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Does Digital Inclusive Finance Promote the Growth of Entrepreneurial Farmers' Income? Evidence from the China Family Panel Studies

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Abstract

This study examines the impact of digital financial inclusion on the income of entrepreneurial farmers based on data from the China Family Panel Studies and Peking University Digital Inclusive Finance Index. It also explores the role of industrial structure optimization in the relationship between digital inclusive finance and entrepreneurial farmers' income. The results indicate that digital inclusive finance has a significantly positive impact on the income of entrepreneurial farmers. The industrial structure optimization plays a mediating role in the process of digital inclusive finance increasing the income of entrepreneurial farmers. Infrastructure construction can significantly enhance the impact of digital inclusive finance on the income of entrepreneurial farmers. Based on the findings of the study, this paper puts forward policy insights: accelerating the development of digital inclusive finance, continuing to promote the structural adjustment and optimization and upgrading of rural industries, and strengthening and improving the construction of infrastructure in rural areas.

Keywords

Digital Inclusive Finance, Entrepreneurial Farmers' Income, Industrial Structure Optimization

1. Introduction

Entrepreneurial farmers play a crucial role in rural development by leading the cultivation of agriculture and rural areas. However, their production and operations in China still have inefficiencies and weaknesses. Many entrepreneurial farmers have low levels of financial literacy, lack capital, and face difficulties in

financing, thus resulting in the high risk and weak sustainability of their businesses. This circumstance often leads to a small increase in income from entrepreneurship. Digital inclusive finance is a stage in the development of financial services that uses digital technology to provide universal, accessible, and cost-effective solutions with high efficiency. In rural areas, inclusive digital finance offers convenient start-up funds for aspiring entrepreneurial farmers and encourages them to start businesses. It also provides funds for established farmers to expand their businesses, thus alleviating financing constraints faced by entrepreneurial farmers in the process.

Previous research has concentrated on the function of digital inclusive finance in increasing the income of ordinary farmers. Digital inclusive finance has a substantial positive impact on farmers' income, reduces the probability of farmers' relative poverty, and has a pronounced effect on the earnings of low-income groups (Guo et al., 2023). Moreover, it has the greatest impact on farmers' wage income, followed by production income, property income, and transfer income (Yu & Wang, 2021). Additionally, digital inclusive finance can significantly and steadily alleviate relative poverty by improving credit availability and promoting household entrepreneurship (Xie et al., 2023). However, insufficient research has been conducted on the impact of digital inclusive finance on the income of farmers who have already engaged in entrepreneurial activities.

This study aims to answer the question of whether digital inclusive finance can increase the income of farmers who have started their own businesses and how to achieve sustained income. The research focuses on the income of entrepreneurial farmers and analyzes the direct and indirect impact of digital inclusive finance on their income. The contributions of this study are as follows. First, it takes the entrepreneurial farmers as the research object to study the impact of digital inclusive finance on their income. Second, the mediating effect of industrial structure optimization variables and the moderating effect of infrastructure development are explored to further analyze the indirect impact of digital financial inclusion on entrepreneurial farmers' income. This work aims to provide policy references for advancing the effective service of digital inclusive finance to entrepreneurial farmers.

2. Hypothesis Development

2.1. Direct Impact

The impact of digital inclusive finance on the income of entrepreneurial farmers is mainly reflected in the following aspects. First, it reduces the initial funding threshold for farmers' entrepreneurship (Fan & Chen, 2022). Traditional agricultural management has a long cycle, high risk, and slow capital return. As a result, new entrepreneurial farmers often lack experience, and financial institutions are often reluctant to lend to them. Although many farmers who are starting their own businesses have a certain amount of capital, their own funds are often insufficient to meet the demand in the early stages of entrepreneurship. As a result,

they need loans to address the shortage of business funds. Digital inclusive finance can solve the difficult financing, expensive financing, and slow financing of entrepreneurial farmers with the characteristics of inclusiveness, low cost, and high efficiency (Bu, 2023). Hence, entrepreneurial farmers can easily and quickly obtain funds and ensure that enterprises can start operations in time, thus increasing the income of entrepreneurial farmers. Second, digital inclusive finance improves the timeliness of information transmission and reduces the degree of information asymmetry between entrepreneurial farmers and the market (Zhang & Zhuang, 2022). Entrepreneurial farmers can acquire market information in a timely and effective manner. They can then adjust their business strategies accordingly, thus enabling them to stay updated with the trends, remain stable, develop steadily, and achieve sustained income growth in the competitive market. Third, digital inclusive finance can utilize digital technology to monitor enterprise operations in real time, thereby ensuring that inputs and outputs are at a reasonable level and continuously improving entrepreneurial performance (Li & Pang, 2023). This advantage can assist entrepreneurial farmers in reducing business risks. Finally, during the growth stage, digital inclusive finance can provide funds for entrepreneurial farmers to expand their business scale. This support creates a cycle of venture capital for farmers, thus leading to sustainable growth in their income. Based on the above direct effects, the following research hypotheses are proposed:

