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Original Paper

The Impact of Regional Digital Finance Development on Farmers' Income - Based on Panel Data from Southeast Chongqing

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Abstract
In recent years, the rapid advancement of digital inclusive finance in China has presented significant opportunities to bolster the growth of farmers' incomes. This study leverages county-level panel data from the southeastern region of Chongqing between 2014 and 2016, employing the Peking University Digital Inclusive Finance Index, benchmark regression models, mediation effect models, and moderation effect models to investigate the impact of digital inclusive finance development on farmers' income. The analysis also examines the specific roles of county-level industrial structure and government support in this influencing process. The research findings indicate that the development of digital inclusive finance has a substantial positive effect on increasing the incomes of farmers in the southeastern Chongqing region. Furthermore, the upgrading of industrial structure plays a mediating role in the process through which digital inclusive finance drives the growth of farmers' incomes. However, government intervention was found to weaken the impact of digital inclusive finance on the growth of farmers' incomes.

Keywords
digital inclusive finance, farmers' income, county level, government support, mediating effect

1. Introduction

The longstanding issue of absolute poverty in China has been completely resolved as of 2020, marking the successful achievement of the first centenary goal of building a moderately prosperous society. The Fifth Plenary Session of the 19th Central Committee of China has outlined strategic plans for the second centenary goal - to develop China into a fully modernized socialist power by 2035, with a focus on attaining substantive progress in common prosperity for all. Since the reform and opening up era, the annual per capita disposable income of Chinese citizens has steadily increased. However, the problem of unbalanced and insufficient development persists, characterized by significant income disparities and the risk of falling into the "middle-income trap". As such, the most arduous task ahead lies in consolidating poverty alleviation gains and promoting common prosperity, particularly in China's rural areas.

The ethnic minority regions of southeastern Chongqing exemplify this challenge. These areas are densely populated, prone to natural disasters, and economically underdeveloped, despite their rich natural resources. The incidence of poverty is high, and the risk of poverty relapse is severe. Strengthening financial service provision is crucial to improving farmers' incomes in these areas. However, the traditional financial model, coupled with geographical constraints and information barriers, has hindered the expansion of financial service coverage and accessibility in rural southeastern Chongqing. The momentum of digital inclusive finance in this region remains untapped, limiting the channels for boosting farmers' incomes and consolidating the achievements of poverty alleviation. Given the backdrop of rural revitalization and the pursuit of common prosperity, the impact of digital finance on farmer incomes in southeastern Chongqing warrants urgent investigation. This study aims to employ county-level data to examine the temporal, individual, and spatial dynamics of this relationship, in order to reveal the mechanisms and actual effects of digital finance in promoting rural income growth in western China's mountainous areas. The findings are intended to provide a theoretical basis and policy recommendations for leveraging digital inclusive finance to drive rural income growth.

2. Literature Review and Research Hypotheses

The relationship between financial institutions and geographic regions is complex. Commercial banks tend to prioritize providing services in areas with superior locations and higher economic development, as the potential benefits often outweigh the costs. However, remote and impoverished regions often face limited access to financial services due to the high costs and meager returns, hindering the long-term development of inclusive finance.

The emergence of digital inclusive finance, driven by the integration of technology and finance, has brought new opportunities for the growth of inclusive finance. A study by Liu Jinyi et al. (2020) found that digital inclusive finance, with its high accessibility beyond geographic limitations, has penetrated into many households and the long-tail group, optimizing financial resource allocation, promoting market integration, and increasing incomes while reducing poverty.

However, the impact of digital finance on household incomes exhibits significant heterogeneity. Wang Xiuhua et al. (2020) observed that for impoverished households in remote and economically disadvantaged areas, the "tool exclusion," "regional exclusion," and "knowledge exclusion" make it difficult to fully benefit from digital finance, resulting in a relatively small impact on their incomes. Conversely, digital finance has a more substantial poverty reduction and income increase effect on non-impoverished households.

Chen Huiqing et al. (2021) found that the rural income increase effect of digital inclusive finance is greater in the central region compared to the eastern and western regions. He Yiqing et al. (2021) further identified a threshold effect, where digital inclusive finance can only promote rural residents' income growth when its development level exceeds a certain threshold.

From a micro perspective, Zhang Xun et al. (2019) concluded that digital finance improves household incomes for both urban and rural residents, contributing to inclusive growth. Additionally, the report shows a significant increase in the breadth of digital financial services in county-level areas across China, suggesting that financial digitization has helped overcome spatial barriers and reach financially suppressed groups, thereby promoting farmers' income growth.

