Economic Society and Humanities Vol. 1 No. 11, 2024

Research on the Mechanism and Effects of Digital Inclusive Finance in Promoting the Development of Rural Revitalization: Based on Spatial Spillover Effects

Qi Zheng, Jianhua Zhu, Xinyi Li
School of Applied Economics, Guizhou University of Finance and Economics, Guiyang, Guizhou, China

Abstract: This paper first analyzes the mechanism of digital inclusive finance in promoting the development of rural revitalization from a theoretical perspective, and then conducts, using provincial panel data from 2012 to 2022 as a sample, an empirical study of the effects of digital inclusive finance in promoting the development of rural revitalization. The empirical results show that firstly, digital inclusive finance can significantly promote the development of rural revitalization, and through technological innovation in agriculture, it can also indirectly promote the development of rural revitalization; this result has passed stability test and endogeneity test. Secondly, the promoting effect of digital inclusive finance on rural revitalization is significant in the eastern and western regions, but its incentive effect is not obvious in the central region. Finally, digital inclusive finance displays a significant spatial spillover effect in promoting rural revitalization. Based on the above empirical research conclusions, this paper proposes a series of targeted recommendations to help better promote rural revitalization.

Keywords: Digital Inclusive Finance; Rural Revitalization; Mediator Effect; Spatial Spillover Effect

1. Introduction

Agriculture has always been regarded as a foundation for national stability and people's livelihood. In recent years, a series of important policies and guidelines have been introduced focusing on issues related to agriculture, rural areas, and farmers (referred to as the "Three Rural Issues"), particularly with regard to the execution of the rural revitalization strategy. These policies deeply elaborate on the strategy's essence, direction, framework, fundamental tasks, and guiding principles, providing essential guidance for advancing a rural revitalization path tailored to local characteristics. The latest report emphasizes that the most challenging tasks in achieving modernization goals remain in rural areas. As a vital component of the financial system, rural finance plays a crucial role in driving rural economic development and addressing the "Three Rural Issues." Thus, the full-scale promotion of rural revitalization depends on strong financial support.

By integrating digital technology into inclusive finance, digital inclusive finance overcomes the spatial and temporal constraints inherent in traditional economic activities, creating new opportunities for capital acquisition. Furthermore, advancements in technology drive the continuous improvement of financial services. Amid the digital transformation, this financial model has rapidly evolved to address challenges faced by traditional inclusive finance in rural regions. It effectively tackles the "last mile" issue in providing financial services, thereby opening up greater potential for rural economic development and revitalization [1].

Strengthening rural revitalization is a critical step toward enhancing China's agricultural capabilities. Fundamentally, it involves the transformation and surpassing of traditional rural society in China [2]; Academically, it is widely understood as encompassing five key dimensions: thriving industries, harmonious living environments, social integrity, effective governance, and prosperity [3].

Although many studies have explored the role of digital inclusive finance in rural revitalization, most have focused on theoretical aspects or its contributions to

poverty alleviation and industrial integration. [4] However, limited attention has been paid to its specific mechanisms and impacts in this context. To address this research gap, this study builds hypotheses and selects rural revitalization indicators based on existing literature. Using provincial panel data spanning 2012 to 2022, the study conducts an empirical analysis to explore how digital inclusive finance affects rural revitalization and evaluates its impact.

2. Research Hypotheses

2.1 Direct Impact of Digital Inclusive Finance on Rural Revitalization

By addressing financial exclusion in rural areas, financial institutions leveraging internet-based platforms can enhance the accessibility of financial services. Referencing the 2018 No. 1 Central Document, titled Opinions on Implementing the Rural Revitalization Strategy, it is evident that digital inclusive finance directly impacts rural revitalization across five specific dimensions: (1) Enhancing Industrial Structure: Digital inclusive finance facilitates industrial upgrading by integrating digital technologies that foster innovation and entrepreneurial activities. Its broad reach and deep integration further accelerate the transformation of industrial structures [5]; (2) Promoting Rural Culture: Digital inclusive finance supports the growth of rural culture by providing essential financial resources and funding. This reduces the financial burden on rural families, enabling children to access quality educational resources while encouraging households to increase investments in education and improve cultural literacy [6]; (3) Digital inclusive finance can enhance the effectiveness of rural governance. It accelerates the deep integration of digital technology with government supervision, providing an efficient and convenient digital service platform for rural governance [7]; (4) Digital inclusive finance can contribute to rural environmental development. Digital finance can provide appropriate loans to residents, laying an economic foundation for a habitable rural environment. Moreover, it can guide green industries and projects into rural areas, promoting rural revitalization and playing a positive role in the protection and cultivation of forest resources and in technological transformation of the breeding sector [8]; (5) Digital inclusive finance improves rural residents' economic conditions and living standards. To evaluate rural revitalization effectively, clear indicators are required, with rural residents' income being the most direct. The digital features of inclusive finance, which steadily reduce the urban-rural income gap, play a pivotal role in driving rural revitalization People can utilize idle funds to diversify asset allocation and obtain support conveniently when there is a need for financial integration in their production and daily life [9]. Additionally, some rural families, empowered by digital inclusive finance, have embarked on e-commerce, which not only allows them to smoothly market their products across the country but also enriches their own consumption methods, uncovers the nation’s latent consumption potential, and stimulates domestic demand [10]. Building on the above statement, this paper proposes Hypothesis One (H1).

H1: Digital inclusive finance has a significant, direct, and positive impact on the development of rural revitalization.

