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STUDY ON THE IMPACT OF DIGITAL ECONOMY ON RURAL

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Abstract: Rural revitalization is a major and challenging topic in national economic development. With the arrival and popularization of the digital economy era, the impact of the digital economy on rural revitalization has become increasingly significant. As a marginal region in China, Xinjiang faces problems such as inconvenient transportation, lack of educational resources, and imperfect security facilities, and rural revitalization has become a nationally important challenge, therefore, this paper argues that it is of great value to study rural revitalization in Xinjiang. Given to the fact that the concept of big data in China was born in 2016, this study focuses on rural revitalization in the era of digital economy, with Xinjiang as the target. The model is constructed using data from 2016-2019 and analyzed using the coupled scheduling model, the level of digital economy and the level of rural revitalization, with special emphasis on the relationship between digital economy and rural revitalization. Some factors for the coordinated development of digital economy and rural revitalization are revealed through the coupling level and obstacle model. The results of the study show that the digital economy in Xinjiang shows a steady growth trend, and the coordinated development of rural revitalization and digital economy is generally on the rise, showing a good development prospect.

Keywords: Digital economy; Rural revitalization, Regional heterogeneity; Coupled coordination degree model; Barrier model

1 INTRODUCTION

With the progress of information technology and the widespread popularization of mobile Internet, digital information has become an important factor in production and daily life. According to relevant research, in 2022, the scale of China's digital economy will have reached 50.2 trillion yuan, accounting for 41.5% of GDP. With the deep development of the new round of science and technology, digital transformation has become a trend of economic development and is advancing globally. The transformation and upgrading of traditional industries towards intelligence, greening and integration has accelerated. New industries and new modes are flourishing, and the way of production and life is profoundly changing. Since the 18th CPC National Congress, China has taken the improvement of the digital economy as a national strategy, introduced a series of major policies, and comprehensively promoted the construction of digital China. By the end of 2023, China's gross domestic product (GDP) reached 56.1 trillion yuan, a nominal increase of 11.75% over the previous year. It accounts for 39.8% of GDP . In addition, digital economy, as a new form of economic and social development, is an important driving force to stimulate the endogenous development power of rural areas, which can tap the potential of green development in rural areas, promote the transformation and modernization of rural industries, and improve the level of agricultural and rural modernization .

In 2021, the No. 1 document of the central government explicitly proposed to comprehensively promote rural revitalization, implement the digital rural construction project, and accelerate rural modernization. 2022 "Digital Rural" Development Action Plan (2022-2025) pointed out the strategic significance of the digital economy in promoting urban-rural integration, assisting in the comprehensive revitalization of rural areas, promoting common prosperity, and solving the problem of balanced development . prosperity, and solving the problem of unbalanced development. These policies and documents reflect the potential and importance of digital economy for rural revitalization, and indicate that the research in this paper has theoretical and practical significance. It is well known that the development of digital technology facilitates the interaction between DEL and Rural Revitalization Level (RRL) for economic prosperity. In the face of the challenge of economic recovery after the New Crown Pneumonia pandemic, it is important to explore the evolution of the coupling coordination degree (CCD) between DEL and RRL, which has become a hot topic of academic attention.

Digital economy has been a hot topic in academia. Tapscott first proposed the concept of digital economy in the 1990s, and he described the digital economy but did not give a clear definition. In 2016, the G20 Initiative on Development and Cooperation in the Digital Economy explicitly pointed out that the digital economy is a digital knowledge and information as inputs, supported by information networks, with a A series of economic activities with the effective use of information and communication technology as the driving force to improve efficiency and optimize economic structure. Currently, the research hotspots in the field of digital economy focus on the three phrases of "cloud computing, big data, and artificial intelligence", which involve the fields of employment, environment, productivity, and economic development. The research perspectives are complex and wide-ranging.

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The CCD model is an analytical tool for evaluating and analyzing the interrelationships among different elements.Fu et al used it to analyze the spatial and temporal evolution characteristics of DEL and ecological environmental level (EEL) in China. They found that the CCD between DEL and EEL is well developed and the level has improved. Li et al used a composite synergy model to evaluate the level of coordination between DEL and logistics industry. Through the analysis, it was found that the level of their coordination has improved. However, the synergistic effect needs to be further strengthened[1]. Wang et al. discussed the relationship between DEL and urban low-carbon economic transformation and found that there is a u-shaped relationship between the two. Zhang et al examined the impact of DEL on the green economy using the SBM-GML model [2].