Based on these insights, the following hypotheses are proposed:

H1: The development of digital inclusive finance can improve the income level of farmers in the southeastern region of Chongqing.

H2: Digital inclusive finance increases the income of farmers by promoting the upgrading of county-level industries.

H3: Government subsidies have a moderating effect on increasing farmers' income through digital inclusive finance.

3. Research Design

3.1 Variable Selection

The dependent variable in this study is the growth of farmers' income(Y). Specifically, the article examines the per capita disposable income of farmers in six districts and counties in southeastern Chongqing from 2014 to 2022. To unify the dimension and alleviate heteroscedasticity, the natural logarithm of per capita disposable income of rural residents is used as the measurement indicator, following the approaches of Lin Song et al. (2023) and Sun Jiuwen et al. (2019).

The core explanatory variable is the development level of digital inclusive finance(diif). This is measured using the Peking University Digital Inclusive Finance Index, which comprehensively captures different dimensions of China's digital finance development, including the Digital Inclusive Finance Total Index, Digital Finance Coverage Width Index, Digital Finance Usage Depth Index, and Inclusive Finance Digitalization Degree. The data for this index is extracted from the 2014-2022 period and divided by 100 to unify the dimensions.

The mediating variable is county-level industrial upgrading(IS), measured as the proportion of the added value of the tertiary industry to the sum of the added values of the primary and secondary industries, following the approach of Zhang Lin (2021). A higher value indicates faster industrial upgrading.

The moderating variable is government support(Support G), depicted by the ratio of local fiscal general budget expenditure to nominal GDP, as per the method used by Zhang Guojian et. al. (2019).

The control variables include: (1) the regional financial development level, measured by the ratio of financial institution loan balance to regional GDP(PF); (2) the level of regional economic development, represented by local GDP(PD); and (3) the savings level, characterized by the resident savings deposit balance. All data are sourced from the Chongqing Statistical Yearbook(IS). The descriptive statistics for each variable are provided in the following table.

Table 1. Descriptive Statistical Results of Each Variable

Variable	Sample size	Mean	Std	Min	Max
Y	52	4.065	0.114	3.812	4.265
diif(DIFI/100)	52	0.946	0.243	0.316	1.170
PF	52	1.035	0.231	0 .575	1.509
PD	52	1.960	0.620	1.090	3.581
Dep	52	1.600	0.495	0.837	2.759
IS	52	0.882	0.395	0.002	2.021
Support G	52	0.296	0.072	0.156	0.449

3.2 Model Construction

Basic Model: To examine the impact of digital inclusive finance on farmers' income, a panel data econometric model is constructed based on references to existing literature. The model is specified as follows:

$$Y_{it} = \beta 0 + \beta 1 DIFI/100_{it} + \beta 2 PF_{it} + \beta 3 PD_{it} + \beta 4 Dep_{it} + \varepsilon_{it} \quad (1)$$

Mediation Effect Model: Building upon the previous analysis, this study aims to explore the impact mechanism of digital inclusive finance on farmers' income through a mediation effect model. The regression models are specified as follows:

$$IS_{it} = \beta 0 + \beta 1 DIFI/100_{it} + \beta 2 PF_{it} + \beta 3 PD_{it} + \beta 4 Dep_{it} + \varepsilon_{it} \quad (2)$$

$$Y_{it} = \beta 0 + \beta 1 DIFI/100_{it} + \beta 2 IS_{it} + \beta 3 PF_{it} + \beta 4 Dep_{it} + \beta 5 Dep_{it} + \varepsilon_{it} \quad (3)$$

Regulatory Effect Model: This study further explores whether government support has a moderating effect on the relationship between digital inclusive finance and farmer income. To this end, a moderation effect model is constructed as follows:

$$Y_{it} = \beta 0 + \beta 1 DIFI/100_{it} + \beta 2 SupportG_{it} + \beta 3 DIFI/100_{it} \times SupportG_{it} + \beta 3 PD_{it} + \beta 4 Dep_{it} + \varepsilon_{it} \quad (4)$$

3.3 Empirical Testing of the Impact of Digital Inclusive Finance on Increasing Farmers' Income

1. Benchmark Regression: Based on the models specified earlier, the impact of digital inclusive finance on farmers' income was estimated using a random effects model. Table 2 reports the regression results. Even after including control variables, the results show a statistically significant positive correlation between the development level of digital inclusive finance and the income growth of farmers in the southeastern Chongqing region. Specifically, at a 1% confidence level, the expansion of digital

inclusive finance can significantly improve farmers' incomes in this area. These findings suggest that, holding other factors constant, the widespread adoption of digital inclusive finance can play a crucial role in enhancing farmers' incomes and consolidating poverty alleviation achievements. Thus, the first hypothesis of this study has been empirically validated.