2.2 The Indirect Impact of Digital Inclusive Finance on Rural Revitalization

The rural revitalization strategy is a cornerstone of China’s high-quality development; adherence to the priority of agricultural and rural development is an essential component of building up China’s strength in agriculture, while the innovation of agricultural technology, which is typically facilitated by the use of digital inclusive finance, is another key point during this effort. By providing convenient payment services, accessible credit facilities, and functions such as product traceability and market connection, digital inclusive finance equips farmers and agricultural practitioners with better tools and support, thereby promoting the development and application of agricultural technology [11]. Promoting the sustainable and high-quality advancement of agriculture, achieving rural and agricultural modernization, and contributing to rural revitalization are critical challenges for China. Since the launch of reform and opening-up, technological innovation has played a pivotal role in agriculture. It has significantly driven

agricultural economic growth, propelled industrial progress in the agricultural sector, and sped up the modernization of agriculture and the revitalization of rural areas.

H2: Digital Inclusive Finance indirectly promotes the development of rural revitalization through optimizing agricultural technological innovation.

2.3 Spatial Effects of Digital Inclusive Finance on Rural Revitalization

Spillover effects, in the context of economic activities, refer to the external effects from a given economy on surrounding areas. Similar to externality, spillover effects can be either positive or negative. Digital inclusive finance, by nature, breaks through geographical constraints, with its dissemination and development exerting widespread spatial effects in disregard of vehicle limitations [12]. In a state of spatial interaction, regions are interdependent, and as the range of resource flow extends, the digital inclusive finance of a region affects its neighboring areas. Digital inclusive finance not only drives rural revitalization within developed regions but also benefits surrounding areas [13]. Remote regions with weaker economic foundations can utilize internet and mobile technology to enhance access to financial services. Furthermore, with advancements in artificial intelligence, inclusive digital finance improves fund liquidity across regions, offering crucial financing opportunities for small and micro-enterprises that have historically struggled to obtain credit. The capital required for rural development can be transferred from more developed areas through digital inclusive finance services, thus inducing positive spillover effects on various industries [14]. In light of the statement in this paragraph, this paper proposes the Hypothesis Three (H3).

H3: Digital Inclusive Finance has a significant positive spatial spillover effect on rural revitalization.

3. Research Design

3.1 Variable Selection

(1) Explained Variable. Measurement Indicators for Rural Revitalization (Rural): There are various ways to measure rural revitalization. This paper follows the principles of constructing a composite indicator system that is effective, systematic, and operable. Drawing on the research of Huang and Yang [15], This paper adopts the five dimensions outlined in the Report — thriving businesses, livable environments, social civility, effective governance, and prosperity — as the core indicators for measuring rural revitalization. Based on this, 18 secondary indicators and 33 tertiary indicators (see Table 1) are selected, and the entropy weight method is employed to measure the level of rural revitalization development across China's 31 provinces from 2012 to 2022, offering a comprehensive evaluation of rural revitalization.

(2) Explanatory Variable. Digital Inclusive Finance (Difi): This paper utilizes the Peking University Digital Financial Inclusion Index of China (2012–2022) to assess the development level of digital inclusive finance: [16]

(3) Mediator Variable. Technological Innovation in Agriculture (Tech): Agricultural technological innovation serves as the key driver of high-quality agricultural development and a crucial pathway for advancing rural revitalization. Agricultural technology innovation generally refers to the innovation of agricultural technology invention, which has three effects in reducing agricultural costs, improving the output rate of agricultural factors, and optimizing the agricultural structure, all of which contribute to the high-quality development of the agricultural economy, thereby increasing farmers' income. Increasing farmers' income is the primary focus of rural revitalization. Accordingly, drawing from existing research, this paper defines the variable Tech as the natural logarithm of the total number of authorized agricultural invention patents plus 1.

(4) Control Variables. In order to maximize the accuracy of empirical results and reduce endogeneity issues arising from omitted variables, the following control variables are selected after reviewing existing literature and research.

Table 1. System of Measurement Indicators for Rural Revitalization

Primary Indicators	Secondary Indicators	Tertiary Indicators
Thriving Businesses	Basic Capacity for Agricultural Production	Per Capita Total Agricultural Machinery Power
		Comprehensive Grain Production Capacity

	Level of Agricultural Development	Grain Total Output Value/Rural Population
	Agricultural Production Efficiency	Agricultural Labor Productivity
	Level of Industry Integration	Prime Operating Revenue of Agricultural Product Processing Enterprises Above a Designated Size
	Green Development in Agriculture	Effective Recycling Rate of Livestock and Poultry Waste
	Rural Human Settlement Environment Management	Proportion of Administrative Villages with Domestic Wastewater Treatment
		Proportion of Administrative Villages with Household Garbage Treatment
		Proportion of Villages with Sanitary Toilets
	Rural Ecological Protection	Rural Greening Rate
Social Etiquette and Civility	Educational Level of Farmers	Proportion of Rural Residents' Education and Cultural Expenditure
		Percentage of Full-time Teachers Holding a Bachelor's Degree or Higher in Rural Compulsory Education Schools
		Average Years of Education for Rural Residents
	Traditional Culture Dissemination	Cable TV Coverage Rate
		Percentage of Administrative Villages Covered by Broadband Internet Services
	Rural Public Cultural Construction	Average Coverage Rate of Rural Broadcast Programs and Television Programs
		Number of Rural Cultural Stations
Effective Governance	Governance Capability	Proportion of Villages with the Same Individual Holding Both the Positions of Village Secretary and Head of the Villagers Committee
	Governance Measures	Proportion of Administrative Villages with Compiled Village Plans
	Rural Poverty Level	Number of Rural Residents on the Minimum Living Security
Prosperity	Income Level of Farmers	Per Capita Net Income of Farmers
		Growth Rate of Per Capita Income of Farmers
		Income Ratio Between Urban and Rural Residents
		Proportion of Rural Residents Below the Poverty Line
	Consumption Structure of Farmers	Engel's Coefficient for Rural Residents
	Living Conditions of Farmers	Number of Cars Per Hundred Households
		Average Housing Area Per Rural Resident
	Level of Infrastructure Construction	Proportion of Villages with Safe Drinking Water
		Proportion of Villages with Hardened Roads
		Average Road Area Per Person
	Basic Public Service Guarantee Level	Investment in Public Facilities Construction
		Number of Health Technicians Per 1,000 Rural Residents

① Industrial Structure (Indus): The industrial structure reflects the proportional relationship between various industries in the economy, and different industrial structures have different impacts on rural development. For example, the development of the service industry and manufacturing can provide rural areas with more employment opportunities and increase farmers' income, while also promoting rural industrialization and urbanization.

