

Original Paper

Theoretical Analysis and Empirical Test of Digital Inclusive Finance Enabling Rural Revitalisation

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Abstract

Digital inclusive finance has become a key driver of rural revitalisation in the wave of booming information technology. This study analyses its theoretical foundation, constructs a rural revitalization evaluation system based on the panel data of 30 provinces in China from 2012 to 2023, and empirically explores the association between the two using the spatial Durbin model. The results show that there is a positive spatial correlation between digital financial inclusion and rural revitalisation, and the former has positive promotion and spillover effects on the latter. Accordingly, strategies such as strengthening scientific and technological support, improving information infrastructure, enhancing financial literacy and optimising rural industries are proposed, aiming to improve the quality and effectiveness of digital inclusive financial services for rural revitalisation, and to provide a new perspective and a strong basis for policy formulation and academic research.

Keywords

rural revitalization, digital financial inclusion, spatial measurement, policy recommendations

1. Introduction

In today's era, the information technology revolution has profoundly reshaped the economic landscape, and digital inclusive finance has risen to prominence, injecting a strong impetus into China's rural revitalisation strategy. As the strategy of rural revitalisation advances in a comprehensive manner, the economic and social development of rural areas has ushered in new opportunities and challenges. It has become a key task for economic and social development to build a complete inclusive financial protection system and achieve comprehensive rural revitalisation. In this context, exploring the mechanism and path of influence of digital inclusive finance on rural revitalisation is of far-reaching significance for improving the financial service system and promoting the sustainable development of the countryside,

and it is an important issue for realising the modernisation of agriculture and rural areas and moving towards the great rejuvenation of the Chinese nation.

2. Theoretical Foundations and Analysis of Impact Mechanisms

2.1 Theoretical Evolution

In the 1980s, Keynes's theory of government interventionism and Knox's theory of the vicious circle of poverty gave rise to the theory of agricultural credit subsidies. At a time when the rural economy was suffering, the poor had low productivity, and financial services were scarce, government subsidies and the establishment of inclusive financial institutions became an important means of breaking the shackles of poverty and promoting agricultural development. Since then, the financial constraints theory has further emphasised the key role of efficient financial markets in rural development, and government regulation of financial institutions, the implementation of inclusive subsidies, and the construction of fair financial markets have become an important support for the implementation of the strategy of rural revitalisation, which has laid a solid theoretical cornerstone for subsequent research.

The financial constraint theory argues that the government can create rental opportunities for financial institutions and incentivise them to increase the supply of credit to rural areas by moderately intervening in the financial market, such as controlling interest rates and restricting market access. At the same time, the theory also emphasises the importance of financial institutions' own risk management and innovation capabilities. Under the influence of this theory, Governments have begun to adjust their rural financial policies, strengthen their supervision and guidance of financial institutions, and encourage them to develop financial products and services suitable for the rural market.

2.2 Deconstructing the Endogenous Relationship between Finance and Rural Development

From the perspective of financial services for rural economic development, along with the increase in agricultural productivity, rural capital demand has surged, and the demand curve has shifted to the right, but the characteristics of rural small and micro-enterprises have led to a low willingness of financial institutions to provide services, the supply curve is rigid, and the cost of borrowing has risen. Digital inclusive finance with the help of policy assistance, effectively reversing this predicament, promoting the right shift of the capital supply curve, cost reduction, solving the bottleneck of rural development funds, and becoming a financial power source for rural revitalisation (Lu, 2019). Its development history of rural revitalisation has an 'U' type impact: at the initial stage, it is constrained by the delay in the promotion of technology and learning costs, and is not effective; at the later stage, it provides villagers with financial management, insurance and other services directly by virtue of the diversified services and the economic radiation effect, helps the growth of small and micro-enterprises, and indirectly promotes entrepreneurship, optimizes the distribution of income, and drives consumption, driving the process of rural revitalization in an all-round way. The process of rural revitalisation is driven in an all-round way. In the early stage of the development of digital inclusive finance, farmers in most areas know little about emerging financial products and services, and due to imperfect network infrastructure, some areas can

not even access the Internet, making the promotion of digital inclusive finance face difficulties. However, with the government's increased investment in rural network infrastructure construction, and financial institutions and related enterprises to strengthen the financial literacy training of farmers, digital financial inclusion has gradually spread in rural areas. Today, farmers can conveniently manage their finances, purchase insurance, apply for loans and other operations through mobile banking and other applications, effectively enhancing the economic security and development capacity of their families.

