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The Intrinsic Logic and an Empirical Study of the Coupling Between the Digital Economy and Rural Economic Resilience

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Abstract. The coordinated advancement of the digital economy and rural economic resilience is a new dynamic engine for high-quality rural and agricultural development. To quantitatively evaluate the degree of coordinated development between the digital economy and rural economic resilience, this paper selects provincial panel data from 10 Chinese provinces for 2016–2023, and constructs an indicator system for the digital economy that reflects digital infrastructure and industrial digitalization, as well as a chained economic-resilience evaluation system reflecting "resistance–adaptation–transformation." Indicator weights are determined comprehensively using the entropy-weight method. Based on a coupling-coordination-degree model, a comparative analysis is then conducted on the coupling-coordination types of urban digital economy and ecological resilience across 30 provinces nationwide. The study finds that: in terms of temporal evolution, the coupling-coordination degree of the provinces has grown steadily, although many provinces remain in a state of disequilibrium; overall the development trend is positive. Spatially, the coupling-coordination degree exhibits an "east-high, west-low; south-high, north-low" pattern. By 2023, most regions were in a coordinated state.

Keywords: digital countryside, digital economy, rural economic resilience, coupling coordination

1. Introduction

Agriculture is a fundamental basis for the secure and stable development of the national economy. Because agriculture itself is vulnerable to natural disasters, market risks, and supply–demand contradictions, the degree of external disturbance has been gradually deepening. Consequently, how the agricultural economy can resist shocks from uncertain factors and achieve stable and secure development has become an important issue [1]. "Resilience" is a key concept in interpreting secure development, and improving industrial resilience is central to ensuring agricultural security. Strengthening rural economic resilience is of great significance for promoting rapid economic growth and high-quality, green development. Economic resilience refers to the ability of economic agents to mitigate, adapt to, and recover from shocks arising from uncertainty; it reflects the capacity of an economic system to maintain long-term stable development under external shocks and pressures [2]. Therefore, how to enhance rural economic agents' capacity to respond to risks and improve rural economic resilience is a research topic worthy of attention.

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With the application of a new generation of innovative technologies, the digital economy — in which data is a key production factor — has developed rapidly and given rise to new economic forms that play an important role in the national economy. As the digital economy extends into rural areas, digital technologies are increasingly integrated with rural governance, urban–rural integration, and green development, promoting the construction of the digital countryside. The development of digital countryside is closely linked to rural economic resilience: digital technology applications help eliminate disparities in digital access among groups and promote the balanced allocation of digital resources [3]. Embedding digital technologies in rural and agricultural development helps facilitate two-way flows of production factors, expand employment channels, and enhance overall rural economic resilience. This paper analyzes the intrinsic logic and coordinating relationship between the digital economy and rural economic resilience, with the aim of providing a reference for agricultural economic development.

2. The intrinsic logic of the digital economy and rural economic resilience

Rural economic resilience emphasizes the ability of an economic system to remain stable, adapt to changes, and achieve transformation in the face of external shocks. The digital economy, through technological empowerment, organizational change, and systemic reconstruction, provides critical support for this process. The intrinsic logic of how the digital economy empowers rural economic resilience can be systematically elaborated from the following three dimensions.

2.1. Digitalization of production factors and optimization of resource allocation

The digital economy embeds information technologies into all stages of agricultural production, significantly enhancing the efficiency of factor allocation. The application of technologies such as big data, the Internet of Things (IoT), and artificial intelligence (AI) has enabled precision and intelligent agriculture, effectively reducing the impacts of natural risks and production fluctuations. Studies have shown that the digital economy strengthens agricultural economic resilience by improving agricultural productivity and optimizing resource allocation [4]. Specific applications of digital technologies—such as intelligent agricultural machinery and precision irrigation—substantially increase production efficiency [5]. In addition, digital finance, through innovative service models, improves the accessibility of rural financial services, thereby providing capital support for rural economic resilience [6].

2.2. Digitalization of industrial ecology and organizational structure innovation

The digital economy promotes the digital transformation of rural industrial chains, reshaping organizational modes and enhancing industrial synergies and risk diversification. In terms of industrial chain integration, the digital economy connects every stage from production to sales, reducing transaction costs and improving overall efficiency. Research has found that the application of digital technologies significantly improves the efficiency of agricultural product circulation and strengthens market stability [7]. Moreover, the digital economy fosters the integration of agriculture with tourism, culture, and other industries, forming diversified industrial structures and enhancing the ability to disperse economic risks [8]. By constructing platform-based industrial organizational models, it builds closer industrial communities and strengthens systemic coordination capabilities [9].

