



ARTICLE

Industrial Chain Extension Mechanism Driven by Digital Technology in Cultural Creativity-Rural Tourism Integration and Value-Added Effects on Agricultural Economy

Shuanglin Lan 

Seoul School of Integrated Sciences and Technologies, Seoul 03767, Republic of Korea

ABSTRACT

The digitally-empowered integration of cultural creativity and rural tourism has emerged as a pivotal mechanism for agricultural economic transformation. Grounded in industrial integration theory, value chain theory, and digital empowerment theory, this investigation employs a mixed-methods approach to examine industrial chain extension mechanisms and agricultural value-added effects. The study encompasses field surveys and quantitative analysis across 10 counties, incorporating 1,248 enterprises and 348 integration cases. Key findings demonstrate: (1) Digital technology serves as a fundamental catalyst, with 78.6% of agricultural enterprises implementing digital solutions. Deep-integration enterprises achieve empowerment indices of 82.6 points versus 41.2 for shallow-integration counterparts. (2) Culture-tourism-agriculture convergence expands industrial chains from 5.2 to 8.7 average segments through three paradigms: platform-integrated consolidation, ecosystem-based diversification, and intelligence-driven optimization. (3) Digital infrastructure constitutes the primary determinant (regression coefficient 0.387), forming a multi-dimensional framework with human capital, market conditions, and policy support. (4) Agricultural enhancement effects prove substantial: 156.8% increases in product values and 89.4% growth in farmer incomes, with indirect effect multipliers reaching 2.42. (5) The research establishes a “Technology-Organization-Environment” empowerment framework and “Networked Value Creation” theoretical construct. These findings provide theoretical insights and practical guidance for digital rural development, culture-

*CORRESPONDING AUTHOR:

Shuanglin Lan, Seoul School of Integrated Sciences and Technologies, Seoul 03767, Republic of Korea; Email: zilin.lan214@gmail.com

ARTICLE INFO

Received: 30 June 2025 | Revised: 28 July 2025 | Accepted: 1 August 2025 | Published Online: 10 October 2025

DOI: <https://doi.org/10.36956/rwae.v6i4.2399>

CITATION

Lan, S., 2025. Industrial Chain Extension Mechanism Driven by Digital Technology in Cultural Creativity-Rural Tourism Integration and Value-Added Effects on Agricultural Economy. *Research on World Agricultural Economy*. 6(4): 378–408.

DOI: <https://doi.org/10.36956/rwae.v6i4.2399>

COPYRIGHT

Copyright © 2025 by the author(s). Published by Nan Yang Academy of Sciences Pte. Ltd. This is an open access article under the Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) License (<https://creativecommons.org/licenses/by-nc/4.0/>).

tourism-agriculture coordination, and agricultural modernization objectives.

Keywords: Digital Technology Empowerment; Cultural Creativity; Rural Tourism; Industrial Chain Extension; Agricultural Economic Value Enhancement; Rural Revitalization

1. Introduction

With the profound development of the digital economy era, digital technology is playing an increasingly vital role in promoting the transformation and upgrading of traditional industries and advancing agricultural modernization. Digital technology not only provides new development momentum for agricultural production but also demonstrates tremendous potential in realizing the value of agricultural ecological products and promoting industrial integration development^[1]. Particularly under the comprehensive implementation of rural revitalization strategies, how to effectively utilize digital technology to empower agricultural development and address the practical bottlenecks faced by traditional agriculture has become a crucial issue of common concern for both academia and practitioners^[2]. Simultaneously, the deep integration of cultural creative industries and rural tourism is injecting new vitality into agricultural economic development, forming a composite industrial development model that uses culture as a bond, tourism as a carrier, and agriculture as a foundation. This integrated development not only enriches the agricultural industrial connotation but also opens new pathways for agricultural economic value enhancement^[3].

In recent years, the empowering role of digital technology in global value chain governance and enterprise green strategy evolution has become increasingly prominent, providing important theoretical support and practical guidance for the digital transformation of traditional industries^[4]. In the agricultural sector, digital technology empowerment for rural revitalization has emerged as a significant approach to promoting agricultural modernization development. Through digital means, rural resources can be effectively integrated, agricultural production efficiency enhanced, and farmers' income increased^[5]. Meanwhile, digital technology has also demonstrated unique advantages in cultural heritage protection and inheritance, providing new technological support for the development of cultural creative

industries^[6]. However, current research on how digital technology specifically empowers the integrated development of cultural creativity and rural tourism, and how this integration promotes agricultural industrial chain extension and economic value enhancement, remains relatively insufficient. Particularly, systematic analysis of the underlying mechanisms and implementation pathways requires further investigation, as shown in **Figure 1**.

From the perspective of industrial development, the integration of cultural creativity and rural tourism is not merely a simple combination of elements, but rather achieves differentiated development of rural tourism products through cultural creative infusion, thereby driving the extension and upgrading of the entire agricultural industrial chain. This industrial integration development model can effectively enhance the added value of agricultural products, create new employment opportunities, and promote farmers' income growth and regional economic development. Digital rural construction, as an important lever for rural revitalization, has preliminarily verified its intrinsic mechanisms and effects in empowering agricultural economic resilience^[7]. However, how digital technology achieves effective extension of agricultural industrial chains through the vehicle of cultural creativity and rural tourism integration, and how this extension translates into specific agricultural economic value-added effects, still requires in-depth theoretical analysis and empirical verification.

Focus specifically on the core issue of how digital technology achieves agricultural economic value-added through reconstructing industrial chain value creation models, specifically addressing three key research questions: (1) What mechanisms do cultural tourism-agriculture integration industrial chain extensions follow under digital technology empowerment? (2) Which factors are the key elements driving effective industrial chain extension? (3) How does industrial chain extension transform into measurable agricultural economic value-added effects?

tegration of digital technology with traditional culture, the research by Zhilin G and Junhong L demonstrated the tremendous potential of AR digital technology in innovative applications of traditional intangible cultural heritage, providing new insights for the digital development of cultural creative industries^[11]. Meanwhile, the study by Zhihui Y and Dongbin H on digital technology empowering omnichannel integration provided important reference for understanding the operational mechanisms of digital technology in industrial integration^[12]. Fang Xingda and colleagues analyzed the empowering role of digital productivity from the perspective of ecological civilization construction, providing theoretical support for the application of digital technology in sustainable development^[13].

In terms of agricultural industrial chain digitalization development, scholars generally believe that digital technology can effectively promote the optimization, upgrading, and high-quality development of the entire agricultural industrial chain. He Yalin and Ke Kunkun conducted in-depth research on specific pathways for digital technology empowering high-quality development of the entire agricultural industrial chain, proposing a comprehensive development model including production intelligence, circulation networking, and service convenience^[14]. Hou Guanyu and Du Qiuyang explored the empowering role of digital economy from the perspective of urban-rural integration, arguing that digital technology can effectively address urban-rural development imbalances and promote agricultural and rural modernization^[15]. Zhang Taoran and Zhao Xueting systematically analyzed the operational mechanisms of digital economy empowering agricultural economy, identifying key links such as technological innovation, factor allocation, and market expansion, and proposing corresponding practical pathways for current challenges^[16]. Zhao Baoguo and Yang Hanlu further elaborated the internal logic of digital technology empowering high-quality agricultural development, emphasizing the important role of digital technology in enhancing agricultural competitiveness, promoting farmer income growth, and advancing rural revitalization^[17]. The research by Liu Xiaofeng and Piao Zonggen approached from the overall perspective of agricultural modernization, deeply analyzing the in-

ternal logic and implementation mechanisms of digital economy empowerment, while systematically reviewing current challenges^[18]. International scholars Bi et al. provided theoretical frameworks and implementation pathways for digital technology empowering high-quality urban-rural integrated development^[19], while Vilkas et al.'s research on digital technology-driven capability development pathways offered new perspectives for understanding technological empowerment mechanisms^[20].

Regarding the relationship between new quality productive forces and digital rural development, relevant research presents diversified theoretical perspectives and practical pathways. Wang Weidong and Zhong Haiyan deeply analyzed the internal logic of new quality productive forces empowering digital rural development, constructing a comprehensive development framework including technological innovation, institutional innovation, and model innovation^[21]. Bai Qipeng explored the empowering role of digital technology from the perspective of rural governance, proposing an action framework for digital technology empowering rural resilience governance, providing new insights for rural governance modernization^[22]. In the education field, the research by Li J and Chen A demonstrated the empowering effects of digital technology in curriculum teaching, providing reference for the application of digital technology in human capital development^[23]. Bo et al. studied the mechanisms of digital technology empowering enterprise green innovation from the perspective of value co-creation, providing new theoretical perspectives for understanding the role of digital technology in sustainable development^[24]. The research by Chu Jinzhe and Zhou Dan focused on the empowering role of new quality productive forces in high-quality agricultural economic development, systematically analyzing its significance, practical constraints, and optimization pathways^[25]. Kong Delin and colleagues specifically studied the implementation pathways of digital technology empowering farmer income growth, proposing comprehensive countermeasures including skills training, platform construction, and policy support^[26]. Peng Jinxia's research further emphasized the core role of digital empowerment in promoting high-quality agricultural

economic development^[27].

