Study of the Digital Inclusive Finance, Entrepreneurial Activism and Rural Revitalization Based on Provincial Panel Data in China

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Abstract. According to the Central Document No. 1 of 2022, digital technology-driven rural financial inclusion will continue to take root across the country, and innovative applications of digitalization in financial services will continue to emerge, providing innovative solutions for rural revitalization. On the basis of the rural revitalization index measured by the entropy weight method, mediation effect model and spatial Durbin model are empirically tested to examine the inherent mechanism. Firstly, the findings indicate that digital inclusive finance significantly contributes to rural revitalization, even after modifying the method of robustness testing to employ the entropy TOPSIS method and selecting historical data as an instrumental variable. Second, stimulating mass entrepreneurship is an effective mechanism for digital inclusive finance to promote rural revitalization. Third, The positive impact of digital inclusive finance is accompanied by spatial spillovers, as demonstrated by spatial autoregression models and spatial Durbin models.

Keywords: Digital inclusive finance; Rural revitalization; Entrepreneurial activity; Spatial panel model.

1. Introduction

Rural revitalization is not only one of the core objectives of the 14th Five-Year Plan, but also a new challenge for building a strong socialist modern state and rejuvenating Chinese society as a whole. As a capital relief channel, rural finance is of utmost importance in rural revitalization strategies, because it is capable of supporting rural revitalization through individual behavior , industry-driven , environmental improvement , and social norm(Ye X.,2018). With the decrease in the threshold of financial services, reduced physical outlet restrictions, and an expansion of business hours, digital inclusive finance is able to facilitate the solution of the "last mile" feature of financial services and offers new opportunities for rural revitalization.

Therefore, how does digital inclusion finance contribute to rural revitalization? And whether to consider spatial transfer effects? It is imperative to address these theoretical and practical issues as soon as possible. Existing studies on the indirect effect of digital inclusive finance on rural revitalization are not extensive and rarely involve spatial factors, which may lead to some bias in the conclusions drawn. The paper also has the potential to contribute marginally.

According to related studies, First, digital inclusive finance reduces rural poverty. By taking advantage of channels and information, digital inclusive finance can decrease the cost of financial services, increase efficiency, and widen coverage, which can increase consumption, raise income levels, and reduce rural poverty(Park C and Mercado R., 2015).Second, digital inclusive finance can narrow the income gap between urban and rural areas. The urban-rural income gap can be effectively closed by innovating and developing the basic function of inclusive digital economy (Zhou L et al., 2020).Thirdly, In terms of industrial development, digital inclusive finance provides a set of financial services aimed at integrating rural industries by reducing geographic segmentation in traditional finance, which is critical for rationalizing and advancing industries (Li Z G et al., 2021). Therefore, digital inclusive finance can stabilize agricultural production and promote industrial upgrading, resulting in a comprehensive rural renaissance. Finally, In terms of ecological civilization, as inclusive digital finance increases green total factor productivity ,it also reflects "green water and green mountains are golden mountains", (He Z et al., 2022). Through innovative financial products

and services, digital inclusive finance can effectively reduce the transfer of resources to highly polluting industries, increase capital flows to green industries, and reduce the transaction costs of green financial products (Liu Jet al., 2022), thereby increasing the contribution of regional entrepreneurship to green total factor productivity.

Specifically, The marginal contributions are as follows. (1)Research perspective. little research is being conducted on rural revitalization from the perspective of entrepreneurial activity, so this article contributes to the advancement of research on rural revitalization development. (2)research methodology, the article measures the rural revitalization development index through the entropy method, and also systematically investigates the impact using intermediary effect model, spatial panel model and instrumental variable method, in order to provide deeper theoretical explanations and empirical evidence for China's rural revitalization.