In recent years, there has been extensive academic interest in rural development, with some scholars taking a qualitative approach to explore the relationship between DEL and RRL. For example, Katara argues that the integration of information and communication technology (ICT) into smart village construction can improve farmers' living standards and promote the use of mobile technology to make e-government services more accessible to rural residents.Sutherland argues that Internet carrier innovations have changed rural consumption patterns, and Young argues that the digital economy can help rural residents to improve their living standards by constructing a "physical world" and a "physical world". Young believes that the digital economy realizes the comprehensive development of rural areas by constructing the virtual space of the "physical world" and the "digital world" and empowering the application scenarios of agricultural production, rural distribution, social governance, lifestyle, cultural concepts, and so on [3].

Mossberger argued that the increasing popularity of digital technology in economically backward countries creates educational and economic opportunities, and that information technology can break down barriers to socio-economic activities and reduce poverty [4]. Zhu and Shang argued that information technology can increase total factor productivity in agriculture, and that digital technology can change the way of agricultural development[5]. Zhao and Ding found that digitization can improve the agricultural quality and competitiveness, optimize rural production, living and ecological space, and improve the integrated urban-rural development system and policy system[4]. Feng and Zhang point out that DEL can promote rural infrastructure construction, empower digital agriculture and new rural business, promote effective governance, and provide further impetus for industrial upgrading [6].

Based on the existing academic research, this paper constructs a comprehensive, measurable and evaluable indicator system with the spatial scale of 14 Xinjiang prefectures and cities in 2016 - 2019. The entropy weight method and CCD model are used to objectively and scientifically reflect the development of DEL and RRL, and the trend of CCD changes. Meanwhile, the obstacle factors in the process of coupling coordination were analyzed by using the obstacle degree model. It is hoped that this study can enrich the research content in the field of digital economy and fill the gap between DEL and RRL in regional research. Power.

2 STATUS AND TRENDS OF DIGITAL RURAL DEVELOPMENT IN CHINA

2.1 Current Status of Research on Rural Industrial Revitalization

Research on rural industrial revitalization mainly focuses on two aspects:First, industrial integration and development. Rosenberg and Yoffie believe that industrial integration and development is not only an important research direction in industrial economics and information economics, but also has become a mainstream industrial form with the development of society. Jiang Changyun and Guo Jun, among others, believe that the fundamental purpose of integrated development is to give full play to the multifunctionality of agriculture, enhance the added value of agriculture, stimulate the endogenous motivation of farmers, and realize better production efficiency and economic benefits. The second is the high-quality development of agriculture and rural areas. The definition of the connotation of China's rural industrial revitalization stems from a profound understanding of the high-quality development of agriculture and rural areas, from an economic development model that better meets the growing practical needs of the people, and from the full embodiment of the Five Development Concepts. Emphasizing the coordinated development of multiple parties, it should involve multiple perspectives such as economic, social, ecological environment, national, and opening up to the outside world. Efficient, stable growth and innovation-driven development are realized from multiple aspects such as supply and demand, input and output, and income distribution. For the revitalization of rural industry, some literature suggests that it should be realized from multiple dimensions such as agricultural production and management system. It is an organic combination of rural ecology, culture, governance, agricultural production and farmers' life, and should be consistent with the overall goal of rural revitalization.

2.2 Current State of Research on the Digital Economy

One is from a conceptual perspective.Don Tapscott first introduced the concept of digital economy, stating that the digital economy is a new type of economic relationship that emerged after the advent of Internet technology.Institutions such as USDC (1999), USBC (2001), DBCDE (2013), and OECD (2016) define the digital economy as the evolving Internet and new technologies such as big data, and the economic and social activities derived from them. Second, in terms of scope, the core component is the digital sector itself. In a narrow sense, it refers to new business models created through the digital economy, such as the platform economy, e-commerce, etc., in a broad sense, it includes all digitalized economic activities, such as precision agriculture, digital media, digital transactions, etc. Third, in terms of

the composition of the digital economy, digital infrastructure is the fundamental support of the digital economy, and digital industrialization is steadily advancing as a pillar and leading industry. Among them, the digitization of agriculture is a prominent shortcoming in the development of the digital economy.

