et al. (2012) believe that the survival activities of entrepreneurship reflect the quality of entrepreneurship. In order to improve the shortcomings of existing research, this paper refers to Chen's (1995) enterprise life cycle theory and Åstebro et al. (2012) and uses the stock of private enterprises and individuals to measure the quality of entrepreneurship.

H2: Digital inclusive finance can achieve income growth by promoting entrepreneurship and business activities of rural households.

3.3 Analysis of digital inclusive finance alleviating rural formal credit constraints

First of all, through its unique advantages and innovative technologies, digital inclusive finance has significantly reduced the formal credit constraints of households, broadened farmers' access to financial services, enhanced their participation in economic activities and profitability, and thus promoted an increase in farmers' income. Specifically, the income-increasing effect of digital inclusive finance comes from mechanisms such as alleviating credit constraints, alleviating information constraints, strengthening social trust, and promoting information sharing (He & Li, 2019; Guo & Yin, 2022). The poverty reduction effect comes from entrepreneurial incentives, credit constraint alleviation, agricultural risk elimination, and other channels (Sun et al., 2020; Meng et al., 2023), indicating that the most basic function of digital inclusive finance is to alleviate the credit constraints of underdeveloped areas, small and medium-sized enterprises, and rural residents.

Secondly, for rural areas, digital inclusive finance expands the financing scale and channels for farmers, promotes farmers' integration into the market, transforms farmers from small producers to rational economic individuals, and promotes the realization of inclusive development and common prosperity (Song Wei, 2022). Digital inclusive finance has weakened the friction in the rural financial market, increased the marginal income of rural investment, and

promoted capital to go to the countryside, thus relaxing the financing constraints of farmers. However, in areas with higher modernization and commercialization of production organizations, the proportion of non-agricultural income is relatively high, and farmers benefit more. Therefore, digital inclusive finance has not solved the problem of difficult and expensive financing for tail farmers but has created a "digital divide" (Xu Yueli and Ji Xiaodan, 2024).

Finally, regarding the theory of household credit constraints, Hayashi (1985) divides credit constraints into advance loan constraints, borrowing scale constraints, and borrowing interest rate constraints. Song Quanyun et al. (2017) believe that household formal credit constraints are divided into two parts: participation decision-making and lending decision-making, that is, deciding whether to borrow from formal channels and deciding the scale of borrowing. At present, the measurement methods of household credit constraints in academic circles are mainly directly measured by questionnaire surveys and indirectly measured by the consequences of credit constraints. Based on the above analysis of credit constraint theory and measurement methods, this paper puts forward the third hypothesis:

H3: Digital inclusive finance can achieve farmers' income growth by alleviating the formal credit constraints of rural households.

3.4 Heterogeneity analysis of digital inclusive finance promoting inclusive growth in urban and rural areas

First of all, digital inclusive finance can increase the income of urban and rural residents, but there are still objections to the impact of digital inclusive finance on income distribution. Liu et al. (2023) claim that digital finance may widen the wage income gap, but Zhang et al. (2022), Lu et al. (2023), and Zhou et al. (2024) believe that digital inclusive finance is of great significance to the inclusive development of urban and rural areas and the realization of common prosperity. In addition, Zhou et al. (2024) found that the synergistic effect of e-commerce and digital finance is conducive to narrowing the income gap between urban and rural areas, especially for rural areas with a low degree of agricultural modernization and a low level of traditional financial development, and is inclusive during the sample period. This inclusiveness gradually improves.

Secondly, the inclusiveness of digital inclusive finance may be affected by the adjustment of the urban-rural gap. The development of rural digital inclusive finance faces multiple challenges from the digital facility gap, the financial ecological gap, and the educational cognition gap (Xing, 2021). Additionally, financial literacy, the neighborhood demonstration effect, and digital infrastructure will affect farmers' response to the development of digital inclusive finance (Zhang et al., 2021; Yin et al., 2023; Zhuang et al., 2024). Furthermore, there may be structural problems in the development of digital finance. The digital divide has caused people with Internet access to crowd out the digital financial resources of people without access, especially the poor (He et al., 2020), and the popularization of Internet access has brought about differences in the use of Internet capital (Qiu et al., 2016). However, Zhang et al. (2021) and Gong et al. (2023) believe that digital inclusive finance can effectively avoid the problem of the "digital divide." Similarly, Zhou et al. (2020) believe that the "digital dividend" is significant in the process of reducing the income gap between urban and rural areas in digital inclusive finance.

