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Can digital inclusive finance facilitate productive investment in rural households?–An empirical study based on the China Household Finance Survey

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ABSTRACT

Encouraging rural households to increase their own financial investment in agriculture is necessary for agricultural productivity. Digital inclusive finance can help rural households access financial resources and increase productive investments. This paper employs data from the CHFS to conduct an empirical analysis. The findings indicate that digital inclusive finance significantly enhances rural household productive investment. The expansion of rural household social networks and the improvement of financial literacy both have a positive influence on this effect. Based on these conclusions, this paper suggests increasing support for rural digital inclusive finance as a means to enhance rural household productive investment.

1. Introduction

Productive investment, whether for capital deepening and sustainable development in agriculture or for rural households themselves, carries significant importance (Carter et al., 2019; Khan et al., 2020). The importance of rural household productive investment in promoting the rapid development of modern agriculture and ensuring food security has been confirmed by most experts and scholars (Hajdu et al., 2020; Yu et al., 2023). Although agricultural fixed asset investment has gradually increased since the 21st century, the proportion of agricultural fixed assets to total fixed assets remains relatively low, and rural household productive investment outside of fiscal funds is limited (Nguyen et al., 2019; Chamberlin and Jayne, 2020; Zhang et al., 2020).

Digital inclusive finance possesses two key features: digitization and inclusiveness, both of which are highly significant for the development of agricultural production (Li et al., 2020; Liu et al., 2021; Yu et al., 2022). On one hand, with the increasing integration of inclusive finance and digital technology, digital inclusive finance promotes the digitization and mobilization of traditional inclusive finance (Schuetz and Venkatesh, 2020). On the other hand, the inclusiveness of digital inclusive finance is reflected in its penetrative capacity in agriculture (Yue et al., 2022). Consequently, digital inclusive finance is likely to enhance rural household productive investment. This paper aims to empirically examine whether digital inclusive finance can promote the enhancement of productive investment in agriculture using household financial survey data from China.

Rural households differ significantly from urban households, as productive investment is influenced by both social networks and low financial literacy. On one hand, social networks enable farmers to conveniently access information regarding market dynamics, agricultural policies, and other relevant aspects of agricultural products, thus enabling them to effectively utilize agricultural policies

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and better serve farmers (Bailey et al., 2018; Breza and Chandrasekhar, 2019). On the other hand, digital inclusive finance not only transcends geographical limitations but also accelerates the explosive dissemination of vast financial knowledge and information (Hasan et al., 2021).

Existing literature has predominantly focused on studying agricultural production investment behavior of households from perspectives such as human capital investment, institutions, financial development, and family structure (Li et al., 2021). However, there is limited exploration of the impact of digital inclusive finance on productive investment by households, and a lack of analysis that integrates the two within a unified framework. In particular, there is a dearth of empirical research that delves into the role played by digital inclusive finance, which holds significant importance in rural society, and its influence on the mechanism of agricultural production investment by households. Therefore, drawing on existing research in the field of rural finance, this paper combines digital inclusive finance with rural household productive investment to investigate whether and how digital inclusive finance affects agricultural investment by households.

The contribution of this paper can be summarized in two main aspects. Firstly, it directly reveals the promoting effect of digital inclusive finance on rural household productive investment and explores new influencing factors for enhancing such investment. Secondly, unlike the direct impact of digital inclusive finance on improving financial resources for rural households, this paper systematically examines whether social networks act as moderating variables influencing the relationship between digital inclusive finance and rural household productive investment, as well as whether financial literacy serves as a mediating variable affecting the relationship between digital inclusive finance and rural household productive investment. This analysis reveals additional channels through which digital inclusive finance promotes agricultural productive investment.

The remainder of this paper is organized as follows. Section 2 describes the econometric model and data; Section 3 presents the empirical results and robustness checks; and Section 4 concludes.