2.3 Current Status of Research on the Digital Economy for Agricultural and Rural Development

Pilat and Zheng Shilin concluded that informatization has a contributing effect on productivity improvement. Focusing on the field of agriculture, the findings of research on the impact of informatization on agricultural total factor productivity include:First, informatization has a significant contribution to agricultural total factor productivity, second, the effect is not significant, and third, there is a nonlinear or heterogeneous effect. Due to the fact that agricultural production itself is characterized by geographical, cyclical, seasonal and low elasticity of demand for agricultural products, farmers lack original capital accumulation, entrepreneurial talent, data information and other factors of production, which makes the development of the agricultural sector lag behind the urban sector for a long time. Meanwhile, problems such as information asymmetry, financial exclusion and financial threshold effects, insufficient rural infrastructures, and mismatches between the supply of and demand for financial resources and services have greatly constrained agricultural development. The advantages of the digital economy, such as renewability, non-competitiveness, inclusiveness and non-exclusiveness, can empower and enhance other factors of production through integration. The integration and development of the digital economy with the agricultural and rural economy can reduce information asymmetry, expand the scale effect of agricultural production, optimize the factor flow channels, effectively improve the efficiency of resource utilization, increase farmers' income and well-being, and promote the transformation and upgrading of agriculture and rural modernization.

2.4 Key Issues of Existing Research

Scholars at home and abroad have conducted some research on the empowerment of the digital economy on rural industries, and the research results cover different areas. There are summarized that previous studies have provided valuable insights into the digital economy and rural economy. However, there are few direct studies on the impact of digital economy on rural revitalization. In addition, previous studies have mainly used normative approaches, focusing on concepts and policy paths, and lack empirical studies. The quantitative impact of the digital economy on rural revitalization needs to be further explored.

3 BASIC CONCEPTS OF THE DIGITAL ECONOMY EVALUATION INDICATOR SYSTEM

The core concept of constructing a digital economy development evaluation index system is to vigorously promote digital industrialization and industrial digital integration development based on the digital governance environment and investment in digital economy infrastructure. At present, there are mainly the following types of indicators to measure the level of China's digital economy development:First, the digital city development index provided by Tencent and the global digital economy index provided by Ali Research Institute,Second, the index system is reconstructed based on the research framework of CITIC Tong Research Institute,Third, the coefficient of efficiency of the digital economy is adopted as a measurement variable. Indicators of different dimensions of digital economic development contain useful information about digital economic development, and considering only one or a certain dimension of indicators will lead to a one-sided understanding of digital economic development. Therefore, this paper mainly uses the following four types of indicators:

(1) Digital economy infrastructure indicators. The digital economy is an economic form in which new digital technologies are widely applied, and the prerequisite for the application of digital technologies is a sound digital economy infrastructure. For example, there are indicators that show how long fiber optic cables are and how many cell phone base stations there are. There are also indicators showing how many Internet broadband access ports there are and how many Internet users there are.

(2) Industrial digitization indicators. Industrial digitization improves output and efficiency through the integration and penetration of ICT products and services in other areas, especially in the three major industries. This paper uses indicators such as digital financial inclusion index, enterprise informatization level, number of express delivery operations, and e-commerce sales to measure this.

(3) Digital governance indicators. Digital governance is an important guarantee for the healthy and orderly development of the digital economy, covering multiple levels such as government, policy, industry, innovation, property rights, and corporate governance. The indicators selected in this paper include the number of years of education per capita, the intensity of R&D investment, the number of digital economy enterprises, the total number of technology contract transactions, the number of patent applications, the number of licensing applications, and the number of government websites (the level of digital government) to measure the level of digital governance.

(4) Digital industrialization indicators. Digital industrialization refers to the added value of the information industry characterized by digital technology, including digital technological innovation and digital industrial production, which mainly includes the electronic information manufacturing industry, the information and communication industry, the software service industry and the Internet-related industry. This paper adopts the indicators of digital industry

employees, digital industry gross industrial output value, telecommunication business volume and software industry revenue to measure the digital industrialization indicators.

4 EMPIRICAL RESEARCH

Considering the availability and authenticity of the data, this paper selects the panel data of 14 Xinjiang municipalities from 2013 - 2019 for the study. The digital financial inclusion index is from the Digital Finance Research Center of Peking University. Other data are from Xinjiang Statistical Yearbook, Economic Forecasting System, China Rural Statistical Yearbook and statistical bulletins of 14 Xinjiang prefectures (cities). For some missing data, trend extrapolation forecasting method was used to define their values.