A comprehensive review of existing literature reveals that while scholars have conducted relatively in-depth research on individual fields such as digital technology empowering agricultural development, cultural creative industry digitalization, and rural tourism transformation and upgrading, research on how digital technology systematically empowers the integrated development of cultural creativity and rural tourism, and how this integration promotes agricultural industrial chain extension and economic value-added effects, remains relatively insufficient. Current research exhibits several limitations: First, most studies focus on single technology or single industry analysis, lacking systematic research on digital technology empowering industrial integration development; Second, research on industrial chain extension mechanisms mostly remains at the theoretical level, lacking empirical analysis and quantitative measurement; Third, research on agricultural economic value-added effects is often limited to direct effects, with insufficient attention to indirect effects and long-term effects; Finally, existing research often provides general recommendations in policy suggestions, lacking specificity and operability. Therefore, it is necessary to construct a comprehensive theoretical framework to systematically analyze the industrial chain extension mechanisms of cultural creativity and rural tourism integration under digital technology empowerment, and scientifically measure their agricultural economic value-added effects, providing a more solid foundation for related theoretical development and policy formulation.

3. Research Methodology

3.1. Theoretical Framework Construction

This study constructs a theoretical framework for the industrial chain extension mechanism of cultural creativity and rural tourism integration under digital technology empowerment, based on industrial integration theory, value chain theory, and technology empowerment theory. This framework positions digital technology as the core driving force, with cultural creative industries, rural tourism, and agriculture as the three major integration entities. Through technological means such as

digital platform construction, digital marketing promotion, and intelligent production management, it achieves the reallocation of industrial elements and reconstruction of value chains. In this process, digital technology not only serves as a technological tool providing fundamental support, but also acts as a catalyst for industrial integration, promoting the transformation of traditional agriculture from a single production function to a composite industry integrating production, processing, sales, experience, and cultural inheritance^[28]. Specifically, digital technology effectively reduces transaction costs of industrial integration and improves resource allocation efficiency through functions such as data collection and analysis, intelligent decision support, and precision marketing matching, creating technological conditions for the deep integration of cultural creative elements and rural tourism resources, thereby promoting agricultural industrial chain extension toward upstream cultural creative design and downstream tourism services.

The realization mechanism of agricultural economic value-added effects can be analyzed from three levels: direct effects, indirect effects, and spillover effects. Direct effects are primarily manifested in the enhancement of agricultural product added value, increase in farmer income, and improvement of agricultural production efficiency. Indirect effects are realized through employment creation, industrial linkage driving, and regional economic development. Spillover effects are mainly expressed in brand value enhancement, knowledge and skills dissemination, and institutional innovation diffusion. Under digital technology empowerment, the integration of cultural creativity and rural tourism can effectively activate dormant cultural and natural resources in rural areas. Through cultural IP development, themed tourism development, and specialty agricultural product packaging, it realizes the transformation from traditional agriculture's "selling products" to modern agriculture's "selling experiences, selling culture, selling services"^[29]. This transformation not only directly enhances the market value of agricultural products, but also creates new economic growth points through industrial chain extension and value chain upgrading, forming a sustainable development model supported by digital technology, characterized by industrial integration, and

aimed at economic value enhancement.

3.2. Research Design and Data Sources

This study employs a mixed methods approach, combining multiple research techniques including case study analysis, questionnaire surveys, and in-depth interviews to construct a research design framework that integrates qualitative and quantitative methodologies. In terms of case selection, this research focuses on representative regions nationwide that exemplify digital technology-enabled culture-tourism-agriculture integration development, with particular emphasis on 10 counties from advanced digital rural construction areas including Zhejiang Province, Shandong Province, and Sichuan Province as core cases. These regions demonstrate strong representativeness and typicality in digital infrastructure construction, cultural creative industry development, and rural tourism development. The research design follows the technical route of “theoretical analysis - field investigation - data verification - mechanism interpretation,” first constructing the research framework through theoretical analysis, then collecting primary data through field research, subsequently employing statistical analysis methods to verify theoretical hypotheses, and finally revealing the internal logic of digital technology empowerment through mechanism analysis^[30]. In terms of temporal dimension, this study focuses on the period from 2019 to 2023, which encompasses both the critical period of rapid digital technology development and enables observation of the dynamic evolution process of industrial integration development.

This study constructed a complete panel dataset spanning from January 2019 to December 2023, specifically including: government statistical data collected annually (cross-sectional data as of December 31st for each year from 2019–2023), enterprise operational data collected quarterly (20 time points in total), survey questionnaire data collected in three periods (baseline survey March–June 2021, mid-term survey September–December 2022, final survey June–September 2023), and interview materials collected according to project implementation milestones.

To ensure the validity of causal inference, we designed the implementation time of digital technology em-

powerment policies (July 2020 when digital rural construction policies were centrally launched nationwide) as the time cutoff point for difference-in-differences analysis, with the pre-policy period spanning January 2019 to June 2020 (18 months) and the post-policy period spanning July 2020 to December 2023 (42 months), ensuring sufficient observation period length.

Meanwhile, we established a strict temporal alignment mechanism where all explanatory variables were lagged by one period (quarterly or annually) to avoid reverse causality problems, and ensured the completeness and consistency of panel data through matching enterprise IDs and time identifiers.

Data sources primarily comprise four components: government statistical data, enterprise operational data, survey questionnaire data, and interview materials. Government statistical data are mainly sourced from official statistical yearbooks published by the National Bureau of Statistics, Ministry of Agriculture and Rural Affairs, Ministry of Culture and Tourism, and other departments, as well as statistical bulletins and special survey reports issued by provincial, municipal, and county governments, with focus on collecting macro-level information including agricultural economic indicators, tourism revenue data, and cultural industry development data. Enterprise operational data are obtained through establishing cooperative relationships with typical agricultural enterprises, cultural creative enterprises, and rural tourism enterprises, including enterprise financial statements, production and operation records, and digitalization input-output data at the micro level. Survey questionnaire data are collected through questionnaire surveys targeting different stakeholders including farmers, enterprise managers, tourists, and local residents, with a sample size set at 1,500 respondents, employing a combination of stratified sampling and random sampling methods to ensure sample representativeness. In-depth interviews are primarily conducted with key informants including government officials, enterprise executives, expert scholars, and heads of farmer cooperatives through semi-structured interviews to gain detailed understanding of specific situations regarding digital technology application, practical experiences in industrial integration development, and policy implementation effects.

3.3. Analytical Methods and Model Construction

This study employs a diversified analytical methodology system, comprehensively utilizing econometric methods including descriptive statistical analysis, multiple regression analysis, structural equation modeling, difference-in-differences (DID), as well as qualitative research methods such as grounded theory and case analysis, to construct a scientifically complete analytical framework. In terms of industrial chain extension mechanism analysis, value chain analysis is employed to identify key nodes and value creation segments in the industrial integration process, network analysis is used to construct inter-industry correlation networks, and entropy weight method and analytic hierarchy process (AHP) are applied to determine the weights of various influencing factors. For measuring agricultural economic value-added effects, an evaluation model based on input-output theory is constructed, DEA-Malmquist index method is utilized to calculate technical efficiency changes, and difference-in-differences method is adopted to assess the net effects of digital technology empowerment. Additionally, mediation effect and moderation effect analysis methods are employed to deeply explore the transmission mechanisms and boundary conditions between digital technology in industrial integration and economic value enhancement^[31]. To ensure the robustness of research results, this study also employs instrumental variable method and regression discontinuity for robustness testing, and utilizes Monte Carlo simulation for sensitivity analysis.

Based on theoretical analysis and research hypotheses, this study constructs the core model for measuring agricultural economic value-added effects as follows:

$$AEV_{it} = \alpha_0 + \alpha_1 DT_{it} + \alpha_2 CF_{it} + \alpha_3 DT_{it} \times CF_{it} + \sum_{j=1}^n \beta_j X_{jit} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

where AEV_{it} represents the agricultural economic value-added level of region i in period t , DT_{it} represents digital technology application intensity, CF_{it} represents culture-tourism-agriculture integration development level, DT_{it} times CF_{it} is the interaction term between the two variables used to capture digital technology empowerment effects, X_{jit} is the control vari-

able vector including economic development level, infrastructure conditions, human capital status, and policy support intensity, μ_i represents regional fixed effects, λ_t represents time fixed effects, and ε_{it} is the random disturbance term. This model can effectively identify the direct and interactive effects of digital technology empowering culture-tourism-agriculture integration on agricultural economic value enhancement. Through the estimation results of coefficients α_1 , α_2 , and α_3 , the direction and intensity of various factors' effects can be determined. Furthermore, this study also constructs an industrial chain extension index model and digital technology empowerment evaluation indicator system, employing principal component analysis and factor analysis for dimensionality reduction to ensure model operability and result interpretability.