Hypothesis 1. Digital inclusive finance can promote the increase of entrepreneurial farmers' income.

2.2. Impact of Intermediary Effects

Academics generally accept that industrial structure optimization can be divided into two dimensions: rationalization and upgrading. Rationalization of industrial structure mainly measures the efficiency of resource factor allocation, focusing on the allocation of resources among the three types of industries, reflecting the coupling of factor inputs and outputs as well as inter-industry collaboration, that is to say, it is a measure of the degree of coupling of factor input and output structures (Gan et al., 2011). Digital inclusive finance can provide timely and effective digital financial services for the development of the agricultural industry with its technological advantages, which can quickly and accurately match the different needs of the agricultural industry, improve the resource allocation efficiency (Hong, et al., 2022), and manage the allocation of elements in the industrial structure at a reasonable level. Furthermore, digital inclusive finance can effectively alleviate information asymmetry, reduce transaction costs, and adjust the optimal amount of factor inputs for industrial development by using the capital accumulation effect and technological innovation. As such, it enhances the resource allocation efficiency of the financial system and promotes the streamlined industrial structure. Influenced by digital inclusive finance, entrepreneurial farmers in disadvantaged market positions can obtain the necessary funds for production and operation, access market information fairly and effectively, and optimize input

elements. This support leads to continuous improvement in business performance and sustainable income growth. Industrial structure upgrading refers to the improvement of industrial efficiency and the increase of the share of high-efficiency industries, which is typically characterized by the tendency of the economic structure to be service-oriented (Gan et al., 2011), i.e., the tertiary industry grows faster than the secondary industry (Ren et al., 2023). On the one hand, digital inclusive finance can stimulate the growth and upgrading of residents' consumption with convenient and low-cost financial services, thus forcing the transformation and upgrading of the industrial structure and helping the upgrading and development of the agricultural industry. On the other hand, digital inclusive finance encourages entrepreneurial farmers to engage in technological innovation activities by increasing their investment scale (Chava et al., 2013). This move accelerates the upgrading of agricultural technology and the development of industrial integration, thus enhancing the benefits for entrepreneurial farmers. Entrepreneurial farmers have greater opportunities for innovation and development in optimized and upgraded industries. This advantage promotes sustainable enterprise development and increases income growth sustainability. Based on the above direct effects, the following research hypotheses are proposed:

Hypothesis 2. Industrial structure optimization (industrial structure rationalization and upgrading) plays a mediating role in the process of digital inclusive finance promoting the income increase of entrepreneurial farmers.

2.3. Moderating Effect Impact

Rural infrastructure is a necessary condition for rural production and farmers' lives; improving and upgrading the level of rural infrastructure and accelerating the pace of modernization are the objective basis for increasing the income of entrepreneurial farmers. The impact of digital inclusive finance on increasing the income of entrepreneurial farmers will vary depending on the degree of improvement of infrastructure construction. Rural infrastructure mainly includes road transportation, communication networks, etc., as well as related supporting facilities and service facilities. On the one hand, a perfect transportation infrastructure can enhance the breadth of coverage of digital inclusive finance, and play a fundamental and guaranteed role in digital inclusive finance to promote the income increase of entrepreneurial farmers. Perfect transportation infrastructure can promote the full flow of commodities and factors (Yang, 2023), increase the economic vitality of the entrepreneurial enterprises of farmers (Chen et al., 2021), and make the exchanges between the rural enterprises and the various industries in other regions closer, so as to improve the business performance of the entrepreneurial enterprises of farmers and increase the income of entrepreneurial farmers. The improvement of transportation infrastructure helps the application of digital inclusive finance to promote, therefore, for the areas with more perfect transportation infrastructure, the implementation of digital inclusive finance is more efficient, and the effect of increasing the income of entrepreneurial farmers is more

