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Original Paper

Nonlinear Influence of Digital Economy on Rural Revitalization

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Abstract

By measuring the level of digital economy and rural revitalization in different regions, this paper analyzes the nonlinear impact of digital economy on rural revitalization by using a panel threshold regression model. It is found that when the consumption level of rural residents and digital inclusive finance level are taken as threshold variables, the impact of digital economy on rural revitalization has single and double threshold effects respectively. With the improvement of rural residents' consumption and digital inclusive finance levels, the digital economy plays an increasingly important role in promoting rural revitalization, showing a rising trend. Further, through grouping regression, it is found that the promotion of digital economy to rural revitalization is only significant in the western region where the economy is relatively backward, but not significant in the central and eastern regions.

Keywords

digital economy, rural revitalization, threshold effect, regional heterogeneity

1. Introduction

In recent years, the digital economy has been developing rapidly and has become the most active part of China's economic development field, playing an essential role in stimulating consumption, creating employment, and boosting investment (Zhao et al., 2020). Similarly, the related advantages of digital economy have brought obvious positive effects to the development of rural areas in all aspects:

First of all, the development of digital economy has promoted the combination of information technology and traditional agriculture, which boosts the production efficiency of rural industries. With the development of digital technology, traditional agricultural production has realized intelligent transformation. Agricultural robots, unmanned aerial vehicle spraying, intelligent sensing and other technologies provide intelligent and automatic services for every link of agricultural production, making agricultural production more efficient and accurate. Secondly, the development of digital economy has reduced the cost of information search for residents in rural areas. The abundant resources

on the Internet can enable young people to improve their cultural literacy and professional skills at a lower cost (Li et al., 2022), thereby improving the level of human capital in rural areas, improving the quality of labor force in rural areas and attracting the inflow of talents with high human capital. Third, the application of digital technology in agricultural production promotes the green and low-carbon development of agriculture. Relying on digital technology, precise irrigation, fertilization and spraying can be achieved in the process of agricultural production, thus avoiding resource waste and environmental pollution, improving the efficiency of resource conversion and utilization, and promoting the green development of agriculture (He et al., 2022). Fourth, the rapid development of the Internet enables the masses to effectively supervise rural governance and make rural governance more transparent. The cross-level information transmission system established by the Internet enables grassroots residents to transmit their demands to the upper level efficiently and at low cost, which not only enhances the sense of participation of the masses but also enhances the sense of responsibility of managers and enhances the transparency of grassroots governance (Mary et al., 2020).

According to "Metcalfe's Law", it is known that the value of the Internet is the quadratic value of Internet nodes, and digital economy, a new economic form relying on Internet information technology, should also have this self-expanding nature. That is to say, with the gradual development of digital economy, its promotion of rural revitalization should also show a trend of gradual enlargement. At the same time, the development of digital economy itself also has the phenomenon of self-expansion and strengthening, and the phenomenon of marginal increase (Li et al., 2021). In the early stage of the development of digital economy, the related infrastructure construction is not perfect, and the immature objective conditions limit the spillover effect of the development of digital economy, so its promotion of rural revitalization is also limited. However, with the continuous improvement of digital infrastructure, the continuous improvement of rural residents' digital literacy and the continuous advancement of relevant policies, the digital economy in rural areas is constantly maturing, and its proportion in the new economic form is also increasing (Sun et al., 2022), and its role in promoting rural revitalization will also show a trend of continuous enlargement. Moreover, many scholars have found that the development of digital economy has a nonlinear promotion effect on the optimization of regional industrial structure (Chen et al., 2023), agricultural modernization level (Fu et al., 2023) and urban-rural integration development level (Yu et al., 2023). Therefore, the impact of digital economy on rural revitalization should also be nonlinear, which is demonstrated in this paper.

