



# Research on the Coupling and Coordinated Development of Digital Economy and Rural Revitalization

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## ABSTRACT

As a new driving force of China's economic development, digital economy is a vital path to make rural revitalization come true. In order to promote the coordinated development of rural revitalization and digital economy, the evaluation index system of rural revitalization and digital economy is constructed on the basis of analyzing of their coupling mechanism. The entropy method is taken to calculation the comprehensive level of rural revitalization and digital economy from 2002 to 2021. The coupling coordination degree model is used to analyze the change characteristics, and the curve fitting method is used to digitally characterize the relationship between the two. It is found that the coupling coordination degree of digital economy and rural revitalization is on the rise. In the past two years, the development of rural revitalization has lagged behind; There is a mutually reinforcing between digital economy and rural revitalization.

**Keywords:** *digital economy, rural vitalization, entropy method, coupling and coordination model.*

## 1. INTRODUCTION

The weakness of common prosperity under the dual structure of rural and urban areas, the imbalance between rural and urban development requires that we must give priority to rural development and promote agricultural and rural modernization. With the rapid economic development, smart devices such as mobile phones have been popularized in rural areas, providing a cornerstone for the application of digital technology to rural development. The application of digital technology will reconstruct the spatial relationship between urban and rural areas, accelerate the flow of urban and rural resources, expand the advantages of local industrial development, effectively advance the development of process of industries in rural, and build a digital village is a new path to achieve rural revitalization [8].

Based on the overall data of the country from 2002 to 2021, from the point of view on coupling coordination, this paper uses entropy method to calculate the weight of our select barometers to explore the relationship and development status between digital economy and Rural Revitalization. The results will be conducive to seeking the development status of both, digital economy will

become a better tool to boost the strategy of rural revitalization.

## 2. LITERATURE REVIEW

Up to now, most scholars have studied rural revitalization and digital economy respectively. Some scholars analyzed the new situation of rural economic development - the dialectical and unified relationship between rural tourism and Rural Revitalization from the perspective of the coupling coordinated development mechanism of rural tourism and rural revitalization [6]. There are scholars studied the Coupled co scheduling of e-commerce in rural and rural revitalization in 10 demonstration counties in Guizhou. With the rapid development of digital economy, scholars have studied the important role of digital economy in various fields [1]. There are also studies the impact of digital economy on social governance mechanism [3]; and studied the important role of digital economy in environmental pollution control by using simultaneous spatial equations and generalized third-order least squares (GS3SLS) [7].

Few mathematicians have put the two subsystems of digital economy and Rural Revitalization into one framework to study their interaction. Digital economy is closely related to rural revitalization. We should make

full use of the advantages of digital economy to vigorously promote rural revitalization and development [10]. There are scholars studied the development degree of digital villages in Zhejiang Province and concluded that important influencing factors of digital village construction [9].

### 3. EMPIRICAL RESEARCH

#### 3.1 Index Selection

The indicators of the model are selected from two aspects: Rural Revitalization and digital economy. The relevant indicators of Rural Revitalization refer to *The National Strategic Plan for Rural Revitalization (2018-2022)* [4] (State Council 2018), and the indicators of digital economy refer to the government document *The Digital Economy Development Plan of the State Council* (State Council 2021) [5]. This paper analyzes the overall national data from 2002 to 2021. The original data are from the Ministry of industry and information technology, the statistical report on the development of China's Internet, the China e-commerce development report of the Ministry of Commerce, and the China Statistical Yearbook. Some missing values are filled in by interpolation, forward extrapolation or backward extrapolation. The details of indexes is shown in table 1.

#### 3.2 Model Introduction

##### 3.2.1 Entropy Method

Entropy method is one of objective weight assignment methods. It judge the dispersion degree of an index by using entropy. The degree of dispersion is positively correlated with the influence of the index on the comprehensive evaluation.