In addition, the digital divide may affect the probability of rural household entrepreneurship and the size of credit constraints (Zhang, 2022; Zhao et al., 2023). Therefore, this paper comprehensively considers the above theories and focuses on analyzing the regulating effect of

the "digital divide" on digital inclusive finance, entrepreneurial management, and credit constraints. Based on the above analysis, this paper puts forward the fourth hypothesis:

H4: Digital inclusive finance can narrow the income gap between urban and rural areas, thus achieving inclusive growth; When there are "digital access divide", "digital usage divide" and "digital information divide", digital inclusive finance has heterogeneous effects on entrepreneurial business activities and formal credit constraints.

Based on the above assumptions, the theoretical framework of this paper is proposed, as shown in Figure 2.
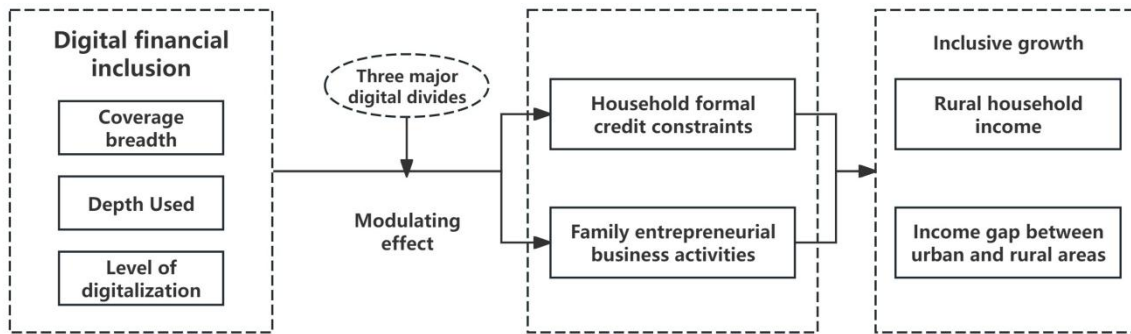

Figure 2 The theoretical framework diagram of this paper

4. Empirical models and data

4.1 Model setting

First, referring to the practices of Zhang et al. (2019; 2021) and Zhou et al. (2020), a total effect model of digital inclusive finance affecting farmers' income is constructed.

$$\ln\left(Inc_{ijt}\right) = \alpha_0 + \alpha_1 DF_{i,t-1} + \alpha_2 X_{ijt} + \phi_j + \varphi_t + \varepsilon_{ijt} \tag{1}$$

In the model, i denotes the province, j denotes the household, and t denotes the year. Inc_{ijt} represents per capita household income, while $DF_{i,t-1}$ represents the development level of digital inclusive finance, including the digital inclusive finance index and its three sub-dimensions[1]. X_{ijt} denotes the control variables, ϕ_j represents household fixed effects, φ_t represents time fixed effects, and ε_{ijt} denotes the residual term. To mitigate potential endogeneity issues between the digital inclusive finance index and household income, this paper lags the digital inclusive finance index by one period. The per capita household income is logarithmically transformed.

$$Ent_t = \beta_0 + \beta_1 DF_{i,t-1} + \beta_2 X_{ijt} + \upsilon_t + \pi_{ijt} \tag{2}$$

Model (1) is used to estimate the overall impact of the development of digital financial inclusion on household income in urban and rural areas. In order to further explore whether digital inclusive finance is conducive to increasing rural household income and narrowing the income gap between urban and rural areas, thereby promoting inclusive growth and common prosperity in rural areas, this paper will discuss the transmission mechanism of digital inclusive finance from the micro level and macro level respectively under the overall framework of Model (1). Secondly, the core content of digital inclusive finance is finance, and its most distinctive feature is inclusiveness. Therefore, through its financial attributes, digital inclusive finance is conducive to encouraging families to start businesses and alleviating credit constraints, thereby increasing the income of rural

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[1] The three sub-dimensions are: coverage breadth, usage depth and digitalization degree

families. In this process, household entrepreneurial behavior and household credit constraints serve as transmission intermediaries for digital inclusive finance to indirectly increase household income. Therefore, this paper will construct an intermediary effect model of digital inclusive finance to increase rural household income. Regarding entrepreneurial activity, this article refers to the practices of Xie et al. (2018) and Tian et al. (2023) to construct a regression model of digital inclusive finance on mechanism variables. Household entrepreneurial behavior is characterized by the Probit binary choice model. Usually, there is a latent variable in the path of families increasing their income through entrepreneurship. When the latent variable is greater than 0, under the influence of digital inclusive finance, rural families can earn income through business activities, thereby narrowing the income gap between urban and rural areas and achieving inclusive growth, so rural families choose to start a business; When this path does not exist when the latent variable is equal to 0, rural families will not choose to start a business. In the past, the classic literature believed that the latent variable could not be directly observed, so the observable family entrepreneurial decision was regarded as the observation value of the latent variable.

