The Effect Mechanism of Digital Economy Empowering Rural Revitalization

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Abstract: Based on the panel data of 30 regions in China from 2011 to 2021, this paper establishes an index system of digital economy and rural revitalization, measures the level of digital economy and rural revitalization in each region, and deeply analyzes the impact of digital economy on rural revitalization by using two-way fixed effect model and intermediary effect model. It is found that digital economy can significantly promote rural revitalization, and this result is still valid after robustness test and endogenous test; The digital economy mainly affects the dimension of residents' "affluent life" in rural revitalization; The development of digital economy can promote rural revitalization by improving the basic transportation level, residents' living standards and expanding the scale of agricultural economy.

1. Introduction

Digital economy is a new economic form emerged after the emergence of agricultural economy and industrial economy. The key element of digital economy is data resources, the main carrier is the Internet, and the core leading force is scientific and technological innovation, emphasizing the deep combination of digital technology and traditional economic forms [1], leading digital transformation in various fields through digital industrialization and industrial digitalization, and stimulating new driving force of China's economy. In view of rural areas, the development of digital economy has brought about the digital transformation of rural industries, life and government services, promoted the upgrading of rural industries, improved the income and living standards of rural residents, met the diversified needs of rural residents, improved the modernization level of rural governance, and promoted rural revitalization in all directions [2]. The existing research on digital economy promoting rural revitalization mainly starts from the perspectives of rural residents' income and consumption, rural industrial development and rural revitalization as a whole.

From the perspective of residents' income and consumption, Tang Hongtao et al. [3] established a coupling collaborative model based on CFPS panel data and found that digital economy can significantly promote the improvement of farmers' income and consumption level. From a macro perspective, the development of digital economy has improved the efficiency of circulation and promoted the upgrading of rural industrial structure; From a micro perspective, it creates more employment opportunities and stimulates employment in rural areas.

From the perspective of rural industrial development, Tian Ye et al. [4] found that the development

of digital economy can promote rural industrial revitalization through the mechanism of urban-rural integration development, and its promotion effect will be different due to the different scale of agricultural labor. Zhou Qingxiang et al. [5] found that digital economy can significantly promote the high-quality development of agriculture, enhance the comprehensive benefits of agricultural production and promote rural revitalization from the perspective of innovation, coordination, green, openness and sharing. Tang Hongtao et al. [6] combined industrial poverty alleviation and found that digital economy can promote the connection between industrial poverty alleviation and industrial revitalization, in which human capital plays a role as intermediary variable between them.

From the overall perspective of rural revitalization, He Leihua et al. [7] calculated the level of digital economy and rural revitalization based on the data of 30 provinces and cities in China. Through research, it was found that digital economy can promote rural revitalization by promoting scientific and technological innovation and strengthening human capital, and its promotion effect has a spatial spillover effect, which can drive the development of surrounding areas. By analyzing its heterogeneity, it is found that the western region can better enjoy the dividends brought by the development of digital economy. Meng Weifu et al. [8] confirmed the transmission mechanism of digital economy to promote rural revitalization by stimulating innovation, entrepreneurship and consumption upgrading.

2. Effect model of digital economy on rural revitalization

2.1 Data Sources and Variable Descriptions

In order to ensure the availability and integrity of data, this paper selects the provincial data of 30 regions in China from 2011 to 2021 as the research object of this paper, and some missing data are supplemented by linear interpolation. The data in this paper are all from the National Bureau of Statistics, China Statistical Yearbook, China Labor Statistical Yearbook and provincial statistical yearbooks.

a. Explained variable: Rural revitalization level (Rur). Referring to the practice of Zhang Ting et al. [9], this paper focuses on five major objectives and tasks: industrial prosperity (Rural1), ecological livability (Rural2), rural civilization (Rural3), effective governance (Rural4) and affluent life (Rural5), and selects 14 secondary indicators to construct the evaluation system of rural revitalization level indicators. After that, the entropy method is used to give weight and take logarithm. The specific indicators are introduced as shown in Table 1.

