Research on the Mechanism and Path of the Digital Economy Empowering Rural Industrial Revitalization in Liaoning

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Abstract: Taking the practice of rural industrial revitalization in Liaoning as the research object, this paper combines the technical characteristics of the digital economy with the endowment features of Liaoning's rural industries-characterized by a focus on agriculture, strong manufacturing capabilities, and a need for upgrading. By applying the analytical framework of "technology empowerment - factor restructuring - industrial upgrading", it reveals the internal mechanism through which the digital economy empowers rural industrial revitalization via the penetration of data factors, the application of digital technologies, and the construction of a digital ecosystem. The study finds that Liaoning's rural industries face problems such as weak digital infrastructure, lagging digital transformation of agriculture, a shortage of rural digital talents, and insufficient digital collaboration in industries. Based on this, practical paths for the digital economy to empower rural industrial revitalization in Liaoning are proposed from four dimensions: infrastructure upgrading, in-depth industrial integration, talent system construction, and policy mechanism improvement. This provides a reference for the high-quality development of rural industries in the old industrial base of Northeast China.

Keywords: Digital Economy; Rural Industrial Revitalization; Liaoning

1. Introduction

The 2024 Central No.1 Document proposes to "continue implementing digital rural development initiatives, develop smart agriculture, and narrow the urban-rural digital divide", identifying the digital economy as a core means to address bottlenecks in rural industrial development. As a core province in the old industrial base of Northeast China, Liaoning's rural industries mainly focus on grain production, livestock and poultry breeding, and the processing of characteristic agricultural products. In 2022, the total output value of agriculture, forestry, animal husbandry, and fishery reached 540 billion yuan. However, prominent issues persist, including low integration of the primary, secondary, and tertiary industries, weak risk resistance, and insufficient technological penetration. The digitalization rate of agricultural production is only 28.3%, 6.7 percentage points lower than the national average; the proportion of e-commerce transactions for agricultural products is less than 15%; and the gap in rural digital skilled talents exceeds 120,000.

Current academic research on the digital economy empowering rural industrial revitalization mostly focuses on the national level or developed regions in southern China, with relatively few studies targeting rural areas in the old industrial bases of Northeast China. On one hand, Liaoning's rural industries have the dual characteristics of a solid agricultural foundation and profound industrial roots, so the empowerment of the digital economy must take into account both agricultural modernization and rural industrial upgrading. On the other hand, Liaoning's rural aging rate reaches 23.5%, and the coverage rate of county-level digital infrastructure is only 79%, showing significant differences from southern regions. Based on this, this paper, grounded in Liaoning's actual conditions, systematically analyzes the mechanism of the digital economy empowering rural industrial revitalization, proposes targeted paths, fills gaps in regional research, and provides a reference for similar regions.

2. Core Concepts and Theoretical Foundations

2.1 Definition of Core Concepts

Digital Economy: With reference to the

Statistical Classification of the Digital Economy and Its Core Industries (2021), this paper defines it as the sum of economic activities that take data as a key factor of production, digital technology as the core driving force, and achieve improved production efficiency and industrial upgrading through the penetration, transformation, and restructuring of traditional industries. It specifically includes two dimensions: digital industrialization and industrial digitalization.

Rural Industrial Revitalization: In accordance with the Rural Revitalization Strategy Plan (2021-2025), its core is to "build an industrial system integrating the primary, secondary, and tertiary industries—with agriculture as the foundation and the secondary and tertiary industries as extensions—based on rural resource endowments, so as to expand industrial scale, improve quality, increase benefits, and drive farmers' income growth and rural development". It is specifically reflected in three goals: agricultural modernization, industrial integration, and digitalized operation.

2.2 Theoretical Foundations

Factor Restructuring Theory: Traditional rural industries take land, labor, and capital as core factors. The digital economy restructures the production function through the penetration of data factors. The essence of rural revitalization is a process of restructuring original production factors. The combination of data with traditional factors can break resource constraints: for example, combining data with land enables precision farming, combining it with labor improves skill efficiency, and combining it with capital broadens financing channels, fostering innovations in the production function.

