A Study on the Impact of the Digital Economy on Rural Development

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Abstract: The integration of the digital economy and rural development is the key to promoting the construction of a digital village and an important step in creating a digital China. This paper conducts an empirical study to explore the impact of China's digital economy on rural development, relying on Chinese data from 2011-2021. The results found that the digital economy has a certain driving effect on rural development, but the effect is not very high; for every 1% increase in the digital economy development level index, the rural development index only increases by 0.165%.

Keywords: digital economy, rural development, empirical study

1 Introduction

With the rapid development of information technology, the digital economy, with the Internet and big data technologies at its core, has emerged, and the development of the digital economy has brought a strong innovative energy as well as growth potential to society. In the current and future development environment, the impact of digital technology on the economy is increasing, digital technology has been developing and expanding to all economic activities and societies, this new reality makes the economy more intelligent and data driven (Steles and Simionescu, 2020)[1]. Especially in the context of the epidemic, global economic development has been hit hard and the downward pressure on the overall economy has been increasing, but the digital economy has been steadily advancing in various traditional sectors, and its advantages of high growth, penetration and wide coverage are becoming increasingly prominent in driving economic growth in China and globally, making the vigorous development of the digital economy extremely important for China's high-quality development and the building of a digital China. With the rapid development of the digital economy, the use of digital technology has been extended and penetrated into the countryside, which therefore creates opportunities for the development of digital countryside, smart agriculture, and provides a new dynamic and engine for rural development. China is a dual identity with a large network country and a large agricultural country, the network field is rich in digital resources, the field of application in agriculture and its broad. The digital economy has become a new engine for economic development and is deeply changing China's traditional economic structure, and rural development is to make full use of the advantages of the digital economy to promote the leapfrog development of rural society (Gao Hongcun and Chen Xiaojuan, 2018)[2].

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2 Theoretical Analysis

Rural development is a comprehensive and systematic project that should focus on the integrated application of resources, policies and methods, and points out that the digital economy is a breakthrough for rural development, and that if the digital economy model is applied rationally, it can promote the high-quality development of the rural economy and enhance the autonomy and cohesion of the countryside, thus helping the development of rural revitalization (Peng Zhao, 2020)[3]. The digital economy has become a new engine of economic development and is deeply changing China's traditional economic structure, while rural development is to make full use of the advantages of the digital economy to promote the leapfrog development of rural society The synergistic development of the digital economy and the countryside is the only way to achieve the modernization and construction of agriculture and rural areas, and the digital economy provides digital infrastructure, data elements and digital technology for rural development, and the three overlap and permeate each other, thus opening up the difficult and painful points encountered in the process of rural development. The subsystems of the digital economy and the subsystems of rural development are closely linked, mutually reinforcing and synergistic through the structures and elements between them, thus realizing the phenomenon of integration between them and forming an organic coupling.

Rural economic development refers to the flourishing of industries, and the digital economy is the basis for rural economic development. The integration and development of the digital economy and rural industries is a means to promote rural economic development and a dynamic innovation process (Wu Xiaoxi, 2021)[4]. The mechanism by which the digital economy promotes rural economic development is manifested in the following aspects: first, the development of the digital economy can promote the mutual integration of rural industries and digital technology, and promote the digital industrialization of the countryside and the digital capacity of the industry. When the digital economy is embedded in rural economic development, digital technology will generate human capital and industrial structure effects for the countryside, thus giving rise to new business models and modes of rural economic development and providing opportunities for optimizing rural industrial structures and rural production relations. Secondly, the development of the digital economy can serve as a carrier of information dissemination for rural economic development and enhance the connection between the countryside and the outside world. The digital economy is not limited by physical time and space, and the digital infrastructure represented by the Internet and e-commerce can then receive information from the outside world and carry out exchanges and cooperation, which means that the development of the digital economy can reduce the information asymmetry between rural market players providing a solution to further reduce information search costs and promote the optimization and upgrading of rural industrial chains. Third, the development of the rural economy provides support for the synergistic development of the digital economy and rural revitalization. Although, in many aspects, it is the digital economy that empowers rural economic development, the development of the rural economy can provide perfect infrastructure, comprehensive digital talents and generate abundant relevant data for the development of the digital economy, etc.