Table 1: Rural revitalization index evaluation system.

rural revitalization level	industrial prosperity	Added value of agriculture, forestry, animal husbandry and fishery
		Total power of agricultural machinery
		Proportion of effective irrigation area to total sown area
	ecological livability	Total rural electricity consumption
		Number of village clinics
		Proportion of the number of people participating in endowment insurance to the total population
	rural civilization	Local 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
		Proportion of rural residents' expenditure on education, culture and entertainment to total expenditure

b. Core explanatory variable: Digital economy level (Dig), this paper refers to the method of Zhao

Tao et al. [10], constructs the evaluation system of digital economy indicators, and also uses the entropy method to give weight and take logarithm. In addition, in the stage of standardizing the original data related to rural revitalization level and digital economy level, the practice of Liu Jun et al. [11] was used for reference, and the original data was standardized with 2011 as the base period.

c. Intermediary variables: Basic transportation level (Tra), residents' living standard (Lis) and agricultural economic scale (Agr). In this paper, the ratio of highway mileage to local area is used to measure the basic transportation level. For families with relatively scarce resources, consumption level can better measure the living standard and welfare of residents [12]. Therefore, the logarithmic value of per capita consumption expenditure of rural residents is used to measure the living standard of rural residents. The logarithmic value of regional total agricultural output value is used to measure the scale of agricultural economy.

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 of variables.

	Variable	Mean	Std. Dev.	Min	Max
explained variables	Rur	3.609	0.380	2.304	4.485
	Rural1	2.095	0.581	0.562	3.228
	Rural2	1.981	0.674	-0.161	3.069
	Rural3	2.006	0.643	0.226	3.446
	Rural4	1.481	0.824	-2.231	2.627
	Rural5	1.819	0.442	-0.825	2.468
explanatory variable	Dig	4.371	0.991	0.296	6.271
intermediary variables	Tra	0.956	0.509	0.089	2.234
	Lis	9.214	0.382	8.258	10.211
	Agr	7.178	1.032	4.628	8.789
control variables	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 test the impact of digital economy development on rural revitalization, this paper builds the following models:

$$Rur_{it}=\alpha_1 Dig_{it}+\alpha_z Control_{it}+\alpha_0+\mu_i+\sigma_t+\varepsilon_{it} \tag{1}$$

Rur_{it} represents the rural revitalization level of i province in the t year, Dig_{it} represents the digital economy level of i province in the t year, and $Control_{it}$ represents each control variable. In addition, μ_i represents the fixed effect of provinces, σ_t represents the fixed effect of years, α_1 is the influence coefficient of digital economy on rural revitalization, and ε_{it} is a random disturbance term.

In order to deeply analyze the effect mechanism of digital economy development affecting rural revitalization, this paper takes basic transportation level, residents' living standard and agricultural economic scale as intermediary variables, and builds an intermediary effect model:

$$Rur_{it}=\alpha_1 Dig_{it}+\alpha_z Control_{it}+\alpha_0+\mu_i+\sigma_t+\varepsilon_{it} \qquad (2)$$

$$M_{it}=\beta_1 Dig_{it}+\beta_z Control_{it}+\beta_0+\mu_i+\sigma_t+\varepsilon_{it} \qquad (3)$$

$$Rur_{it}=\gamma_1 Dig_{it}+\gamma_2 M_{it}+\gamma_z Control_{it}+\gamma_0+\mu_i+\sigma_t+\varepsilon_{it} \qquad (4)$$

Among them, M_{it} is the intermediate variable, α_1, α_z, β_1, β_z, γ_1, γ_2 and γ_z are the coefficients of each variable, and the remaining variables are consistent with the above.

3. Empirical Analysis

3.1 Benchmark Regression Result Analysis

After Hausman test, this paper determines the fixed effect model as the benchmark regression model of this paper. Table 3 shows the regression results of digital economy affecting rural revitalization and different dimensions of rural revitalization. It can be seen from column (1) that the digital economy has a significant role in promoting rural revitalization, with a significant level of 1%. It proves that the dividends brought by the development of digital economy have contributed to rural revitalization. Further analysis of different dimensions in terms of rural revitalization shows that digital economy has the most significant positive impact on the dimension of "affluent life" of rural residents, with the highest coefficient, but has no significant effect on other dimensions. It can be seen that the development of digital economy mainly has a positive impact on the income of rural residents, and then improves the living conditions of residents.