Industrial Integration Theory: Digital technology promotes the integration of rural primary, secondary, and tertiary industries by reducing transaction costs and breaking information barriers. Technologies such as the Internet of Things (IoT) and digital platforms can connect the entire chain from farm to table, gather various market entities to achieve accurate supply-demand matching, and at the same time spawn new business formats, fully releasing the amplification, superposition, and multiplication effects of the digital economy.

3. Mechanism Analysis of the Digital Economy Empowering Rural Industrial Revitalization in Liaoning

The empowerment of the digital economy on Liaoning's rural industrial revitalization is not a single application of technology, but rather a chain transmission process of "technology penetration - factor reorganization - industrial upgrading - benefit transformation", which is specifically reflected in three core mechanisms:

3.1 Resolving the Pain Point of Information Asymmetry through the Penetration of Data Factors

Liaoning's rural industries have long been constrained by information gaps: on the one hand, farmers engage in blind planting due to a lack of market information; on the other hand, processing enterprises face unstable raw material supply because they cannot accurately grasp data from the production end.

The digital economy resolves this issue through the penetration of data factors:Data collection at the production end: Real-time collection of farmland moisture, livestock and poultry growth data through IoT devices to form an agricultural production database. For example, the core production area of Panjin rice has realized full-chain traceability (including plot numbering, growth cycle data, and quality inspection), solving the problem of "high quality not leading to high prices".Data connection at the market end: Integration of consumer demand data through e-commerce platforms to guide production in reverse. In 2022, cherries from Dalian Wafangdian achieved a unsalable rate of less than 5% by matching e-commerce pre-sale data with planting plans, a 20-percentage-point decrease compared with the traditional model.Data sharing in the supply chain: Unblocking data links through blockchain technology. For example, the peanut industry cluster in Heishan County, Jinzhou, established a blockchain traceability platform, reducing the raw material loss rate of processing enterprises from 12% to 6% and shortening farmers' payment collection cycles from 3 months to 15 days.

3.2 Accelerating the Application of Digital Technology to Promote Full-Chain Upgrading

Liaoning's rural industries are typically characterized by a focus on production over services. Agricultural production still relies mainly on manual labor, with a mechanization rate of 78% but an intelligentization rate of less

than 20%. Rural industries are mostly low-value-added processing (e.g., primary grain processing accounts for over 60%). Digital technology promotes industrial upgrading through full-chain integration, specifically reflected in three aspects:Promoting intelligent transformation of traditional agriculture at the production end: Leveraging Liaoning's advantages of concentrated major grain-producing areas and a solid foundation for large-scale planting, digital technology enables precise and unmanned production.Advancing digital upgrading of rural industries at the processing end: Liaoning's rural industries have long suffered from outdated equipment and extensive production processes; digital technology optimizes production workflows, improves product quality, and extends the industrial chain.Speeding up digitalization to expand market channels at the sales end: To address the issue of Liaoning's high-quality agricultural products having weak brands and narrow channels, digital technology connects online and offline sales links. On one hand, the influence of regional brands is enhanced through live-streaming e-commerce—for example, Dandong strawberries achieved e-commerce transaction volume exceeding 2 billion yuan in 2022 through county magistrate live streams and influencer promotion, a 2-fold increase compared with 2020. On the other hand, 45 traditional villages in Liaoning have joined the national digital museum, displaying resources through panoramic tours and other forms, driving the development of industries such as homestays and cultural and creative products, and realizing the digital upgrading of rural cultural tourism.

3.3 Promoting the Construction of a Digital Ecosystem to Improve the Support System

The revitalization of rural industries requires the coordinated support of technology, talents, capital, and policies. The digital economy makes up for the shortage of rural factors in Liaoning by building a digital ecosystem:Digital service platforms integrating resources: For example, the Liaoning Provincial Department of Agriculture and Rural Affairs built the "Liaonong Cloud" platform, which provided over 100,000 technical consultations for farmers and facilitated loan connections of 320 million yuan in 2022.Digital finance alleviating financing difficulties: In Dashiqiao City, Yingkou, more than 50 million yuan in unsecured loans was provided to rural small and medium-sized enterprises through enterprise production data and blockchain-based rights confirmation.Digital governance improving management efficiency: Beizhen City, Jinzhou, implemented village-level digital ledgers to achieve full-process transparency of industrial projects, with the project implementation rate increasing to 85% in 2022.