② Level of Fiscal Support for Agriculture (Fisal): The level of fiscal support directly influences the momentum of rural development. Establishing robust rural infrastructure is a key strategy to advance rural industries, enhance self-governance, and improve living conditions in rural areas.

③ Digital Infrastructure (Infra): The construction of digital infrastructure is the foundation of digitization and the cornerstone of promoting rural revitalization through digital inclusive finance.

④ Level of Fertilizer Implementation in Agriculture (Fertail): As per *Action Plan for Chemical Pesticides Reduction by 2025* issued by Ministry of Agriculture and Rural Affairs of the People's Republic of China in 2022, which

proposed the "One Reduction and Three Increases" strategy (referring to a specific approach in fertilizer management that focuses on reducing the amount of chemical fertilizers while increasing the utilization of organic fertilizers, the coverage of soil testing and formulation-based fertilization, and the efficiency of fertilizer application), fertilizer use should be reduced by 10% in fruit, vegetable, and tea areas to establish a system of "high yield, high quality, economical, and environmentally friendly" fertilizer application and ecological tolerance, so as to help rural revitalization.

3.2 Model Construction

(1) Benchmark Regression Model. The use of linear regression methods to analyze the interactions and impacts between variables is widespread in data analysis. Therefore, this paper selects the least squares method as the benchmark model to reflect the direct impact of digital inclusive finance on rural revitalization:

$$Rural = \beta + \beta_1 Difi + \beta_2 Indus + \beta_3 Fisal + \beta_4 Infra + \beta_5 Fertail + \omega \quad (1)$$

In equation (1), Rural is the dependent variable, reflecting the degree of rural revitalization, while Difi serves as the core independent variable, representing the digital financial inclusion index. The control variables include Indus, Fisal, Infra, and Fertail, as previously discussed. The random error term is denoted by σ, and the coefficient β0 captures the influence of digital inclusive finance on rural revitalization. A significantly positive β0 suggests that digital inclusive finance exerts a notable positive effect on rural revitalization. This version minimizes redundancy while retaining the original meaning.

(2) Mediator Effect Model. To investigate whether digital inclusive finance impacts rural revitalization through agricultural technological innovation, this study applies a mediator effect model. The model construction involves three steps: First, the benchmark regression model (Model 1) is established as the foundation for the test. Second, Model 2 incorporates control variables, including agricultural industrial structure, fiscal support for agriculture, digital infrastructure, and fertilizer implementation levels. Finally, Model 3 integrates the mediator variable to assess the combined effects of digital inclusive finance and agricultural technological innovation on rural revitalization.

$$Tech = \sigma_0 + \sigma_1 Difi + \sum_{j=1}^{n} \sigma_j X + \omega \quad (2)$$

$$Rural = \theta_0 + \theta_1 Difi + \theta_2 Tech + \sum_{j=0}^{n} \theta_j X + \omega \quad (3)$$

(3) Spatial Spillover Effect Model. After a series of spatial model tests, this paper ultimately chooses to construct a spatial lag model to test its spatial spillover effect. The specific estimation model is as follows:

$$Rural = \varphi_1 + \varphi_2 X + \nu Difi + \mu WRural + \omega \quad (4)$$

Where Difi and WRural are the spatial lag terms for all explanatory variables including digital inclusive finance and rural revitalization. The spatial weight matrix used in this paper is set to the inverse of distance, that is, the larger the distance, the smaller the value.

4. Empirical Analysis

4.1 Descriptive Statistics

The data for this paper primarily originates from sources such as the Peking University Digital Financial Inclusion Index of China, the China Statistical Yearbook, the EPS database, and the China Rural Statistical Yearbook, encompassing provincial data from 2012 to 2022. Missing data were interpolated to ensure completeness. Additionally, to mitigate the impact of outliers on the results, some data were log-transformed. Detailed descriptive statistics for each variable are presented in Table 2.

Table 2. Descriptive Statistical Results of Variables

Variable	Rural	Difi	Tech	Indus	Fisal	Infra	Fertail
Mean	0.323	5.489	7.505	0.334	6.239	1.753	4.779
Standard Deviation	0.142	0.4199	1.191	0.058	0.567	0.907	1.307
Minimum	0.088	4.119	2.485	0.148	4.615	0	1.040
Maximum	0.794	6.132	9.720	0.462	7.215	6.456	6.574
Sample Size	341	341	341	341	341	341	341

4.2 Benchmark Regression Results and Analysis

Table 3 presents the benchmark regression results analyzing the direct impact of digital inclusive finance on rural revitalization. This

study tested robustness by incrementally adding control variables, observing changes in degrees of freedom. Robustness was assessed by examining the relationship between the core explanatory variable and the explained variables under various control conditions. Consistent signs of the core explanatory variable indicate strong robustness, while changes suggest poor robustness and potential inaccuracies in the results.