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2.3. Human capital enhancement and innovation capacity development

The digital economy enhances farmers' digital literacy and skill levels, cultivates new agricultural business entities, and provides talent support for rural economic resilience. Improvements in digital literacy directly increase farmers' capacity to adapt to market changes. Studies have shown that farmer groups with higher levels of digital literacy experience lower income volatility and exhibit stronger livelihood resilience [10]. Digital education platforms allow farmers to conveniently access professional knowledge and continuously improve their skill levels [11]. Such human capital accumulation not only increases production efficiency but also enhances innovation capacity, thereby providing sustained momentum for rural economic transformation.

3. The coupling-coordination mechanism between the digital economy and rural economic resilience

3.1. Research content and data sources

Taking into account the rationality and availability of indicators, the research sample comprises 30 provinces in China (excluding Tibet, Hong Kong, Macao, and Taiwan), covering the period 2016–2023. The entropy-weight method and the coupling-coordination model are applied following the approach in [12]. The relevant indicator data are drawn from the China Statistical Yearbook, the China Rural Statistical Yearbook, and the statistical yearbooks of each province. Missing data are supplemented using linear interpolation.

3.2. Construction of the indicator system

According to systems theory, the construction of digital villages involves multiple dimensions of rural society, production, and daily life, making it a complex systemic project. It emphasizes the synergistic development of digital technology and the rural industrial economy, embodying people-centered attributes such as "scale, intensification, inclusiveness, and sustainability." At the same time, the concept of resilience has evolved from "single equilibrium" to "multiple equilibria" to "complex adaptive systems." Rural economic resilience, therefore, can be understood as the rural economy's ability to resist and recover from shocks caused by internal and external uncertainties, its capacity for adaptive adjustment using digital technologies, and its transformative and innovative ability to pursue digitalization following shocks. On this basis, this paper constructs a digital economy evaluation system from two dimensions: digital infrastructure and industrial digitalization. In parallel, based on the logic of "external stress–pressure state–mechanism feedback," a chained rural economic resilience evaluation system is built, supported by three subsystems: resistance and recovery, adaptive adjustment, and transformation and innovation. The specific indicator system is shown in Table 1.

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Table 1. Indicator system for evaluating the digital economy and rural economic resilience

Dimension	Primary Indicator	Measurement Method	Attribute
Rural Economic Resilience	Resistance and Recovery Capacity	Disaster losses	-
		Effective irrigated area	+
		Gross output of farming, forestry, animal husbandry, and fishery	+
	Adaptive Adjustment Capacity	Total power of agricultural machinery	+
		Per capita disposable income of rural residents	+
	Transformation and Innovation Capacity	Fixed asset investment of rural households	+
Digital Economy	Digital Infrastructure	Internet broadband access ports	+
		Mobile Internet users	+
		Internet broadband subscribers	+
	Digital Industrialization	Per capita volume of telecom services	+
		Software business revenue as a share of GDP	+
	Industrial Digitalization	Digital inclusive finance index	+

3.3. Coupling-coordination analysis

The coupling-coordination degree results are shown in Table 2. From the perspective of temporal evolution, the coupling-coordination degree has improved to varying extents across provinces. In 2016, only provinces such as Shandong, Henan, and Guangdong were at the stage of primary coordination, while provinces such as Qinghai, Ningxia, and Tianjin were in moderate or even serious imbalance. By 2023, Shandong, Henan, and Jiangsu had reached the stage of good coordination, while Hebei, Zhejiang, Hunan, Guangdong, and Sichuan achieved intermediate coordination. Other provinces also showed improvement, with most reaching barely coordinated or primary coordination. A steady upward trend is evident, though the extent of improvement differs significantly across provinces. For instance, Shandong recorded an average annual growth rate of 0.7–0.9, followed closely by Jiangsu. From the perspective of spatial differentiation, the coupling-coordination degree improved across the country between 2016 and 2023, showing an overall pattern of “higher in the east, lower in the west; higher in the south, lower in the north.” Shandong and Henan remained in leading positions, evolving from primary to intermediate coordination, far ahead of other provinces. Regions such as Gansu, Qinghai, and Ningxia lagged behind, although they also showed an upward trend. In most provincial capitals, the coupling-coordination degree remained below 0.5; however, their average annual growth rates ranged from 5.06% to 7.34%, reflecting steady progress through the stages of serious imbalance → moderate imbalance → mild imbalance → near imbalance.