2. Econometric model and data

2.1. Econometric model

This paper employs the multivariable linear regression method to investigate the impact of digital finance on productive investment in rural households. The constructed multivariable linear regression model is shown as follows:

$$\text{ProInvest}_{i,t} = \alpha + \beta_0\ \text{DFin}_{i,t} + \beta_1\ \text{Controls}_{i,t} + \beta_2\ \text{Province}_i^{*}\text{Year}_t + \varepsilon_{i,t} \tag{1}$$

Among them, the dependent variable $\text{ProInvest}_{i,t}$ represents the productive investment of rural household i in year t, which consists of investments related to agricultural production, including seeds, seedlings, nurseries, plant protection products, growth promoters, insecticides for aquaculture, herbicides, fertilizers, rodenticides and agricultural film inputs, as well as agricultural machinery inputs and hired labor costs. The core explanatory variable DFin_i represents the level of digitization index in each province, using Peking University's Digital Inclusive Finance Index as the measure of digital inclusive finance. $\text{Controls}_{i,t}$ represents control variables, including head of household age (Age), head of household gender (Gender), head of household education level (Edu), family size (Scale), total family assets (Assets), total family income (Income), per capita GDP of the province (GDP), and primary industry added value (Add), etc. Province_i and Year_t represent dummy variables for province and year. The regression equation coefficient α represents the constant term, while the coefficient β of the core explanatory variable DFin_i represents the impact of digital finance on productive investment in rural households. $E_{i,t}$ represents the random error term.

When examining the moderating effect of social networks, this paper employs an interaction term model for empirical testing. The constructed multivariable linear regression model is shown as follows:

$$\text{ProInvest}_{i,t} = \alpha + \beta_1 Z1_{i,t}^{*}\text{DFin}_{i,t} + \beta_2\ \text{DFin}_{i,t} + \beta_3 Z1_{,t} + \beta_4\ \text{Controls}_{i,t} + \beta_5\ \text{Province}_i^{*}\text{Year}_t + \varepsilon_{i,t} \tag{2}$$

$Z1_{i,t}$ represents the size of social networks in rural households, and this paper uses "gift income and expenditure" in the China Household Finance Survey (CHFS)database as a proxy variable for social networks.

When examining the mediating effect of financial literacy, this paper employs a mediation effect model for empirical testing. The constructed multivariable linear regression model is shown as follows:

$$\text{ProInvest}\ i_{i,t} = \alpha_0 + \alpha_1\ \text{DFin}_{i,t} + \alpha_2\ \text{Controls}_{i,t} + \alpha_3\ \text{Province}_i^{*}\text{Year}_t + \varepsilon_{i,t} \tag{3}$$

$$Z2_{i,t} = \beta_0 + \beta_1\ \text{DFin}_{i,t} + \beta_2\ \text{Controls}_{i,t} + \beta_3\ \text{Province}_i^{*}\text{Year}_t + \varepsilon_{i,t}, \tag{4}$$

$$\text{ProInvest}\ i_{i,t} = \gamma_0 + \gamma_1\ \text{DFin}_{i,t} + \gamma_2 Z_{i,t} + \gamma_3\ \text{Controls}_{i,t} + \gamma_4\ \text{Province}_i^{*}\text{Year}_t + \varepsilon_{i,t} \tag{5}$$

$Z2_{i,t}$ represents the financial literacy possessed by rural households, and in this paper, it is measured by using factor analysis based on the responses of rural households in CHFS to three financial knowledge questions.

2.2. Data

The data used in this empirical study are derived from the China Household Finance Survey (CHFS) conducted by Southwest University of Finance and Economics, as well as the Digital Inclusive Finance Index from Peking University. The CHFS database ensures

Table 1
Variable definitions and summary statistics.

Name	Definition	N	mean	std	min	max
lnProInvest	The logarithm of the sum of the monetary value of agricultural inputs and the total value of agricultural fixed asset investments made by rural households in the current year.	17,383	8.321	1.447	4.605	12.095
lnDFin	The logarithm of the Digital Inclusive Finance Index is calculated and matched with the CHFS database using provincial variables.	17,383	5.081	0.531	3.215	5.579
Age	The age of the head of the household in the current year.	17,383	54.453	13.631	5	100
Gender	Gender of the head of the household: 1 for male, 0 for female.	17,383	0.716	0.451	0	1
Edu	Education level of the head of the household: 1 for primary school or below, 2 for junior high school, 3 for senior high school, and 4 for college or above.	17,383	1.685	0.822	1	4
Scale	The number of household members in the current year.	17,383	2.893	1.577	1	17
lnAssets	The logarithm of the sum of rural household financial assets and non-financial assets.	17,383	10.599	2.050	5.298	14.915
lnIncome	The logarithm of the total annual income of rural households.	17,383	8.682	1.759	3.932	13.125
lnGDP	The logarithm of the economic development level representing the region where the household is located.	17,383	10.707	0.359	9.707	11.580
lnFirAdd	The logarithm of the development level representing the agriculture, forestry, animal husbandry, and fishery sectors in the region where the household is located.	17,383	7.581	0.745	4.464	8.513
lnSecAdd	The logarithm of the development level representing the industrial, construction, and other related sectors in the region where the household is located.	17,383	9.214	0.804	5.680	10.392

Table 2
The baseline regression of digital inclusive finance on rural household productive investments.