obvious. On the other hand, the role of digital inclusive finance in increasing the income of entrepreneurial farmers is also affected by digital infrastructure. The development of digital infrastructure is a prerequisite for the role of digital inclusive finance in rural areas (Zhao & Wu, 2023), which helps to promote the digitization process in rural areas and enhances the efficiency of the role of digital inclusive finance in increasing the income of entrepreneurial farmers. The development of digital infrastructure facilitates the rapid promotion of digital inclusive finance in rural areas, so that inclusive finance is combined with the Internet, cloud computing and other information network technologies, breaking the spatial limitations of financial entity outlets and services (Xu et al., 2023), improving the efficiency of financial services in the rural market and the efficiency of the use of funds, so that the entrepreneurial farmers can obtain the funds required for production and operation at a lower cost and at a faster speed, promoting the normal operation of their entrepreneurial enterprises, thus realizing the sustained growth of entrepreneurial farmers' incomes. Therefore, for the role of digital inclusive finance in increasing the income of entrepreneurial farmers, the implementation effect is relatively stronger in regions with more complete digital infrastructure construction. On this basis, this paper proposes hypothesis H3:

Hypothesis H3. Infrastructure construction (transportation infrastructure construction and digital infrastructure construction) plays a moderating role in the process of digital inclusive finance to promote entrepreneurial farmers' income growth.

3. Research Design

3.1. Data and Data Sources

The data in this study have been sourced from the China Family Panel Studies (CFPS), the Peking University Digital Inclusive Finance Index, the China Statistical Yearbook, and provincial statistical yearbooks. Using the 2020 CFPS data, this study matches the family economic database with the adult database to obtain a sample of 478 entrepreneurial farmers. The sample excludes irrelevant household data on urban households, household data on non-entrepreneurial farmers, and household data with missing values of the variables.

3.2. Variable Selection

3.2.1. Explained Variable: Entrepreneurial Farmers' Income

This research measures the income of entrepreneurial farmers by using the logarithm of their per capita income. The per capita income of entrepreneurial farmers is calculated as the ratio of their total household income to their family scale.

3.2.2. Explanatory Variable: Digital Inclusive Finance

The Peking University Digital Inclusive Finance Index is highly regarded among academics. This study utilizes the index to measure the level of digital inclusive finance.

3.2.3. Mediating Variable: Industrial Structure Optimization

Industrial structure optimization comprises two indicators: rationalization and upgrading. Industrial structure upgrading is calculated as the logarithm of the ratio of tertiary and secondary industry output (Gan et al., 2011). Industrial structure rationalization is calculated as the inverse of the TL index (Gan et al., 2011). This index is calculated as follows:

$$TL_i = \sum_{i=1}^{3}\left(\frac{Y_i}{Y}\right) \times \ln\left(\frac{Y_i}{L_i} \Big/ \frac{Y}{L}\right), \tag{1}$$

where Y represents the annual GDP of the primary, secondary, and tertiary industry. In addition, Y_i represents the GDP of industry i in the current year, L represents the total employment of the primary, secondary, and tertiary industry in the current year, and L_i represents the employment of industry i in the current year.

3.2.4. Moderator Variable

Level of infrastructure. The level of infrastructure can be measured in terms of both the level of transportation infrastructure and the level of digital infrastructure. The most dominant form of transportation bearer in China is highway. In this paper, we draw on Chen et al. (2021) and use the number of road miles per square kilometer to measure the level of transportation infrastructure. Whether the digital infrastructure of a region is sound directly affects whether the residents of the region can enjoy digital technology services at a reasonable price, and the cell phone penetration rate can better reflect the soundness of the digital infrastructure of the region. Therefore, this paper draws on Chen and Wang (2022) to measure the level of digital infrastructure by cell phone penetration.

3.2.5. Control Variable

This study has selected seven control variables from two aspects: the characteristics of the householder and the characteristics of the family. The householder characteristics include age, marital status, health status, and political background of the householder. These variables are used to control the impact of micro-individual characteristics on household income status. Family characteristic variables, such as family scale, family property, and family financial assets, are used to control for the effect of the farmer's family characteristics on income status. Specific variable definitions and descriptive statistics are shown in **Table 1** and **Table 2**.