2. Theoretical mechanism and research hypothesis

2.1 Mechanisms of digital inclusive finance on rural revitalization

The process of entrepreneurship involves integrating different resources to create value, which relies inevitably on financial support. Rural enterprises face serious financial constraints due to a lack of financial institutions in rural areas, low credit ratings and unstable incomes of farmers(Paulson A L and Townsend R., 2004).Digital Inclusive Finance promotes farmer entrepreneurship in two ways. First, financial services such as remittances, payments, loans and investments can now be delivered online for farmers, reducing service constraints, transaction costs and bringing convenience, which overcome time and space constraints and reduce operational barriers (He J and Li Q H., 2019).Second, digital inclusive finance optimizes traditional financial information collection and processing by collecting information on taxation, industry and trade, subsidies, and other relevant factors to fully understand farmers' creditworthiness and repayment ability(Xie W et al., 2020).

At the same time, Rural revitalization has also been facilitated by increased entrepreneurial activity. On the one hand, the key to revitalizing the countryside is to develop industries. Supporting migrant workers start their own businesses contributing to the revitalization of rural areas, which promotes more talent, technologies, capital, and other factors to gather in rural areas and opens up new employment channels. On the other hand, entrepreneurship leads to the affluence of farmers' lives and increases their income by promoting employment and rural economic growth(Crépon B et al., 2015).As a result, entrepreneurs' income increases, which is indirectly transmitted to consumers' consumption and stimulates economic growth even further. It has been shown that successful entrepreneurship boosts entrepreneurial vitality in rural areas, creating a competitive advantage and promoting rural economic development（Sato Y., 2000).

In conclusion, entrepreneurial activities can create employment opportunities, increase the incomes of rural residents, stimulate consumption, and contribute to the revitalization of the countryside. Therefore, a research hypothesis is proposed.

Hypothesis 1: Digital financial inclusion can have a positive effect on rural revitalization development by increasing entrepreneurial activity.

2.2 Spatial impact of digital inclusive finance on rural revitalization

With advanced digital information technology, time and space barriers will be broken down, as well as the flow and transaction costs of resources, which accelerates the process of financial agglomeration and diffusion(Keller W., 2002).Firstly, digital finance can expand the supply of financial services, assist in the development of technological innovation activities of enterprises in neighboring regions, and therefore have a positive impact on the transformation of their industrial structures through big data technology(Huang Q et al., 2019).Secondly, the "demonstration effect" enhances digital finance and indirectly increase the export of financial factors from traditional financial institutions to the surrounding areas(Jiao S and Sun Q., 2021). Thirdly, due to the free flow

of capital, technology, manpower, and natural resources between regions over time, competition or cooperation will emerge between them. As rural revitalization spreads across different regions, the "trickle-down effect" may result in the development of lagging regions, such as those in which the first rich bring the last rich to promote the development of the lagging regions. Therefore, a research hypothesis is proposed(Aghion P and Bolton P., 1997).

Hypothesis 2: Rural revitalization in neighboring areas can be influenced by spatial spillover effects of digital financial inclusion.

3. Method and data

3.1 Model construction

3.1.1 Intermediary model

In order to discuss a possible mediating variable of digital inclusive finance, a mediating effect model is constructed. The specific form of the above regression model was set as follows.

On the basis of the regression coefficient α_1 of the effect of digital inclusive finance $\mathrm{LNDIFI}_{i,t}$ on rural revitalization $\mathrm{LNRURAL}_{i,t}$ in the baseline linear regression model (1) passing the significance test, the linear regression equations of $\mathrm{LNDIFI}_{i,t}$ on the mediating variable agricultural entrepreneurial activity $\mathrm{Entrep}_{i,t}$, as well as $\mathrm{LNDIFI}_{i,t}$ and $\mathrm{Entrep}_{i,t}$ on $\mathrm{LNRURAL}_{i,t}$ are calculated. The model is set as follows.

$$\mathrm{LNRURAL}_{i,t} = \alpha_0 + \alpha_1 \mathrm{LNDIFI}_{i,t} + \alpha_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \tag{1}$$

$$\mathrm{Entrep}_{i,t} = \beta_0 + \beta_1 \mathrm{LNDIFI}_{i,t} + \beta_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \tag{2}$$

$$\mathrm{LNRURAL}_{i,t} = \gamma_0 + \gamma_1 \mathrm{LNDIFI}_{i,t} + \gamma_2 \mathrm{Entrep}_{i,t} + \gamma_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \tag{3}$$