Columns 2 through 6 in Table 3 present the regression outcomes with the progressive inclusion of control variables. The results are largely positive, indicating a strong positive correlation between the strength of digital inclusive finance and the effectiveness of rural revitalization. Columns 2 indicates the direct impact of digital inclusive finance on rural revitalization without controlling for other variables, and the result is statistically significant at a 99% confidence level ($\rho < 0.01$), suggesting a high level of confidence in the findings. The coefficient for the effect of digital inclusive finance on rural revitalization is considerable, at 0.113, which signifies a favorable outcome. In the next column, after the introduction of controls for agricultural industrial structure (Indus). The influence of digital inclusive finance on rural revitalization remains statistically significant at the 99% confidence level with a coefficient of 0.0938. However, the coefficient for industrial structure is found to be significantly negative at the 99% confidence level, implying that it acts as a constraint on rural revitalization. This may be attributed to the fact that secondary industry, which includes sectors like mining, manufacturing, and energy, potentially dominates at the expense of other industries. The secondary industry makes notably less contribution to rural revitalization than do other industries and hinders the integration of the three industries, thus offsetting the positive impact of its development. For the next column, the level of fiscal support for agriculture (Fisal) is further added. The core explanatory variable continues to be significant at the 99% confidence level, and the coefficient for the level of fiscal support for agriculture is also significant at the 95% confidence level ($\rho < 0.05$). The rationale may involve fiscal support providing direct financial assistance to rural development and overcoming capital constraints, while also sending positive signals to attract social capital to rural industries, thereby promoting rural revitalization. The next column adds digital infrastructure (Infra) to the model. The core explanatory variable remains significant at the 99% confidence level, although the coefficient decreases by 0.0125. The coefficient for digital infrastructure is -0.055; the underlying cause is the expanding share of urban broadband subscribers, which correspondingly decreases the proportion of rural users. This disparity is compounded by the relative paucity of income-generating opportunities in rural regions, prompting a shift towards urban labor among the youth. Additionally, the inadequate digital infrastructure in rural areas underpins the shallow penetration of inclusive finance, contributing to a persistent imbalance in the rural financial market. These factors collectively impede the maximization of resource efficiency. In the next column, the level of fertilizer implementation in agriculture (Fertail) is added. The coefficient for the core explanatory variable increases by 0.021, and the level of agricultural fertilizer application is also significantly positive at the 99% confidence level for rural revitalization. The rationale is attributed to its contributions in boosting fertilizer efficiency, enhancing soil conditions, controlling pests and diseases, advancing agricultural modernization, and stimulating the growth of associated sectors, all of which offer substantial support to the revitalization of rural areas. In light of these findings, the evidence confirms H1.

Table 3. Benchmark Regression Results

Variable	(1)	(2)	(3)	(4)	(5)
Difi	0.113***	0.0938***	0.0695***	0.057***	0.078***
	(6.74)	(5.50)	(3.56)	(3.03)	(4.24)
Indus		-0.402***	-0.505***	-0.441***	-0.506***
		(-3.93)	(-4.63)	(-4.09)	(-4.88)
Fisal			0.0369**	0.075***	0.044***
			(2.50)	(4.90)	(3.00)
Infra				-0.055***	-0.064***
				(-5.97)	(-6.44)
Fertail					0.026***
					(4.95)
_cons	-0.288***	-0.0511	-0.113	-0.436***	-0.436***
	(-3.18)	(-0.48)	(-1.05)	(-4.09)	(-4.09)
N	341	341	341	341	341

t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ (the same below)

4.3 Mediator Effect Regression Results and Analysis

The benchmark regression results demonstrate

that inclusive digital finance contributes to rural revitalization. To explore the mechanism behind this effect, agricultural technological innovation is incorporated as a mediator variable. The regression findings are detailed in Table 4. The second column in Table 4 shows the baseline results for the direct influence of inclusive digital finance on rural revitalization. The following column analyzes the impact of inclusive digital finance on agricultural technological innovation, which is highly significant at the 99% confidence level. A regression coefficient of approximately 1.333 confirms the strong and positive effect of inclusive digital finance on agricultural technological innovation. In the final column, when both variables are included in the model, the coefficient for inclusive digital finance becomes insignificant, while agricultural technological innovation retains its significant positive coefficient. This validates the full mediation effect, confirming the pathway of "inclusive digital finance → agricultural technological innovation → rural revitalization" and supporting hypothesis H2.

Table 4. Mediator Effect Regression Results

	(1)	(2)	(3)
	Rural	Tech	Rural
Difi	0.0777***	1.3325***	-0.0243
	(0.0000)	(0.0000)	(0.1985)
Tech			0.0766***
			(0.0000)
_cons	-0.4356***	-7.6052***	0.1468
	(0.0001)	(0.0000)	(0.2290)
N	341	341	341
adj. R^2	0.2707	0.6323	0.4208

4.4 Robustness Tests

This study utilizes four methods to ensure the robustness of the model and validate the hypotheses:

Data Treatment: Logarithmic and absolute value transformations were applied to minimize distortions in empirical results. Following Li Weibing's approach, the time window was shortened, and the sample adjusted to include data from 2012 to 2021. Regression results in the second column of Table 5 demonstrate significance at the 99% confidence level.

Sub-dimensions of Digital Inclusive Finance: The core explanatory variable was replaced with two sub-dimensions—depth of use and breadth of coverage—to analyze their impacts on rural revitalization. Results in the third and fourth columns of Table 5 reveal consistency with the comprehensive index, with breadth of coverage showing a larger coefficient. This suggests that its direct effects become evident once coverage reaches a certain threshold, while depth of use has more pronounced impacts on rural industries over time. Both sub-dimensions confirm the role of digital inclusive finance in alleviating rural poverty.