Among them, Ent_t indicates the entrepreneurial activity in the first year. Model (2) is used to estimate the overall impact of digital financial inclusion on rural entrepreneurial activity. As the sample size is decreasing year by year, this paper uses rural entrepreneurial activity to represent rural entrepreneurship, and redefines rural entrepreneurship and business activities, that is, the ratio of newly started private enterprises, self-employed households and retained business activities to the sample size of the current year to measure rural entrepreneurial activity in the current year.

Regarding credit constraints, because only households willing to borrow money will face credit constraints, it is often believed that data is intercepted. Therefore, this paper uses the Tobit model with reference to the practice of He & Li (2019). Diagne et al. (2000) proposed to use direct method or indirect method to measure household credit constraints. This paper selects the direct method to measure household credit constraints. This paper directly measures whether households face credit constraints based on the answer in the questionnaire about "whether there is any experience of being rejected for borrowing money". Therefore, referring to the practice of Liu et al. (2021), the Probit binary choice model is used to construct a regression model of digital inclusive finance on mechanism variables. If rural households face formal credit constraints, the indirect impact of digital inclusive finance on rural household income will be reduced; If credit constraints are eased, the indirect impact of digital financial inclusion will expand. Therefore, this paper amplifies the influence of household formality credit constraints on household income by constructing 0-1 dummy variables.

$$FinA_{ijt}^* = \gamma_0 + \gamma_1 DF_{i,t-1} + \gamma_2 X_{ijt} + \rho_t + \tau_{ijt} \tag{3}$$

$$Prob(FinA_{ijt} = 1) = Prob(FinA_{ijt}^* > 0)$$
$$Prob(FinA_{ijt}^* > 0) = \Phi(\gamma_0 + \gamma_1 DF_{i,t-1} + \gamma_2 X_{ijt} + \rho_t) > 0 \tag{4}$$

In this, $FinA_{ijt}$ denotes the formal credit availability in year t for the j-th household in the i-th province. Model (3) is used to estimate the impact of digital inclusive finance on formal credit constraints of rural households, and model (4) describes the credit constraints faced by rural households. It is assumed that there are only two situations of formal credit constraint: complete formal credit constraint and formal credit constraint alleviation, that is, formal credit is completely unavailable ($FinA_{ijt} = 0$) and formal credit is available ($FinA_{ijt} = 1$).

4.2 Data sources

This article refers to the research of Yi & Zhou (2018), Zhang et al. (2019; 2020), He et al. (2020), and Tian et al. (2023), and uses two parts of data in the main return part: the data used in this article comes from the China Digital Inclusive Finance Index, which is jointly compiled by the Peking University Digital Finance Research Center and Ant Financial Group (Guo et al., 2020), and is an authoritative indicator to measure the development level of China's digital inclusive finance. Since the development level of digital inclusive finance lags behind by one period in the previous article, and the industry generally regards the opening of Yu'e Bao in 2013 as the first year of China's digital finance, this article selects samples from 2013, 2015, 2017, and 2019. Another part of the data used in this article comes from the China Family Tracking Survey (CFPS) funded by Peking University and the National Natural Science Foundation of China and conducted by the China Social Science Survey Center of Peking University. The survey is conducted every two years. Since 2022 is the survey data, this article selects survey samples from 2014, 2016, 2018, and 2020 as data. In addition, the data used in the robustness test section of this paper are from the China Macroeconomic Database of the EPS Database.