3.1.2 Spatial econometric models

The spatial impact of digital inclusive finance on rural revitalization is further investigated, and spatial interaction terms are introduced in equation (1), which is further expanded into a spatial Durbin model (SDM).

$$\begin{aligned}\mathrm{LNRURAL}_{i,t} = {} & \alpha_0 + \rho\, \mathrm{W}_{i,t}\mathrm{LNRURAL}_{i,t} + \phi_1\, \mathrm{W}_{i,t}\mathrm{LNDIFI}_{i,t} + \alpha_1\, \mathrm{LNDIFI}_{i,t} \\ & + \phi_c W_{i,t} Z_{i,t} + \alpha_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t}\end{aligned} \tag{4}$$

Where $W_{i,t}$ is an N × N dimensional spatial weighting matrix, The geographical distance matrix is represented by the inverse distance matrix $W_d = 1/d_{ab}^2$, where d_{ab} is the distance of a and b, and a larger distance between regions means a smaller spatial weight. Adjacency weight matrix W_l, 1 for region adjacency, 0 for non-adjacency.The economic distance matrix is $W_e = 1/|gdp_a - gdp_b|$.The economic geography matrix is $W_m = W_d * W_e$;otherwise, 0.

3.2 Data

3.2.1 rural revitalization

Based on the National Strategic Plan for Rural Revitalization (2018-2022) and Zhang T et al.'s (2018) study, this paper selects indicators scientifically. Ultimately, this paper outlines an evaluation system of "two highs, three degrees, three winds, three governance, and three riches" (see Table 1). A weighted average of the indicators in Table 1 is calculated, along with the indices for the five primary indicators, using the information entropy method. Empirical measurements are taken of rural revitalization in 30 province-level regions (except Tibet) between 2011 and 2020.

Table 1. Rural Revitalization Evaluation Index System

Tier 1 indicators	Tier 2 indicators	Tier 3 indicators	Indicator attributes
Prosperous industries	Efficient agriculture	Food production per capita	+
		Total power of agricultural machinery	+
	High agricultural investments	Amount of investment in fixed assets by rural farm households	+
Eco-friendly living	Natural habitability	Forest coverage	+
	Livability of life	Rural sanitary toilet renovation rate	+
	Medical coverage	Rural health workers per 1,000 population	+
		Community Health Service Stations	+
Civilization of the Countryside	The Winds of Family	Average years of schooling for farmers	+
	Winds of Society	Rural education, culture and recreation expenditure	+
		Average number of township culture stations	+
		Number of rural cable broadcasters as a percentage	+
	The Winds of Folklore	Number of performing arts organizations	+
Effective governance	Foundations of Governance	Number of Autonomous Organization Units	+
	Governance inputs	Insurance depth	+
		Total investment in pollution control	+
	Governance outcomes	Number of rural residents with five guarantees	+
		Number of rural residents with minimum subsistence allowance	+
Wealthy living	Farmer income	Disposable income per capita in rural areas	+
	Quality of life	Engel's coefficient for rural permanent residents	-
		Consumption levels of rural residents	+
	Urban-rural gap	Income ratio between urban and rural residents	-
		Level of urbanization	+

3.2.2 Digital Inclusive Finance

A provincial Digital Inclusive Finance Index (LNDIFI) is calculated based on the Peking University Digital Inclusive Finance Index.

3.2.3Entrepreneurship in rural areas

According to Zhao T et al. (2020), the sum of private and self-employment as a percentage of rural population is used as a proxy variable for rural entrepreneurial dynamism (ENTEP).

3.2.4 Control variables

Fiscal decentralization (LNFISD) measures the proportion of local fiscal expenditures to central fiscal expenditures; the proportion of fiscal expenditure on agriculture, forestry and water to total expenditure is used to represent the level of fiscal support for agriculture (LNAFE); the level of information technology (LNTEC) is expressed as the logarithm of the number of website registrations of enterprises in each province. The old-age dependency ratio (LNODR) is calculated as the number of non-working-age elderly people in the total population of each province, region and city as a proportion of the working-age population; A secondary sector's contribution to GDP is measured by the industrial structure (CJ) .