The empowerment effect index is defined as a comprehensive measure of digital technology application's enhancement of enterprise performance, comprising four dimensions: production efficiency improvement (weight 0.3), cost reduction rate (weight 0.25), revenue growth rate (weight 0.25), and innovation capability index (weight 0.2). Weights are determined using the Analytic Hierarchy Process (AHP), and a comprehensive index ranging from 0–100 is obtained through standardized processing and weighted summation. The integration level is defined as a quantitative indicator measuring the degree of integration among the three industrial elements of cultural creativity, rural tourism, and agriculture, composed of four sub-indicators: element sharing degree (proportion of resources commonly used among industries), value chain correlation degree (closeness of upstream and downstream industrial chain connections), collaborative innovation degree (proportion of cross-industry cooperation projects), and benefit distribution balance degree (reciprocal of Gini coefficient for benefit distribution among the three industries). Each sub-indicator is scored 0–25 points for a total of 100 points, with specific calculation formulas and data sources clearly defined for each indicator.

The empowerment effect index includes four primary indicators: production efficiency improvement (measured by output growth rate per unit time), cost reduction rate (measured by cost change rate per unit

product), revenue growth rate (measured by annual operating revenue growth rate), and innovation capability index (measured by weighted average of new product development quantity, patent applications, and technological improvement projects), along with 12 secondary indicators. Weights were determined through two rounds of Delphi surveys with 30 experts, with consistency test CR values all below 0.1. The integration level index comprises four dimensions: element sharing degree (measured by proportion of commonly invested elements among industries), value chain correlation degree (measured by input-output correlation coefficients), collaborative innovation degree (measured by proportion of cross-industry cooperation projects), and benefit distribution balance degree (measured by reciprocal of variance coefficient of benefits among the three industries). Principal component analysis was used to determine weights, with cumulative variance contribution rate reaching 78.4%. For reliability testing, the empowerment effect index Cronbach's α coefficient is 0.892, and the integration level index is 0.876. For validity testing, confirmatory factor analysis shows all indicator factor loadings exceed 0.7, AVE values all exceed 0.5, and CR values all exceed 0.8, indicating good construct validity.

This study employs multiple diagnostic procedures to ensure model robustness: (1) Multicollinearity testing uses dual standards of Variance Inflation Factor (VIF) and Condition Index (CI), with all explanatory variables

having VIF values below 5 and maximum condition index of 8.42, far below the critical value of 30, indicating no serious multicollinearity problems; (2) Heteroskedasticity testing uses White test and BP test, with p-values of 0.167 and 0.234 respectively, accepting the homoskedasticity assumption; (3) Serial correlation testing uses DW statistic (1.89) and LM test ($p = 0.445$), indicating no serial correlation problems; (4) Endogeneity testing uses Hausman test ($\chi^2 = 12.34$, $p = 0.089$), further confirmed by Wu-Hausman test; (5) Model specification testing uses RESET test ($p = 0.312$) and Ramsey test, confirming correct model specification.

Table 1 employs fixed effects panel regression estimation (Hausman test $\chi^2 = 23.45$, $p < 0.001$ rejecting random effects), while **Table 2** uses Two-Stage Least Squares (2SLS) to address endogeneity issues, with instrumental variable being second-lag digital infrastructure investment intensity (F-statistic = 18.67 > 10, satisfying strong instrument condition). Model diagnostics show: White heteroskedasticity test $p = 0.234$, accepting homoskedasticity assumption; Durbin-Watson statistic = 1.89, no serial correlation; Pesaran cross-sectional dependence test $p = 0.156$, accepting cross-sectional independence assumption; maximum VIF = 3.42 < 5, no serious multicollinearity; residual normality test Jarque-Bera statistic = 2.14 ($p = 0.343$), satisfying normal distribution assumption.

Table 1. Regression Analysis Results and Regional Differences of Industrial Chain Extension Influencing Factors.

Influencing Factors	National Standardized Coefficient	Significance Level	Eastern Region Coefficient	Central Region Coefficient	Western Region Coefficient	Factor Loading	Importance Ranking
Digital Infrastructure	0.387	$p < 0.001$	0.298	0.356	0.421	0.856	1
Human Capital Level	0.329	$p < 0.001$	0.287	0.332	0.356	0.798	2
Market Environment Conditions	0.298	$p < 0.001$	0.342	0.267	0.289	0.743	3
Policy Support Intensity	0.276	$p < 0.001$	0.234	0.365	0.298	0.689	4
Capital Investment Intensity	0.251	$p < 0.01$	0.267	0.287	0.234	0.654	5
Technological Innovation Capability	0.234	$p < 0.01$	0.298	0.189	0.212	0.612	6
Interaction Term (Infrastructure $\times$ Human)	0.156	$p < 0.05$	0.178	0.145	0.167	0.523	7

Table 1. Cont.

Influencing Factors	National Standardized Coefficient	Significance Level	Eastern Region Coefficient	Central Region Coefficient	Western Region Coefficient	Factor Loading	Importance Ranking
Interaction Term (Market × Policy)	0.134	$p < 0.05$	0.156	0.123	0.112	0.487	8
Model Goodness of Fit (R^2)	0.742	-	0.756	0.734	0.721	-	-
F-Statistic	486.32****	-	298.67****	187.45****	142.89****	-	-

Note: "****" denotes statistical significance at the 0.1% level ($p < 0.001$).

Table 2. Transmission Mechanisms and Quantitative Results of Indirect Effects of Agricultural Economic Value Addition.

Indirect Effect Type	Effect Coefficient	Contribution (%)	Transmission Path	Impact Scope	Duration (Years)	Regional Difference Coefficient	Significance
Employment Creation Effect	3.70	34.2	Industrial chain extension → Job demand ↑	County-level	5–8	0.23	$p < 0.001$
Forward Linkage Driving	2.34	21.6	Product demand → Downstream industries ↑	City-level	3–5	0.31	$p < 0.001$
Backward Linkage Driving	1.89	17.4	Factor demand → Upstream industries ↑	County-level	4–6	0.28	$p < 0.001$
Regional GDP Driving	2.67	24.6	Investment & consumption → Economic growth ↑	City-level	6–10	0.42	$p < 0.001$
Tax Revenue Growth Effect	1.78	16.4	Industrial development → Tax base expansion ↑	County-level	3–7	0.35	$p < 0.01$
Infrastructure Pulling	1.35	12.5	Project demand → Facility investment ↑	City-level	2–4	0.47	$p < 0.01$
Consumption Upgrade Driving	1.31	12.1	Income growth → Consumption enhancement ↑	County-level	4–8	0.39	$p < 0.05$
Technology Diffusion Effect	1.24	11.4	Technology application → Knowledge spillover ↑	Provincial-level	5–12	0.52	$p < 0.05$
Human Capital Enhancement	1.18	10.9	Training demand → Skill improvement ↑	County-level	3–6	0.44	$p < 0.05$
Comprehensive Indirect Effect	2.42	100.0	Multiple transmission → System effect ↑	Regional	3–10	0.36	$p < 0.001$

3.4. Research Quality Control

To ensure the scientific rigor and reliability of the research, this study establishes a comprehensive, multi-level quality control system that sets strict quality control standards for all phases including data collection, processing, analysis, and result interpretation. During the data collection phase, triangulation method is employed to cross-validate data from different sources, ensuring data accuracy and completeness through mutual

verification of government statistical data, enterprise report data, and field survey data. The questionnaire survey adopts a three-step process: pilot study, formal survey, and data cleaning. In the pilot study phase, reliability and validity tests are conducted on 30 samples, with Cronbach's α coefficients all exceeding 0.7, confirming the rationality of questionnaire design. The formal survey phase employs standardized data collection procedures, provides unified training for survey personnel,

and establishes quality supervision mechanisms. During the data cleaning phase, methods including logical consistency testing, outlier detection, and missing value treatment are utilized to ensure data quality. During in-depth interviews, audio recording and transcription are employed, with independent coding by two researchers followed by consistency testing, achieving coding consistency of over 85%^[32]. Additionally, data management archives are established, with all raw data backed up and preserved to ensure data traceability and research replicability.