Table 2. Model Regression Results

	Y	
	(1)	(2)
diif(DIFI/100)	0.393***(0.029)	0.175***(0.051)
PF		0.112***(0.036)
PD		0.048*** (0.016)
Dep		0.051**(0.237)
C	3.693***(0.033)	3.608***(0.034)
N	52	52

Note. *, * *, and * * * respectively represent significant levels at 10%, 5%, and 1%, the same below.

2. Robustness Testing: This study employs two methods to assess the robustness of the model:

(1) Instrumental Variable Approach: The benchmark model results may suffer from endogeneity issues. On one hand, the dependent variable (farmers' income) could also affect the explanatory variable (digital inclusive finance), suggesting a potential bidirectional causal relationship. On the other hand, there could be omitted variable bias due to the exclusion of relevant factors. To address these concerns, this study follows the approach used by Li Chuntao et al. and Song Ke et al. Specifically, the total index of digital inclusive finance in other counties within the same prefecture-level city is closely related to the development of digital finance in the focal county, but has no direct impact on the income gap between rural and urban residents in that county. Therefore, this variable satisfies the requirements of correlation and exogeneity for a valid instrumental variable.

Table 3 reports the results using the total index of digital inclusive finance in other counties (districts) within the same region, excluding the focal county (district), as the instrumental variable. The strong and significant correlation between the instrument and the endogenous digital finance variable (column 1) confirms the relevance of the instrument. Importantly, the results in column 2 are consistent with the benchmark regression, supporting the robustness of the previous findings.

Table 3. Test Results of Instrumental Variables

	(1)	(2)
	diif(DIFI/100)	Y
diif(DIFI/100)		
Instrumental Variable	0.992***(0.018)	0.142***(0.053)
PF		0.113*** (0.038)
PD		0.054*** (0.017)
Dep		0.059** (0.245)
C	0.008(0.021)	3.263***(0.266)

(2) Alternative Explanatory Variables:

In addition to the overall Digital Inclusive Finance Index used earlier, the Peking University Digital Inclusive Finance Index also includes sub-indices measuring digital finance coverage(CD), depth of usage,(UD) and degree of digitization(DD). This study follows the approach of Peng Peng et al. (2022) to further test the robustness of the benchmark regression by replacing the core explanatory variable with these alternative dimensions.

Table 4 presents the impact of these different aspects of digital finance on farmers' income. The results show that the coverage, depth of usage, and degree of digitization indices all have a statistically significant positive effect on rural high-quality development. This indicates that not only does the overall level of digital inclusive finance matter, but its various underlying dimensions can also significantly promote the high-quality development of rural areas.

These supplementary analyses fully demonstrate the reliability and consistency of the benchmark regression results reported earlier. By employing alternative explanatory variables, the study is able to corroborate the core finding that digital inclusive finance is an important driver of improved outcomes for rural residents.

Table 4. Replacement of Explanatory Variable Test Results

	(1)	(2)	(3)
	Y	Y	Y
CD	0.392***(0.046)		
UD		0.314***(0.017)	
DD			0.349***(0.031)
CONTROLV	YES	YES	YES
N	52	52	52

3. Mechanism Analysis

This study further explores the mechanism through which digital inclusive finance increases farmers' income. Table 5 presents the results of a mediation analysis using the three-step method. Column (1) shows that the development of digital inclusive finance has a significantly positive effect on farmers' income. Moving to column (2), we find that the coefficients for both digital finance and county-level industrial upgrading are positive and statistically significant. Importantly, the coefficient for digital finance decreases in magnitude compared to column (1), indicating the presence of a mediating effect through industrial structure transformation.

These results suggest that the positive impact of digital finance on farmers' income is partially channeled through an upgrading of the county-level industrial structure. Specifically, the expansion of digital finance has provided more convenient and accessible financial services, injecting greater productive resources into rural industries. This, in turn, has facilitated the upgrading of the county industrial structure, creating more employment opportunities for farmers. Consequently, the avenues for increasing farmers' incomes have been broadened, leading to the observed rise in their earnings.