An analysis of 10 years of data from 2011 to 2020 for 30 provinces in China is presented in this paper. For this study, data is obtained from the China Statistical Yearbook, the China Rural Statistical Yearbook, and selected prefecture-level city statistical annual reports as well as the Wind Information

Database. For some missing data, linear interpolation is used to fill in the gaps. To remove the effect of outliers, this paper applies a two-sided 0.5% tail reduction to the control variables. Table 2 shows descriptive statistics.

Table 2. Descriptive statistical analysis of variables

	Variables	Obs	mean	Std.Dev.	Min	Max
Explained variable	LNRURAL	300	3.467	0.298	2.231	4.018
Explanatory variable	LNDIFI	300	5.216	0.672	2.786	6.068
Intermediate variable	ENTREP	300	2.696	0.943	0.586	5.671
Control variables	FISD	300	4.547	0.345	4.010	5.389
	IS	300	0.431	0.0875	0.158	0.590
	AFE	300	2.392	0.330	1.413	3.013
	TEC	300	6.452	1.058	2.549	8.266
	ODR	300	2.643	0.243	2.001	3.246

4. Empirical testing

4.1 Analysis of benchmark regression results

Item (1) and (2)in Table 3 shows the regression result , the estimated coefficients of Digital Inclusive Finance (LNDIFI) are significantly positive which indicates digital inclusive finance promotes the development of rural revitalization.

Furthermore, in model (2), fiscal decentralization (FISD), industrial structure (IS), agricultural support effort (AFE) all have significant positive effects on rural revitalization, demonstrating that autonomy in local decision-making, enhanced rural industrial structure, and increased government support for agriculture will significantly contribute to rural revitalization. The level of information technology (TEC) is significantly positive, proving that the Internet contributes to rural regeneration and the overall development of the region through the advancement of information technology.

Table 3. Baseline regression results

VARIABLES	(1) OLS	(2) FE	(3) ENTREP	(4) LNRURAL
LNDIFI	0.214***	0.134***	0.087*	0.097***
	(6.95)	(4.39)	(1.68)	(10.12)
FISD		0.122**	1.023***	0.100*
		(2.23)	(4.20)	(1.85)
IS		0.669***	-0.999	0.119
		(4.66)	(-1.53)	(0.89)
AFE		0.163***	-0.348*	0.114***
		(4.71)	(-1.87)	(3.09)
TEC		0.061**	0.350***	0.184***
		(2.46)	(4.59)	(11.53)
ODR		-0.236***	0.958***	-0.070*
		(-5.23)	(4.73)	(-1.73)
ENTREP				0.066***
				(6.02)
Constant	2.667***	2.056***	-5.935***	1.002***
	(21.78)	(5.85)	(-3.74)	(3.17)
Observations	300	300	300	300
Number of id	30	30	30	30
Province FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Notes: Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p<0.1$

The significant negative effect of old age dependency level (ODR) on rural revitalization can be attributed to the fact that in an aging society there will be less workable people, leading to a lack of labor factors, which are detrimental to industrial development and improving living standards.

After using the stepwise regression method for analysis, the coefficient of digital inclusive finance for rural revitalization in model (4) decreases compared to model (2), indicating that increased entrepreneurial activity is the mechanism and this empirical result supports hypothesis 1. As a result, the value of the mediating effect β1-γ2 / α1 is 15. 93%.

4.2 Analysis of spatial spillover effects

The first step in selecting the spatial econometric model is to perform a Lagrange multiplier test (LM test). In table 4, the SDM is used when both error terms of the LM test are significant. Further validation of the SDM model is conducted using the likelihood ratio test (LR test) and the Wald test. According to Table 4, both the Wald and LR tests reject the original hypothesis at the 1% level, indicating that the SDM model does not degenerate into a SEM or SAR. A spatial Durbin's fixed effect model is employed in this study most appropriately.

Table 4. Applicability test of Spatial Durbin Model

Test type	Statistical value	P value
LM Error test	18.535	0.000
R LM Error test	16.543	0.000
LM Lag test	5.258	0.022
R LM Lag test	3.266	0.071
Wald Spatial lag	120.98	0.000
Wald Spatial error	65.54	0.000
LR Spatial lag	22.04	0.000
LR Spatial error	43.87	0.000
Hausman test	-3.33	--

Note: Hausman test is negative, mainly because the basic hypothesis Corr (X_IT, U_I) =0 of the RE model cannot be satisfied. Therefore, FE should be used in this case.