2. Effect Model of Digital Economy on Rural Revitalization

2.1 Variable Selection

In order to ensure the availability and integrity of data, this paper selects the provincial data of 30 provinces in China (excluding Hong Kong, Macao, Taiwan and Tibet) from 2011 to 2021 as the research object of this paper. The data are all from the National Bureau of Statistics, China Statistical Yearbook, China Labor Statistical Yearbook, Peking University Digital Inclusive Finance Research

Center and provincial statistical yearbooks.

a. Explained variable: Rural revitalization level (Rur), referring to the practice of Zhang Ting et al. (2018), this paper constructs the rural revitalization level index. On the basis of ensuring comprehensiveness and availability, 14 secondary indicators are selected to construct the evaluation system of rural revitalization level index, and logarithm is taken on the basis of entropy method to measure the rural revitalization level in various regions. Specific indicators are described in Table 1.

b. Core explanatory variables: Digital economy level (Dig), this paper refers to the method of Zhao Tao et al. (2020), constructs the evaluation system of digital economy indicators, and also uses entropy method to give weight and take logarithm. The specific indicators are introduced as shown in Table 1.

In addition, in the stage of standardizing the original data related to rural revitalization level and digital economy level, the data are standardized with 2011 as the base period to ensure that the index is comparable across the year.

Table 1. Rural Revitalization and Digital Economy Index Evaluation System

	first-class index	second-class index
digital economy level	Internet penetration level	Number of Internet broadband access households per 100 people
	Internet-related employment	Proportion of employed persons in information transmission, software and information technology services
	Internet-related industrial output	Total telecommunications services per capita
	telephone popularization level	Telephone popularization rate (including cell phones)
	level of digital inclusive finance development	Digital Inclusive Finance Index in Peking University
rural revitalization level	industrial prosperity	Added value of agriculture, forestry, animal husbandry and fishery industry
		Total power of agricultural machinery
		Effective irrigation ratio
	ecological livability	Rural electricity consumption
		Number of rural clinics
		Proportion of old-age insurance participation
	rural civilization	Financial expenditure on culture, sports and media
		Public library collections per capita
		Complete investment in industrial pollution control
	effective governance	Number of autonomous organizations per 10,000 people in villages
		Number of village committees per 10,000 people in villages
	affluent life	Ratio of rural residents' income to urban residents' income

	Engel coefficient of rural residents
	Ratio of rural residents' expenditure on education, culture and entertainment to total expenditure

c. Threshold variables: Rural residents' consumption level (Con) and digital inclusive finance level (Ind). Among them, the logarithmic value of per capita consumption expenditure of rural residents is used to measure the consumption level of rural residents; The level of digital inclusive finance is measured by the natural logarithm of the Peking University Digital Inclusive Finance Index constructed by Guo Feng et al. (2020).

d. control variables: Education accessibility (Edu), measured by the proportion of illiterate people over the age of 15; Foreign trade (Fot), expressed by the natural logarithm of the total investment of foreign-invested enterprises; Population situation (Pop), measured by the total dependency ratio of each place; Government support (Gov), which is measured by the proportion of local fiscal expenditure on agriculture, forestry and water affairs to local government general budget expenditure; Rural Internet Development (Int) is measured by the natural logarithm of Internet broadband access users in rural areas, and some missing data are supplemented by linear interpolation method. Table 2 below shows descriptive statistics of each variable.

Table 2. Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Rur	3.609	0.380	2.304	4.485
Dig	4.371	0.991	0.296	6.271
Con	9.214	0.382	8.258	10.211
Ind	5.283	0.669	2.909	6.129
Edu	4.771	2.737	0.790	16.630
Fot	11.386	1.437	7.948	15.326
Pop	0.381	0.074	0.193	0.578
Gov	0.114	0.033	0.041	0.204
Int	7.189	1.559	1.609	9.655