Outlier Treatment: To address potential outliers, 1% trimming was applied to both ends of the sample data. Results in the fifth column of Table 5 show no significant difference in coefficients from the benchmark regression, reinforcing the robustness of prior findings.

Excluding Pandemic Data: To account for the economic impacts of COVID-19, data from 2020 were excluded, and a regression was conducted on the adjusted sample. Results in the sixth column of Table 5 remain consistent with the benchmark regression, further supporting the robustness of the conclusions.

Table 5. Robustness Test

	(1)	(2)	(3)	(4)	(5)
Variable	Shortened Time Window	Replaced Independent Variable	Replaced Independent Variable	Variable Trimming	Data Excluding Impact of COVID-19 Pandemic
Difi	0.072***			0.077***	0.075***
	(3.68)			(3.86)	(3.95)
Lnc		0.060***			
		(3.93)			
Lnb			0.107***		
			(6.00)		
Fertail	0.025***	0.025***	0.028***	0.028***	0.025***
	(4.62)	(4.75)	(5.43)	(4.62)	(4.47)
Fisal	0.046***	0.047***	0.029**	0.033**	0.047***
	(2.94)	(3.28)	(2.02)	(2.01)	(3.07)

Indus	-0.451***	-0.526***	-0.450***	-0.378***	-0.503***
	(-4.05)	(-5.10)	(-4.49)	(-3.17)	(-4.58)
Infra	-0.063***	-0.063***	-0.061***	-0.059***	-0.062***
	(-6.24)	(-6.34)	(-6.24)	(-4.36)	(-5.92)
Constant	-0.437***	-0.344***	-0.530***	-0.411***	-0.431***
	(-4.00)	(-3.57)	(-5.31)	(-3.22)	(-3.94)
Observations	310	341	341	315	310
R-squared	0.276	0.278	0.313	0.198	0.273

4.5 Endogeneity Test

During the 1980s, China's internet development was in its infancy, with limited fixed telephone penetration constraining internet access. Digital inclusive finance later emerged, relying heavily on mobile internet. Consequently, the number of fixed telephones is linked to the development of digital inclusive finance in this study. Additionally, as rural revitalization progresses, the demand for financial resources grows, prompting upgrades to digital infrastructure. This highlights a bidirectional causality where rural revitalization also fosters financial resource concentration in rural areas.

To address the endogeneity issues, this study employs the two-stage least squares (2SLS) method to improve the reliability of the findings. To resolve reverse causality and biases from omitted variables, the lagged digital inclusive finance index (by one period) and the cross-term of fixed telephone numbers per million people (1984) with national information technology service revenue from the previous year were chosen as instrumental variables.

Table 6. Endogeneity Test

	(4)		(5)	
VARIABLES	Instrumental Variable 1		Instrumental Variable 2	
	first	second	first	second
Difi		0.0622***		0.1054***
		(3.05)		(3.92)
Instrument	0.5744***			
	(57.84)			
Gongju3			0.3951***	
			(19.27)	
Fertail	-0.0162***	0.0244***	0.0179	0.0286***
	(-2.86)	(3.60)	(1.29)	(4.08)
Fisal	0.0539***	0.0505***	0.2115***	0.0315*
	(3.97)	(3.04)	(7.18)	(1.72)
Indus	-0.3100***	-0.5410***	-0.4907**	-0.4418***
	(-2.92)	(-4.24)	(-1.98)	(-3.29)
Infra	-0.0064	-0.0639***	0.0696***	-0.0637***
	(-0.91)	(-7.68)	(4.21)	(-7.64)
Constant	2.2884***	-0.3750***	0.8154***	-0.5464***
	(27.26)	(-3.04)	(3.36)	(-3.85)
Observations	341	341	341	341
R-squared		0.280		0.276

The first test, using the lagged digital inclusive finance index, yielded the following results: LM statistic = 309.957, P-value = 0.0000, rejecting the null hypothesis of "instrumental variable is not identified"; the Wald F value for weak instrumental variable testing was 3344.952, with a P-value = 0.0000, exceeding the 10% critical value. This confirms the appropriateness of the instrumental variables. Similarly, the cross-term test produced identical results (LM statistic = 309.957, P-value = 0.0000; Wald F value = 3344.952, P-value = 0.0000), further validating the reasonableness of the selected instruments.

Table 6 illustrates the regression outcomes for the two instrumental variables. Employing the two-stage least squares (2SLS) method, the core explanatory variable's coefficients are 0.0622 and 0.1054, with both reaching significance at the 1% level. This confirms that, after addressing endogeneity through the 2SLS approach, the core variable's coefficient values and their significance remain stable, affirming the robustness of the regression results.

4.6 Heterogeneity Analysis

Due to notable disparities in the development levels of digital inclusive finance across regions, this study categorizes China into three areas: eastern, central, and western, and performs regression analysis for each. As shown in Table 7, digital inclusive finance exerts a significant positive influence on rural revitalization in both the eastern and western regions, with a stronger effect observed in the western region. However, in the central region, the findings reveal a significant inhibitory impact. The eastern region, with its advanced financial system, higher economic development, and well-established industrial structure, provides farmers with diverse income opportunities, which reduces the relative advantages brought by digital inclusive finance. The central region, on the one hand, it lacks strong policy support, even showing negative effects of government intervention and inhibiting fiscal support for

agriculture; on the other hand, the central region has limited development space, with significant outflow of resources, education, and technology, which has constrained regional economic development, thus making the negative effect particularly prominent.