Rural social development refers to rural civilization and rural governance, and the digital economy is an important way of developing rural society. The mechanism of the digital economy for rural social development is manifested in the following aspects: Firstly, the development of the digital economy helps to realize the civilization of the countryside under the development of rural society. The digital economy provides farmers with digitalized and gridded

cultural resources, and through infrastructure such as the Internet, smartphones and big data, it constructs a communication channel for rural culture. As a result, the digital economy breaks down the barriers of cultural resources between urban and rural areas, enabling rural culture to enter the city and urban culture to go to the countryside, which spreads and enriches the cultural life of farmers, and promotes the digitalized and sustainable development of rural cultural resources. Secondly, the development of the digital economy helps to realize rural governance under the development of rural society, forming the digitalization of rural governance. The digital economy empowers the development of rural society and provides accurate and effective governance tools for rural governance. In particular, the integration of digital technology and rural governance enables farmers to access information resources and express their demands, so that they can consciously participate in rural governance, and can also use the Internet to raise their legal awareness, thus promoting the diversification of rural governance and improving farmers' sense of ownership and legal literacy. Thirdly, the development of rural society has accelerated the integration of the digital economy and rural revitalization. As an emerging economy, the digital economy is difficult for rural areas, which are not very well educated, to integrate into it for a while. The development of rural society can enable farmers to gain a new understanding in their minds, and through their own learning and understanding, they can actively and consciously integrate into the development of the digital economy.

The digital economy is an important economic development model for improving rural living standards and provides a solid foundation for rural revitalization. The coupling and synergistic mechanism between the digital economy and rural living standards is manifested in the following aspects: Firstly, rural industries, under the digital economy model, have reshaped the position of rural markets in the country's and even the world's industrial and value chains, thus being able to generate a large number of employment and entrepreneurial opportunities, such as live-streaming with goods and rural production + e-commerce, which have increased channels for farmers' income and improved their living standards. Secondly, the integration of the data elements of the digital economy and digital technology with rural industries breaks down information barriers and guides the flow of people, goods and money into rural areas, thereby optimizing resource allocation and improving rural living standards.

Rural ecological environment refers to ecological livability, and the development of the digital economy provides innovative ideas for rural ecological environment. The coupling and synergistic mechanism between the digital economy and the development of rural ecological environment is manifested in the following aspects: Firstly, the integration of the digital economy with traditional rural industries helps to digitally transform rural industries, improve the conversion rate and effective utilisation of resources, reduce carbon emissions, give rise to green industries in agriculture and improve the rural ecological environment. Secondly, the development of the rural ecological environment provides greater vitality and space for the development of the digital economy. The development of the rural ecological environment drives the high-quality development of the rural economy, thus enabling the digital economy to be deeply integrated into rural areas, thus widening the spatial scope and boundary of the development of the digital economy.

3 Study Design

3.1 Data Description

On the basis of reading a large amount of relevant literature to evaluate the index system, and according to the policy basis, theoretical basis and the realistic basis of data availability and operability of the digital economy and rural development evaluation index system, the sample data interval of this paper is 2011-2021, and the data are mainly from the China Statistical Yearbook, China Population and Employment Statistical Yearbook, China Rural Statistical Yearbook, China Urban and Rural Construction Statistical Yearbook, China Health and Health Statistical Yearbook, etc.

3.2 Variable Selection

3.2.1 Explained Variables

The explanatory variable in this paper is the rural development level. According to China's requirements for rural development, and the main references to the scholarship of two scholars (Zhang Ting 2018[5], Yu Yunfeng 2020[6]), this paper specifically classifies the rural development level into: rural economic development, rural social development, rural living standard and rural ecological environment. The rural development level index is obtained after determining the weights through the entropy value method, and the specific construction indicators are shown in Table 1.