Figure 3 Development level of digital inclusive finance in China during the sample period from 2013 to 2019

4.3 Variable selection
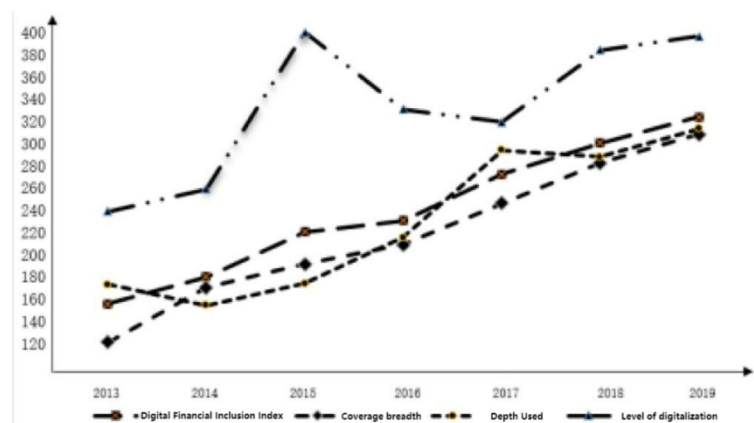
4.3.1 Explained variables

Per capita household income: Considering that there are many missing income data in CFPS personal questionnaire of China Family Tracking Survey, this paper selects per capita household income as the income variable. The per capita income data of households comes directly from the household questionnaire of CFPS, China Household Tracking Survey, including wage income, operating income, property income and transfer payment income, excluding household samples with missing income data.

4.3.2 Explanatory variables

Digital inclusive finance index and its sub-dimensions: The development level of China's digital inclusive finance is directly measured by the China Digital inclusive finance index at the provincial level. In addition, in order to explore the specific impact of digital financial inclusion more deeply, this paper also adds three sub-dimensions of coverage breadth, usage depth and digitalization degree as explanatory variables. Since the digital inclusive finance index and its sub-indicators are hundreds of digits, in order to reduce the estimation bias caused by the too small estimation coefficient, this paper divides the digital inclusive finance and its sub-indicators by 100.

4.3.3 Mediating variables

Entrepreneurial activity: This paper refers to the practices of Zhou et al. (2015), Zhou & Li(2016), and uses dummy variables to describe rural family entrepreneurship. The data of rural household entrepreneurial behavior comes from the household questionnaire of China Family Tracking Survey. Combining the question of "whether anyone is engaged in individual and private activities" in the previous survey year and this survey year, the samples that did not engage in

individual and private activities in the previous survey year but engaged in individual and private activities in this survey year are regarded as starting a business in this survey year, and the Ent_{ijt} assignment of family entrepreneurial behavior is 1. If the entrepreneurial status in the two survey years has not changed above, the Ent_{ijt} assignment is 0.

4.3.4 Adjusting variables

Academic circles generally believe that there are at least two digital divides in today's society, namely the "access divide" and the "usage divide" (Qiu et al., 2016; Cheng & Zhang , 2019; He et al., 2020), and some scholars believe that there is a third digital divide caused by Internet information constraints (He & Li, 2019; Zhao et al., 2023), namely the "information divide". Therefore, this paper uses three dimensions: "access gap", "usage gap" and "information gap" to measure the digital divide. Digital access gap: Referring to the method of He et al. (2020), if the answer to "whether to surf the Internet" in the personal questionnaire is "yes", the "access gap" variable is assigned to 1, otherwise it is assigned to 0.

Digital usage divide: Referring to the method of Zhao et al. (2023), the question about "the importance of conducting Internet business activities" 2 answer, assigned 1-5 according to the degree of importance, is used to measure an individual's ability to use the Internet. That is, "usage ditch", the higher the frequency of Internet business activities, the stronger the ability to use the Internet.

Digital information divide: Referring to Zhao et al. (2023) 's research on information constraints, "the importance of Internet information channels"3 answers, assigned values of 1-5 according to the degree of importance, are used to measure the Internet information constraints faced by individuals. That is, the "information ditch".

4.3.5 Controlled variables

In the main regression analysis at the micro level, referring to the method of He Zongyue et al. (2020), this paper chooses to control the characteristics of the head of household and the household level. At the level of head of household, this paper controls the age, gender, years of education, political outlook, marital status, health status and mobile phone usage of head of household. At the family level, this paper controls the family size, the proportion of children (under 16 years old) and the proportion of the elderly (over 60 years old). Since the sex, years of education and other characteristics of the head of household hardly change with time, and the age of the head of household can be regarded as a linear combination of the fixed effect of household and the fixed effect of time, the coefficient cannot be estimated, so refer to the method of Zhang et al. (2017) and Zhang et al. (2019) to control the square term of the age of the head of household.