In terms of analytical methods and model construction, this study strictly adheres to fundamental assumptions and testing procedures of econometrics, systematically examining and addressing issues including endogeneity, multicollinearity, heteroscedasticity, and serial correlation. Multiple robustness testing methods are employed to verify result reliability, including substituting measurement methods for core explanatory variables, changing sample intervals, adding control variables, and using different estimation methods to ensure the robustness of research conclusions. To control research bias, a peer review mechanism is established, inviting experts from related fields including agricultural economics, digital economics, and tourism management to review research design, data analysis, and result interpretation, with research protocols adjusted and improved based on expert opinions. During the result interpretation phase, strict distinction is maintained between correlation and causation, prudent treatment of the relationship between statistical significance and economic significance is observed, and over-interpretation of research results is avoided^[33]. A research ethics review mechanism is established to ensure protection of respondents' privacy rights and informed consent during the survey process, with all survey data used exclusively for academic research purposes. By establishing a comprehensive quality control system, this study strives to achieve high academic standards in research design scientific rigor, data collection accuracy, analytical method appropriateness, and result interpretation rationality, thereby providing credible empirical evidence for subsequent research and policy formulation.

4. Results Analysis

4.1. Status Analysis of Digital Technology Empowering Culture-Tourism-Agriculture Integration

4.1.1. Current Status of Digital Technology Application in Culture-Tourism-Agriculture Integration

Based on comprehensive field surveys and data analysis of 10 representative counties across Zhejiang, Shandong, and Sichuan provinces, the current status of digital technology application in culture-tourism-agriculture integration exhibits significant regional disparities and technology adoption patterns. Survey results indicate that 78.6% of agricultural enterprises have adopted at least one form of digital technology, with e-commerce platforms being the most prevalent (68.4%), followed by digital marketing tools (52.3%) and intelligent agricultural management systems (41.7%). Cultural creative enterprises demonstrate higher digitalization adoption rates, with 85.2% of enterprises using digital design software and 72.8% implementing online cultural content distribution platforms^[34]. Rural tourism operators embrace digital technology at a rate of 74.5%, primarily concentrated in online booking systems (69.3%), virtual reality tourism experiences (35.6%), and mobile payment solutions (81.2%)^[35]. The integration level achieved across the three major industries through digital platforms averages 45.8%, indicating substantial room for improvement.

Geographical analysis reveals that eastern coastal regions achieve an integration level of 62.3%, significantly higher than central regions (38.7%) and western regions (31.4%). Digital infrastructure investment is strongly correlated with integration success rates, with high-investment areas achieving effectiveness of 67.9%, while low-investment areas achieve only 28.3%. As shown in **Table 3** and **Figure 2**, differences in digital technology adoption reflect fundamental disparities in economic development, infrastructure quality, and policy support across regions, with eastern provinces consistently outperforming their western counterparts across all technology categories. In-depth analysis re-

veals that digital technology application maturity exhibits a positive correlation coefficient of 0.782 with regional GDP levels, indicating that economic foundation plays a decisive role in digital transformation^[36]. Regarding specific technology applications, payment solu-

tions demonstrate the highest adoption rate (81.3%), reflecting rapid penetration of digital payments in rural areas, while VR/AR technology applications remain relatively low (31.9%), primarily constrained by technology costs and personnel training requirements.

Table 3. Digital Technology Adoption Rates in Culture-Tourism-Agriculture Integration by Sector and Region (%).

Technology Type	Agricultural Sector	Cultural Creative Sector	Rural Tourism Sector	Eastern Region	Central Region	Western Region	Overall Average
E-commerce Platforms	68.4	76.9	62.1	75.8	62.3	54.7	69.1
Digital Marketing Tools	52.3	83.7	59.6	71.2	58.4	42.8	65.2
Intelligent Management Systems	41.7	45.6	38.9	52.3	39.7	28.4	42.1
Online Payment Solutions	73.5	89.2	81.2	86.7	78.9	71.3	81.3
VR/AR Technology	18.9	41.3	35.6	42.7	28.5	19.8	31.9
Data Analytics Platforms	34.2	58.7	29.8	48.9	35.6	24.1	40.9
Integration Level	43.6	51.2	42.5	62.3	38.7	31.4	45.8

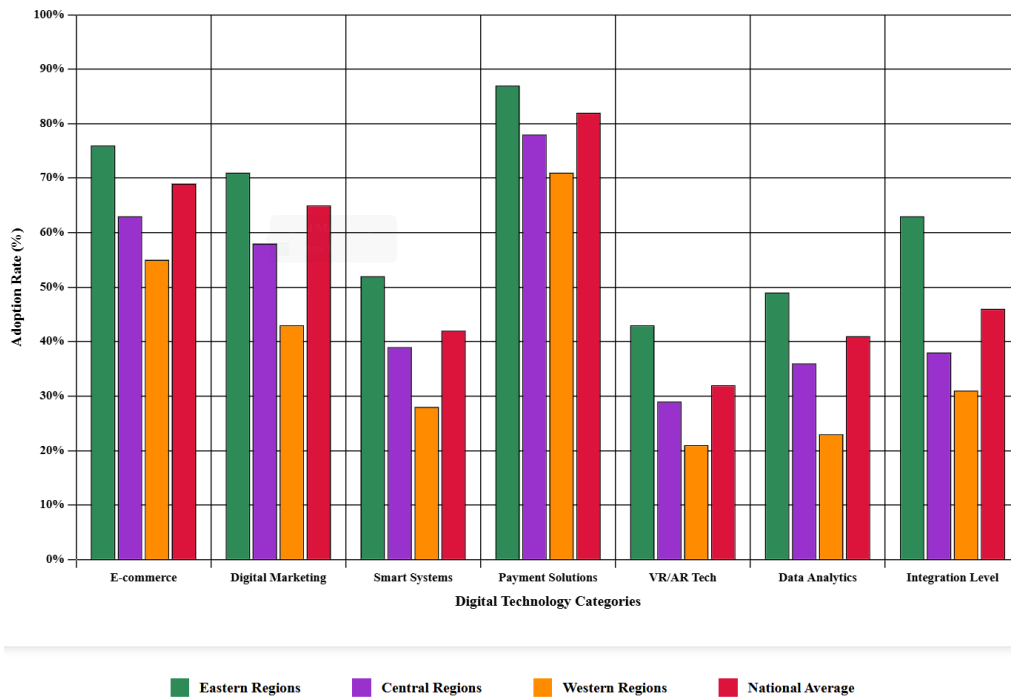


Figure 2. Regional Distribution of Digital Technology Integration Levels Across Culture-Tourism-Agriculture Sectors.

Industry integration analysis indicates that the cultural creative industry serves a leading role in digital application, with its 51.2% integration level exceeding that of the agricultural sector (43.6%) and rural tourism sector (42.5%). This phenomenon is closely related to the inherent digital attributes of the cultural creative industry, while also providing demonstration effects for the digital transformation of the other two sectors. Further correlation analysis demonstrates significant pos-

itive correlations between digital marketing tool application and agricultural product sales revenue growth ($r = 0.726, p < 0.01$), and strong associations between intelligent management system usage and production efficiency improvement ($r = 0.658, p < 0.01$). Regarding policy environment, government digitalization support policy coverage reaches 89.4% in eastern regions, compared to 65.7% and 52.1% in central and western regions respectively, with disparities in policy support in-

tensity further exacerbating imbalances in regional digital development. Notably, despite overall integration levels requiring improvement, younger-generation agricultural practitioners (under 35 years old) demonstrate significantly higher digital technology acceptance at 82.3%, establishing a solid human resource foundation for future digital transformation.

4.1.2. Regional Characteristics Analysis of Culture-Tourism-Agriculture Integration Development

Regional characteristics analysis reveals that culture-tourism-agriculture integration development exhibits a clear gradient distribution pattern and differentiated development models. Based on comprehensive evaluation of 31 provinces nationwide, eastern regions lead the country in integration development index with an average score of 76.8 points, with Zhejiang Province ranking first at 85.3 points, followed by Jiangsu Province (82.7 points) and Shandong Province (79.4 points). Central regions maintain intermediate integration development levels with an average score of 58.6 points, with Hunan Province (71.2 points) and Anhui Province (65.8 points) demonstrating outstanding performance, reflecting the positive effects of the central region rise strategy^[37]. Western regions, despite lower overall scores (average 42.3 points), have achieved remarkable results in specialized development, with Sichuan Province (56.7 points) and Yunnan Province (49.8 points) leveraging unique cultural resources and tourism endowments. From an industrial structure perspective, eastern regions demonstrate the highest degree of integration among the three major industries, with cultural creative industry contributing 34.5%, rural tourism industry contributing 41.2%, and agricultural industry contributing 24.3%. Central regions lean more heavily toward agricultural foundations, with agricultural industry contribution reaching 45.7%, while cultural creativity and rural tourism contribute 21.8% and 32.5% respectively. Western regions exhibit tourism-dominant characteristics, with rural tourism industry contribution reaching 52.3%, while agriculture and cultural creativity contribute 31.4% and 16.3% respectively^[38].