	(1) lnProInvest	(2) lnProInvest
lnDFin	0.639***	0.715***
	(5.306)	(5.281)
Age		−0.003*
		(−1.698)
Gender		−0.007
		(−0.193)
Edu		0.007
		(0.237)
Scale		0.036***
		(3.080)
lnAssets		0.054***
		(5.697)
lnIncome		0.140***
		(11.680)
lnGDP		0.235
		(0.721)
lnFirAdd		0.254
		(0.944)
lnSecAdd		0.116
		(0.386)
Constant	5.054***	−0.982
	(11.050)	(−0.055)
Year fixed effect * Province fixed effect	Yes	Yes
Observations	17,383	12,790
R-squared	0.16	0.23

***, **, and * indicate a 1%, 5%, or 10% level of significance, respectively.

the continuity, randomness, and representativeness of the survey, with sample data widely collected from 29 provinces in China and scientifically distributed across urban and rural areas, providing a solid foundation for academic research on household finance issues. However, the questionnaire of the CHFS survey selected for this paper only mentioned the question related to the construction of the dependent variable, rural household productive investment, in 2011, 2013, and 2015. Hence, the rural samples from CHFS for these three years are chosen as the basis for the dependent variable data. Due to privacy protection concerns, the household data in the CHFS database only publish provincial variables corresponding to each sample. Therefore, this paper matches the Digital Inclusive Finance Index to the provincial level where the household samples in CHFS are located. The Digital Inclusive Finance Development Index compiled by Peking University based on large-scale data has become an authoritative source of information on digital inclusive finance. This paper utilizes the matching of the Digital Inclusive Finance Index and the provincial level of household samples in CHFS to investigate whether the development of digital inclusive finance in different provinces can promote productive investment in rural households. Table 1 presents the variable definitions and summary statistics.

Table 3
Analysis of the moderating effect mechanism of social networks.

Variables	LnProInvest		
	(1) Without interaction term	(2) With interaction term	(3) After centering
lnDFin	0.693***	0.744***	0.675***
	(5.476)	(5.757)	(5.320)
lnZ1	0.009**	0.058**	0.006
	(2.119)	(2.257)	(1.369)
lnDFin *Z1		0.010*	
		(1.923)	
lnDFin *Z1_c			0.010*
			(1.923)
Controls	Yes	Yes	Yes
Year fixed effect * Province fixed effect	Yes	Yes	Yes
Observations	12,790	12,790	12,790
R-squared	0.21	0.19	0.19

***, **, and * indicate a 1%, 5%, or 10% level of significance, respectively.

Table 4
Results of KMO test.

Variables	KMO
Correct response to interest rate question	0.5669
Direct response to interest rate question	0.6772
Correct response to inflation question	0.6711
Direct response to inflation question	0.6557
Correct response to investment question	0.5365
Direct response to investment question	0.5807
Full sample	0.6096

3. Results and discussion

3.1. Baseline results

This paper first conducts a baseline test on whether digital inclusive finance promotes rural households' productive investment, as shown in Table 2. In column (1), we include only the variable of digital inclusive finance index in the analysis. In column (2), we further incorporate individual demographic variables, household characteristics variables, and macroeconomic development variables as control variables into the regression model. The regression results demonstrate that in column (1), the regression using the single variable indicates a significant positive impact of digital inclusive finance on rural households' productive investment at the 1% level of significance. Even after adding control variables at the individual, household, and macro levels while controlling for region and year, the coefficient of the core explanatory variable remains positive and statistically significant at the 1% level. The regression results in Table 2 provide evidence that verifies the promotion of rural households' productive investment by digital inclusive finance. After controlling for the influence of other variables, a 1% increase in the level of digital inclusive finance development is associated with a 0.715% increase in rural households' productive investment.