4.1 Research Methodology

Before exploring CCD, the respective levels of development need to be measured. In order to ensure the objectivity and accuracy of the results, the entropy weighting method is used in this paper. This method determines the weights according to the degree of change in the value of each indicator. It is an objective weighting method that avoids the influence of human factors. The specific steps are as follows:

4.1.1 Data balancing

Data balancing is very important in research to avoid numerical problems and balance the contribution of various features.

$$V_{ij} = r_{ij} + 0.1 = m \times \frac{X_{ij} - min(X_{ij})}{max(X_{ij}) - min(X_{ij})} \tag{1}$$

$$m = \begin{cases} 1 & \text{If the indicator has a positive impact} \\ 0 & \text{If the indicator has a nagative impact} \end{cases} \tag{2}$$

(1) where r_{ij} represents the standardized data, X_{ij} is the original value of item j in year i.

4.1.2 Entropy calculation and weight calculation

$$p_{ij} = \frac{V_{ij}}{\sum_{i=1}^{n} V_{ij}} \tag{3}$$

(3) where p_{ij} represents the share of the jth indicator in year i, V_{ij} is the transformed data in equation (3).

$$H_j = \frac{1}{lnn} \Sigma_{i=1}^{n} p_{ij} lnp_{ij} \tag{4}$$

(4) where H_j is the entropy value of the jth indicator.

$$w_j = \frac{d_j}{\sum_{j-=1}^{n} d_j} = \frac{1-H_j}{\sum_{j-1}^{n} (1-H_j)} \tag{5}$$

(5) where d_j represents the different coefficients of the jth indicator, W_j represents the weight of the jth indicator.

4.1.3 Generation of evaluation indicators

$$\begin{cases} U_1 = \sum_{z=1}^{n} S_z R_z \\ U_2 = \sum_{y=1}^{m} S_y R_y \end{cases} \tag{6}$$

(6) where U_1 and U_2 are DEL and RRL comprehensive evaluation indexes, respectively, S_k is the weight of digital economy index k, and R_k is the standardized value, R_l is the weight value of rural revitalization index l, Rl is the standardized value of rural revitalization indexes, and n and m are the number of DEL and RRL indexes, respectively.

4.1.4 CCD model

Coupling was first applied to physics and later widely used in the social sciences. It represents the degree to which two or more systems interact. It was later developed into the "CCD model" to assess the evolution of CCD between systems. It was proposed by Li et al (2018), and the model is used to evaluate the CCD between DEL and RRL. the specific formula is as follows.

$$C = \sqrt{\frac{U_1 \cdot U_2}{\left(\frac{(U_1+U_2)}{2}\right)^2}} = \frac{2\sqrt{U_1 \cdot U_2}}{U_1+U_2} \quad (7)$$

$$D = \sqrt{C * T} = \sqrt{C * (\varepsilon U_1 + \epsilon U_2)} \quad (8)$$

In Eqs. (7) and (8), C is the coupling degree of DEL and RRL, U_1 denotes DEL, U_2 denotes RRL, and C∈[0,1] denotes the strength of the interaction between the two, T is the composite coordination index of DEL and RRL reflecting the overall synergistic effect. l and m denote the weights of DEL and RRL, respectively, with λ+μ= 1, and D is CCD, d∈[0,1].

Note:In the traditional CCD model, l and m are generally determined by subjective factors and are set to l: m = 1:1, indicating that both systems are equally important.

4.1.5 Handicap model

Analyzing the factors that hinder the development of CCD can provide some suggestions for formulating and adjusting related development policies. Therefore, this paper introduces the obstacle degree model to determine the main obstacles to CCD between the plains and the plains in Xinjiang. The calculation of barrier degree involves three indicators: factor contribution, indicator deviation and barrier [40]. The factor contribution level indicates the contribution value of a factor to the total, which is expressed by the weight of a single factor w_j, the indicator deviation degree refers to the difference between the actual value and the optimal value of each indicator, which is usually expressed as I_{ij} = 1-x_{ij}, and the obstacle degree, Z_{ij} indicates the degree of influence of each indicator or factor at the criterion level on CCD. The formula is:

$$Z_{ij} = \frac{I_{ij} w_j}{\sum_{j=1}^{n} I_{ij}\, w_j} \quad (9)$$

4.2 Indicator Construction

Since DEL and RRL are affected by a variety of factors, we have established their indicator systems separately. Combined with the definition of digital economy, it can be found that the indicator system includes not only infrastructures such as computer networks and information and communication equipment, but also service scenarios such as telecommunication business and digital finance. In this paper, we draw on the indicator selection method of Ye and Liu and take 14 Xinjiang cities as the research object [7]. Five secondary indicators are constructed under the three primary indicators of digital infrastructure, digital investment and digital integration development based on data availability and content similarity (Table 1). As far as the indicators of rural revitalization are concerned, rural revitalization is a long-term historical issue, and its development is a continuous dynamic process that should involve all aspects of social and economic life. Therefore, we integrated the research of Fang and Mao et al. and constructed a rural revitalization indicator system. The indicator system takes into account the unique development characteristics of Xinjiang and balances data availability and representativeness. In the end, we identified eight specific indicators to measure rural revitalization in Xinjiang (Table 1).