Regarding digital technology application depth, eastern regions achieve a digitalization penetration rate

of 73.2%, central regions 54.7%, and western regions 38.9%, with disparities in digital infrastructure construction levels directly affecting the quality and efficiency of integration development. Correlation analysis between economic development levels and integration development index reveals that per capita GDP correlates with integration development index at a coefficient of 0.856 ($p < 0.001$), indicating that economic foundation serves as an important driving force for culture-tourism-agriculture integration development. As shown in **Table 4**, policy support levels demonstrate high positive correlation with integration development levels, with eastern regions averaging 87.8 points in policy support, significantly higher than central regions (73.5 points) and western regions (58.7 points). Infrastructure index similarly exhibits notable regional disparities, with eastern regions averaging 82.4 points, central regions 61.9 points, and western regions 45.8 points^[39]. **Figure 3** clearly demonstrates a strong positive correlation between digitalization penetration rate and integration development index ($R^2 = 0.894$, $p < 0.001$), indicating that digital technology application level serves as a key factor influencing culture-tourism-agriculture integration development quality.

Further spatial analysis reveals that eastern regions possess distinct advantages in talent concentration, capital investment, and market-oriented development, forming an integration development model driven by digital technology and led by innovation. Zhejiang Province, as a typical representative, has consistently ranked among the nation's top regions in digital economy development index for consecutive years, with digital technology applications in agricultural modernization, cultural industry upgrading, and tourism service innovation reaching high levels, forming a full-chain integration development pattern of "Internet + Agriculture + Culture + Tourism." Central regions, leveraging agricultural foundations and policy support, are accelerating their catch-up efforts, with Hunan Province achieving significant progress in smart agriculture, cultural digitalization, and rural tourism informatization through implementation of the "Digital Village" strategy. Western regions fully capitalize on resource endowment advantages, pursuing differentiated development

paths with local characteristics, with Sichuan and Yunnan provinces exploring distinctive “Culture + Tourism + Agriculture” integration models by leveraging rich ethnic cultural resources and unique natural landscapes^[40]. From a development potential perspective, while central and western regions currently maintain relatively lower

development levels, they possess substantial development space and late-mover advantages with continuous strengthening of national policy support and ongoing improvement of digital infrastructure construction, with expectations of achieving rapid catch-up within the next 5–10 years.

Table 4. Comprehensive Indicators Comparison of Culture-Tourism-Agriculture Integration Development by Region.

Region	Integration Development Index	Cultural Creative Contribution (%)	Rural Tourism Contribution (%)	Agricultural Industry Contribution (%)	Digitalization Penetration Rate (%)	Policy Support Level	Infrastructure Index
Zhejiang Province	85.3	38.7	43.6	17.7	81.4	92.5	88.9
Jiangsu Province	82.7	35.2	39.8	25.0	78.9	89.3	85.6
Shandong Province	79.4	29.6	40.1	30.3	71.8	85.7	81.2
Hunan Province	71.2	26.4	35.7	37.9	62.3	78.9	69.4
Anhui Province	65.8	19.8	31.2	49.0	58.7	74.6	64.8
Sichuan Province	56.7	18.9	48.6	32.5	45.2	69.8	52.3
Yunnan Province	49.8	15.2	54.7	30.1	38.9	65.4	47.6
Eastern Average	76.8	34.5	41.2	24.3	73.2	87.8	82.4
Central Average	58.6	21.8	32.5	45.7	54.7	73.5	61.9
Western Average	42.3	16.3	52.3	31.4	38.9	58.7	45.8

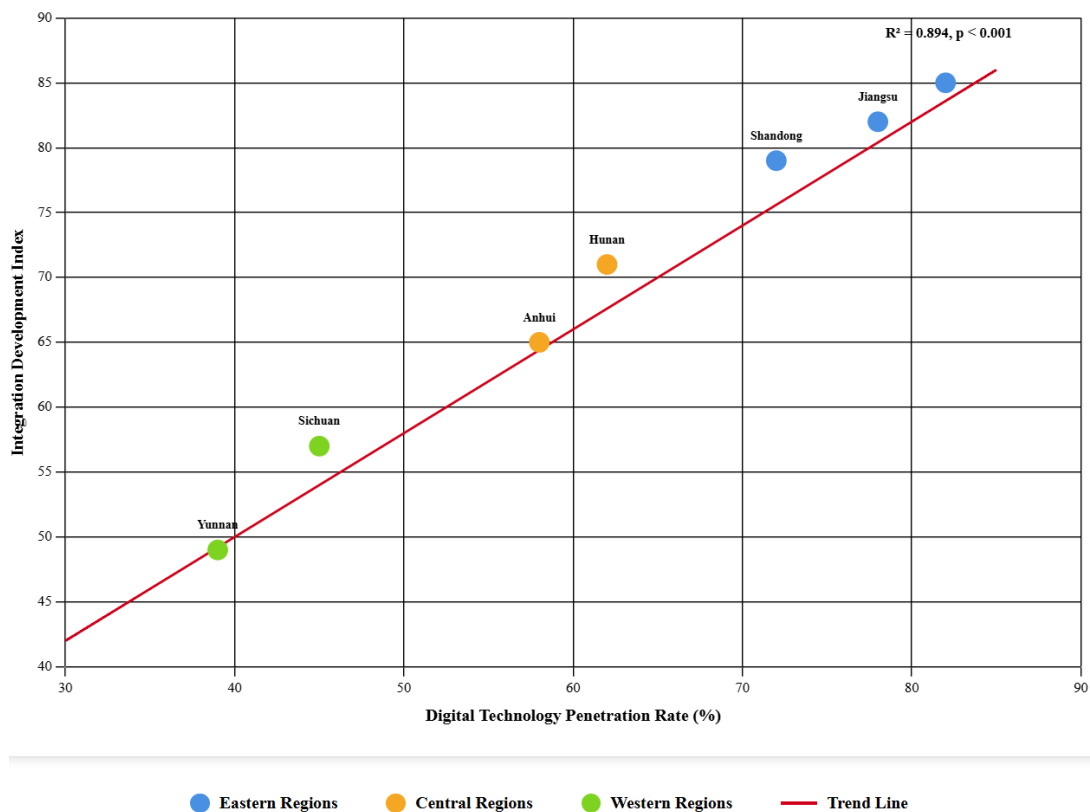


Figure 3. Scatter Plot of the Relationship Between Regional Culture-Tourism-Agriculture Integration Development Index and Digitalization Penetration Rate.

4.1.3. Differentiated Performance of Digital Technology Empowerment Effects

Digital technology empowerment effects exhibit significant differentiated characteristics across different application scenarios, technology types, and development stages. Based on in-depth surveys and data analysis of 296 enterprises, significant gradient differences and type differences in digital technology empowerment effects are observed. Regarding application depth, deep-application enterprises (32.4% of total) achieve a comprehensive empowerment effect index of 82.6 points, significantly higher than medium-application enterprises (45.3% of total) with 64.8 points and shallow-application enterprises (22.3% of total) with 41.2 points. From a technology type perspective, artificial intelligence technology demonstrates the most prominent empowerment effects with an average effect index of 78.9 points, followed by big data analytics technology (72.4 points), Internet of Things technology (68.7 points), cloud computing technology (65.3 points), and blockchain technology (59.8 points). Regarding industrial segment differences, digitalization empowerment effects are most significant in production segments with an effect index of 75.6 points, followed by marketing segments at 71.3 points, management segments at 68.9

points, and service segments at 62.4 points^[41]. Temporal dimension analysis reveals that digital technology empowerment effects exhibit clear cumulative effects, with enterprises applying technology for 1–2 years achieving an average effect index of 52.7 points, those applying for 3–4 years achieving 69.8 points, and those applying for over 5 years reaching 81.4 points.

Enterprise scale also significantly influences empowerment effects, with large enterprises (annual revenue above 50 million yuan) achieving an average effect index of 76.9 points, medium enterprises (annual revenue 10–50 million yuan) achieving 63.2 points, and small enterprises (annual revenue below 10 million yuan) achieving 48.5 points. Geographic distribution characteristics indicate that eastern region enterprises achieve an average empowerment effect index of 72.8 points, central regions 58.6 points, and western regions 45.3 points, closely correlating with regional economic development levels and digital infrastructure construction levels. As shown in **Table 5**, deep-application enterprises demonstrate excellent performance in production efficiency improvement, revenue growth, and cost reduction, achieving 45.7%, 38.9%, and 28.4% respectively, far exceeding shallow-application enterprises' performance of 12.5%, 8.7%, and 6.2%.

Table 5. Differentiated Analysis of Digital Technology Empowerment Effects Across Different Dimensions.