3.3. Model Building

To identify the impact of digital inclusive finance on entrepreneurial farmers' income, the following econometric Model (2) is constructed:

$$Y_i = \alpha_1 + \beta_1 X_i + \gamma_1 Z_i + \varepsilon_{1i} \tag{2}$$

To explore the mediating effect of industrial structure optimization, we refer to the method of Wen and Ye (2014) and construct three models, as shown in Equations (3)-(5).

Table 1. Variable definition table.

Variable Type	Variable Name	Variable Symbol	Variable Definition
Explained Variable	Entrepreneurial Farmers' Income	EFI	Log of per capita household income of entrepreneurial farmers
Explanatory Variable	Digital Inclusive Finance Index	DIFI	Peking University Digital Inclusive Finance Index
	Breadth of Coverage	BC	Coverage breadth of digital inclusive finance
	Depth of Use	DU	Depth of use of digital inclusive finance
	Degree of Digitization	DD	Digital Inclusive Finance Digitization Level
Mediating Variable	Industrial Structure Upgrading	ISU	Logarithm of the ratio of tertiary and secondary industry output
	Industrial Structure Rationalization	ISR	Inverse of the TL index
Moderator Variable	Level of Transportation Infrastructure	LTI	Miles of road per square kilometer
	Level of Digital Infrastructure	LDI	Cell phone penetration rate (number of cell phones per 100 people, in units of units/100 people)
Control Variable	Age	AGE	Age of the householder in the current year
	Marital Status	MS	Marital status of householder in the current year: 1 for married; 0 for other
	Health Status	HS	Health status of householder in the current year: 1 for healthy; 0 for other
	Political Background	PB	Political background of householder in the current year: 1 for members of CPC; 0 for other
	Family Scale	FS	The number of family members in the current year
	Family Property	FP	Logarithm of total family property value
	Family Financial Assets	FFA	Logarithm of total family financial assets

Table 2. Descriptive statistical analysis.

Variable	N	mean	std	Min	Max
EFI	478	9.80	1.21	0	12.83
DIFI	478	4.65	0.10	4.38	4.89
BC	478	4.52	0.08	4.32	4.73
DU	478	4.82	0.17	4.39	5.22
DD	478	4.72	0.07	4.51	4.88
AGE	478	45.02	11.36	20	79
MS	478	0.92	0.27	0	1
HS	478	0.80	0.40	0	1
PB	478	0.01	0.09	0	1
FS	478	4.57	1.96	1	13
FP	478	11.26	4.65	0	16.81
FFA	478	8.42	4.79	0	16.17

$$Y_i = \alpha_1 + \beta_1 X_i + \gamma_1 Z_i + \varepsilon_{1i} \quad (3)$$

$$M_i = \alpha_2 + \beta_2 X_i + \gamma_2 Z_i + \varepsilon_{2i} \quad (4)$$

$$Y_i = \alpha_3 + \lambda M_i + \beta_3 X_i + \gamma_3 Z_i + \varepsilon_{3i} \quad (5)$$

Based on the Model (1) equation, this paper introduces an interaction term to explore the moderating role of the level of infrastructure:

$$Y_i = \alpha_4 + \theta N_i + \beta_4 X_i + \mu N_i * X_i + \gamma_4 Z_i + \varepsilon_{4i} \quad (6)$$

where Y_i represents entrepreneurial farmers' income, X_i represents digital inclusive finance, N_i represents the moderator variable, Z_i represents the control variables, and M_i represents industrial structure optimization.

α_1, α_2, α_3, α_4, β_1, β_2, β_3, β_4, γ_1, γ_2, γ_3, γ_4, and λ, θ, μ represent the parameters to be estimated. ε_{1i}, ε_{2i}, ε_{3i} and ε_{4i} represent the residual term.

4. Empirical Analysis

4.1. Baseline Regression

Based on Model (2), we use OLS regression to test the impact of digital inclusive finance on the entrepreneurial farmers' income. The regression results are shown in Table 3. Column (1) reflects the positive contribution of digital inclusive finance to the growth of entrepreneurial farmers' income. Column (2) controls for seven control variables. The results continue to show that digital inclusive finance significantly contributes to the growth of entrepreneurial farmers' income. Columns (3)-(4) examine the impact of the three sub-dimensions of digital inclusive finance, namely, breadth of coverage, depth of use, and degree of digitization, on the entrepreneurial farmers' income. According to the regression results, the breadth of coverage, depth of use, and degree of digitization of digital inclusive finance are significant at the 1% level in promoting the entrepreneurial farmers' income. A comparison of their regression coefficients shows that breadth of coverage has the highest impact, depth of digitization is the second highest, and depth of use is the lowest. Hypothesis 1 is verified.