Table 1 Digital economy and rural revitalization evaluation index system

Key indicators	Tier 1 indicators	Tier 2 indicators	Weight
Digital Economy Development Index	digital infrastructure	Internet penetration rate (set)	0.290
		Telephone Information Services per Capita	0.299
	Digital Convergence Development	Digital Inclusive Finance Index (%)	0.100
	Digital betting	Per capita education expenditure (CNY)	0.201
		Percentage of Information Talent Practitioners (%)	0.110
Rural Revitalization Index	environment	Per capita afforestation area (ha/million people)	0.052
		Number of hospital beds per 10,000 population (beds)	0.032
		Harmless garbage disposal rate (%)	0.050
	commercialization	Domestic Tourism Income (million yuan)	0.239
	civilization	Investment in Fixed Assets for Education (million yuan)	0.157

	prosperity	Disposable Income of Rural Residents (RMB)	0.124
	social governance	General Public Budget Expenditure (million yuan)	0.058

4.3 Empirical Analysis

4.3.1 DEL (Digital Economy Level) measurement

Analysis of DEL and RRL To examine the development of DEL and RRL in Xinjiang, it is first necessary to measure their comprehensive evaluation indicators. On the basis of the existing index research system, the entropy weight method is used to calculate the weight of each index, Eqs. (1)-(6). As shown in Table 1, digital infrastructure accounts for 58.9% of the total weight, digital investment accounts for 31.1%, and digital integration development accounts for 10%. Digital infrastructure occupies an important position in the digital economic system, which confirms that the modern information network is an important carrier of the digital economy, and the effective use of ICT is the driving force to improve the level of development of the digital economy. In Table 1, the indicator weights of the five factors of enterprise prosperity, comfortable living environment, civilized social etiquette, effective governance and prosperity are 25.9%, 8.9%, 27.7%, 22.1% and 15.4% respectively. The three domains of business prosperity, civilized social etiquette, and effective governance have a greater impact on RRL.

Based on the weights of the indicators, equation (6) was utilized to calculate the DEL of Xinjiang for 2016 - 2019 (Table 2). Considering the geographic location and economic development level of the 14 prefectures (cities), we divided the 14 prefectures (cities) into North, South and East Xinjiang for analysis.

Table 2 Xinjiang DEL (Digital Economy Level) measurement

Distribution	County or City	2016	2017	2018	2019
Northern Xinjiang	Urumqi	0.497	0.576	0.634	0.612
	Karamay	0.480	0.592	0.596	0.489
	Changji Hui Autonomous Region	0.297	0.389	0.356	0.336
	Yili	0.191	0.280	0.272	0.358
	Tacheng	0.184	0.384	0.270	0.325
	Altay	0.427	0.379	0.382	0.401
	Baltimore Mongol Autonomous Prefecture	0.240	0.424	0.421	0.405
Eastern Xinjiang	Turpan	0.237	0.291	0.264	0.342
	Hami	0.282	0.296	0.375	0.446
Southern Xinjiang	Bazhou	0.405	0.622	0.593	0.421
	Asu	0.244	0.304	0.248	0.312
	Kashgar	0.188	0.258	0.258	0.248
	Kashgar	0.141	0.241	0.227	0.264
	Khotan	0.144	0.165	0.192	0.234
Xinjiang average		0.282643	0.3715	0.363429	0.370929

As shown in Table 2, the DEL in Xinjiang shows a slow increasing trend from 2016 - 2019. The overall DEL in Xinjiang increased from 0.2826 to 0.370929. this reflects the great importance Xinjiang attaches to the digital economy. In recent years, China and Xinjiang province have formulated many DEL upgrading implementation programs, such as expanding and upgrading information consumption, developing the industrial Internet, and implementing a three-year action plan to encourage Xinjiang enterprises to use cloud technology. These have contributed to the booming development of the digital economy in Xinjiang. However, due to Xinjiang's vast geographic area and high degree of urban dispersion, there is a "digital divide".