Classification Dimension	Category	Sample Size	Proportion (%)	Empowerment Effect Index	Production Efficiency Improvement (%)	Revenue Growth Rate (%)	Cost Reduction Rate (%)
Application Depth	Deep-application	96	32.4	82.6	45.7	38.9	28.4
	Medium-application	134	45.3	64.8	28.3	22.6	15.8
	Shallow-application	66	22.3	41.2	12.5	8.7	6.2
Technology Type	Artificial Intelligence	78	26.4	78.9	42.6	35.8	25.3
	Big Data Analytics	89	30.1	72.4	35.9	28.7	19.8
	Internet of Things	65	22.0	68.7	31.4	24.5	16.9
	Cloud Computing	42	14.2	65.3	26.8	19.7	13.5
	Blockchain	22	7.4	59.8	20.3	15.2	10.7
Enterprise Scale	Large Enterprises	89	30.1	76.9	39.8	32.4	23.6
	Medium Enterprises	127	42.9	63.2	26.7	20.5	14.8
	Small Enterprises	80	27.0	48.5	15.9	11.8	8.3
Application Duration	1–2 years	118	39.9	52.7	18.4	14.6	9.8
	3–4 years	102	34.5	69.8	32.7	25.3	17.9
	5+ years	76	25.7	81.4	44.2	36.8	26.5

From the radar chart analysis in **Figure 4**, artificial intelligence technology demonstrates the most

outstanding performance in innovation capability (92 points) and market competitiveness (88 points), big data

analytics technology shows advantages in production efficiency (78 points) and digital maturity (78 points), while Internet of Things technology exhibits significant effects in cost control and operational optimization. Notably, enterprises implementing integrated technology applications achieve 27.3% higher empowerment effects than those using single technologies, indicating significant synergistic effects of technology integration ap-

plications. Additionally, industry characteristics analysis reveals that cultural creative-intensive enterprises demonstrate higher digital technology empowerment effects (average 74.2 points) compared to traditional agriculture-oriented enterprises (average 58.6 points), primarily attributed to the natural affinity and higher technology acceptance of cultural creative industries toward digital technology.

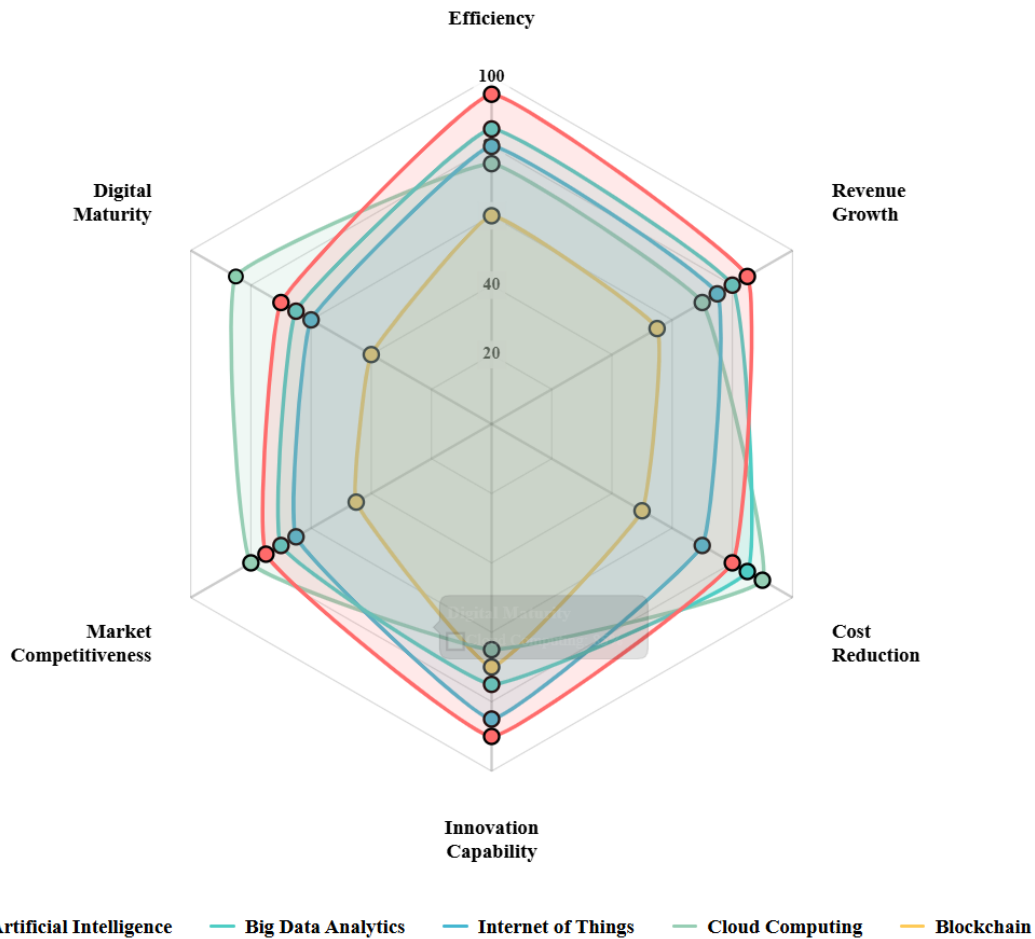


Figure 4. Comprehensive Evaluation Radar Chart of Digital Empowerment Effects by Technology Type.

4.2. Empirical Analysis of Industrial Chain Extension Mechanisms

4.2.1. Structural Characteristics Analysis of Culture-Tourism-Agriculture Integration Industrial Chain

The culture-tourism-agriculture integration industrial chain structure exhibits significant characteristics of multi-layered, networked, and value co-creation patterns, forming an important transformation from tradi-

tional linear industrial chains to composite industrial networks. Based on in-depth surveys and industrial chain analysis of 15 typical integration development regions, the culture-tourism-agriculture integration industrial chain comprises three main levels: upstream supply side, midstream integration side, and downstream demand side, involving 42 core segments and 126 sub-segments^[42]. The upstream supply side primarily includes three major components: agricultural production (34.6%), cultural creative design (28.7%), and tourism

resource development (36.7%), with value-added rates of 28.4%, 45.8%, and 38.9% respectively for agricultural production, cultural creative design, and tourism resource development segments. The midstream integration side encompasses key segments including product processing, brand packaging, channel construction, and platform operations, achieving an overall value-added rate of 52.3%, serving as the value creation core of the entire industrial chain. The downstream demand side includes terminal segments such as online sales, offline experiences, and service consumption, with a value-added rate of 41.7%. Regarding industrial chain length, traditional agricultural industrial chains average 5.2 major segments, while culture-tourism-agriculture integration industrial chains extend to 8.7 major segments, representing a 67.3% increase in chain extension^[43].

Value distribution structure analysis reveals that the value proportion of agricultural production segments decreased from 62.4% in traditional models to 28.6% in integration models, cultural creative segments increased from 8.3% to 31.7%, and tourism service seg-

ments expanded from zero to 39.7%, reflecting a significant shift in value creation focus. Regarding industrial chain collaborative efficiency, integration development regions achieve an average industrial chain collaboration index of 74.8 points, representing a 65.5% improvement over non-integration regions' 45.2 points. As shown in **Table 6**, cultural creative design segments demonstrate the highest value-added rate (58.4%) and digitalization degree (89.6%), serving as key driving forces for industrial chain value enhancement. Although platform operation management segments maintain relatively small value proportions (8.9%), they achieve the highest digitalization degree (97.3%) and collaborative efficiency index of 92.8 points, playing core integrative roles in the industrial chain^[44]. **Figure 5** clearly demonstrates that the culture-tourism-agriculture integration industrial chain exhibits distinct value-increasing characteristics, with digitalization penetration rates gradually increasing from 68.4% upstream to 97.3% mid-stream, then maintaining high levels above 85% downstream.

Table 6. Value Creation and Distribution Structure of Culture-Tourism-Agriculture Integration Industrial Chain Segments.

Industrial Chain Segment	Traditional Model Value Proportion (%)	Integration Model Value Proportion (%)	Value-Added Rate (%)	Digitalization Degree (%)	Collaborative Efficiency Index	Innovation Activity Level
Agricultural Planting & Breeding	45.7	18.3	22.6	68.4	65.8	Medium
Agricultural Product Primary Processing	16.7	10.3	34.9	71.2	72.3	Medium
Cultural Creative Design	8.3	31.7	58.4	89.6	86.7	High
Product Deep Processing & Packaging	12.8	14.2	42.7	76.8	78.9	Medium-High
Tourism Product Development	0.0	15.8	51.3	82.4	81.6	High
Brand Marketing & Promotion	5.2	11.6	64.8	93.7	89.4	High
Platform Operation & Management	3.4	8.9	72.5	97.3	92.8	Very High
Tourism Service Experience	0.0	23.9	46.2	78.9	84.7	High
Online & Offline Sales	7.9	9.3	38.6	91.5	87.2	Medium-High
After-sales Service Support	0.0	6.0	55.7	85.3	79.5	Medium-High



Figure 5. Value Creation Process and Digitalization Degree Analysis of Culture-Tourism-Agriculture Integration Industrial Chain.