2.2 Model Design

In order to verify whether the impact of the development of digital economy on rural revitalization is nonlinear, this paper takes the consumption level of rural residents and the level of digital inclusive finance as threshold variables to analyze their threshold effect. This paper adopts the practice of Hansen (1999) to establish a panel threshold regression model, and constructs a single threshold model and a double threshold model as follows:

$$Rur_{it}=\rho_1 Dig_{it} I(q_{it}\leq\theta_1)+\rho_2 Dig_{it} I(q_{it}>\theta_1)+\rho_z C_{it}+\rho_0+\mu_i+\sigma_t+\varepsilon_{it} \quad (1)$$

$$Rur_{it}=\delta_1 Dig_{it} I(q_{it}\leq\theta_1)+\delta_2 Dig_{it} I(\theta_1< q_{it}\leq\theta_2)+ \delta_2 Dig_{it} I(q_{it}>\theta_2)+ \delta_z C_{it}+\delta_0+\mu_i+\sigma_t+\varepsilon_{it} \quad (2)$$

Among them, Rur_{it} represents the rural revitalization level of i province in t year, Dig_{it} represents the digital economy level of i province in t year, and C_{it} represents each control variable. In addition, μ_i represents the fixed effect of provinces, q_{it} represents threshold variables, θ_1 and θ_2 represent threshold values, and I (·) denotes indicative functions.

3. Analysis of Empirical Results

3.1 Threshold Effect Analysis

Firstly, the significance of threshold effect and the number of thresholds are tested. After 300 calculations by the Bootstrap method, P statistics and F statistics of threshold effect test can be obtained. Table 3 shows the results of threshold effect test. It can be seen from the table that when the consumption level of rural residents is the threshold variable, there is a single threshold, which is significant at the level of 10%. At the same time, when the digital inclusive finance level is taken as the threshold variable, there is a double threshold, which is significant at the 5% level.

Table 3. Threshold Effect Analysis

		threshold value	F	P	critical value		
					10%	5%	1%
rural residents' consumption level	Single	9.6428	18.66	0.0533	15.5678	18.9401	25.8306
	Double	—	11.52	0.1433	12.4543	14.6489	20.9491
digital inclusive finance level	Single	4.5183	31.21	0.0000	13.6577	15.9484	24.6992
	Double	5.7911	18.34	0.0400	13.9178	17.1216	29.1703
	Triple	—	11.88	0.5567	22.1426	26.0838	31.6193

3.1.1 Rural Residents' Consumption Level

Table 4 (1) lists the regression results with the consumption level of rural residents as the threshold variable. It can be seen from the table that no matter which range the consumption level of rural residents is in, the promotion of digital economy to rural revitalization is significant at the level of 1%. When the consumption level of rural residents is lower than the threshold value of 9.6428, the impact coefficient of digital economy on rural revitalization is 0.132; When the consumption level of rural residents is higher than the threshold of 9.6428, the impact coefficient of digital economy on rural revitalization rises to 0.146. It shows that the higher the consumption level and the richer the life of rural residents, the greater the positive impact of digital economy on rural revitalization. The reason may be that the consumption level of rural residents has made the living, social and educational

environments of residents fully intelligent and digitally upgraded, digital technology has penetrated into all fields of residents' consumption, and the empowering role of digital economy in rural revitalization has been brought into full play, reflecting the importance of improving the consumption level of rural residents.

3.1.2 Digital Inclusive Finance Level

Table 4 (2) lists the regression results with the level of digital inclusive finance as the threshold variable. It can also be seen from the table that no matter which range the level of digital inclusive finance is in, the promotion of digital economy to rural revitalization is significant at the level of 1%. Further analysis shows that when the digital inclusive finance level is lower than the threshold value of 4.5183, the impact coefficient of digital economy on rural revitalization is 0.105; When the level of digital inclusive finance is between 4.5183 and 5.7911, the impact coefficient of digital economy on rural revitalization rises to 0.131, and its promotion is obviously accelerated; When the digital inclusive finance level is higher than the threshold value of 5.7911, the impact coefficient further rises to 0.147. After the above analysis, it is found that the higher the level of digital inclusive finance, the greater the promotion of digital economy to rural revitalization, and its promotion shows a rising trend. The reason may be that the rising level of digital inclusive finance overcomes the inherent time and space limitations of traditional financial transactions, lowers the threshold of obtaining funds, broadens the channels for rural residents to obtain funds, and residents have more funds to start their own businesses and upgrade their industries digitally, thus deepening the combination between digital economy and industries in rural areas, thus promoting rural revitalization more effectively. Therefore, it is necessary to vigorously develop digital inclusive finance.