Table 7. Heterogeneity Results for Eastern, Central, and Western Regions of China

	(1)	(1)	(1)
VARIABLES	Eastern Region	Central Region	Western Region
Difi	0.043**	-0.104***	0.068*
	(2.22)	(-4.01)	(1.96)
Fertail	0.013**	-0.052***	0.049***
	(2.06)	(-3.52)	(3.16)
Fisal	0.097***	0.255***	-0.046
	(7.93)	(6.63)	(-1.14)
Indus	-0.503***	-0.711***	0.153
	(-5.24)	(-4.81)	(0.36)
Infra	-0.058***	-0.088***	0.058**
	(-8.78)	(-3.51)	(2.11)
Constant	-0.420***	-0.370	-0.015
	(-3.46)	(-1.60)	(-0.06)
Observations	121	88	132
R-squared	0.613	0.577	0.183

The impact of the identification of poverty-stricken counties on digital inclusive finance is primarily manifested in two aspects. First, the successful identification of poverty-stricken counties usually reflects the significant backwardness of local economic development and infrastructure, which directly hinders the penetration and efficacy of digital inclusive finance. Despite the advantages of digital inclusive finance over traditional finance, such as stronger permeability and faster dissemination, it still relies on infrastructure like the internet. Thus, the inadequacies in infrastructure in poverty-stricken counties may constrain the effectiveness of digital inclusive finance in improving rural poverty. Second, a series of supportive policies implemented by the state for poverty-stricken counties, including educational subsidies, industrial subsidies, and entrepreneurship assistance, can enhance the quality of life and living conditions of residents, thereby promoting the spread of digital inclusive finance and contributing to the alleviation of rural poverty. In summary, the influence of the identification of poverty-stricken counties on digital inclusive finance is dual in nature. Therefore, this section intends to compare different sub-samples, which is classified based on the presence or absence of poverty-stricken counties in each province, exploring the primary aspects of the impact of the identification of poverty-stricken counties on digital inclusive finance.

Table 8. Heterogeneity Results for Provinces with and without Poverty-stricken Counties

	(1)	(1)
VARIABLES	Provinces without Poverty-stricken Counties	Provinces with Poverty-stricken Counties
Difi	0.034	0.048**
	(1.55)	(2.14)
Fertail	-0.040***	0.047***
	(-2.78)	(6.42)
Fisal	0.162***	-0.010
	(7.88)	(-0.52)
Indus	0.177	-0.268
	(0.92)	(-1.60)
Infra	-0.053***	0.036*
	(-7.80)	(1.87)
Constant	-0.760***	0.004
	(-5.09)	(0.03)
Observations	99	242
R-squared	0.676	0.263

The results from Table 8 indicate that the coefficient for provinces with poverty-stricken counties is 0.048 and is significantly positive at the 95% confidence level, whereas the coefficient for provinces without poverty-stricken counties are not significant. This may be due to less governmental policy focus and resource allocation in provinces without poverty-stricken counties. These regions may not benefit from special fiscal subsidies, technical support, and educational training, and thus they suffer from a lack of necessary impetus for the promotion and application of digital inclusive finance. Moreover, the demand for financial services from rural residents and businesses in these areas may not be as urgent as in poverty-stricken regions. Traditional financial services may already adequately meet their needs, which leads to a smaller incremental effect from digital inclusive finance and hence its insignificant role in revitalizing these rural regions.

Considering the higher level of economic development in coastal provinces compared to inland provinces and the impact of maritime trade, this study separates the sample into coastal and inland categories for regression

analysis based on their geographic classification. The results in Table 9 reveal that the influence of digital inclusive finance is not significant in coastal regions but is notably positive in inland areas. This demonstrates that digital inclusive finance plays a crucial role in boosting farmers' income in inland provinces. Additionally, the limited effect of digital inclusive finance on rural revitalization in coastal areas may stem from higher baseline incomes and fewer financing constraints for business activities in those regions.

Table 9. Heterogeneity Results for Coastal and Inland Areas

	(1)	(1)
VARIABLES	Coastal Areas	Inland Areas
Difi	-0.031	0.044*
	(-1.38)	(1.91)
Fertail	-0.060***	0.030***
	(-4.62)	(4.36)
Fisal	0.176***	0.012
	(10.04)	(0.64)
Indus	-0.645***	-0.731***
	(-3.42)	(-5.30)
Infra	-0.025***	-0.014
	(-2.82)	(-0.72)
Constant	-0.042	0.041
	(-0.23)	(0.29)
Observations	110	231
R-squared	0.722	0.227

4.7 Analysis of Spatial Spillover Effects

Before using the spatial econometric model to analyze spillover effects, this study first performed a global spatial autocorrelation analysis on the digital inclusive finance and rural revitalization indices across 31 provinces in China between 2012 and 2022. The results shown in Table 10 indicate that the Moran's I index for digital inclusive finance from 2020 to 2022 was not statistically significant. It is worth noting that the Moran's I test is a straightforward approach for detecting spatial autocorrelation in residuals and is not directly tied to the significance of the spatial lag or error terms of the dependent variable in the model [17]. Additionally, the Moran's I index for digital inclusive finance during 2012–2019 and the rural revitalization index for 2012–2022 were found to be significant. Therefore, it can still be inferred that digital inclusive finance shows a certain degree of spatial correlation, ensuring the validity of the spatial spillover analysis. Combining these findings with relevant literature, it can be summarized that the spatial clustering phenomenon of digital finance is objectively present. [18]