Table 1 Descriptive statistics

Variables		Urban			Villages		
		Sample size	Mean value	Variance	Sample size	Mean value	Variance
Explained variable	Gross household income per capita (logarithmic)	12375	10.084	0.955	28171	9.189	1.11
Explanatory variables	Digital Financial Inclusion Index (divided by 100)	12375	2.446	0.69	28171	2.293	0.644
	Coverage breadth (divided by 100)	12375	2.172	0.739	28171	2.02	0.705

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2 the importance of Internet business activities: 1 means very unimportant, 5 means very important, and if there is no access, it is assigned 0.

3 the importance of Internet information channels: 1 means very unimportant, 5 means very important, and if there is no access, it is assigned 0.

	Depth used (divided by 100)	12375	2.465	0.806	28171	2.236	0.73
	Degree of digitalization (divided by 100)	12375	3.318	0.711	28171	3.295	0.685
Mediating variables	Entrepreneurial business activity	12375	0.062	0.025	28171	0.062	0.025
	Formal credit availability (available = 1)	12375	0.72	0.449	28171	0.769	0.421
Adjusting variables	Access to the Internet (Access = 1)	12375	0.522	0.5	28171	0.31	0.462
	Importance of Internet Business Activities	12375	1.202	1.806	28171	0.681	1.491
	Degree of Internet information dependence	12375	2.714	1.69	28171	2.205	1.561
Controlled variables	Age of head of household (quadratic)	12375	3074.6	1612.1	28171	2776.8	1448.8
	Gender of head of household (male = 1)	12375	0.49	0.5	28171	0.544	0.498
	Years of education of head of household	12375	10.053	4.587	28171	6.507	4.314
	Whether the head of household is a member of the Communist Party (Yes = 1)	12375	0.104	0.305	28171	0.038	0.19
	Marital status of head of household (with spouse = 1)	12375	0.806	0.396	28171	0.85	0.358
	Health status of head of household (health = 1)	12375	0.671	0.47	28171	0.639	0.48
	Does the head of the household use a mobile phone	12375	0.863	0.344	28171	0.832	0.374
	Household size	12375	3.299	1.637	28171	3.969	1.959
	Proportion of children in households	12375	0	0.018	28171	0	0.009
	Proportion of elderly people in households	12375	0.169	0.271	28171	0.122	0.239

5. Analysis of empirical results

5.1 Benchmark regression results

According to the urban-rural classification of the sample, the model was subjected to least squares OLS regression, and the digital inclusive finance index was lagged by one period, and the household fixed effect and time fixed effect were added to miscluster the robust standard to the district and county level. The results of the benchmark regression are reported in Table 3.4

The first and third columns of Table 3 report the regression results of uncontrolled household head and household characteristics, unadded household fixed effect and time fixed effect respectively. The second and fourth columns of Table 3 report the regression results with the addition of control variables and two-way fixed effects. The results show that digital inclusive finance has a significant improvement effect on the per capita income of rural households, with an

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4   All regression results are shown in Attachment 3

impact coefficient of 0.238, but has no significant impact on the per capita income of urban households, with a coefficient of 0.180. Therefore, digital inclusive finance has a greater role in promoting rural household income, verifying the hypothesis that digital inclusive finance improves rural household income and promotes inclusive growth. Of course, Hypothesis 4 still needs to be further explored and tested, and this part will be shown below.

Table 2 Digital Inclusive Financial Development and Urban and Rural Household Income: A Benchmark Analysis

	Per capita income of rural households		Per capita income of urban households	
	(1)	(2)	(3)	(4)
Digital financial inclusion	0.337** (0.136)	0.238* (0.134)	0.235** (0.112)	0.180 (0.109)
Controlled household head characteristics	No	Yes	No	Yes
Controlling household characteristics	No	Yes	No	Yes
Family fixation effect	Controlled	Controlled	Controlled	Controlled
Time-fixed effect	Controlled	Controlled	Controlled	Controlled
Observations	26186	26186	10621	10579
Adjusted R^2	0.479	0.488	0.591	0.600

In order to clarify the specific impact of digital inclusive finance on household income, this article will cover the breadth, depth of use and degree of digitalization lagging behind by one period, and repeat the least squares regression of the model. Table 4 reports the benchmark regression results for the three sub-dimensions.