4. Practical Problems of the Digital Economy Empowering Rural Industrial Revitalization in Liaoning

From March to June 2023, this study conducted field surveys in 24 villages across 12 counties in 6 cities (including Shenyang, Tieling, and Dandong). Combining field surveys and data analysis, four prominent problems were identified in the digital economy's empowerment of Liaoning's rural industrial revitalization:

4.1 Large Urban-Rural Gap and Uneven County-Level Distribution of Digital Infrastructure

Infrastructure is a prerequisite for the digital economy's empowerment, but Liaoning's rural digital infrastructure has two "low" characteristics:Low county-level coverage: In 2022, the coverage rate of 5G networks in rural Liaoning was only 79%, 8 percentage points lower than the national average. Remote areas such as Jianping (Chaoyang City) and Jianchang (Huludao City) still face issues of weak signals and slow network speeds, which cannot support the application of technologies such as IoT and AI.Low penetration of agriculture-specific facilities: The installation rate of agricultural IoT equipment in the province is less than 10%, and it is concentrated in large-scale cooperatives. 65% of small-scale farmers reported that they either do not know how to use or cannot afford such equipment.

4.2 Slow Digital Transformation and Superficial Industrial Integration

Lagging digital transformation of agriculture: Liaoning's agricultural digitalization rate is lower than the national average, and it is concentrated in the mechanization of production links. In-depth applications such as data collection and intelligent decision-making are insufficient—only 18% of large-scale growers

use big data to analyze market demand, and 70% of farmers still rely on experience for planting. In the livestock and poultry breeding sector, only 25% of large-scale pastures have implemented AI-based disease monitoring.Low integration of the three industries: Digital technology has not effectively connected the links of primary industry production, secondary industry processing, and tertiary industry services. Data is fragmented between the production and processing ends—for example, 40% of shiitake mushroom processing enterprises in Xinbin County, Fushun, face raw material waste. Collaboration between the processing and sales ends is insufficient: only 20% of rural processing enterprises have established integrated online-offline channels, and the average price of Liaoning's coarse grain processed products is 15%-20% lower than that of southern brands.Total Shortage and Poor Structure of Rural Digital TalentsThe digital economy's empowerment requires compound talents who understand technology, industry, and rural areas, but Liaoning faces significant rural talent shortages:Total shortage: The province's gap in rural digital skilled talents exceeds 120,000, with e-commerce operations and agricultural IoT technicians accounting for 60% of the gap.Structural imbalance: 75% of rural e-commerce practitioners only master basic skills (such as product upload and customer service communication) and lack capabilities in traffic operation and brand building.Retention difficulties: The outflow rate of rural youth reaches 30%, and the outflow rate of young people with digital skills exceeds 50%.Fragmented Policy Support and Difficult Implementation

Although Liaoning has issued the Liaoning Provincial Digital Rural Development Action Plan (2022-2025), three shortcomings exist in policy implementation:Insufficient financial support: 60% of counties and cities reported that "digital rural funds can only cover key projects and cannot benefit small-scale farmers".Insufficient policy coordination: Departments such as agriculture, industry and information technology, and commerce lack overall planning. For example, the agricultural department of a certain county promoted IoT-based planting, but e-commerce platforms did not access production data.Insufficient assessment mechanisms: Some regions equate digital rural development with the number of installed devices, leading to "image projects" with idle equipment.

5. Path Suggestions for the Digital Economy Empowering Rural Industrial Revitalization in Liaoning

Combining the endowments and practical problems of Liaoning's rural industries, targeted paths are proposed from four dimensions: infrastructure, industrial integration, talent development, and policy guarantees:

5.1 Consolidating Digital Infrastructure to Build a Comprehensive and Demand-Adapted Support Network

Promoting balanced development of county-level digital infrastructure: Prioritize addressing shortcomings in remote areas. Based on the distribution of Liaoning's major grain-producing areas and characteristic industrial counties, focus on promoting full 5G coverage in major agricultural cities (such as Tieling, Jinzhou, and Dandong), and achieve a rural 5G coverage rate of over 95% by 2025. For large-scale planting areas, build agriculture-specific IoT base stations; reduce the equipment installation cost for small-scale farmers by 50% through government subsidies and enterprise discounts.