4.2. Endogeneity Test

Although part of the problem of endogeneity is weakened with the addition of control variables, it does not solve the problem of endogeneity arising from reverse causation and omitted variables; therefore, this paper will construct instrumental variables for two-stage least squares estimation. First, the research of Guo et al. (2017) shows that although digital inclusive finance uses the network as a carrier, its development level is still affected by geography and space and exhibits the characteristic that the further it is from Hangzhou, the more difficult it is to advance. Therefore, the first instrumental variable selected in this paper is "the distance between the provincial capital of the province where the entrepreneurial farmers are located and Hangzhou", which includes "the straight-line distance from the provincial capital to Hangzhou" and "the spherical distance from the provincial capital to Hangzhou". Secondly, Ren and Liu (2021) argued that, as the

Table 3. Baseline regression of digital inclusive finance on entrepreneurial farmers' income.

Variable	(1)	(2)	(3)	(4)	(5)
DIFI	3.600***	2.534***			
	(6.77)	(5.09)			
BC			2.473***		
			(3.56)		
DU				1.571***	
				(5.57)	
DD					2.313***
					(3.00)
AGE		−0.019***	−0.019***	−0.019***	−0.019***
		(−4.80)	(−4.77)	(−4.82)	(−4.66)
MS		0.070	0.081	0.069	0.051
		(0.42)	(0.47)	(0.43)	(0.30)
HS		0.109	0.094	0.127	0.127
		(0.94)	(0.81)	(1.10)	(1.06)
PB		0.359**	0.332**	0.389**	0.395***
		(2.07)	(2.14)	(2.18)	(3.72)
FS		−0.151***	−0.153***	−0.152***	−0.163***
		(−6.66)	(−6.59)	(−6.73)	(−7.13)
FP		0.028***	0.028***	0.028***	0.030***
		(2.80)	(2.76)	(2.84)	(2.89)
FFA		0.031***	0.034***	0.032***	0.039***
		(2.87)	(3.09)	(2.91)	(3.51)
Constant	−6.957***	−1.193	−0.580	3.009**	−0.331
	(−2.83)	(−0.49)	(−0.18)	(2.06)	(−0.09)
N	478	478	478	478	478

Note: ***, **, * indicate significant at the 1%, 5%, and 10% levels, respectively; t-values for robust standard errors are in parentheses. Same as below.

main carriers of digital financial inclusion applications, telephones and smartphones have a close relationship with the development of digital financial inclusion. Therefore, the second instrumental variable selected in this paper is "telephone penetration rate in the province where the entrepreneurial farmers are located", which includes "cell phone penetration rate" and "telephone penetration rate". Both instrumental variables satisfy the conditions of "correlation" and "exogenous". The results in Table 4 and Table 5 show that both types of instrumental variables are significant in the first-stage regression; in the second-stage regression, the fitted digital financial inclusion still has a significant positive impact on entrepreneurial farmers' income. And the results of weak instrumental variables and unidentifiable tests reject the orig-

inal hypothesis, which verifies the validity of the two types of instrumental variables, and the endogeneity problem of the model is solved to some extent.

Table 4. Instrumental variable method regression results 1.

Variable	Straight-line distance from the provincial capital to Hangzhou		Spherical distance from the provincial capital to Hangzhou	
	Phase I	Phase II	Phase I	Phase II
Instrumental variable	−0.104***		−0.104***	
	(−19.73)		(−19.71)	
DIFI		4.646***		4.647***
		(6.26)		(6.26)
Controls	Y	Y	Y	Y
N	463	463	463	463
Phase I F-value (p-value)	389.199 (<0.01)		388.652 (<0.01)	
Kleibergen-Paap rk LM value (p-value)	110.041 (<0.01)		109.905 (<0.01)	

Note: The number of observations after matching is 463 due to missing data in the "Distance from provincial capital to Hangzhou" part of the sample.

Table 5. Instrumental variable method regression results 2.