Control variables and two-way fixed effects were added to this regression. The results show that both the breadth of coverage and the depth of use have a significant promotion effect on the income increase, while the degree of digitalization has an insignificant negative impact on the income of urban and rural households. Furthermore, the breadth of coverage and the depth of use have a greater impact coefficient on rural household income, which is also in line with the assumption that digital inclusive finance promotes inclusive growth. The reason why the degree of digitalization shows no significant negative impact may be due to the limitations of friction costs and technology popularization in the early stage of digital transformation, which cannot benefit most users and limits the inclusive potential. Although the improvement of the level of digitalization faces technical and operational challenges, and its direct contribution to the growth of total revenue is not yet obvious, with the continuous maturity of technology and the deepening of application, the level of digitalization is expected to play a more active role in promoting inclusive growth in the future. role.

Table 3 Sub-dimensions of digital financial inclusion and urban and rural household income: A benchmark analysis

	Per capita income of rural households			Per capita income of urban households		
	(1)	(2)	(3)	(4)	(5)	(6)

	0.3740** (0.158)			0.3350** (0.135)		
Coverage breadth	0.3740** (0.158)			0.3350** (0.135)		
Depth Used		0.2190*** (0.083)			0.1780** (0.085)	
Level of digitalization			-0.0639 (0.064)			-0.0370 (0.047)
Controlled household head characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Controlling household characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Family fixation effect	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Time-fixed effect	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Observations	26186	26186	26186	10579	10579	10579
Adjusted R^2	0.488	0.488	0.488	0.600	0.600	0.600

5.2 Analysis of conduction mechanism

The previous article verified the impact of digital inclusive finance on inclusive growth. The following will analyze the micro-transmission mechanism of digital inclusive finance to promote income increase and inclusive growth.

5.2.1 Intermediary analysis of entrepreneurial management

Firstly, according to the method of variable explanation, this paper calculates the activity of rural entrepreneurship in each survey year. Then, according to the model, the least squares regression is carried out on the overall effect of digital inclusive finance in stimulating rural entrepreneurship. Table 4 reports the regression results of digital inclusive finance and rural entrepreneurial business activity. The results show that digital inclusive finance has a significant positive impact on the activity of rural entrepreneurship. Specifically, the regression coefficient between digital inclusive finance and rural entrepreneurial activity has passed the significance level of 1%, indicating that with the development of digital inclusive finance, entrepreneurial activity in rural areas has increased, which verifies the positive effect of encouraging rural entrepreneurial operations. Furthermore, Table 4 also reports the impact of different sub-dimensions of digital inclusive finance on rural entrepreneurial business activities, and the coefficient is also significantly positive, further confirming the role of digital inclusive finance in promoting rural entrepreneurial business activities. Among them, the coefficients of coverage breadth and use depth are larger, indicating that these two dimensions may be more important in promoting rural entrepreneurship.

Table 4 Digital inclusive finance and rural entrepreneurial business activity: An analysis of mediating effects

	Activity of rural entrepreneurship and management			
	(1)	(2)	(3)	(4)

	(1)	(2)	(3)	(4)
Digital financial inclusion	0.0397*** (0.000)			
Coverage breadth		0.0361*** (0.000)		
Depth Used			0.0325*** (0.000)	
Level of digitalization				0.0198*** (0.001)
Variable control	Controlled	Controlled	Controlled	Controlled
Fixed effects	Controlled	Controlled	Controlled	Controlled
Observations	26186	26186	26186	26186
Adjusted R^2	0.984	0.987	0.753	0.335

5.2.2 Intermediary analysis of access to credit

According to model (3), the mediation effect of digital inclusive finance on alleviating the formal credit constraints of rural households is regressed, and the results are shown in Table 5. The results show that the regression coefficient of digital inclusive finance to formal credit of rural households is significantly positive, indicating that with the development of digital inclusive finance, the formal credit constraints of rural households have been alleviated. Further, the regression coefficients of coverage breadth and depth of use are significantly positive, while the regression coefficients of digitization degree are significantly negative. The breadth of coverage enhances the accessibility of digital inclusive finance, and the depth of use promotes the availability of formal credit by meeting the diversified needs of farmers and improving the efficiency of capital allocation; The increase in digitalization has instead reduced the availability of formal credit for rural households. The reason may be that although the increase of digitalization has reduced the demand for formal credit, digital technology has reduced information asymmetry, lowered the threshold of financial services, and improved the efficiency of capital flows, which has stimulated the demand for informal credit in rural areas more (Fu & Huang, 2018), thus showing that the degree of digitalization has reduced the availability of formal credit for rural households.