3. Research Design

3.1 Selection of Variables

With the Rural Revitalisation Evaluation Index as the explanatory variable, and following the National Rural Revitalisation Strategic Plan, we have constructed the 'Six Harmonisation and Four Rates' system, which covers the following areas: Industrial Prosperity (multi-dimensional development indicators of agriculture), Ecological Livability (indicators of rural infrastructure and medical care), Civilised Countryside (indicators of culture, education and protection), Effective Governance (indicators of governance and insurance), and Prosperous Living (indicators of income and quality). The 'Three Rule, Three Winds, Three Dimensions' system accurately measures the degree of rural revitalisation.

In terms of industrial prosperity, per capita GDP and per capita grain output reflect the economic benefits of agricultural production and food security capacity; investment in fixed assets by farm households reflects the strength of farmers' investment in agricultural production; the rate of agricultural mechanisation and per capita electricity consumption in rural areas show the modernisation level of agricultural production; and local financial expenditure on science and technology demonstrates the strength of the government's support for the development of agricultural science and technology.

Among the indicators of ecological livability, the popularity rate of sanitary latrines, the proportion of administrative villages with centralised water supply, the number of health technicians per 1,000 people in rural areas, the number of grassroots healthcare institutions, and the per capita area of roads comprehensively reflect the level of the living environment and infrastructure construction in rural areas. In villages where the construction of ecological livability has been effective, the quality of life of villagers has been significantly improved and their health is better protected.

In terms of rural civilisation, indicators such as villagers' per capita education time, rural residents' per capita investment in cultural and recreational consumption, local financial expenditure on culture, sports and media, rural population's access to public library collections, comprehensive population coverage of TV programmes and total investment in pollution control reflect the level of cultural and educational development and social civilisation in the countryside. For example, some villages have enriched the spiritual and cultural life of villagers by building cultural halls and organising cultural activities, which have enhanced their cultural literacy and civilised awareness.

The indicators of effective governance, such as total investment in pollution control, the number of rural residents with minimum livelihood protection and the depth of insurance, reflect the effectiveness of

rural governance and the level of social security. In villages with effective governance, the environment is effectively protected, the basic life of villagers is guaranteed, and the social order is stable.

Among the indicators of affluent living, per capita disposable income of villagers, Engel's coefficient of permanent residents in rural areas, the ratio of income of urban and rural residents and the number of cars owned per 100 households reflect intuitively the level of economic income and the quality of life of farmers. In rural areas with better economic development, farmers' incomes have been increasing, their consumption structure has been upgraded, and their lives have become more and more affluent.

The Digital Inclusive Finance Index is derived from the research results of Peking University. It accurately quantifies the level of financial services from multiple dimensions such as the breadth of coverage, the depth of usage, and the degree of digitalization, and serves as a core explanatory variable (Fu & Huang, 2018). Among them, the breadth of coverage is reflected through indicators such as the account coverage rate, the proportion of Alipay users bound with bank cards, and the average number of bank cards bound to each Alipay account, which reflects the popularity of digital inclusive finance in rural areas. The depth of usage is composed of indicators in aspects such as payment services, money fund services, personal consumer credit services, micro and small business operator credit services, insurance services, investment services, and credit services, demonstrating the frequency and depth of farmers' use of digital inclusive finance products and services. The degree of digitalization is measured from the perspectives of mobility, affordability, creditworthiness, and convenience, reflecting the technological level and service convenience of digital inclusive finance.

The control variables cover the fiscal burden (difference between revenue and expenditure), the degree of openness to the outside world (trade GDP share), and the level of urbanisation (urban population share), to comprehensively consider the impact of external factors. Fiscal burden reflects the financial situation of local governments, which may have an impact on the investment capacity of rural revitalisation; regions with a higher degree of openness to the outside world may attract more external capital and technology to promote the development of the rural economy; and an increase in the level of urbanisation may lead to the transfer of the rural labour force and the structural adjustment of the rural industry, which will in turn affect the process of rural revitalisation.

3.2 Data Sources

The data were collected from a wide range of national and local yearbooks from 2012 to 2023, covering economic, social, health, construction, insurance and other fields, with 30 provinces and cities (excluding Tibet, Hong Kong, Macao and Taiwan) as the samples, which were rigorously screened and organised to build a solid data foundation for the empirical study and ensure the reliability and universality of the research results.