Variable	Cell phone penetration rate		Telephone penetration rate	
	Phase I	Phase II	Phase I	Phase II
Instrumental variable	0.332***		0.275***	
	(10.07)		(9.24)	
DIFI		6.208***		6.080***
		(4.58)		(4.34)
Controls	Y	Y	Y	Y
N	478	478	478	478
Phase I F-value (p-value)	101.346 (<0.01)		85.413 (<0.01)	
Kleibergen-Paap rk LM value (p-value)	26.180 (<0.01)		27.556 (<0.01)	

4.3. Robustness Test

Table 6 displays the results of the robustness test. To ensure objectivity, Columns (1) shows the results of replacing the measure of entrepreneurial farmers' income with the measure of the consumption expenditure of entrepreneurial farmers. The level of income may impact their consumption level. The consumption level is relatively stable in the short term. Given that extreme values can influence the impact of digital inclusive finance on entrepreneurial farmers' income, Column (2) shows the results after a 1% winsorization of the explanatory variables. Municipalities and other provinces have systematic differences with one another.

Therefore, municipalities are eligible for special support from the state in various ways. The regression was rerun after excluding the municipality sample in Column (3). According to Chinese law, the retirement age for men and women is set at 60 and 55, respectively. Column (4) shows the regression results after excluding samples where the householder is aged 55 or older. Columns (1)-(4) indicate that the results are all significant at the 1% level, thus suggesting that digital inclusive finance significantly increases entrepreneurial farmers' income, which is consistent with the hypothesis of this study.

Table 6. Robustness test results.

Variable	(1)	(2)	(3)	(4)
	EFE	EFI	EFI	EFI
DIFI	2.657***	2.746***	1.916***	2.228***
	(5.34)	(6.57)	(3.38)	(3.76)
Controls	Y	Y	Y	Y
Constant	−2.072	−2.268	1.754	0.520***
	(−0.88)	(−1.13)	(0.64)	(0.18)
N	466	478	462	390

4.4. Mediation Effect Test

Table 7 presents the results of the mediated effects test. Columns (1) and (2) show the results of industrial structure upgrading as a mediating variable. The coefficient of the digital inclusive finance index in Column (1) is significantly positive, thus indicating that digital inclusive finance has a positive effect on promoting industrial structure upgrading. In Column (2), the industrial structure upgrading variable is added to the baseline regression model. The results show that the coefficients of the digital inclusive finance index and industrial structure upgrading are significant and positive at the 1% level, thus proving the significant mediation effect of industrial structure upgrading. Columns (3) and (4) show the results of industrial structure rationalization as a mediating variable. The coefficient of the digital inclusive finance index in Column (3) is significantly positive, thereby indicating a positive contribution of digital inclusive finance to the rationalization of the industrial structure. Column (4) adds the industrial structure rationalization variable to the baseline regression model. The results show that the coefficients of the digital inclusive finance index and the industrial structure rationalization are significantly positive at the 1% level, thus proving the significant mediating effect of the industrial structure rationalization. Hypothesis 2 is verified.

4.5. Analysis of the Moderating Effect

In order to examine the moderating role of infrastructure development in the process of digital financial inclusion to promote the income of entrepreneurial farmers, this paper introduces the "cross-multiplier of digital financial inclusion

Table 7. Mediation effect test results.

Variable	(1)	(2)	(3)	(4)
	ISU	EFI	ISR	EFI
DIFI	0.374***	1.621***	84.076***	1.808***
	(7.93)	(2.69)	(8.35)	(2.97)
ISU		2.440***		
		(3.84)		
ISR				0.009***
				(3.25)
Controls	Y	Y	Y	Y
Constant	0.669***	−2.825	−381.901***	2.106
	(3.05)	(−1.28)	(−7.93)	(0.72)
N	478	478	478	478

and transportation infrastructure development" and the "cross-multiplier of digital financial inclusion and digital infrastructure development", respectively, followed by regression analysis. The results of the moderating effect test are shown in Table 8. The results in Columns (1) and (3) show that the coefficients of the explanatory variable, total digital financial inclusion index, and the moderator variable, infrastructure development, are significantly positive when "transportation infrastructure development" and "digital infrastructure development" are introduced into the main regression model, respectively. After continuing to introduce two cross-multipliers, "total digital financial inclusion index * transportation infrastructure development" and "total digital financial inclusion index * digital infrastructure development", it is found that the coefficients of the explanatory variable total digital financial inclusion index in Column (2) are negative and insignificant, while the coefficients of transportation infrastructure development are significant. The explanatory variables digital financial inclusion aggregate index and digital infrastructure development in Column (4) are both significant and negative. The reason for the change in the coefficients is that with the inclusion of the cross-multiplier terms, there may be more multicollinearity problems between the explanatory variable Total Digital Financial Inclusion Index, the moderator variable Infrastructure Development, and their cross-multiplier terms, i.e., there is a duplication (over-) of interpretations of the explanatory variables among the variables. However, at this point, the coefficients of "Total Digital Inclusion Index*Transportation Infrastructure Development" and "Total Digital Inclusion Index*Digital Infrastructure Development" in Columns (2) and (4) are 1.696 and 0.088, respectively, and both are significant, indicating that transportation infrastructure construction and digital infrastructure construction play a positive moderating role in the process of digital inclusive finance to promote entrepreneurial farmers to increase their income, i.e., transportation infrastructure construction