Table 5 Digital Financial Inclusion and Formal Credit Availability for Rural Households: An Analysis of Mediation Effects

	Formal credit availability for rural households			
	(1)	(2)	(3)	(4)
Digital financial inclusion	0.709*** (0.059)			
Coverage breadth		0.728*** (0.059)		
Depth Used			0.475*** (0.036)	

					-0.368*** (0.062)
Level of digitalization					
Variable control	Controlled	Controlled	Controlled	Controlled	
Fixed effects	Controlled	Controlled	Controlled	Controlled	
Adjusted R²	28161	28161	28161	28161	

5.2.3 Literature method explanation of mediation effect

Considering that there may be potential variables in the survey data that affect the development of digital inclusive finance, entrepreneurial decision-making and credit constraints at the same time are omitted, which leads to errors in the estimation of the coefficient of household per capita income to the regression of mediation variables, and the traditional mediation effect test[5] has obvious defects (Jiang Ting, 2022), so this paper only tests the model and model, and the remaining mediation effect mechanism is explained by literature method.

Digital inclusive finance promotes rural families' entrepreneurial activities and formal credit constraints, and shows a decreasing trend in three dimensions: coverage breadth, use depth and digitalization degree. On the one hand, digital inclusive finance can promote inclusive growth by increasing the activity of rural entrepreneurship. Jiang et al. (2023) believe that digital inclusive finance can accurately optimize rural credit, allow groups with low income and low credit risks to enjoy financial services equally, increase their development opportunities, alleviate the inequality between the rich and the poor in rural areas, and reduce the Thiel index of urban-rural gap. To sum up, digital inclusive finance has formed an effective intermediary effect by alleviating the formal credit constraints of households and promoting entrepreneurial behavior, and ultimately promoted inclusive growth that increased farmers' income and narrowed the gap between urban and rural areas.

5.3 Test of moderating effect

Considering the existence of the digital divide, digital inclusive finance may have a heterogeneous impact on household entrepreneurship and credit constraints. This article refers to the research of Wen Zhonglin et al. (2005, 2006), Jiang Ting (2022) and Yin Ximing et al. (2023), adding the moderating variable Z_{ijt} on the basis of the mediation effect model to test whether the digital divide will affect the entrepreneurial activity and formal credit constraints of rural households. Among them, Z_{ijt} represents the digital access divide, digital usage divide and digital

$$Ent_t = \beta_0' + \beta_1' DF_{i,t-1} + \beta_2' Z_{ijt} + \beta_3' DF_{i,t-1} * Z_{ijt} + \beta_4' X_{ijt} + \upsilon_t + \pi_{ijt} \tag{6}$$

$$FinA_{ijt}^* = \gamma_0' + \gamma_1' DF_{i,t-1} + \gamma_2' Z_{ijt} + \gamma_3' DF_{i,t-1} * Z_{ijt} + \gamma_4' X_{ijt} + \rho_t + \tau_{ijt} \tag{7}$$

$$Prob(FinA_{ijt} = 1) = Prob(FinA_{ijt}^* > 0);$$
$$Prob(FinA_{ijt}^* > 0) = \Phi(\gamma_0' + \gamma_1' DF_{i,t-1} + \gamma_2' Z_{ijt} + \gamma_3' DF_{i,t-1} * Z_{ijt} + \gamma_4' X_{ijt} + \rho_t) \tag{8}$$

information divide of the digital divide.

According to models (5) (6) (7), moderated mediation effect regression is carried out to explore the group differences caused by digital divide (i.e. digital access gap, digital usage gap and digital information gap). Table 6 reports the results of the heterogeneity test of digital inclusive finance on rural entrepreneurial operations and formal credit.

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[5] Stepwise method test

Table 6 Digital financial inclusion and the urban-rural income gap: An analysis of moderating effects

	Entrepreneurial activity			Credit Availability		
	(1)	(2)	(3)	(4)	(5)	(6)
Digital financial inclusion	0.0391*** (0.000)	0.0393*** (0.000)	0.0393*** (0.000)	0.7570*** (0.043)	0.7380*** (0.043)	0.8150*** (0.047)
Access trench	-0.0013*** (0.000)			0.5380*** (0.081)		
Digital financial inclusion×Access trench	0.0010*** (0.000)			-0.2800*** (0.033)		
Use ditch		0.0012*** (0.000)			0.1440*** (0.031)	
Digital financial inclusion×Use ditch		0.0010*** (0.000)			-0.0737*** (0.011)	
Information ditch			0.0012*** (0.000)			0.1150*** (0.023)
Digital financial inclusion×Information ditch			-0.0002*** (0.000)			-0.0716*** (0.009)
Controlled household head characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Controlling household characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Family fixation effect	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Time-fixed effect	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Observations	26186	26186	26186	28161	28161	28161
Adjusted R^2	0.984	0.985	0.984	-	-	-