4.3.2 Measurement of RRL

According to the index system constructed in Table 1, equation (6) is used to calculate the rural revitalization index of Xinjiang from 2016 - 2019. The RRL of Xinjiang is shown in Table 3.

Table 3 Xinjiang RRL (Rural Revitalization Level) Indicator

Distribution	County or City	2016	2017	2018	2019
Northern Xinjiang	Urumqi	0.281	0.288	0.364	0.475
	Karamay	0.176	0.178	0.306	0.289
	Changji Hui Autonomous Region	0.408	0.416	0.326	0.424
	Yili	0.226	0.234	0.266	0.359
	Tacheng	0.257	0.254	0.258	0.266
	Altay	0.182	0.178	0.217	0.241
Eastern Xinjiang	Baltimore Mongol Autonomous Prefecture	0.081	0.186	0.201	0.205
	Turpan	0.167	0.173	0.169	0.178
	Hami	0.122	0.142	0.144	0.138
Southern Xinjiang	Bazhou	0.264	0.261	0.249	0.282
	Asu	0.287	0.284	0.273	0.315
	Kashgar	105	0.102	0.15	0.121
	Kashgar	0.225	0.384	0.401	0.412
	Khotan	0.119	0.229	0.332	0.245
Xinjiang average		0.20714	0.236357	0.258643	0.282143

As shown in Table 3, from 2016 to 2019, the RRL of Xinjiang has continued to increase, from 0.207 to 0.282. from 2017 to 2019, the development of RRL in Xinjiang has grown significantly. This is because, during this period, China has continuously implemented a series of measures to revitalize the countryside, laying a solid foundation for the construction of a beautiful and livable modern countryside, and at the same time providing a historic opportunity for the development of the rural economy. In line with the development strategy, specific projects have been carried out in this regard and have been effective in rural construction.

Regionally, Xinjiang's RRL is relatively unbalanced, showing a pattern of decline in the north, east and south. In order to more intuitively reflect its spatial distribution differences . The development level of rural revitalization in Northern Xinjiang, led by Karamay and Changji, is higher than that in Southern Xinjiang.In 2016, rural revitalization efforts were increased across the region, and the development of rural areas in Northern Xinjiang was relatively balanced, there were obvious regional differences in Southern Xinjiang. Bazhou and Kashgar had higher levels, while Hotan and Kezhou had lower levels. The rural revitalization index of Turpan and Hami in the eastern region of Xinjiang is lower than 0.13, lagging behind other regions.In 2019, thanks to the great development of the southern border, Xinjiang's rural revitalization has been effective. The overall level of the northern border has been improving, showing a fan effect centered on Urumqi, the southern border region of Kashgar has successfully crossed into the first echelon of rural revitalization, with a development index of more than 0.35, and the development of rural revitalization in Hami and Kexu has been relatively slow and needs to be improved.

Rural revitalization is a multi-factor and multi-dimensional dynamic development process. According to the weights of the indicators in equation (6), the scores of the five dimensions of the rural revitalization system are calculated to reflect the changes that have occurred in the countryside at different levels, as shown in Figure 3. In terms of time, the levels of the five level 1 indices are all on an upward trend, with similar trends of change. Among them, Industrial Prosperity and Effective Governance show the largest increase, while Comfortable Living Environment and Prosperity show relatively small increases.

RRL showed a good growth trend, rising from 0.132 to 0.270.Since the Central Document No. 1 of 2014, which proposed deepening rural reforms and promoting agricultural modernization, the Xinjiang government has invested a large amount of financial, human, and material resources in support of rural development, which has greatly improved the level of rural governance.In 2018, the country introduced the Rural Revitalization Strategy as a package of policies to formulate the Rural Revitalization roadmap, and rural development entered a new stage. Long-term poverty, inconvenient transportation and weak industrial development in some areas of Xinjiang have constrained rural development. To achieve rural revitalization, poverty must first be eliminated. As of 2018, Xinjiang has implemented precise poverty alleviation policies, lifting 537,000 poor people out of poverty, improving the problem of lagging rural development, and effectively upgrading the level of local governance. In recent years, the country has paid more attention to the construction of ecological civilization, which has promoted the construction of blue sky and green water ecology in Xinjiang.

4.3.3 Analysis of CCD between DEL and RRL

As shown in Table 4, the development of CCD in Xinjiang is broadly divided into two phases: the first phase is from

2016 to 2017, focusing on the improvement of RRL, the second phase is from 2018 to 2019, focusing on the development of rural revitalization.