Table 1. Descriptive Statistics

VARIABLE	OBS	MEAN	STD.DEV	MIN	MAX
INCLUSION INDEX	264	145.2215	125.2444	4.635	408.154
PUBLIC	264	1	0.4728	0.19386	2.571
ESTATE	264	43.644	7.535	18.1	58.1
GOVERNMENTS	264	-1765.667	1200.96	-6355.66	-132.88
OPENNESS	264	0.2435	0.0389	0.00162	0.23005
ECONOMICS	264	3.507	2.0301	0.5672	9.355
URBANISATION	264	52.637	11.662	20.7	87.2

3.3 Model Construction and Testing

In view of the spatial correlation of the data, spatial econometric models of SAR, SEM and SDM were constructed for in-depth analysis. According to Elhorst's test, the LM test is the first screening model type, and both SEM and SAR are significant, so SDM is chosen; the LR test confirms that SDM cannot be simplified; and then after the LR screening, the two-way fixed-effects SDM model is identified, which can effectively control the heterogeneity of individuals and time, accurately capture the spatial and temporal effects of variables, and lay a scientific model framework for the empirical analyses. On this basis, the spatial measurement models of SAR, SEM and SDM were established:

$$Rei_{ij} = \beta_1 Dif_{ij} + \beta_2 BURDEN_{ij} + \beta_3 OPEN_{ij} + \beta_4 URBAN_{ij} + \varepsilon_{ij}, \varepsilon_{ij} \\ = \lambda \sum_{j=1}^n W_{ij} \varepsilon_{ij} + \mu_{ij} \quad (1)$$

$$Rei_{ij} = \rho \sum_{j=1}^n W_{ij} Rei_{ij} + \beta_1 Dif_{ij} + \beta_2 BURDEN_{ij} + \beta_3 OPEN_{ij} + \beta_4 URBAN_{ij} + \mu_{ij}, \mu_{ij} = \\ \lambda \sum_{j=1}^n W_{ij} \varepsilon_{ij} + \varepsilon_{ij} \quad (2)$$

$$Rei_{ij} = \alpha_i + \rho \sum_{j=1}^N W_{ij} Rei_{ij} + \beta_1 Dif_{ij} + \beta X_{ij} + \varphi_1 W * Dif_{ij} + \varphi_2 W + \varphi \sum_{j=1}^N W_{ij} X_{ij} + \\ U_{ij}, U_{ij} = \lambda W \mu_{ij} + \varepsilon_{ij} \quad (3)$$

Spatial autocorrelation test is an important part of model construction. By calculating indicators such as the Moran Index, it is found that there is a significant positive spatial correlation between the digital financial inclusion and rural revitalisation indices, i.e. the level of digital financial inclusion development and the degree of rural revitalisation in neighbouring regions are similar. This provides a strong basis for adopting the spatial measurement model. In the process of model selection, the results of LM test and LR test corroborate each other, indicating that the SDM model is the most suitable model for this study. The two-way fixed-effects SDM model can fully take into account the differences between different regions and different times, so as to more accurately estimate the effect of digital financial inclusion on rural revitalisation.

4. In-depth Analysis of Empirical Results

4.1 Benchmark Regression Profiling

The OLS and two-way fixed effects model shows that the coefficient of digital financial inclusion is significantly positive, which strongly confirms its positive role in rural revitalisation. The coefficient of 0.143 in the mixed OLS is significant at the 1% level, and the coefficient of 0.097 under the two-way fixed-effects model is significant at the 5% level, and the model is well fitted, indicating that the improvement of financial services can significantly enhance the level of rural revitalisation, and laying the foundation for the subsequent effect analysis.

Table 2. Baseline Regression Effects of Digital Financial Inclusion on Rural Revitalisation

VARIABLES	OLS	FIXED EFFECT
DIFI	0.139***	0.089**
BURDEN	0.015	0.159
OPEN	-0.025	0.030
URBAN	1.101***	0.249
CONSTANT	-7.275***	-4.713***
OBSERVATIONS	265	275
R-SQUARED	0.578	0.814
INDIVIDUALS	NO	YES
TIME	NO	YES

Further research shows that the impact of digital inclusive finance on rural revitalization varies in different regions. In the eastern region where the economy is relatively developed, the development level of digital inclusive finance is relatively high, and its role in promoting rural revitalization is more significant. In contrast, in the central and western regions, although the development of digital inclusive finance is relatively slow, it still has great potential for improvement. With the continuous popularization and in-depth development of digital inclusive finance, its promoting effect on rural revitalization in the central and western regions is expected to be gradually strengthened (Wang & Huo, 2022).