In summary, these findings validate Hypothesis 2 of the study - the development of digital inclusive finance in the southeastern Chongqing region has indeed promoted the upgrading of county-level industries, which has served as an important mechanism for improving farmers' income levels.

Table 5. Mediation Effect and Moderating Variable Regression Results

	(1)	(2)	(3)
	IS	Y	Y
diif(DIFI/100)	0.812***(0.188)	0.362***(0.041)	0.339***(0.032)
IS		0.046*(0.017)	
Support G			-0.615***(0.126)
diif(DIFI/100)×Support G			-1.123***(0.361)
CONTROLV	YES	YES	YES
N	52	52	52

4. Regulatory Effect of Government Support

To consider the potential moderating role of government support, the study applies equation (4) to estimate the interaction between the level of digital inclusive finance development and the degree of government support. The results are presented in Table 5.

The findings show that when the two factors - digital finance development and government support - are considered jointly, the regression coefficient for the digital finance development level is significantly positive, while the interaction term coefficient is significantly negative. Both are statistically significant at the 1% level.

This indicates that government support significantly weakens the positive impact of digital inclusive finance development on growth in farmers' incomes. Thus, Hypothesis 3 proposed in this study is not supported.

One potential explanation for this result is that areas with less government intervention often have a higher degree of market competition among digital finance enterprises. This competitive pressure forces firms to expand their financial services to reach more remote locations and innovate new products to better meet the needs of rural populations. This, in turn, further promotes the development of digital inclusive finance in rural areas, allowing more farmers to benefit.

In contrast, in regions where enterprises rely heavily on government subsidies and social investment capital, financial resources may be directed towards less efficient and lower-income areas, rather than being allocated efficiently by market forces. This non-market behavior may become increasingly difficult to sustain as the digital economy evolves and information asymmetries in rural areas diminish.

Overall, these findings suggest that over-reliance on government support can actually hinder the positive impacts of digital inclusive finance on improving farmers' incomes, highlighting the important role of market competition and efficiency in driving rural financial development.

4. Conclusion and Recommendations

This article analyzes the impact and mechanism of digital inclusive finance on the income of farmers in the southeastern region of Chongqing, using county-level panel data from 2014 to 2022 for empirical testing. The findings are as follows:

The development of digital inclusive finance has a significant positive effect on increasing farmers' income in the southeastern region of Chongqing. The digitalization of traditional financial systems and the extension of financial services have led to more financial resources flowing into agriculture and rural areas, boosting the agricultural economy and farmers' incomes.

The upgrading of county-level industries has played a mediating role in improving farmers' income through digital inclusive finance. The development of digital finance has promoted the transition from labor-intensive to capital-intensive and technology-intensive industries, expanding income sources for rural residents and driving farmers' income growth.

Government intervention is not conducive to the healthy development of digital inclusive finance, which in turn affects farmers' incomes. Strengthening financial supervision, improving fund utilization efficiency, and clarifying financial property rights are crucial to promoting the market-oriented allocation of financial resources.

Based on these findings, the following policy recommendations are proposed:

Strengthen the organic integration of financial services and digital technology, expand coverage and deepen usage. Improve rural internet infrastructure, build agricultural information databases, and provide more efficient digital financial services for small-scale users.

Continuously promote the development of digital inclusive finance. Increase investment in rural digital infrastructure, support the digital transformation of traditional financial institutions, and explore new digital finance products and formats tailored to farmers' production and life needs.

Standardize local government behavior, reduce coercion, and improve policy targeting. Strengthen fiscal and financial supervision, implement accountability systems, and ensure that financial funds are used for their intended purposes, improving the efficiency of fiscal expenditure.

Clarify financial property rights and promote market allocation of financial resources. Coordinate the relationship between the market and the government, affirm the decisive role of the financial market in resource allocation, and establish a more perfect market intermediary system.

The study has certain limitations, as it only covers the southeastern region of Chongqing with a small sample size, and cannot fully represent the nationwide impact of digital inclusive finance on farmers' incomes. Further research is needed to expand the scope and deepen the analysis.

Fund project

The driving mechanism and implementation path of digital finance empowering migrant workers in the southeast of Chongqing to return to their hometowns for re employment (xj2318), Wang Zefang, Department of Finance and Tourism Business.

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