Table 3: Benchmark regression results.

	(2)	(2)	(3)	(4)	(5)	(6)
	Rur	Rural1	Rural2	Rural3	Rural4	Rural5
Dig	0.073***	0.062	-0.054	-0.027	0.093	0.537***
	(0.022)	(0.045)	(0.064)	(0.076)	(0.096)	(0.120)
Edu	-0.013**	-0.038***	0.003	-0.041**	0.021	-0.007
	(0.006)	(0.012)	(0.008)	(0.020)	(0.020)	(0.015)
Fot	0.051***	0.070***	0.057**	0.048	-0.047	0.105***
	(0.015)	(0.020)	(0.023)	(0.042)	(0.041)	(0.037)
Pop	-0.983***	-0.468	0.453	-0.561	-1.501	-3.430***
	(0.318)	(0.512)	(1.000)	(0.961)	(1.221)	(0.848)
Gov	0.734	0.187	2.562***	-0.480	1.141	0.283
	(0.520)	(1.062)	(0.860)	(1.490)	(1.537)	(1.313)
Int	-0.035	-0.084***	0.014	-0.065	-0.009	-0.042
	(0.022)	(0.027)	(0.065)	(0.043)	(0.033)	(0.061)
_cons	3.104***	1.837***	0.732*	1.951***	1.866**	0.208
	(0.240)	(0.321)	(0.396)	(0.636)	(0.834)	(0.523)
year	Yes	Yes	Yes	Yes	Yes	Yes
province	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.812	0.679	0.340	0.493	0.370	0.779
Note. ***, **, and * represent significant at 1%, 5%, and 10% levels respectively. The brackets are robust standard errors clustered to provinces, the same as below.						

3.2 Robustness Tests

3.2.1 Replace the Explained Variable

In order to ensure the robustness of benchmark regression results, this paper replaces the explained variables. In this paper, the new rural revitalization level (Rur2) is calculated by using the weighting method of Liu Jun et al. [11] to replace the explained variables obtained by entropy method above,

and the fixed effect model is used for regression. Table 4 (1) shows the regression results after replacing the explained variables. The results show that the digital economy still plays a significant role in promoting rural revitalization, which is consistent with the benchmark regression results.

3.2.2 Replace the Explanatory Variable

In order to further verify the validity of the benchmark regression results, a new digital economy level (Dig2) is obtained by using the weighting method of Liu Jun et al. [11] to replace the core explanatory variables calculated by entropy method above, and then regression is carried out. Table 4 (2) shows the regression results after replacing the core explanatory variables, which are consistent with the baseline regression results.

3.2.3 Instrumental Variable Method

There is probably a two-way causal relationship between digital economy and rural revitalization. In order to alleviate endogeneity, this paper takes the lag one and lag two of digital economy level as instrumental variables for 2SLS regression analysis. Column (3) and column (4) of Table 4 are the regression results with the first and second lags of digital economy as instrumental variables respectively. It can be seen that the promotion of digital economy to rural revitalization is still significant, and both are significant at the level of 1%. From the P value and Wald F value of Kleibergen-Paap rk LM, it can be seen that the two instrumental variables have passed the identification deficiency test and weak instrumental variable test, which shows the rationality of the instrumental l variable setting.

Table 4: Robustness tests.

	(1)	(2)	(3)	(4)
	replace the explained variable	replace the explanatory variable	One-stage lagging instrumental variable	Two-stage lagging instrumental variable
	Rur2	Rur	Rur	Rur
Dig	0.114^{***}		0.164^{***}	0.288^{***}
	(0.027)		(0.034)	(0.075)
Dig2		0.090^{***}		
		(0.023)		
control	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
province	Yes	Yes	Yes	Yes
R^2	0.861	0.815	0.967	0.962
LM			27.502[0.0000]	20.130[0.0000]
Wald F			120.901{16.38}	85.976{16.38}
Note. [] is the P value and {} is the critical value at the 10% level of the Stock-Yogo test.				