4.2 Decomposition of Spatial Effects

In terms of spatial direct effect, the coefficient of digital financial inclusion is significant at 0.124 at 1%, i.e., when the financial index rises by 1%, local rural revitalisation rises by 0.124%, highlighting its core drive for local development; the indirect effect is significant at -0.105 at 5%, stemming from regional competition, financial development or inhibition of neighbouring regions' rural revitalisation. The effects of financial burden, openness to the outside world and urbanisation are all significant, with financial burden locally increasing to promote revitalisation, openness to the outside world and urbanisation

having both positive spillovers from local and neighbouring areas, and all variables synergistically shaping the spatial pattern of rural revitalisation.

Table 3. Decomposition of Spatial Effects Based on the SDM Model

VARIABLES	MAIN	WX	DIRECT EFFECT	INDIRECT EFFECT	AGGREGATE EFFECT
DIFI	0.128*** (0.019)	-0.098*** (0.040)	0.988*** (0.030)	-0.121** (0.039)	0.021 (0.038)
BURDEN	0.138*** (0.030)	0.016 (0.051)	0.150*** (0.031)	0.099* (0.059)	0.198** (0.068)
OPEN	-0.010 (0.020)	0.098*** (0.029)	0.001 (0.020)	0.153*** (0.051)	0.148** (0.048)
URBAN	0.101 (0.071)	0.298** (0.131)	0.135* (0.071)	0.498*** (0.181)	0.597** (0.203)
RHO	0.359*** (0.058)	0.359*** (0.058)	0.359*** (0.058)		
SIGMA2_E	0.004*** (0.000)		0.004*** (0.000)		
OBSERVATI ONS	264	264	264	264	264
R-SQUARED	0.392	0.392	0.392	0.392	0.392
BODY	27	27	27	27	27

With regard to the fiscal burden, in some regions with large fiscal expenditures and relatively stable fiscal revenues, the Government is able to have more funds to invest in the construction of rural infrastructure, the support of agricultural industries and the development of rural social undertakings, thereby effectively promoting the revitalisation of the local countryside. At the same time, the development of these regions may also have a demonstration effect and a radiation-driven effect on the neighbouring regions, promoting rural revitalisation in the neighbouring regions.

The increase in the level of urbanisation provides more employment opportunities for rural labourers, promotes the transfer of rural population to cities and towns, and is conducive to the centralised transfer and large-scale operation of rural land, thus promoting the adjustment and optimisation of the rural industrial structure. In addition, the process of urbanisation will also bring about the flow of factors such as capital, technology and talent to rural areas, promoting rural revitalisation.

4.3 Dynamic Effects Insights

In the short term, the total effect of digital financial inclusion is negative and significant, which is attributed to the lagging technology promotion and high learning cost, and the initial investment is difficult to be instantly transformed into the results of rural revitalisation; in the long term, financial inclusion, financial burden and urbanisation pass the 10% significance test, and the policy continues to exert force to effectively overcome the bottleneck of technical talents and continue to promote rural revitalisation, which highlights the long-term strategic value of the policy and the enduring power of financial services.

Over time, digital financial inclusion has gradually spread in rural areas, farmers' financial literacy has been improving, and financial institutions have been optimising their service processes and product design. At the same time, the government has continued to increase policy support and financial investment in rural areas, and strengthened rural infrastructure construction and talent cultivation, creating a favourable environment for the revitalisation of rural areas with digital inclusive financial services. In the long term, digital inclusive finance works in tandem with financial burdens, urbanisation and other factors to form a strong synergy that continues to promote the implementation of the rural revitalisation strategy.

4.4 Endogeneity and Robustness Tests

The instrumental variable method chooses lagged one-period digital financial inclusion to deal with endogeneity, and the results are robust, and the 'U' shape relationship survives, eliminating potential endogenous interference. The robustness test replaces the 0 - 1 matrix with the geographic distance matrix, the significance of the core variables is stable, and the static and dynamic spatial effects are reliable, which strongly supports the scientific validity of the research conclusions, and enhances the credibility and application value of the research results.

The endogeneity problem may lead to the bias of the research results, so it is necessary to use the instrumental variable method to deal with it. The digital inclusive finance in the lagged period is used as an instrumental variable, which is related to the digital inclusive finance in the current period but is not affected by the rural revitalisation in the current period, thus effectively solving the endogeneity problem. The reliability of the findings is further verified by robustness tests. After replacing the spatial weight matrix, the significance and coefficient size of the core variables basically remain stable, indicating that the research results are highly robust and can provide a reliable basis for policy formulation and academic research.