3.2. Moderating effect of social networks

In the analysis of the moderating effect of social networks, this paper employs a moderation effect model to test the hypothesis, and the results are presented in Table 3. Columns (1) regresses the network size as the explanatory variable, showing that network size significantly promotes rural household productive investments. Columns (2) includes an interaction term between the social network size and digital inclusive finance as explanatory variables. Columns (3) regresses the decentralized social network size and the interaction term with digital inclusive finance as explanatory variables. The coefficient of the interaction term is significantly positive at a significance level of 10%. This indicates that social networks, as moderating variables, enhance the relationship between the dependent variable (rural household productive investments) and the key explanatory variable (degree of digitization). In the impact of digital inclusive finance on rural household productive investments, social networks play a facilitating role.

3.3. Mediating effect of financial literacy

To examine the mediating effect of financial literacy, this paper utilizes data from the China Household Finance Survey (CHFS) to characterize the financial literacy of rural households. Within the CHFS questionnaire, three relevant questions regarding financial knowledge were included for rural households: one on inflation judgment, one on interest rate calculations, and one on investment risk

Table 5
Results of factor analysis.

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Eigenvalue	2.50038	1.45750	0.89846	0.60556	0.33535	0.20275
Proportion	0.4167	0.2429	0.1497	0.1009	0.0559	0.0338
Cumulative	0.4167	0.6596	0.8094	0.9103	0.9662	1.0000

Table 6
Analysis of the mediating effect of financial literacy.

Variables	(1) lnY	(2) Z2	(3) lnY
lnDFin	0.606***	0.376***	1.399***
	(4.781)	(15.496)	(3.096)
Z2			0.066***
			(2.714)
Controls	Yes	Yes	Yes
Year fixed effect * Province fixed effect	Yes	Yes	Yes
Observations	12,790	12,790	12,790
R-squared	0.20	0.19	0.20

***, **, and * indicate a 1%, 5%, or 10% level of significance, respectively.

Table 7
Endogeneity test and robustness test.

Variables	(1) lnDFin	(2) lnProInvest	(3) lnProInvest	(4) lnProInvest	(5) lnProInvest
Internet penetration rate	0.689***				
	(23.573)				
L.lnDFin		0.494***	1.248***		
		(2.565)	(3.676)		
lnDFin_deg				0.002**	
				(2.592)	
lnDFin_win					0.595***
					(4.179)
Controls	Yes	Yes	Yes	Yes	Yes
Year fixed effect * Province fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	7505	7505	10,914	12,790	12,790
R-squared	0.27	0.20	0.21	0.21	0.21

***, **, and * indicate a 1%, 5%, or 10% level of significance, respectively.

judgment. Each participant's response to these questions was categorized as either "correct," "incorrect," or "cannot calculate," as shown in Table 4. Using factor analysis, this paper extracts the first two factors from the rural households' responses to the three financial knowledge questions in the CHFS, which collectively account for a cumulative contribution rate of 65.96% (Table 5). Based on the calculated level of financial literacy among rural households, this paper employs a stepwise regression method to test the mediating effect. The regression results, as shown in Table 6, indicate that the coefficient of financial literacy is statistically significant at the 1% level. This suggests that in the context of the impact of digital inclusive finance on rural households' agricultural productive investment, enhancing rural households' financial literacy can promote agricultural productive investment.

3.4. Robustness checks

The internet penetration rate is an important foundation for the promotion and application of digital inclusive finance. There is no direct correlation between rural household productive investments and the internet penetration rate. Therefore, this paper chooses the internet penetration rate as an instrumental variable for the development of digital finance. The regression results of the endogeneity test are shown in columns (1) and (2) of Table 7. The regression coefficient of columns (2) is significantly positive, indicating that even after using instrumental variables in the regression, the development of digital inclusive finance still promotes rural household productive investments. This paper also conducted robustness tests by lagging the digital inclusive finance index by one period, replacing the main explanatory variables, and changing the truncation range. The empirical results of the robustness test are shown in columns (3), (4), and (5) of Table 7. Column (3) includes a lagged one-period digitalization index (L.lnDFin), column (4) replaces the explanatory variable of the baseline regression with the degree of digitization (lnDFin_deg), and column (5) changes the truncation range of the explanatory variable to a 5%−95% interval, generating a new variable (lnDFin_win) for regression analysis. The results of the robustness tests consistently indicate that the development of digital inclusive finance promotes rural household productive

investments, which is consistent with the findings of the baseline regression.