and digital infrastructure construction can well promote digital inclusive finance to improve the income level of entrepreneurial farmers. Hypothesis 3 of this paper is verified.

Table 8. Moderating effect test results.

Variable	(1)	(2)	(3)	(4)
DIFI	1.764***	−0.182	1.863***	−7.964**
	(2.80)	(−0.15)	(2.98)	(−2.14)
LTI	0.311**	−7.581*		
	(2.02)	(−1.96)		
*DIFI*LTI*		1.696**		
		(2.02)		
LDI			0.012***	−0.410***
			(2.77)	(−2.72)
*DIFI*LDI*				0.088***
				(2.80)
Controls	Y	Y	Y	Y
Constant	2.083	11.104*	0.571	47.761***
	(0.71)	(1.95)	(0.21)	(2.69)
N	478	478	478	478

4.6. Heterogeneity Analysis

4.6.1. Analysis of Regional Heterogeneity

As the development level of digital inclusive finance is different within different regions, its impact on the income of entrepreneurial farmers will also produce certain differences, so the analysis of regional heterogeneity is particularly important. In this paper, the sample of entrepreneurial farmers is divided into regions, and then explore the role of digital inclusive finance in the eastern central and western regions in boosting the income of entrepreneurial farmers. The results in Table 9 show that digital inclusive finance has a significant impact on the income of entrepreneurial farmers in the eastern region, while it has a non-significant impact on the income of entrepreneurial farmers in the central and western regions, and the coefficient in the western region is significantly larger than that in the central region, i.e., the impact of digital inclusive finance on entrepreneurial farmers in the western region is larger than that on entrepreneurial farmers in the central region. The reason for this is mainly that the economic development of the eastern region is relatively faster, the digital infrastructure is relatively well developed, the breadth of coverage, depth of use, and degree of digitization of digital inclusive finance are relatively high, and the digital literacy of local entrepreneurial farmers is also higher, which makes entrepreneurial farmers have a stronger awareness of digital inclusive finance, and digital inclusive finance can give full

play to its role in realizing the entrepreneurial farmer's income increase.

Table 9. Analysis of regional heterogeneity.

Variable	(1) Eastern region	(2) Central region	(3) Western region
DIFI	2.749***	0.470	1.138
	(4.22)	(0.36)	(0.79)
Controls	Y	Y	Y
Constant	−2.586	9.066	4.809
	(−0.85)	(1.48)	(0.72)
N	185	158	135

4.6.2. Analysis of Heterogeneity in Levels of Economic Development

Since the acceptance and use of digital inclusive finance vary with the level of economic development of each region, it is important to analyze the heterogeneity of the degree of economic development. In this paper, the sample of entrepreneurial farmers is categorized into "economically developed regions", "medium economic development regions", and "economically underdeveloped regions" according to the different degrees of economic development of each province to explore the impact of digital financial inclusion on the income of entrepreneurial farmers under different degrees of economic development. The results in Table 10 show that the impact of digital financial inclusion on entrepreneurial farmers' income is significant in both economically developed and underdeveloped regions, and the significance is higher in economically developed regions, but the impact of digital financial inclusion on entrepreneurial farmers' income is not significant in the region of medium economic development. The possible reasons for this are: entrepreneurial farmers in economically developed regions are more digitally literate and have a higher degree of acceptance of digital inclusive finance, and are more effective in utilizing digital inclusive finance to achieve income generation; in economically underdeveloped regions, it is difficult for traditional finance to play an effective role in generating income because of its inherent shortcomings, while the development of digital inclusive finance has lowered the entry threshold of financial services, so that entrepreneurial farmers can obtain more appropriate and effective financial services at lower prices, thus realizing income generation.