3.3 Intermediary Effect Analysis

3.3.1 Basic Transportation Level (Tra)

In Table 5 (1), (2) and (3) are the test results with the basic transportation level (Tra) as the intermediary variable. Through column (2), it cannot be seen that the digital economy has a significant role in promoting basic transportation; Column (3) shows that both digital economy and basic transportation have a significant positive impact on rural revitalization; Comparing columns (1) and (3), it is found that after adding the explanatory variable of basic transportation, the influence coefficient and significance of digital economy level have a downward trend. So it is necessary to use Sgmediation command for Sobel test to judge whether the mediation effect exists. Sobel test has

achieved significant results, which confirms the existence of some intermediary effects, that is, digital economy can promote rural revitalization by improving the basic transportation level in various places.

3.3.2 Residents' Living Standard (Lis)

In Table 5, columns (4) and (5) show the results of the test with the living standard of rural residents (Lis) as the mediating variable. Column (4) shows that the digital economy has a significant positive impact on the living standard of rural residents; Column (5) shows that the digital economy and the living standard of rural residents have significantly promoted rural revitalization; It is also found that the influence coefficient and significance of the level of digital economy decrease, and the results of Sobel test are also significant, indicating that there is a partial intermediary effect. That is, the development of digital economy can promote the implementation of rural revitalization strategy by improving the living standards of rural residents.

3.3.3 Agricultural Economic Scale (Agr)

Columns (6) and (7) in Table 5 are the test results with agricultural economic scale (Agr) as the intermediary variable. Column (6) shows that the digital economy significantly promotes the expansion of agricultural economy; Column (7) shows that both digital economy and agricultural economy scale significantly promote rural revitalization, and compared with Column (1), the influence coefficient and significance of digital economy level are significantly reduced, and its Sobel test passes, which proves the existence of some intermediary effects, that is, the development of digital economy can improve rural revitalization level by expanding agricultural economy scale.

Table 5: The results of the intermediary effect tests.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		basic transportation level		residents' living standard		agricultural economic scale	
	Rur	Tra	Rur	Lis	Rur	Agr	Rur
Dig	0.073***	0.033	0.063***	0.050***	0.051*	0.173**	0.042*
	(0.022)	(0.021)	(0.022)	(0.012)	(0.026)	(0.066)	(0.024)
Tra			0.285***				
			(0.059)				
Lis					0.429***		
					(0.134)		
Agr							0.177**
							(0.068)
control	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
province	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sobel		0.009*(z=1.843)		0.021***(z=3.213)		0.031***(z=3.631)	
R^2	0.812	0.577	0.824	0.980	0.825	0.804	0.823

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 fixed effect model and an intermediary effect model, and analyzes the influence of digital economy on rural revitalization level and its effect mechanism. The results show that: First, the digital economy can significantly improve the level of rural revitalization, and mainly promote the "affluent life" of rural residents. Second, the digital economy can promote rural revitalization by improving the basic transportation level, and residents' living standards and expanding the scale of agricultural economy.

In conclusion, some suggestions are put forward: First, we should continue to strengthen the construction of digital infrastructure such as the Internet of Things, Internet, communication networks and 5G in rural areas to ensure smooth and stable network communication signals in rural areas. Relevant government departments should actively formulate relevant incentive policies to attract more digital talents into the countryside and actively build the countryside. At the same time, we should actively improve the digital literacy of rural residents, so that rural residents can better understand and make good use of the Internet, improve the network penetration rate of rural residents, train local digital talents, and maximize the efficiency of digital economy empowering rural revitalization. Second, we should actively promote the modernization of agriculture and rural areas and improve the income and living standards 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, and actively promote the integration and innovative development of digital economy and rural traditional economy, and improve the income level of residents in rural areas. Secondly, we should let digital technology penetrate into all areas of rural residents' lives, enrich and facilitate the daily life of rural residents by using information technologies such as the Internet and big data, improve the living standards of rural residents, and improve the efficiency of digital economy development in promoting rural revitalization.

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