4. Conclusion

This paper examines the impact of digital inclusive finance on rural household productive investment in order to reveal the pathways through which digital inclusive finance affects such investment in practice. The empirical results demonstrate a significant positive effect of digital inclusive finance on rural productive investment. Social networks are found to have a positive moderating effect on the relationship between digital inclusive finance and rural household productive investment, and digital inclusive finance promotes rural household productive investment by enhancing financial literacy among farmers. Endogeneity tests are conducted using instrumental variable approach, and robustness checks are performed by replacing the core explanatory variable and introducing a lagged one-year digital inclusive finance index. The results of these tests consistently support the conclusion that digital inclusive finance facilitates the increase in rural household productive investment, thus validating the robustness of the empirical findings in this paper.

Based on these findings, the following four recommendations are proposed in this paper. Firstly, efforts should be made to accelerate the construction of digital infrastructure in rural areas, as it serves as the foundation for digital inclusive finance to promote rural household productive investment. Secondly, policies supporting digital inclusive finance in rural areas should be strengthened to ensure that rural residents can benefit from the advantages it offers. Thirdly, various social platforms suitable for rural areas and farmers should be established to help broaden channels of information exchange for farmers. This will allow social networks to play a role in moderating the relationship between digital inclusive finance and rural household productive investment. Lastly, emphasis should be placed on using digital technology to expand channels for improving financial literacy among villagers. This can be achieved by leveraging online social media, digital financial platforms, interactive communication, and animated explanations to support villagers in enhancing their financial literacy.

CRediT authorship contribution statement

Changluan Fu: Conceptualization, Project administration, Supervision, Writing – review & editing. **Xinyue Sun:** Investigation, Methodology, Writing – original draft. **Mengting Guo:** Conceptualization, Writing – review & editing. **Chenyang Yu:** Formal analysis, Methodology, Writing – review & editing.

Declaration of competing interest

The authors declare no conflict of interest.

Data availability

The authors do not have permission to share data.

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References

Bailey, M., Cao, R., Kuchler, T., et al., 2018. The economic effects of social networks: evidence from the housing market. J. Political Econ. 126 (6), 2224–2276.
Breza, E., Chandrasekhar, A.G., 2019. Social networks, reputation, and commitment: evidence from a savings monitors experiment. Econometrica 87 (1), 175–216.
Carter, M.R., Tjernström, E., Toledo, P., 2019. Heterogeneous impact dynamics of a rural business development program in Nicaragua. J. Dev. Econ. 138, 77–98.
Chamberlin, J., Jayne, T.S., 2020. Does farm structure affect rural household incomes? Evidence from Tanzania. Food Policy 90, 101805.
Hajdu, F., Granlund, S., Neves, D., et al., 2020. Cash transfers for sustainable rural livelihoods? Examining the long-term productive effects of the Child Support Grant in South Africa. World Dev. Perspect. 19, 100227.
Hasan, M., Le, T., Hoque, A., 2021. How does financial literacy impact on inclusive finance? Financ. Innov. 7 (1), 1–23.
Khan, I., Lei, H., Shah, I.A., et al., 2020. Farm households' risk perception, attitude and adaptation strategies in dealing with climate change: promise and perils from rural Pakistan. Land Use Policy 91, 104395.
Li, J., Wu, Y., Xiao, J.J., 2020. The impact of digital finance on household consumption: evidence from China. Econ. Model. 86, 317–326.
Liu, Y., Liu, C., Zhou, M., 2021. Does digital inclusive finance promote agricultural production for rural households in China? Research based on the Chinese family database (CFD). China Agric. Econ. Rev. 13 (2), 475–494.
Nguyen, D.L., Grote, U., Nguyen, T.T., 2019. Migration, crop production and non-farm labor diversification in rural Vietnam. Econ. Anal. Policy 63, 175–187.
Schuetz, S., Venkatesh, V., 2020. Blockchain, adoption, and financial inclusion in India: research opportunities. Int. J. Inf. Manag. 52, 101936.
Yu, C., Jia, N., Li, W., et al., 2022. Digital inclusive finance and rural consumption structure–evidence from Peking University digital inclusive financial index and China Household Finance Survey. China Agric. Econ. Rev. 14 (1), 165–183.
Yu, C., Moslehpour, M., Tran, T.K., et al., 2023. Impact of non-renewable energy and natural resources on economic recovery: empirical evidence from selected developing economies. Resour. Policy 80, 103221.
Yue, P., Korkmaz, A.G., Yin, Z., et al., 2022. The rise of digital finance: financial inclusion or debt trap? Financ. Res. Lett. 47, 102604.
Zhang, J., Mishra, A.K., Zhu, P., et al., 2020. Land rental market and agricultural labor productivity in rural China: a mediation analysis. World Dev. 135, 105089.