Table 5. Test of spatial transfer effect

Type of space matrix	Adjacent Matrix	Geographic matrix	economic geographic matrix
Variables	LNRURAL	LNRURAL	LNRURAL
ρ	0.458*** (8.10)	0.606*** (7.80)	0.654** (8.26)
LNDIFI	0.116*** (3.69)	0.109*** (4.48)	0.099*** (4.25)
W×LNDIFI	0.063*** (1.95)	0.085*** (2.95)	0.076* (2.48)
Control variables	YES	YES	YES
Direct effect	0.106*** (3.86)	0.101*** (4.46)	0.101*** (4.29)
Indirect effect	0.013 (0.59)	0.015 (1.05)	0.013 (0.746)
Total effect	0.119*** (7.05)	0.115*** (7.64)	0.114*** (3.34)
LOGL	481.129	685.506	477.102
R^2	0.516	0.374	0.402

Notes: Standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p<0.1

Table 5 reports the results of the spatial regression model of digital inclusive finance on rural revitalization under three different spatial weight matrices. This paper identifies the SDM model with dual space-time fixed effects as the optimal choice. Then spatial lagged model (SAR) with double fixed effects in space and time is also presented in the paper for the purpose of comparing the

robustness of the estimates. Referring to the partial differential approach proposed by LeSage J et al. (2009), the coefficients of the effects of the respective variables on rural revitalization are decomposed into direct effects, indirect effects, and total effects. Taking the geographical matrix as an example, the coefficient of digital inclusive finance on rural revitalization is 0.101 in direct effect and passes the significance test. In indirect effects, the coefficient (0.015) is significant. The coefficient in the total effect is 0.115 and significant. The increase in digital inclusive finance in the local area has a positive effect on the growth in rural revitalization in regional and territorial provinces, validating hypothesis2.

5. Robustness test

5.1 Endogenetic treatment

On the one hand, despite controlling for variables affecting the development of rural revitalization to the greatest extent possible, there may be reverse causality. This paper mitigates the possible endogeneity problem by using the explanatory variable lagged by one period as the instrumental variable. On the other hand, static spatial panel model tends to ignore the influence of temporal factors beyond the explanatory variables and spatial influences. To address this issue, this paper develops a dynamic spatial panel model . In column(1) and (2) of Table 6, The coefficients of the impact of digital inclusive finance on rural revitalization are significantly positive, which is consistent with the previous benchmark regression.

5.2 Robustness test

Firstly, replace the explanatory variables. The TOPSIS method is applied to re-measure the rural revitalization index. Secondly, Due to the special status and policy bias, four municipalities, Beijing, Shanghai, Tianjin, and Chongqing, are excluded and re-estimated among the provincial administrative units. In Table 6,the results is still robust.

Table 6：Endogeneity and robustness test results

Variable	(1)	(2)	(3)	(4)
L.LNRURAL		0.844*** (31.92)		
*W*LNRURAL*		-0.195*** (-2.84)		
L.LNDIFI	0.129*** (4.84)			
LNDIFI		0.064* (1.70)	0.084*** (6.38)	0.148*** (4.35)
ENTREP	0.033*** (3.34)	-0.009* (-2.12)	-0.037** (-2.50)	0.045*** (3.88)
Control variables	YES	YES	YES	YES
Constant	2.048*** (6.22)		-0.566 (-1.20)	1.821*** (4.65)
ρ		0.345**		
Observations	270	270	300	260
Number of id	30	30	30	26
Province FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
R	0.980	0.970	0.770	0.977
Loglikelihood	674.7721	674.7721	674.7721	674.7721

Notes: Standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p<0.1

6. Conclusions and policy implications

On the basis of the rural revitalization index measured by the entropy weight method, mediation effect model and spatial Durbin model are empirically tested to examine the inherent mechanism. The findings are as follows: Firstly, digital inclusive finance directly improve rural revitalization. Various robustness tests, such as the endogeneity test, the exclusion of municipalities under the central government, and the replacement of explanatory variables, have confirmed that the above statements are valid; secondly, entrepreneurial activity can indirectly promote rural revitalization, indicating that the two-wheel drive phenomenon formed by "mass entrepreneurship and innovation" is of great significance in realizing China's rural economic development. Thirdly, the spatial spillover effects have also been confirmed, indicating the spatial spillover effects between regions.