- 1) Standardized treatment:

$$\begin{aligned}
 X'_{ij} &= \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})} \quad (+) \quad \text{or} \\
 X'_{ij} &= \frac{\max(X_{ij}) - X_{ij}}{\max(X_{ij}) - \min(X_{ij})} \quad (-) \quad (1)
 \end{aligned}$$

$$i=1, 2, \dots, m; j=1, 2, \dots, n$$

$X_{ij}$  is the value of the index  $j$  in the year  $i$ ,  $X'_{ij}$  is the standardization result of index,  $\max(X_{ij})$  is the maximum value of index  $X_{ij}$ ,  $\min(X_{ij})$  is the minimum value of index  $X_{ij}$ .

- 2) Calculate the proportion of indicator  $j$  in the year  $i$ :

$$d_{ij} = X'_{ij} / \sum_{i=1}^m X'_{ij} \quad (2)$$

- 3) Calculate the information entropy of the index  $j$ :

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

- 4) Calculate the weight of the index  $j$ :

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

$$W_j \in [0,1]; \sum_{j=1}^n W_j = 1$$

- 5) Calculate the composite scores of each subsystem in year  $i$ :

$$\begin{aligned}
 f(x) &= \sum_{j=1}^n W_j X_{ij} \\
 g(y) &= \sum_{j=1}^n W_j Y_{ij}
 \end{aligned} \quad (5)$$

$m$  is the number of years,  $n$  is the number of indicators, and  $f(x)$  and  $g(y)$  are the composite scores of digital economy subsystem and rural revitalization subsystem respectively.

##### 3.2.2 Coupling Coordination Degree Model

The coupling coordination degree model is used to analyze the coordinated development level of things. It involves the calculation of three index values. The value of coupling degree  $C$  reflects the interaction between two or more systems, realizes the dynamic correlation of coordinated development, and reflects the degree of interdependence and mutual restriction between systems. The value of coordination index  $t$  refers to the degree of benign coupling in the coupling interaction relationship, which can reflect the quality of coordination [2]. The value of coupling coordination degree  $D$  indicates the coordination degree between systems. The

Table 1 Rural Revitalization and digital economy development level system

variable	Primary index	Secondary index	Symbol	weight coefficient(w)
rural vitalization ( Y )	Industrial prosperity	Total output value of agriculture, forestry, animal husbandry and fishery	Y1	8.08%
		grain yield	Y2	5.63%
		Total power of agricultural machinery	Y3	5.60%
		Effective irrigation area	Y4	8.96%
	Ecologically livable	Number of rural hydropower stations	Y5	9.25%
		Rural power consumption	Y6	5.79%
		Prevalence of sanitary toilets in rural areas	Y7	6.61%
	Rural civilization	Number of township (street) cultural stations	Y8	4.63%
		Per capita expenditure on education, culture and entertainment of rural residents	Y9	9.91%
	Effective governance	Number of villagers' committee units	Y10	4.80%
		Number of village clinics	Y11	2.74%
	Affluent life	Engel coefficient of rural residents	Y12	6.63%
		Per capita disposable income ratio of urban and rural residents	Y13	11.60%
		Total domestic tourism expenses of rural residents	Y14	9.76%
Digital economy ( X )	Digital industrialization	Software business income	X1	12.76%
		Internet penetration	X2	7.39%
		Telecommunication revenue	X3	5.97%
		Number of IPv6 addresses	X4	18.29%
		Mobile phone penetration	X5	5.90%
		National online retail sales	X6	18.99%
		E-commerce transaction scale	X7	13.16%
	Industrial Digitalization	Number of patent applications for high-tech industries (caliber of large and medium-sized industrial enterprises)	X8	10.68%
		Number of websites	X9	6.86%

coordination degree model of digital economy Rural Revitalization coupling system can be expressed as:

$$T = \alpha f(x) + \beta g(y); \tag{8}$$

$$D = \sqrt{C \times T} \tag{6}$$

$\alpha$  and  $\beta$  is the undetermined coefficient, which is usually taken as 0.5, the coupling coordination degree D is in the range of [0,1].