Table 1: Construction of rural development level indicators

Tier 1 indicators	Secondary indicators	Tertiary indicators
Level of Rural Development	Rural Economic Development	Labour Productivity
		Total Mechanical Power Per Capita
		Share of Primary Sector Value Added
		Land Productivity
	Rural Social Development	Thousands of Village Health Office Staff
		Average Years of Schooling
		Cultural Station Coverage
		Village Council Coverage
	Rural Living Standards	Comparison of Income Between Urban and Rural Residents
		Engel's Coefficient
		Living Space Per Person
		Colour TV Ownership in 100 Rural Households
	Rural Ecology	Water Supply Coverage
		Greenery Coverage
		Domestic Waste Disposal Rate
		Sanitary Toilet Penetration Rate

3.2.2 Explanatory Variables

The explanatory variable in this paper is the digital economy, which is specifically measured through the construction of a digital economy development index. As this paper explores the

study of the impact of the digital economy on rural development, the digital economy indicators are selected to focus on the digital economy under the countryside. Here we draw mainly on the scholarship of two scholars (Mu Juan 2021[7], Zhang Wang 2022[8]), the digital economy is divided into digital infrastructure, agricultural digitization and digital industrialization. The digital economy index was obtained after determining the weights through the entropy value method, and the specific construction indicators are shown in Table 2.

Table 2: Construction of digital economy indicators

Tier 1 indicators	Secondary indicators	Tertiary indicators
Digital Economy	Digital Infrastructure	Rural Internet Penetration Rate
		Rural Smartphone Penetration Rate
		Agrometeorological Observatory
	Digitization of Agriculture	Digital Scale in Agriculture
		Digital Trading of Agricultural Products
		Investment Efforts in Agricultural Production
	Digital Industrialization	Rural Network Payment Levels
		Rural IT Applications
		Agricultural and Rural Entrepreneurship and Innovation Base

3.3 Index Calculation

The entropy method is an objective weighting method that can, to a certain extent, avoid bias caused by subjective factors and provide a basis for the comprehensive evaluation of relevant indicators, so as to calculate the development index. The specific steps are as follows:

Standardization

$$x_{ij}^{*} = \frac{x_{ij} - min(x_{ij})}{max(x_{ij}) - min(x_{ij})} \quad (+)$$

$$x_{ij}^{*} = \frac{max(x_{ij}) - x_{ij}}{max(x_{ij}) - min(x_{ij})} \quad (-)$$

i=1,2,…,t; j=1,2,…,n (1)

In equation (1), x_{ij} is the value of the j indicator in year i, x_{ij}^{*} is the normalised value, $max(x_{ij})$ is the maximum value of the indicator and $min(x_{ij})$ is the minimum value of the indicator.

Calculating the weighting of indicator values

$$p_{ij} = x_{ij}^{*} / \sum_{i=1}^{t} x_{ij}^{*} \quad (2)$$

Calculating the entropy value of an indicator

$$e_j = -1/\ln t \sum_{i=1}^{t} p_{ij} \ln p_{ij} \quad (3)$$

Calculation of indicator variance factors

$$\omega_j = (e_j - 1)/(m - \sum_{j=1}^{n} e_j) \quad (4)$$

Calculating indicator weights

$$\varphi_j = \omega_j / \sum_{j=1}^{n} \omega_j \quad (5)$$

Calculation of indexes at all levels

$$U_1 or U_2 = \sum_{j=1}^{n} \varphi_j \times p_{ij} \quad (6)$$

In equations (2)-(6), t is the number of years and n is the number of indicators. According to the above equations, U_1, U_2 denote the digital economy development index, and the rural development level index respectively. As shown in Table 3.

Table 3: Indexes for each indicator

Year	U_1	U_2
2011	0.095	0.275
2012	0.108	0.290
2013	0.119	0.299
2014	0.123	0.313
2015	0.128	0.323
2016	0.135	0.324
2017	0.157	0.331
2018	0.178	0.328
2019	0.199	0.331
2020	0.224	0.340
2021	0.245	0.346

4 Empirical Analysis

With the help of Stata statistical software, the explanatory variable digital economy and the explanatory variable rural development level were subjected to regression analysis to verify the effect of digital economy on rural development level. The development indices of digital economy (U_1) and rural development level (U_2) were first taken as logarithms, lnU_1 and lnU_2respectively, and then a smoothness test was conducted to avoid "pseudo-regression" in the analysis of the problem, and the results of the smoothness test are shown in Table 4. From the test results, it can be seen that in the horizontal state, both variables do not have significant unit roots, so to a certain extent, the variables can be considered as smooth and can be regressed.