Promoting shared infrastructure: Encourage cooperatives and enterprises to build shared platforms and establish county-level digital agricultural service centers, providing shared drone plant protection and IoT data collection services. Small-scale farmers can access professional services at a cost of 50-100 yuan per mu, lowering the threshold for digitalization.

5.2 Deepening Industrial Digital Integration to Build a Full-Chain, High-Value-Added Industrial System

Promoting precise and intelligent upgrading of agricultural production: Focus on three advantageous industries (grain, livestock and poultry, and characteristic agricultural products) to promote technologies in a classified manner. By 2025, achieve an intelligentization rate of 60% in large-scale planting areas of major grain-producing regions; build digital pastures in livestock and poultry breeding areas to control the disease incidence rate below 10%; establish blockchain traceability systems in characteristic agricultural product areas to increase product prices by over 20%.

Building a digital collaboration platform for the integration of the three industries: Establish county-level digital collaboration centers for rural industries to connect data links across production, processing, and sales: the production end uploads data to match orders, the processing end releases demand to achieve flexible production, and the sales end connects to e-commerce platforms to push consumer demand. Take the Dandong strawberry industry as a pilot to build a collaboration platform by 2024, increasing the efficiency of production-sales matching by 30%.

Cultivating new rural digital business formats: Develop characteristic formats combining industry and agriculture. In agriculture and cultural tourism: launch online virtual tours and offline experience models at Panjin's rice field painting scenic spots. In rural industry and e-commerce: build e-commerce bases for industrial clusters (such as Liaoyang socks and Fuxin coarse grains), and increase the proportion of e-commerce transactions in rural industries to 40% by 2025.

5.3 Improving the Digital Talent System to Create a Positive Cycle of Talent Recruitment, Cultivation, and Retention

Precise talent recruitment: Focus on "urgently needed" fields, cooperate with Liaoning Agricultural Vocational and Technical College and Shenyang Agricultural University to cultivate targeted agricultural IoT engineers and e-commerce operators, sign 3-year rural service agreements, and provide tuition waivers. Launch support policies for rural digital entrepreneurship targeting outflows of young people, providing entrepreneurial subsidies and low-interest loans.

Tiered talent cultivation: Cover governments, enterprises, and farmers to establish a tiered training system. Train no fewer than 2,000 grassroots cadres annually, achieve full coverage of training for leaders of key enterprises, and train no fewer than 100,000 farmers. Form local digital mentor teams to provide on-site guidance for farmers on using digital tools.

Optimizing talent retention: Improve benefits and development guarantees. Provide post subsidies and performance bonuses for digital talents and include them in the county-level shortage talent pool. Establish rural digital entrepreneurship incubation bases, providing office space and technical support to expand development opportunities.

5.4 Improving the Policy Guarantee Mechanism to Build a Coordinated and Effective Support System

Establishing a coordination mechanism: Set up a leading group for digital rural industrial revitalization in Liaoning Province, led by the Provincial Department of Agriculture and Rural Affairs, to coordinate resources across departments (agriculture, industry and information technology, commerce, etc.), and hold quarterly coordination meetings to resolve policy conflicts and implementation barriers.

Strengthening financial and technical support: Establish a special fund for the digitalization of Liaoning's rural industries, integrating county-level financial funds and social capital. Build an industry-university-research-application cooperation mechanism, and jointly establish digital agriculture research institutes with universities and technology enterprises to develop targeted technical equipment for Liaoning's rural areas.

6. Conclusion

The digital economy provides a historic opportunity for Liaoning to achieve leapfrog development in rural industrial revitalization. Through its three core mechanisms—resolving information asymmetry via data factor penetration, promoting full-chain upgrading through digital technology application, and improving the support system via digital ecosystem construction—it can effectively activate the advantages of Liaoning's rural industrial foundation in agriculture and its potential in industrial heritage. Although Liaoning currently faces challenges such as uneven digital infrastructure, superficial industrial integration, talent shortages, and insufficient policy coordination, the empowering effect of the digital economy can be fully released through balanced infrastructure development, full-chain digital integration of industries, the establishment of a talent recruitment-cultivation-retention system, and coordinated policy guarantees.

Acknowledgement

Foundation project:2024 Basic Scientific Research Project of the Education Department of Liaoning Province (Project No.: 2024JYTKYTD-07)

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