$$C = \sqrt{\frac{f(x)g(y)}{[f(x)+g(y)]^2}} \tag{7}$$

### 3.3 Result Discussion

#### 3.3.1 Comprehensive Development Index Analysis

The comprehensive scores of Rural Revitalization and digital economy are calculated by using the weight coefficient obtained by the entropy method. The results are demonstrated in the table below:

Table 2: comprehensive scores of digital economy and Rural Revitalization

Years	Comprehensive score of digital economy	Comprehensive score of Rural Revitalization
2002	0.012364126	0.142608
2003	0.018285978	0.095859
2004	0.030063217	0.12775
2005	0.041889634	0.168078
2006	0.056349764	0.184606
2007	0.091335352	0.215916
2008	0.133969312	0.342929
2009	0.162392176	0.396831
2010	0.1736731	0.472478
2011	0.23633266	0.551945
2012	0.293407	0.605686
2013	0.35052	0.676185
2014	0.408111	0.727353
2015	0.465247	0.77071
2016	0.533324	0.789125
2017	0.621898	0.823692
2018	0.734562	0.847645
2019	0.811625	0.885275

2020	0.877089	0.825671
2021	0.994083	0.856583

Through the calculation in Table 2, the trend chart of comprehensive scores of Rural Revitalization and digital economy is drawn, as shown in Figure 1.

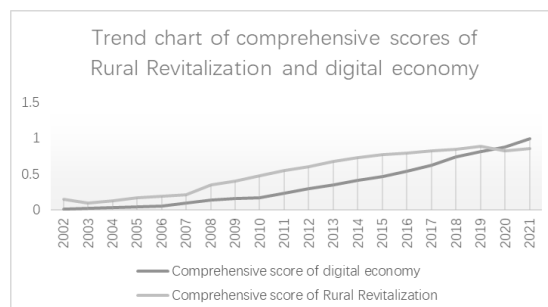


Figure 1: development trend of Rural Revitalization and digital economy

It can be known from Figure 1 that during the epidemic years from 2019 to 2021, the impact on rural revitalization and construction was serious. The level of Rural Revitalization and development decreased slightly, and began to diverge from the level of digital economy development.

#### 3.3.2 Analysis of Coupling Coordination Degree

The calculation results obtained by SPSS are shown in Table 3. In Table 3, items 1 to 20 respectively represent the calculation results from 2002 to 2021. It can be noted that after 2007, the value of coupling degree C has been stable above 0.9, and the coupling degree is high; It is observed that the early development of digital economy has little effect on Rural Revitalization, and the coordination index with Rural Revitalization and development, and the

Table 3: calculation results of coupling coordination degree

Item	Coupling C value	Coordination index T value	Coupling coordination D value	Coordination level	Coupling coordination degree
1	0.646	0.029	0.138	2	Severe maladjustment
2	0.734	0.029	0.146	2	Severe maladjustment
3	0.847	0.063	0.232	3	Moderate maladjustment
4	0.854	0.101	0.294	3	Moderate maladjustment
5	0.86	0.13	0.335	4	Mild maladjustment
6	0.906	0.172	0.395	4	Mild maladjustment
7	0.926	0.256	0.487	5	Verge of maladjustment

8	0.929	0.305	0.532	6	Reluctantly coordinate
9	0.912	0.357	0.571	6	Reluctantly coordinate
10	0.934	0.428	0.632	7	Primary coordination
11	0.949	0.486	0.679	7	Primary coordination
12	0.956	0.552	0.726	8	Intermediate coordination
13	0.963	0.609	0.766	8	Intermediate coordination
14	0.97	0.663	0.802	9	Good coordination
15	0.98	0.711	0.835	9	Good coordination
16	0.987	0.772	0.873	9	Good coordination
17	0.995	0.836	0.912	10	High quality coordination
18	0.997	0.895	0.944	10	High quality coordination
19	1	0.909	0.953	10	High quality coordination
20	1	0.978	0.989	10	High quality coordination

between the two is very low. As the level of digital economy improves, it is more and more coordinated T value of the degree of coordination between the two is also increasing, but there is a large gap with the coupling C value. The coupling coordination index is also coordination level in 2019.