This study proposes the following policy suggestions. Firstly, it is necessary to foster farmers' entrepreneurship to improve the employment opportunities. On the one hand, it is imperative to accelerate the integration of digital technology and financial products, develop diversified and humane financial products and services to meet the needs of people in a variety of ways. On the other hand，governments can introduce preferential policies in order to stimulate farmers' business start-ups and create more employment opportunities. Secondly, pay attention to the spatial spillover effects of digital inclusive finance and rural revitalization from a regional perspective. It is essential to coordinate the development of neighboring provinces, avoid negative spatial externalities caused by excessive competition, allocate financial resources rationally.

References

[1] Ye X. The general principles of the China’s rural vitalization strategy in the new era[J]. Reform, 2018, 1: 65-73.

[2] Park C Y, Mercado R. Financial inclusion, poverty, and income inequality in developing Asia[J]. Asian Development Bank Economics Working Paper Series, 2015 (426).

[3] Zhou L, Feng D W, Yi X J. Digital inclusive finance and urban-rural income gap:“Digital dividend” or “Digital divide”[J]. Economist, 2020, 5: 99-108.

[4] Li Z G, Che S H, Wang J. The Development of Digital Economy and the Transformation and Upgrading of Industrial Structure: Based on the Heterogeneity Test of 275 Cities in China[J]. J. Guangdong Univ. Financ. Econ, 2021, 36: 27-40.

[5] He Z, Chen H, Hu J, et al. The impact of digital inclusive finance on provincial green development efficiency: empirical evidence from China[J]. Environmental Science and Pollution Research, 2022: 1-15.

[6] Liu J, Jiang Y, Gan S, et al. Can digital finance promote corporate green innovation?[J]. Environmental Science and Pollution Research, 2022, 29(24): 35828-35840.

[7] Paulson A L, Townsend R. Entrepreneurship and financial constraints in Thailand[J]. Journal of Corporate Finance, 2004, 10(2): 229-262.

[8] He J, Li Q H. Digital finance and farmers' entrepreneurship[J]. China Rural Economy, 2019 (1).

[9] Xie W, Wang T, Zhao X. Does Digital Inclusive Finance Promote Coastal Rural Entrepreneurship?[J]. Journal of Coastal Research, 2020, 103(SI): 240-245.

[10] Crépon B, Devoto F, Duflo E, et al. Estimating the impact of microcredit on those who take it up: Evidence from a randomized experiment in Morocco[J]. American Economic Journal: Applied Economics, 2015, 7(1): 123-50.

[11] Sato Y. Linkage formation by small firms: The case of a rural cluster in Indonesia[J]. Bulletin of Indonesian Economic Studies, 2000, 36(1): 137-166.

[12] Keller W. Trade and the Transmission of Technology[J]. Journal of Economic growth, 2002, 7(1): 5-24.

[13] Huang Q, Yu Y, Zhang S. Internet development and productivity growth in manufacturing industry: Internal mechanism and China experiences[J]. China Industrial Economics, 2019, 8: 5-23.

[14] Jiao S, Sun Q. Digital Economic Development and Its Impact on Econimic Growth in China: Research Based on the Prespective of Sustainability[J]. Sustainability, 2021, 13(18): 10245.

[15] Aghion P, Bolton P. A theory of trickle-down growth and development[J]. The review of economic studies, 1997, 64(2): 151-172.

[16] Zhang T, Li M, Xu Y. The construction and empirical study of rural revitalization evaluation index system. Manag[J]. World, 2018, 34: 99-105.

[17] LeSage J, Pace R K. Introduction to spatial econometrics[M]. Chapman and Hall/CRC, 2009.