Table 10. Results of Spatial Autocorrelation Test

Year	Digital Inclusive Finance				Rural Revitalization			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	I	Sd	Z	P-value	I	Sd	Z	P-value
2012	0.012	0.034	1.318	0.094	0.139	0.034	5.013	0.000
2013	0.012	0.034	1.325	0.093	0.139	0.034	5.013	0.000
2014	0.007	0.034	1.177	0.120	0.134	0.034	4.866	0.000
2015	0.013	0.034	1.358	0.087	0.105	0.034	4.045	0.000
2016	0.016	0.034	1.437	0.075	0.135	0.034	4.903	0.000
2017	0.014	0.034	1.369	0.086	0.140	0.034	5.066	0.000
2018	0.011	0.034	1.296	0.098	0.150	0.034	5.323	0.000
2019	0.011	0.034	1.287	0.099	0.154	0.034	5.423	0.000
2020	0.010	0.034	1.245	0.107	0.158	0.034	5.551	0.000
2021	0.007	0.034	1.166	0.122	0.164	0.035	5.716	0.000
2022	0.008	0.034	1.027	0.114	0.166	0.035	5.750	0.000

Table 11 presents the results of the LR test and LM test using the Stata software to preliminarily select the model. The null hypothesis of the LR test is that the Spatial Durbin Model (SDM) can be simplified to the Spatial Lag Model (SAR) or Spatial Error Model (SEM). As shown in the table, the result of SEM is not significant in the LR test, while the result of SAR is significant at the 99% confidence level. Combined with the LM test, the spatial lag model is chosen to examine the spatial spillover effects.

Table 11. Results of LM Test and LR Test

Model	LM Test		LR Test	
	Test Statistic	P Value	Test Statistic	P Value
SEM	2.247	0.134	26.59	0.001
SAR	6.92	0.000	9.27	0.098

Table 12 examines the spatial effects of digital inclusive finance on rural revitalization. The total effect of inclusive digital finance on rural revitalization is reported as 0.619, significant at the 99% confidence level. This total effect is broken down into direct and indirect impacts, with coefficients of 0.343 and 0.306, respectively, both significant at the 99% confidence level. These findings indicate that inclusive digital finance not only advances rural revitalization in the local province but also supports the revitalization of surrounding regions. Inclusive digital finance, characterized by its "digitization" and "inclusiveness," enables users to overcome geographical barriers and access convenient financial services anytime and anywhere. As a result, inclusive digital finance enhances rural revitalization locally while also fostering rural revitalization in neighboring areas.

Regarding the level of fertilizer implementation, its total effect is also significant at the 99% confidence level, with direct and indirect effects of 0.132 and 0.118, respectively. This suggests that an increase in a province's fertilizer usage not only contributes to local rural revitalization but also stimulates rural revitalization in adjacent provinces. This may be because higher fertilizer implementation improves farmers' incomes, driving rural revitalization. Additionally, collaborative efforts in fertilizer technology research and promotion with neighboring provinces, including inter-provincial demonstration zones and technical training, have helped farmers master advanced fertilization methods, improving agricultural productivity and supporting rural development.

The coefficient for the total effect of fiscal support for agriculture is 0.08, significant at the 95% confidence level, with direct and indirect coefficients of 0.042 and 0.038, which are significant at the 99% and 95% confidence levels, respectively. Fiscal support for agriculture has an overall positive impact on rural revitalization and development. For the development of agriculture and rural areas, fiscal support plays a crucial role, such as enabling infrastructure projects like roads, water facilities, and broadband networks, and ensuring subsidies for farmers during poor harvest years. In recent years, governments at all levels have actively promoted rural revitalization through increased agricultural subsidies and investments in the Building a Beautiful Countryside initiative, effectively boosting local agriculture and rural development. Insignificant statistical results of Indus and Infra indicate that an excessive secondary industry proportion and oversized urban broadband access are detrimental to local and neighboring rural revitalization. In light of the above results, H3 has been verified.

Table 12. Spatial Spillover Effect

	(1)	(2)	(3)
VARIABLES	Direct	Indirect	Overall
Difi	0.343***	0.306***	0.649***
	(5.04)	(5.77)	(6.02)
Fertail	0.132***	0.118***	0.250***
	(3.17)	(2.96)	(3.19)
Fisal	0.042***	0.038**	0.080**
	(2.63)	(2.36)	(2.56)
Indus	-0.174	-0.156	-0.329
	(-1.46)	(-1.41)	(-1.45)
Infra	-0.003	-0.003	-0.006
	(-0.58)	(-0.57)	(-0.58)
rho	0.515***		
	(10.23)		
sigma2_e	0.001***		
	(12.78)		
Observations	341	341	341
R-squared	0.005	0.005	0.005
Number of id	31	31	31

5. Conclusion and Policy Recommendations

5.1 Conclusion

This research adopts a dataset covering 31 provinces in China from 2012 to 2022 to explore the roles and impacts of inclusive digital finance on rural revitalization. Key findings include: (1) Inclusive digital finance significantly enhances rural revitalization, a result confirmed through robustness and endogeneity testing. (2) Agricultural technological advancements are a vital channel through which inclusive digital finance supports rural development. (3) There are notable spatial spillover effects, where inclusive digital finance impacts not just local areas but also contributes to the growth of neighboring regions. This highlights how inclusive digital finance promotes coordinated regional development while narrowing inter-regional disparities. (4) The analysis

reveals variations in the influence of inclusive digital finance on rural revitalization across regions, with more pronounced effects observed in inland provinces compared to coastal ones. Furthermore, the growth effect is stronger in provinces containing poverty-stricken areas and is evident across both eastern and western regions.

5.2 Policy Recommendations

Based on the conclusions drawn above, this paper offers the following policy recommendations for the consideration of policymakers:

(1) The findings from the empirical analysis of this research reveal that inclusive digital finance serves as a significant contributor to the ongoing progress within the rural revitalization framework. Consequently, the government should take a leading role by increasing fiscal investment and enhancing policy support for inclusive digital finance. Banks and financial institutions are encouraged to innovate in digital financial services while fostering the expansion of digital finance. Furthermore, the government can utilize its organizational capacity and motivational influence to actively advance and popularize inclusive digital finance within rural communities.