### 3.3.3 Curve Fitting

The relationship between digital economy and rural revitalization is complex. In order to further obtain the internal relationship between the two, This paper first determines the correlation between the two (in table 4) and then curve fitting the two types of comprehensive scores, and the results are displayed in table 5.

Table 4: Correlation matrix

	Data economy	Rural revitalization
correlation	1.000	0.913
	Rural revitalization	0.913 1.000

It can be observed that the correlation between digital economy and rural revitalization has reached more than 90%

According to the fitting results in Table 5, the R-square and f-value of cubic curve fitting are larger, which has better fitting significance. Thus, the basic function form between digital economy (x) and Rural Revitalization (y) can be obtained as follows:

$$Y=0.058+2.608X-2.808X^2+0.99X^3 \tag{9}$$

The fitted image is shown in Figure 2. The horizontal axis is the comprehensive score of digital economy and the vertical axis is the comprehensive score of Rural Revitalization.

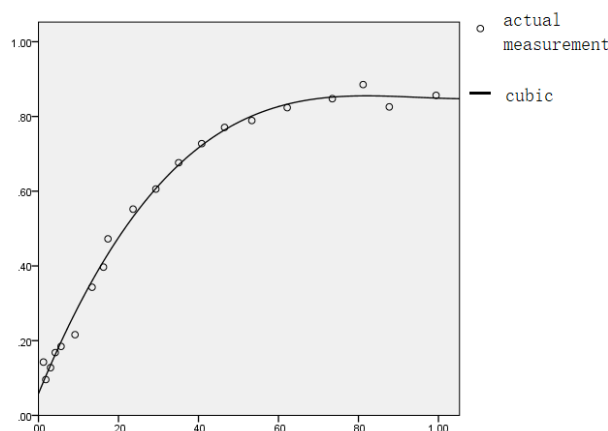


Figure 2 fitting diagram of digital economy and Rural Revitalization

## 4. CONCLUSION

Based on the data of national digital economy development and Rural Revitalization from 2002 to 2021, this paper constructs an evaluation index system for the coupling and coordinated development of digital economy and rural revitalization, calculates the comprehensive score index to judge the developmental level of digital economy and rural revitalization by using the entropy weighting method, and calculates and fits the digital economy development index and Rural Revitalization development index, The following conclusions are drawn: (1) in terms of correlation, we use the correlation matrix to prove that the correlation between digital economy and rural revitalization is more than 90%, and the gap between digital economy and

Rural Revitalization index is decreasing, so there is a lack of stamina for Rural Revitalization. (2) In terms of coupling coordination, the interaction between the two subsystems of digital economy and Rural Revitalization has different coupling coordination. It can be seen from the coupling and coordination degree between the development of the two subsystems that there is still

space for development. Specifically, the development of digital economy is relatively stable, and the realization of rural revitalization strategy should give full play to the role of digital economy. (3) We fitted the two indexes and found their three development relationships. There is indeed a mutual promotion between digital economy and Rural Revitalization.

Table 5: model summary and parameter estimates

Dependent variable: comprehensive score of Rural Revitalization									
equation	model summary					parameter estimates			
	R <sup>2</sup>	F	Degree of freedom 1	Degree of freedom 2	Significance	Constant	b1	b2	b3
linear	.833	89.938	1	18	.000	.228	.843		
logarithm	.931	241.063	1	18	.000	.870	.209		
inverse	.524	19.796	1	18	.000	.658	-.010		
secondary	.988	697.421	2	17	.000	.087	2.111	-1.398	
Cubic	.993	762.518	3	16	.000	.058	2.608	-2.808	.990
Compound	.693	40.588	1	18	.000	.210	7.314		
power	.950	342.049	1	18	.000	1.041	.546		
S	.654	34.025	1	18	.000	-.478	-.029		
increase	.693	40.588	1	18	.000	-1.563	1.990		
index	.693	40.588	1	18	.000	.210	1.990		
Logistic	.693	40.588	1	18	.000	4.771	.137		

The independent variable is the comprehensive score of digital economy.

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