Table 4 Table showing the extent of change in DEL and RRL

Year	2016	2017	2018	2019	Mean
Digital Economy Development Index	0.271	0.310	0.351	0.369	0.32525
GrowthΔU_1		0.041	0.018	0.028	0.0029
Rural Revitalization Development Index	0.192	0.235	0.274	0.287	0.301
GrowthΔU_2		0.043	0.039	0.013	0.031

4.3.4 Diagnostic Analysis of Disorder Factors

Improving Xinjiang's regional development plan and regional development planning to achieve high-quality coordination requires both taking the national strategic plan as a top-level design and recognizing the obstacles in the development process. Through the obstacle degree model, we calculated the obstacle degrees of digital infrastructure (V1), digital investment (V2), digital integration and development (V3), business prosperity (V4), pleasant living environment (V5), social etiquette and civilization (V6), effective governance (V7), and prosperity (V8) in different years by using formula. The specific results are shown in Table 5.

Table 5 Factors that hinder the extent of coupled and harmonized development (%)

Year	V1	V2	V3	V4	V5	V6	V7	V8
2016	34.7	20.65	2.18	8.8	4.6	10.39	13.28	5.4
2017	21.8	8.52	3.52	16.2	3.75	15.22	16.89	14.2
2018	18.84	10.42	3.59	16.49	4.8	20.01	16.02	11.53
2019	22.5	8.88	6.84	14.93	5.92	18.29	16.22	12.34

Considering the obstacles posed by the factors, digital infrastructure, rural civilization, digital investment and effective governance have a more significant impact on CCD between DEL and RRL. In the first stage of CCD development (2016-2017), the top three factors in the degree of hindrance are digital infrastructure, digital investment and effective governance, with an average annual degree of hindrance of 34.72%, 20.65% and 16.98%, respectively. The digital infrastructure and digital investment subsystems are expanding and their impact on CCD development has increased. The subsystems of pleasant human environment, business prosperity, and prosperity fluctuate less and have a relatively stable impact on CCD development. The Digital Convergence Development subsystem declines significantly, and its impact on CCD development gradually diminishes. In the second stage (2017 - 2019), digital infrastructure, business prosperity and social etiquette and civilization are the main factors, with annual average obstacles of 22.5%, 18.29% and 1.17%, respectively. The rural revitalization strategy has intensified the barriers of the rural revitalization subsystems and deepened the impact on CCD development.

It was found that the digital infrastructure subsystem had the highest degree of hindrance and the digital integrated development and pleasant living environment subsystems had the weakest degree of hindrance. This indirectly proves that digital infrastructure, which is the cornerstone of the digital economy and covers the three areas of Internet, communication and transportation, has a greater impact on DEL. In addition, in the process of rural development, digital infrastructure construction can utilize ICT to integrate traditional industries, drive the flow of technology, materials, capital and talents throughout rural areas, break the barriers of the urban-rural dichotomy, and improve the rural economy. Local finance has promoted the development of rural network infrastructure, improved the digital management mechanism of rural roads, and made up for the lack of rural digital infrastructure. However, local finance has not invested enough in digital inclusive finance and ecologically sustainable social construction, making its development process relatively slow and its impact on CCD weakened.

In the second stage (2018 - 2019), the average barrier degree of business prosperity and social etiquette and civilization increases significantly. This indicates that the impact of business prosperity, social etiquette and civilization on coupled coordinated development is strengthened in this phase. Prosperous business includes three aspects: agricultural production, mechanization level and tourism. For a long time, rural areas have been dominated by agricultural production. Insufficient rural labor force, low level of agricultural mechanization, and relatively irrational structure of agricultural industry have led to lagging development of secondary and tertiary industries, affecting the process of rural development. Tourism is a strategic pillar industry in Xinjiang. The integration and development momentum brought by "Tourism Plus" has promoted the integration and development of tourism and agriculture, animal husbandry, forestry, ecology and health in Xinjiang, which is conducive to the structural adjustment of Xinjiang's economy, promotes the employment of local residents, and gradually improves the quality of life of residents. The construction of rural

civilization is an important part of the rural revitalization strategy, and is also a practice of the "Nourishing Xinjiang with Culture" project. On the one hand, it can cultivate good rural customs, family and folk customs, stimulate rural cultural creativity, and lay the foundation for creating unique rural tourism. On the other hand, through the investment in culture and education, it can improve the cultural quality of farmers, strengthen the popularization of rural information and communication technology, alleviate the situation of lagging development of rural information and communication technology, and promote the establishment of rural data resource system. In the process of exploring the coupled coordination obstacle factors, it is found that the obstacle factors have gradually shifted from the early digitalization problems to the rural problems, which also confirms that the level of the digital economy in Xinjiang is increasing. However, the rural revitalization strategy was proposed late, and the rural development in some areas is still relatively backward, which affects the development process of DEL and RRL CCD in Xinjiang.