(2) Priority should be given to the training of digital talent in rural areas and the enhancement of agricultural technological innovation capabilities. As rural industries undergo digital transformation, local governments should devise tailored implementation plans based on the fundamental conditions and specific needs of diverse entities. For individuals responsible for rural digital infrastructure, such as the resident first secretaries of CPC village committees, village officials assumed by college graduates, and other people of responsibility, the focus should be on training in digital management, with an emphasis on establishing digital management platforms and addressing unforeseen issues. For management personnel in leading enterprises and extensive agricultural and livestock farms, the training should focus on key digital agricultural technologies, their application, promotion, innovative governance strategies, and relevant policy documentation.

(3) The top-level design of digital inclusive finance should be accelerated to fully harness its inclusive and digital nature in rural areas. Inclusive financial development plans should be tailored for the regional characteristics of the eastern, central, and western regions of China to ensure the full circulation and effective utilization of digital resources among these regions. Differentiated regulatory measures should be implemented and a comprehensive digital inclusive financial supervision system should be established.

Acknowledgments

This paper is suppotted by Scientific Scientific Research Program for Students Enrolled in Guizhou University of Finance and Economics, FY2024 [Project No.2024ZXS], and Graduate Education Innovation Program Project: "Mechanisms and Strategies for Digital Inclusive Finance to Promote Common Prosperity for Farmers and Rural Areas in Guizhou under the Context of New Productive Forces"[Projiect No.2024YJSKYJJ254]

References

[1] Weber, R., & Musshoff, O. (2012). Is Agricultural Microcredit Really More Risky? Evidence From Tanzania. Agricultural Finance Review, 72(3), 345-358.

[2] Fan, J. (2018). The Era Significance of the Rural Revitalization Strategy. Administrative Management Reform, (02), 16-21. (in Chinese)

[3] He, X. (2018). Some Issues Regarding the Implementation of the Rural Revitalization Strategy. Journal of Nanjing Agricultural University (Social Science Edition), 18(03), 19-26+152. (in Chinese)

[4] Zhou, L., Han, L., & Xiu, J. (2022). How Digital Inclusive Finance Helps Rural Revitalization: From the Perspective of Industrial Development. Southern Finance, (04), 70-78. (in Chinese)

[5] Si, Z., Cao, L., & Zhang, Y. (2024). Research on the Effect and Mechanism of Digital Inclusive Finance in Promoting Industrial Structure Upgrading. Journal of Capital University of Economics and Business, 26(02), 19-32. (in Chinese)

[6] Peng, J., & Li, Y. (2022). Digital Inclusive Finance and Equalization of Educational Opportunities. Statistics and Decision, 38(13), 142-146. (in Chinese)

[7] Chen, M., & Liu, Y. (2019). Interactive Group Governance: Research on Rural Governance Mode in the Internet Era. Issues in Agricultural Economy, (02), 33-42. (in Chinese)

[8] Yu, D., Zhao, J., & Lan, H. (2020). Research on the Mechanism of Rural Environmental Protection in the Tuojiang River Basin: From the Perspective of Green Finance. Journal of Chongqing University of Science and Technology (Social Science Edition), (04), 46-51. (in Chinese)

[9] Zhang, Y., Hu, W., & Li, J. (2022). Study on the Impact of Digital Inclusive Finance on the Consumption Gap Between Urban and Rural Residents. Macroeconomic Research, (04), 51-63. (in Chinese)

[10] Liang, Y., & Zhu, Y. (2022). Research on the Poverty Reduction Effect of Digital Inclusive Finance: An Empirical Analysis Based on Nationally Designated Poverty Counties. Industrial Economics Review, (05), 86-99. (in Chinese)

[11] Ye, Z. (2023). Research on the Impact of Digital Inclusive Finance on Agricultural Technology Progress Against the Background of Agricultural Modernization. Modern Finance, (09), 34-40+33. (in Chinese)

[12] Liu, D., Fang, R., & Tang, Y. (2019). The Spatial Spillover Effect of Digital Inclusive Finance Development on Farmers' Non-agricultural Income. Research on Financial Economics, 34(03), 57-66. (in Chinese)

[13] Zhang, S., & Li, J. (2024). The Spatial Spillover Effect of Digital Inclusive Finance in Promoting Rural Revitalization: An Empirical Analysis Based on Anhui Province. Journal of Guizhou Minzu University (Philosophy and Social Sciences), (01), 60-75. (in Chinese)

[14] Liu, J. (2023). The Impact of Digital Inclusive Finance on Rural Revitalization in Sichuan Province. [Doctoral dissertation, Sichuan University]. (in Chinese)

[15] Huang, B. W., & Yang, Y. C. (2018). Evaluation Indicators and Development Strategies of Agricultural Revitalization for Rural Rejuvenation. Journal of Reviews on Global Economics, (7), 123-134.

[16] Guo, F., Wang, J., Wang, F., et al. (2020). Measuring the Development of China's Digital Finance: Index Compilation and Spatial Characteristics. China Economic Quarterly, 19(04), 1401-1418. (in Chinese)

[17] Jiang, L. (2016). Reflection on the Selection of Spatial Regression Models. Statistics and Information Forum, 31(10), 10-16. (in Chinese)

[18] Liu, D., Fang, R., & Tang, Y. (2019). The Spatial Spillover Effect of Digital Inclusive Finance Development on Farmers' Non-agricultural Income. Research on Financial Economics, 34(03), 57-66. (in Chinese)