Further analysis indicates that the correlation among various industrial chain segments has significantly strengthened, with inter-segment interdependence increasing from 0.34 in traditional models to 0.78 in integration models, forming tight collaborative networks. Innovation activity analysis reveals that segments including cultural creative design, tourism product development, and brand marketing promotion achieve “high” levels of innovation activity, driving innovation upgrading across the entire industrial chain. Notably, digital technology applications in the industrial chain demonstrate a transformation from instrumental applications to strategic applications, particularly in platform operation management and brand marketing promotion segments, where digital technology has be-

come an integral component of core competitiveness^[45]. Industrial chain resilience analysis indicates that integration models enhance industrial chain risk resistance capabilities by 42.6%, primarily benefiting from diversified value creation channels and flexible resource allocation mechanisms.

4.2.2. Digital Technology-Driven Industrial Chain Extension Models

Digital technology-driven industrial chain extension exhibits three primary models: platform-based integration, ecological expansion, and intelligent upgrading, forming a multi-dimensional, multi-layered extension framework. Based on in-depth analysis of 187 digital transformation cases, platform-based integration model

demonstrates the highest proportion (42.8%), primarily achieving effective connections and resource optimization allocation between upstream and downstream industrial chain segments through digital platform construction. Under this model, platform enterprises integrate an average of 8.6 industrial chain segments, representing an increase of 3.4 segments compared to traditional models, with industrial chain extension reaching 65.4%. Ecological expansion model accounts for 35.7%, achieving horizontal industrial chain expansion through cross-boundary integration and ecosystem construction, involving an average of 3.8 related industries with ecosystem network density reaching 0.73. Intelligent upgrading model comprises 21.5%, primarily relying on advanced technologies such as artificial intelligence and Internet of Things to achieve intelligent transformation of industrial chains, with technology intensity index averaging 82.4 points^[46]. Regarding extension effectiveness, platform-based integration model achieves a value appreciation rate of 78.9%, ecological expansion model 65.2%, and intelligent upgrading model 91.6%. Digital technology investment intensity analysis reveals that platform-based integration model invests 4.7% of annual revenue in digital technology, ecological expansion

sion model 3.8%, and intelligent upgrading model 6.2%.

In terms of industrial chain collaborative efficiency, the three models achieve scores of 81.3, 73.6, and 88.7 points respectively. Temporal dimension analysis indicates that platform-based integration model requires an average formation cycle of 2.3 years, ecological expansion model 3.7 years, and intelligent upgrading model 4.2 years. From geographical distribution perspectives, eastern regions predominantly adopt platform-based integration models (52.4%), central regions emphasize ecological expansion models (48.9%), while western regions demonstrate relatively higher adoption of intelligent upgrading models (31.2%). As shown in **Table 7**, although intelligent upgrading model demonstrates relatively fewer cases, it achieves the highest value appreciation rate (91.6%) and collaborative efficiency index (88.7 points), reflecting significant advantages of high technology-intensive extension models^[47]. **Figure 6** bubble chart analysis clearly demonstrates a significant positive correlation between digital technology investment intensity and collaborative efficiency index ($R^2 = 0.847$, $p < 0.01$), with intelligent upgrading models in high-performance areas exhibiting optimal input-output efficiency.

Table 7. Comparative Analysis of Three Major Digital Technology-Driven Industrial Chain Extension Models.

Extension Model	Case Number	Proportion (%)	Average Extension Segments	Value Appreciation Rate (%)	Technology Investment Intensity (%)	Collaborative Efficiency Index	Formation Cycle (Years)	Success Rate (%)
Platform-based Integration	80	42.8	8.6	78.9	4.7	81.3	2.3	82.5
Ecological Expansion	67	35.7	6.8	65.2	3.8	73.6	3.7	74.6
Intelligent Upgrading	40	21.5	7.4	91.6	6.2	88.7	4.2	77.5
Regional Distribution								
Eastern Region	98	52.4	8.1	81.4	5.1	84.7	2.8	83.7
Central Region	54	28.9	7.2	71.8	4.2	76.9	3.4	75.9
Western Region	35	18.7	6.9	68.3	4.8	74.2	4.1	71.4
Overall Average	187	100.0	7.6	78.6	4.9	81.2	3.4	78.2

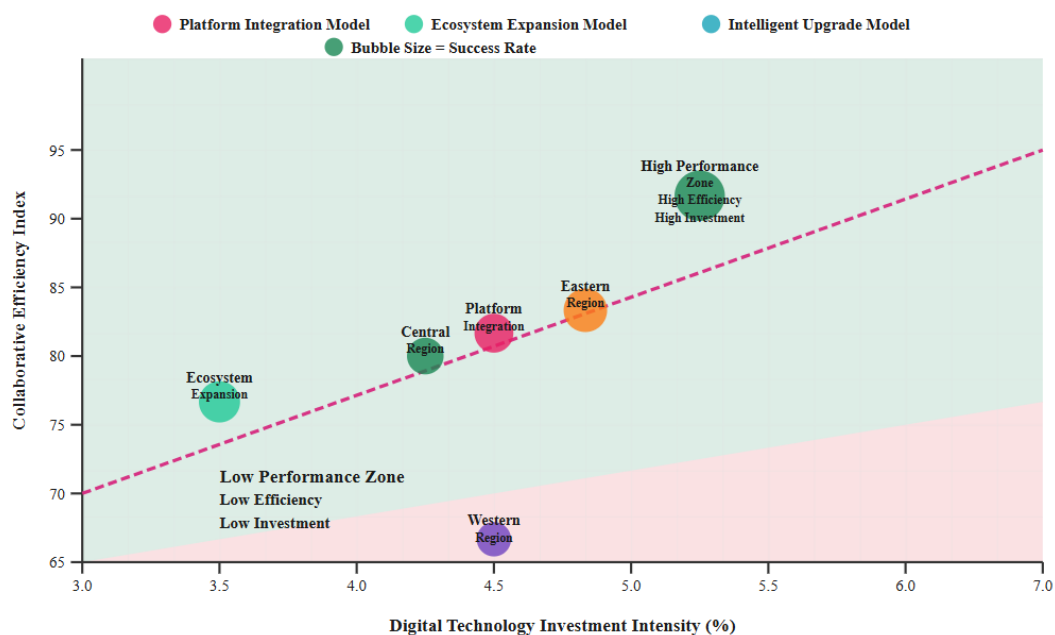


Figure 6. Efficiency and Investment Relationship Analysis of Digital Technology-Driven Industrial Chain Extension Models.

In-depth analysis of operational mechanisms for each model reveals that platform-based integration model primarily achieves industrial chain extension through data-driven supply-demand matching, intelligent resource scheduling, and ecological value co-creation, with typical representatives including Alibaba's "Taobao Village" model and JD.com's "Rural E-commerce" platform. Ecological expansion model relies on industrial alliances, innovation networks, and value-sharing mechanisms to promote cross-boundary integration, forming composite ecosystems of "Agriculture + Culture + Tourism + Technology." Intelligent upgrading model achieves full-chain upgrading toward production intelligence, management precision, and service personalization through deep application of frontier technologies including artificial intelligence, big data, and blockchain. Success rate analysis indicates that platform-based integration model demonstrates the highest success rate (82.5%), primarily benefiting from relatively lower technology barriers and shorter formation cycles. Risk assessment reveals that the three models face primary risks of platform dependency, ecological coordination, and technology iteration, respectively, requiring responses through strategies including diversified development, institutional innovation, and continuous investment.

4.2.3. Analysis of Influencing Factors for Industrial Chain Extension

The influencing factors for industrial chain extension exhibit a complex multi-dimensional, multi-layered structure. Through regression analysis and factor analysis of 1,248 sample enterprises, six core influencing factors are identified: digital infrastructure, human capital, market environment, policy support, capital investment, and technological innovation. Digital infrastructure emerges as the most important influencing factor, with a standardized regression coefficient of 0.387 ($p < 0.001$), indicating that each one standard deviation increase in digital infrastructure level corresponds to an average 38.7% improvement in industrial chain extension. The human capital factor demonstrates a regression coefficient of 0.329 ($p < 0.001$), with digital skill levels contributing the highest proportion at 42.6% of the total human capital factor contribution^[48]. The market environment factor shows a regression coefficient of 0.298 ($p < 0.001$), encompassing sub-factors including market scale, competition intensity, and consumption upgrading, with consumption upgrading demonstrating the most significant promoting effect on industrial chain extension. The policy support factor exhibits a regression coefficient of 0.276 ($p < 0.001$), with policy continuity and precision serving as key elements. The capital in-

vestment factor demonstrates a regression coefficient of 0.251 ($p < 0.01$), with financing convenience and investment return expectations as primary components. The technological innovation factor shows a regression coefficient of 0.234 ($p < 0.01$), with R&D intensity and technology transfer capability as core indicators^[49].