Table 4: Results of unit root tests for variables

Variables	ADF test (P-value)	LLC test (P-value)	Stability
lnU_1	0.000	0.000	Stable
lnU_2	0.006	0.000	Stable

As the sample was panel data, the panel regression model needed to be selected and after conducting the test, the RE model was finally selected and the test results are shown in Table 5 and the regression results are shown in Table 6.

Table 5: Summary of test results

Type of test	Test value	Test conclusion
F-test	F (29,299)=73.577,p=0.000	FE model
BP test	χ^2(1)=1232.530,p=0.000	RE Model
Hausman test	χ^2(1)=-0.390,p=1.000	RE Model

Table 6: Regression results

Variables	RE Model
Intercept distance	-0.843** (-16.151)
Ln(digital economy composite score)	0.165** (5.387)

Note: * p<0.05 ** p<0.01 t-values in brackets

The regression equation is therefore calculated as follows:

$$lnU_2 = -0.843 + 0.165lnU_1$$

The model shows that the elasticity of the digital economy development index to the rural development level index is 0.165, which means that under long-term development equilibrium conditions and without major unexpected factors, the rural development level index will increase by 0.165% for every 1% increase in the development level of the rural digital economy, indicating that the digital economy has a certain influence on rural development, and the digital economy can promote rural development and drive rural revitalization, but the influence of the rural digital economy on rural development is currently not very large and needs to be further strengthened in order to promote the integration of the rural digital economy into rural development, thereby increasing the influence of the digital economy.

5 Conclusions

5.1 Research Findings

Based on data from China over a period of 11 years, this paper presents a comprehensive index calculation for both the digital economy and rural development, as well as a regression analysis between the two.

Firstly, the results of the calculation of the two development indices of the digital economy and the rural development level show that although the rural digital economy development level index is generally lower than the rural development index, the development speed is faster than the latter, which is conducive to the coordinated development of both. Although the development level of China's rural digital economy is currently lagging behind the revitalization of the countryside, the match and drive between the two is gradually increasing.

Secondly, the results of the regression analysis show that there is a certain influence between the digital economy and rural revitalization, and that, all other things being equal, every 1% increase in the level of digital economy development will lead to a 0.165% increase in the level of rural development, and there is a mutual promotion effect between the two. The potential of China's rural digital economy in rural development has not yet been fully realized, and the use of data elements is not yet widespread in rural areas.

5.2 Recommendations

China's digital economy is developing at a rapid pace, and on the whole, the digital economy can significantly contribute to the development of the countryside, and the two are constantly converging and moving forward together. Therefore, based on the above findings, this paper proposes the following recommendations in order to better promote the digital economy and

rural development, so that the digital economy in rural areas can lead to better and faster development of rural areas, and thus enable China's rural areas to achieve better development:

Firstly, it is important to achieve synergy between rural reform and development. The core elements of the digital economy, i.e. data elements, digital technologies and modern information networks that can be accessed and applied in rural development are key to the digital economy and rural development, and it is important to combine rural reforms with specific policies for the digital economy to achieve efficient use of resources.

Second, strengthen the top-level design of the rural digital economy, consolidate the foundation of digital agriculture and promote new infrastructure in rural areas, so as to improve the level of rural informatization and promote the development of agricultural modernization. The digital economy will be integrated with the development of the countryside, the planning and implementation of the construction of the rural digital economy will be further promoted, the digitalization of urban and rural areas will be synchronized, a mutually supportive development will be formed, the agricultural and rural big data system will be built, the deep integration between modern information technology and agricultural production will be promoted, and the elements of the digital economy will be integrated into the development of the countryside so as to build a smart agriculture, promote the revitalization of the countryside and promote the modernization of agriculture.

Thirdly, we need to achieve synergistic development between regions. The implementation of differentiated digital economy development policies, to bridge the "digital economy gap" between regional areas, the development of each region should rely on their own advantageous industries to promote the development of digital economy industry. We should make good use of the opportunity of the digital economy to drive the new engine of rural development, make good use of the digital industry base and the advantages of digital industry talents, promote the use of new digital industry technologies in the construction of the rural digital economy, and drive the development of rural areas. digitization, relying on the Internet platform to promote the sale of agricultural products, thus promoting the level of rural revitalization.

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