5.3.1 The moderating effect of digital divide on entrepreneurial incentives

Table 6 shows that the interaction term coefficients between digital inclusive finance and access gap and usage gap are significantly positive, indicating that when the access gap and usage gap shrink, that is, farmers have Internet access equipment, access to the Internet, and have frequent Internet business activities. When digital literacy, digital inclusive finance will significantly promote rural entrepreneurial activities and business activities. To a certain extent, this amplifies the "digital dividend" brought by accessing the Internet and conducting Internet business activities. However, the interaction term coefficient between digital inclusive finance and information gap is significantly negative at the level of 1%, which indicates that alleviating information constraints itself has a positive impact on entrepreneurial enthusiasm, and when information constraints are reduced, the "dividend" of information gap will also be reduced, so the incentive effect on rural entrepreneurship and management will also be greatly reduced.

From the test results of the moderating effect between the three sub-dimensions of digital inclusive finance (coverage breadth, usage depth and digitalization degree) and entrepreneurial activity [limited by the length of the article, the regression results of this part of the moderating effect are detailed in Annex 3], it is found that: The coverage breadth and usage depth in digital

inclusive finance can better encourage farmers with less access to the Internet and information constraints to start businesses and operate, while the degree of digitalization has stronger incentives for farmers with higher digital usage ability.

5.3.2 The moderating effect of the digital divide on credit availability

It can be seen from Table 6 that the interaction terms between digital inclusive finance and access gap, use gap and information gap are significantly negative at the level of 1%, that is, the narrowing of the "digital divide" (access gap, use ability differences and information constraints) among rural households has inhibited rural households from using digital inclusive finance to obtain formal credit. Combined with the research of Fu & Huang(2018), the reason may be that the narrowing of the digital divide has reduced the demand for productive formal credit in rural areas, and the reduced availability of formal credit may only be the result of the influence of the "digital divide".

From the results of the moderating effect test between the three sub-dimensions of digital inclusion finance and credit availability, it is found that when the "digital divide" narrows, the positive impact of the coverage breadth of digital inclusion finance on formal credit availability may be weakened, the positive impact of the depth of use on formal credit availability may be enhanced, and the impact of the degree of digitalization on formal credit availability may be slightly weakened.

6. Conclusion and enlightenment

Based on the perspective of inclusive development, combined with the microdata of China's digital inclusive finance index and China's household tracking survey, this paper constructs an econometric model of digital inclusive finance to increase urban and rural income and adds control variables and two-way fixed effects. Furthermore, it adds a mediation effect model to the transmission mechanism analysis and a moderation effect model to the heterogeneity analysis. The findings are as follows: First, digital inclusive finance directly increases rural household income and narrows the income gap between urban and rural areas; second, digital inclusive finance indirectly increases rural household income by encouraging rural household entrepreneurial activities and alleviating rural household formal credit constraints; third, rural households with access to the Internet, a strong ability to use smart devices, and easy access to Internet information will benefit more from the development of digital inclusive finance; fourth, despite the heterogeneity of impacts, digital financial inclusion in general still promotes inclusive growth without deviating from its theme of inclusiveness; fifth, strengthening digital construction in rural areas can make digital inclusive finance more inclusive. Therefore, in order to give full play to the advantages of "opening up the last mile" of digital inclusive finance, this paper puts forward the following suggestions: First, improve the digital infrastructure construction in rural and underdeveloped areas and increase the penetration rate and coverage of the Internet to enhance the geographical accessibility of digital inclusive finance, so that more rural families can enjoy the convenience and benefits brought by digital inclusive finance; second, strengthen digital literacy training for rural families, improve their ability to use digital devices and obtain Internet information, help them make better use of digital inclusive finance resources, and improve their income level and quality of life; third, break the Internet information constraints in rural areas, promote the equalization of urban and rural information availability through policy guidance and market mechanisms, reduce information asymmetry, and create a fairer and more transparent market environment for rural families.

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