Table 10. Analysis of heterogeneity in levels of economic development.

Variable	(1) Economically developed regions	(2) Medium economic development regions	(3) Less economically developed regions
DIFI	3.421***	−0.274	2.129**
	(4.44)	(−0.15)	(2.51)
Controls	Y	Y	Y
Constant	−6.031*	12.990	0.611
	(−1.66)	(1.57)	(0.15)
N	149	100	229

4.6.3. Analysis of Income Heterogeneity

In order to study the impact of digital financial inclusion on the income of entrepreneurial farmers in provinces with different income levels, this paper divides the sample into two groups of high-income provinces and low-income provinces according to the mean value of per capita disposable income of residents in each province in 2020 to conduct a regression, and the results are shown in Table 11. The impact of digital financial inclusion on the income of the entrepreneurial farmers' group in high-income provinces is significant at the 1% level, and the impact on the income of the entrepreneurial farmers' group in low-income provinces is not significant. The likely reason for this is the higher disposable income of the high-income entrepreneurial farmer group, which has the financial strength to carry out entrepreneurial activities and implement digital investments, coupled with their relatively high investment in education, which makes these entrepreneurial farmers financially and digitally literate and able to effectively utilize digitally inclusive finance to carry out their entrepreneurial activities and to fully utilize digital financial inclusion to increase their incomes.

Table 11. Analysis of income heterogeneity.

Variable	(1)	(2)
	High income	Lower income
DIFI	3.421***	1.266
	(4.44)	(1.62)
Controls	Y	Y
Constant	−6.031*	4.953
	(−1.66)	(1.36)
N	149	329

5. Conclusion, Implications and Limitations

The results of the study indicate the following: First, digital inclusive finance and its three sub-dimensions have a positive impact on entrepreneurial farmers' incomes. Moreover, they pass the endogeneity test and robustness test, with the most significant impact being on the breadth of coverage. Second, industrial structure optimization (industrial structure upgrading and industrial structure rationalization) plays a significant mediating role in the process of digital financial inclusion, thus promoting the growth of entrepreneurial farmers' incomes. Third, the results of the moderating effects analysis show that the improvement of infrastructure development (transportation infrastructure development and digital infrastructure development) can significantly contribute to the role of digital financial inclusion in increasing the income of entrepreneurial farmers. Fourth, the results of the heterogeneity analysis show that in the eastern region, digital financial inclusion has a significant positive impact on the increase of income of entrepre-

neurial farmers, while the impact is not significant in the central and western regions; in economically developed and economically less developed regions, digital financial inclusion has a significant positive impact on the increase of income of entrepreneurial farmers, while it is not significant in the region of medium economic development; digital financial inclusion has a significant impact on the increase of income of high-income entrepreneurial farmers group, and the impact on the low-income entrepreneurial farmers group is not significant.

Based on the above conclusions, the following two policy recommendations are proposed. First, the development of digital inclusive finance should be continuously promoted in a balanced and coordinated manner. Digital inclusive financial policies should be formulated based on the current situation. It should be developed in a targeted and differentiated way to maximize digital inclusive finance and promote quality economic development in all regions while increasing entrepreneurial farmers' incomes. Second, the industrial structure optimization in rural areas should be accelerated. The government should concentrate on supporting rural industries, integrating digital inclusive finance with industrial development, promoting urbanization in rural areas, and guiding entrepreneurial farmers to achieve stable income growth in industrial structure upgrading and industrial structure rationalization. Third, infrastructure construction in rural areas should be strengthened and improved. In particular, there is an urgent need to improve digital and transportation infrastructure in the central and western regions so as to facilitate the full flow of capital, information, and other resources in the central and western regions, make up for the disadvantages of entrepreneurial farmers in the central and western regions in terms of resource endowment, and enhance the role of digital inclusive finance in promoting the income-generating process of entrepreneurial farmers.

The limitations of this paper are as follows: First, this paper only started the study with the cross-sectional data of 2020 and did not consider whether the findings of this study in recent years are applicable. Therefore, in future research, we can collect relevant data in recent years and use panel regression models and more complex econometric methods to further study the income-generating role of digital financial inclusion. Second, this paper only focuses on the subject of entrepreneurial farmers in China, and the conclusions of this paper may not be applicable to other countries with different levels of digital inclusive finance development and institutional environments, so in the future, we can collect more data on farmers in other countries and use more complex models to conduct research.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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