Table 4. Threshold Effect Regression Results

	（1）		（2）	
	rural residents' consumption level		digital inclusive finance level	
low threshold interval	Lis≤9.6428	0.132***	Ind≤4.5183	0.105***
		(0.023)		(0.019)
middle threshold interval			4.5183 < Ind≤5.7911	0.131***
				(0.019)
high threshold interval	Lis>9.6428	0.146***	Ind>5.7911	0.147***
		(0.022)		(0.019)
Control	Yes		Yes	
year	Yes		Yes	
province	Yes		Yes	
R^2	0.803		0.818	

3.2 Heterogeneity Analysis

Considering the differences in regional development, this paper divides 30 provinces in China into three regions: eastern, central and western, and then makes grouping regression to explore the regional differences in the impact of digital economy development on rural revitalization. Table 5 shows the regression results after regional division. The results show that the promotion of digital economy development to rural revitalization in the western region is significant at the level of 1%, and the coefficient is the largest. However, the promotion of digital economy is not significant in the eastern and central regions. It can be seen that digital economy can give full play to its advantages and better promote the revitalization of local villages in areas with relatively backward economic and technological development.

Table 5. Grouping Regression Results

	(1)	(2)	(3)
	Eastern region	Central region	Western region
Dig	0.051	0.002	0.115***
	(0.117)	(0.066)	(0.030)
Control	Yes	Yes	Yes
year	Yes	Yes	Yes
province	Yes	Yes	Yes
R^2	0.736	0.892	0.891

4. Conclusions and Suggestions

This paper selects the provincial panel data from 2011 to 2021, measures the digital economy and rural revitalization level in various regions, constructs a threshold regression model, and analyzes the nonlinear influence and heterogeneity of digital economy on rural revitalization level. The results show that digital economy has a nonlinear impact on rural revitalization. Specifically, when the threshold variable is the consumption level of rural residents, the impact of digital economy on rural revitalization has a significant single threshold effect. With the improvement of rural residents' consumption level, digital economy accelerates rural revitalization. When digital inclusive finance is the threshold variable, there is a significant double threshold effect. With the improvement of digital inclusive finance level, the promotion of digital economy to rural revitalization is constantly increasing. At the same time, it is found that the promotion of digital economy to rural revitalization is only significant in the western region with relatively backward economic and technological conditions, but not significant in the central and eastern regions.

Therefore, the following suggestions are put forward: First, we should intensify the digital construction in rural areas, and actively improve the digital infrastructure construction and talents training system in

various regions, especially in the western region, so as to maximize the efficiency of the development of digital economy. Only by perfecting the digital infrastructure can we provide a solid material foundation for the development of digital economy and promote rural revitalization. Second, we should actively promote the modernization of agriculture and rural areas and improve the income and consumption level of rural residents. We should speed up the digital transformation of traditional industries and facilities in rural areas, make deep use of digital technology to build digital industrial chains such as smart agriculture and smart logistics, actively promote the integration and innovative development of digital economy and rural traditional economy, improve the overall living standards of residents in rural areas, and maximize the promotion of digital economy to rural revitalization. Third, we should actively promote the development of digital inclusive finance and help the development of digital finance in rural areas. Digital Inclusive finance has the characteristics of convenience, sharing, high coverage and low cost, which can solve the problems of financial exclusion in rural areas. Financial institutions should strengthen the publicity of digital Inclusive finance in rural areas, improve the digital financial literacy of rural residents, and let Inclusive finance's thoughts gradually penetrate into the daily life of rural residents, so that rural residents can become real financial consumers. Local financial institutions should actively combine local industrial characteristics, launch characteristic digital financial products in line with local development, meet the diverse financial needs of rural residents, improve the probability of local residents obtaining funds, promote the development of local digital Inclusive finance, and accelerate rural revitalization.

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