Table 4. Results of Endogenous Treatment

VARIABLES	REI
DIFI	0.073***
BURDEN	0.140***
OPEN	0.019
URBAN	0.216***
CONSTANT	-4.433***
OBSERVATIONS	341
BODY WEIGHT	31
TIME	yes
BODY	yes

5. Policy Recommendations

At the level of technological empowerment, it has deeply tapped the potential of big data, blockchain and AI technologies to accurately match rural needs, customise financial service solutions, reduce costs and increase efficiency, and improve the quality and quantity of services. For example, the use of big data technology can accurately assess the financial needs and risks of rural areas, provide decision-making support for financial institutions, and reduce credit risks; blockchain technology can improve the security and transparency of financial transactions, and enhance farmers' trust in digital financial services; AI technology can realise functions such as intelligent customer service and intelligent investment advisors, and improve the efficiency and quality of financial services.

In the information infrastructure dimension, financial investment should be increased to build a system of full coverage of rural network communications, popularise smartphones, and broaden the reach of financial services. The government should set up special funds to support the construction of rural network base stations and the upgrading of broadband networks to ensure stable network signals and smooth network speeds in rural areas. At the same time, mobile phone manufacturers and communication operators are encouraged to launch preferential packages and smartphone products for the rural market, so as to reduce the cost of using smartphones and network services for farmers, and increase network penetration and smartphone ownership in rural areas.

In terms of financial literacy cultivation, multiple platforms have made concerted efforts to innovate forms of financial education, improve villagers' financial cognition and practical skills, and resolve barriers to technology promotion. Financial institutions can cooperate with local governments, schools and village committees to carry out financial literacy lectures, training courses and promotional activities, and through case analyses and simulations, enable farmers to better understand the characteristics and usage of digital financial products and services. In addition, internet platforms and social media can be

used to produce short videos and graphic materials on financial knowledge to facilitate farmers to learn financial knowledge anytime, anywhere.

On the path of industrial optimisation, focusing on financial support for leading rural enterprises, helping enterprises break through the financial dilemma, driving entrepreneurial income with industrial prosperity, promoting inclusive growth of the rural economy, and realising the grand blueprint for comprehensive rural revitalisation (Zhang, Wan, Zhang, & He, 2019). The government can set up an industrial support fund to provide low-interest loans, guarantee subsidies and other financial support for rural leading enterprises to help them expand their production scale, research and develop new products, and expand market channels. At the same time, it encourages leading enterprises to establish a close interest linkage mechanism with farmers, and drives farmers to increase their income and get rich through order farming and guaranteed purchase, etc., so as to promote the synergistic development of rural industries (Wang & Xie, 2021).

6. Conclusion

This study systematically analyses the theory and practice of digital financial inclusion for rural revitalisation, and empirically reveals the close relationship between the two and the spatial spillover pattern. The policy recommendations are closely related to the findings of the study and provide practical guidance for financial services for rural revitalisation. Future research can expand the samples and variables, deepen the mechanism mining, pay attention to the financial innovation of emerging technologies, and continue to improve the financial theory and practice system of rural revitalisation, so as to continuously inject new vitality and open up new paths for the great cause of rural revitalisation.

In future research, the scope of the research sample can be further expanded to cover more regions and time spans, so as to improve the universality and representativeness of the research results. At the same time, more variables, such as the rural financial ecosystem and farmers' social networks, are introduced to explore in depth the complex relationship between digital inclusive finance and rural revitalisation. In addition, with the continuous emergence of emerging technologies, such as 5G and Internet of Things, research on their application and innovation in digital inclusive financial services for rural revitalisation will help to further improve the financial support system for rural revitalisation and promote the sustainable development of rural economy and society.

In conclusion, digital inclusive finance has great potential and role in rural revitalisation, and through continuous theoretical research and practical exploration, we can better bring the advantages of digital inclusive finance into play, achieve the ambitious goal of rural revitalisation, and give new vitality and vigour to the vast rural areas.

In the future, we should continue to pay attention to the innovative application and development trend of digital inclusive finance in rural revitalisation, strengthen multidisciplinary cross-research, integrate the theories and methods of economics, sociology, information technology and other fields, provide more comprehensive and in-depth theoretical support and practical guidance for rural revitalisation, promote

the sustainable development of the rural economy and society, and realise the beautiful vision of a strong agriculture, a beautiful countryside, and a rich peasantry.

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