5 CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Conclusions

With the continuous development and wide application of digital technology, the digital economy has gradually spread to rural areas, promoting the integration of modern and traditional industries, improving rural infrastructure, and having a significant impact on rural development. At present, few scholars in academia have studied the relationship between digital economy and rural revitalization from the perspective of quantitative analysis. Therefore, this paper aims to conduct an empirical study on the development of rural revitalization in Xinjiang driven by digital economy. And the improved CCD model was used to evaluate the CCD of 14 counties. In addition, the barrier value of first-level indicators to CCD was calculated using the barrier degree model, and the impact of each indicator at different stages of coupled coordination was discussed.

The conclusions drawn in this paper are as follows:From the combined scores of the two systems, we find that Xinjiang's digital economy and Xinjiang's rural revitalization have made some progress over the years, and the overall level is on an upward trend. Among them, the northern border has the best development, followed by the eastern border, and the southern border is relatively backward. Overall, the DEL in Xinjiang is better than the RRL, and there is a lot of room for the development of the RRL in Xinjiang's districts. In the second stage (2017 - 2019), RRL develops faster than DEL. analyzing from the perspective of economic benefits, the rural revitalization strategy initiated by the state in this period has positively affected the development of Xinjiang's countryside and brought good social benefits, and the level of Xinjiang's rural revitalization has increased dramatically. the results of the CCD model show that the development of CCD between DEL and RRL can be divided into two stages . In the first stage (2016 - 2017), the development of DEL is superior to rural revitalization in Xinjiang, with a weight ratio of 0.6:0.4.In the second stage (2018 - 2019), the development of rural revitalization is superior to the development of DEL, with a weight ratio of 0.38 to 0.62.The interaction between DEL and RRL is gradually enhanced.The CCD of 14 prefectures and cities has improved, but there is still significant regional heterogeneity, manifested as high in northern Xinjiang and low in southern Xinjiang.

In summary, this paper has conducted a basic research on digital economy development and rural revitalization in Xinjiang, which enriches the research content in the field of digital economy. At the same time, taking Xinjiang as the research object, it fills the current research gap on the development of digital economy and rural revitalization in remote areas. In addition, studying the spatial and temporal differences and bottlenecks in the development of digital economy and rural revitalization can provide reference for academics to explore the high-quality development of the two, enrich the current theoretical research, and provide feasible suggestions for promoting regional development.

5.2 Policy Recommendations

After analysis, we found that the development of CCD of DEL and RRL in Xinjiang has increased year by year, but there is still a long way to go from the perspective of high-quality coordination. How to use the power of the digital economy to promote the comprehensive development of rural areas, improve the level of rural development and achieve balanced rural development? On this basis, this paper puts forward suggestions to promote the coordinated development of the two.

(1) Effectively promote industrial prosperity and improve the level of digital technology application in rural industry. Strengthen the construction of rural digital industry, build the whole industry chain, and strengthen the integration and application of blockchain, Internet of Things, big data, artificial intelligence and other modern technologies in the five major aspects of rural revitalization. For example, digital technology should be fully utilized in the circulation of agricultural products to ensure the quality and safety of agricultural products, increase farmers' income, and create a high-level, high-quality rural e-commerce industry. It is necessary to seize the location advantage of the Silk Road Economic Belt, promote digital trade exchanges and cooperation between countries and regions, and utilize the power of digital development to push more Xinjiang specialty products into the international market.

(2) Promote coordinated and integrated regional development according to local conditions. From a regional perspective, the northern border has the strongest coupling and coordination capacity, followed by the eastern and southern borders. Therefore, in order to realize the comprehensive and coordinated development of Xinjiang, we will continue to improve the development plan for the northern border region and take the lead in sharing experiences and good practices with the eastern and southern border regions. At the same time, the East and South Xinjiang regions will also rely on rural resources, give full play to the unique advantages of local scenery, local culture, and specialty agriculture, and actively cultivate industries such as tourist agriculture and farming experience, so as to build a new rural digital economy based on tourism.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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