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Table 2. Coupling-coordination types of the digital economy and rural economic resilience (2016–2023)

Province	2016	2017	2018	2019	2020	2021	2022	2023
Beijing	0.354	0.359	0.391	0.452	0.456	0.472	0.48	0.53
Tianjin	0.261	0.286	0.318	0.349	0.388	0.405	0.412	0.457
Hebei	0.597	0.633	0.656	0.676	0.692	0.714	0.737	0.743
Shanxi	0.406	0.438	0.455	0.469	0.466	0.495	0.516	0.527
Inner Mongolia	0.391	0.422	0.455	0.475	0.498	0.518	0.528	0.561
Liaoning	0.464	0.494	0.536	0.538	0.552	0.574	0.561	0.595
Jilin	0.383	0.408	0.435	0.456	0.486	0.494	0.504	0.533
Heilongjiang	0.469	0.494	0.544	0.573	0.597	0.61	0.628	0.639
Shanghai	0.398	0.398	0.4	0.416	0.461	0.505	0.506	0.509
Jiangsu	0.639	0.685	0.726	0.74	0.761	0.787	0.792	0.812
Zhejiang	0.577	0.629	0.658	0.664	0.702	0.716	0.725	0.74
Anhui	0.509	0.574	0.604	0.625	0.662	0.68	0.691	0.727
Fujian	0.458	0.487	0.513	0.536	0.556	0.578	0.596	0.609
Jiangxi	0.406	0.455	0.49	0.498	0.528	0.561	0.587	0.609
Shandong	0.7	0.746	0.776	0.807	0.826	0.853	0.87	0.883
Henan	0.626	0.686	0.718	0.741	0.763	0.792	0.821	0.838
Hubei	0.516	0.552	0.583	0.594	0.634	0.656	0.657	0.686
Hunan	0.522	0.558	0.599	0.618	0.655	0.68	0.707	0.723
Guangdong	0.631	0.652	0.693	0.709	0.748	0.775	0.785	0.799
Guangxi	0.459	0.491	0.534	0.558	0.584	0.619	0.648	0.661
Hainan	0.247	0.293	0.358	0.359	0.38	0.409	0.414	0.43
Chongqing	0.354	0.385	0.408	0.445	0.45	0.492	0.509	0.516
Sichuan	0.564	0.609	0.646	0.681	0.715	0.74	0.764	0.785
Guizhou	0.339	0.388	0.422	0.438	0.476	0.51	0.521	0.541
Yunnan	0.409	0.449	0.498	0.514	0.537	0.572	0.589	0.614
Shaanxi	0.415	0.446	0.48	0.498	0.508	0.548	0.554	0.578
Gansu	0.315	0.332	0.374	0.402	0.415	0.451	0.472	0.475
Qinghai	0.165	0.194	0.228	0.264	0.26	0.33	0.345	0.328
Ningxia	0.231	0.237	0.288	0.295	0.331	0.367	0.388	0.396
Xinjiang	0.407	0.438	0.477	0.485	0.519	0.55	0.559	0.61

4. Conclusion and recommendations

On this basis, digital village development and rural economic resilience have gradually formed an interdependent, mutually reinforcing, and industrially complementary economic system across provinces. Through both qualitative and quantitative analysis of the theoretical framework and coupling coordination mechanism between the digital economy and rural economic resilience, this paper finds that, from the perspective of temporal evolution, the coupling coordination degree of all provinces has shown steady growth. The eastern region has experienced particularly rapid growth, while the northwestern region, led by Qinghai, has lagged behind. Many provinces remain in a state of imbalance, but the overall development trend is positive. From the perspective of spatial differentiation, the overall coupling coordination degree exhibits a spatial pattern of “high in the east, low in the west; high in the south, low in the north.” By 2021, most regions had entered a coordinated state. Based on the above conclusions, this paper puts forward the following recommendations:

First, while advancing digital village construction, it is necessary to further enhance rural economic resilience and improve the degree of coupling coordination between the two. With respect to digital village construction, digital technologies should be embedded throughout the management mechanism of agricultural economic resilience, strengthening early warning and prevention of uncertain risks. It is essential to leverage the advantages of digital villages, improve risk response mechanisms, and enhance the risk perception of agricultural actors.

Second, attention should be paid to the regional differences in agricultural development, and digital village construction should be promoted in a way that is tailored to local conditions. In strengthening digital village construction, regional disparities must be considered, and coordinated development of the digital economy across regions should be promoted. The eastern region should be encouraged to play a leading role in driving the development of central and western regions. For the east, policies should support talent returning to their hometowns to start businesses, cultivate specialized local digital farmers, and continue to release the potential of digital village construction to boost agricultural economic development.

Third, the transmission effect of rural industrial upgrading should be emphasized, and multi-actor cooperation on digital platforms should be strengthened. Industrial upgrading is an important pathway through which digital village construction empowers rural economic resilience. Efforts should be made to strengthen the role of digital infrastructure in fostering resilience, and to establish joint mechanisms for agricultural data platforms involving universities, governments, and enterprises.

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