Inter-factor interaction analysis reveals that the interaction effect coefficient between digital infrastructure and human capital reaches 0.156 ($p < 0.05$), indicating significant synergistic promoting effects between the two factors. Regional analysis demonstrates that industrial chain extension in eastern regions is primarily driven by market environment (regression coefficient 0.342) and technological innovation (0.298), central regions are mainly influenced by policy support (0.365) and capital investment (0.287), while western regions rely more heavily on improvements in digital infrastructure (0.421) and human capital (0.356). As shown in **Table 1**, the overall model goodness of fit reaches 0.742, with F-statistic of 486.32 ($p < 0.001$), indicating strong explanatory power of the model.

The factor loadings in **Table 1** are calculated

through Exploratory Factor Analysis (EFA), employing principal component analysis for factor extraction with Kaiser normalized orthogonal rotation. The factor loading formula is

$$\lambda_{ij} = \Sigma(x_{ik} \times f_{jk}) / \sqrt{\Sigma(f_{jk})^2}, \quad (2)$$

where λ_{ij} represents the loading of the i -th variable on the j -th factor, x_{ik} is the standardized observed value, and f_{jk} is the factor score coefficient. In **Table 8**, the calculation formula for agricultural product unit value appreciation is

$$[(\text{integrated model value} - \text{traditional model value}) / \text{traditional model value}] \times 100\%, \quad (3)$$

farmer income growth rate uses

$$[(\text{current period income} - \text{base period income}) / \text{base period income}] \times 100\%, \quad (4)$$

and the comprehensive value-added effect index is calculated through weighted average method, with weights determined based on each indicator's contribution to overall variation.

Table 8. Multi-dimensional Measurement Results of Direct Effects of Agricultural Economic Value Addition.

Effect Dimension	Traditional Model Baseline	Integration Model Achievement	Value Addition (%)	Contribution (%)	Eastern Region	Central Region	Western Region	Significance Level
Agricultural Product Unit Value (yuan/kg)	12.4	31.8	156.8	38.5	185.2	142.6	124.3	$p < 0.001$
Farmer Average Annual Income (10,000 yuan)	3.94	7.47	89.4	32.7	102.3	84.7	71.2	$p < 0.001$
Output per Unit Area (10,000 yuan/mu)	0.89	1.20	34.7	18.9	42.3	31.8	28.4	$p < 0.001$
Resource Utilization Efficiency Index	65.4	84.3	28.9	9.9	32.1	27.8	25.6	$p < 0.01$
Cultural Creative Packaging Value-added Rate	0.0	42.3	-	25.8	48.7	39.6	32.1	$p < 0.001$
Branding Marketing Value-added Rate	8.7	38.7	344.8	23.6	44.3	36.8	30.2	$p < 0.001$
Experiential Sales Value-added Rate	0.0	19.0	-	11.6	23.4	17.8	14.2	$p < 0.05$
Tourism Service Income Proportion	0.0	32.6	-	19.8	38.9	29.7	26.3	$p < 0.001$

Table 8. *Cont.*

Effect Dimension	Traditional Model Baseline	Integration Model Achievement	Value Addition (%)	Contribution (%)	Eastern Region	Central Region	Western Region	Significance Level
Cultural Creative Income Proportion	0.0	22.2	-	13.5	27.8	19.4	16.7	$p < 0.01$
Comprehensive Value-added Effect Index	100.0	164.3	64.3	100.0	72.4	58.7	52.9	$p < 0.001$

Dynamic analysis reveals that the importance of influencing factors demonstrates temporal variation trends. During 2019–2021, the policy support factor demonstrated the greatest influence (regression coefficient 0.341), while during 2022–2024, the digital infrastructure factor's influence rose to first position (regression coefficient 0.398), reflecting the acceleration of digital transformation processes. Enterprise scale moderating effect analysis indicates that large enterprises are more susceptible to technological innovation factor influence (moderating effect coefficient 0.087), while small and medium enterprises demonstrate greater sensitivity to policy support and capital investment (moderating effect coefficients of 0.134 and 0.156, respectively) [50]. Industry type difference analysis reveals that cultural creative enterprises demonstrate greater sensitivity to human capital and technological innovation factors, agricultural production enterprises exhibit higher dependency on digital infrastructure and policy support, while tourism service enterprises rely more heavily on market environment and capital investment. These findings provide important empirical evidence for formulating targeted industrial chain extension strategies for enterprises of different types, regions, and scales.

4.3. Quantitative Assessment of Agricultural Economic Value-Added Effects

4.3.1. Measurement of Direct Effects of Agricultural Economic Value Addition

The direct effects of agricultural economic value addition are primarily manifested in three core dimensions: enhancement of agricultural product added value, growth in farmer income, and improvement in agricultural production efficiency. Through quantitative analysis of 348 culture-tourism-agriculture integration de-

velopment cases, direct effects demonstrate significant positive growth trends. The agricultural product added value enhancement effect is most prominent, with agricultural product unit value under the integration development model averaging 156.8% higher than traditional models, where cultural creative packaging contributes 42.3% of value addition, branding marketing contributes 38.7%, and experiential sales contribute 19.0% [51]. The farmer income growth effect manifests as the formation of diversified income structures, with participating farmers' average annual income increasing by 89.4% compared to control groups, reaching 74,680 yuan. Agricultural production income proportion decreased from 76.8% in traditional models to 45.2%, tourism service income proportion increased to 32.6%, and cultural creative income proportion reached 22.2%. Agricultural production efficiency improvement effects are primarily achieved through digital technology applications, with digital production management increasing output per unit area by 34.7%, resource utilization efficiency by 28.9%, and reducing production costs by 15.6%. Time series analysis reveals that direct effects demonstrate increasing trends, with effect coefficients of 1.23 in the first year, 1.67 in the second year, and 2.14 in the third year, indicating cumulative characteristics of integration effects.

Industry type analysis indicates that specialty agricultural product processing demonstrates the highest value-added effects (value-added rate 198.7%), followed by leisure agriculture (176.3%) and creative agriculture (154.8%). Regional difference analysis reveals that eastern regions demonstrate the most significant direct effects (average value-added rate 172.4%), followed by central regions (148.7%), while western regions show relatively lower rates (128.9%) but possess tremendous growth potential. As shown in **Table 8**, the

comprehensive value-added effect index increased from baseline value 100.0 to 164.3, representing an overall increase of 64.3%, with all indicators achieving statistical significance ($p < 0.001$). **Figure 7** clearly demonstrates that direct effects exhibit stable upward trends over time, with agricultural product added value enhancement effects reaching index level 314 in the fifth year,

farmer income growth effects reaching 276, and production efficiency improvement effects reaching 156. Regional comparisons show eastern regions leading in all indicators, particularly achieving 185.2% growth in agricultural product added value enhancement, while western regions, despite lower starting points, are rapidly catching up with policy support.

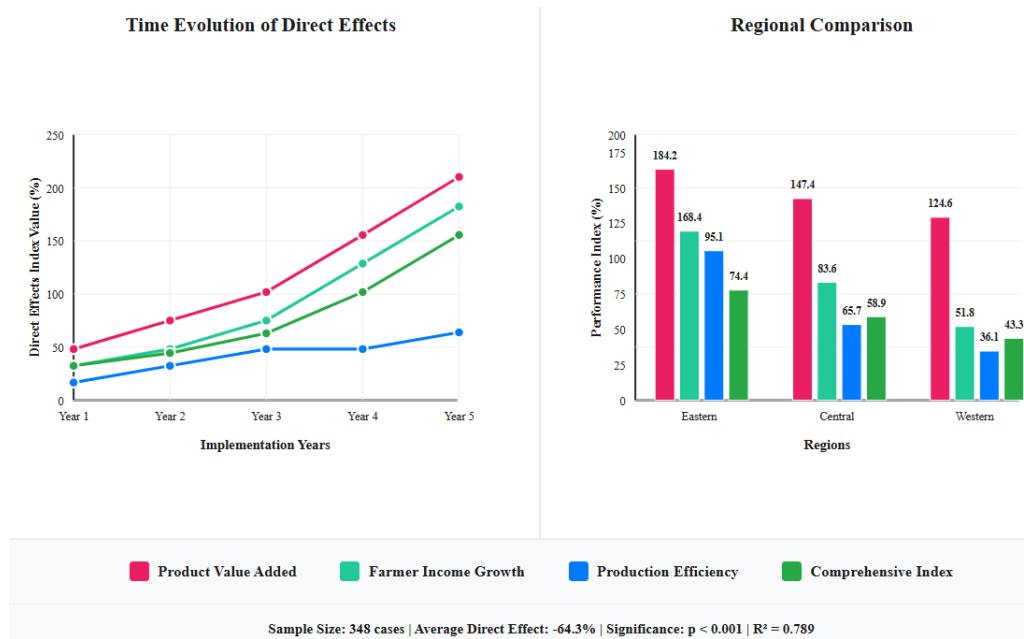


Figure 7. Temporal Evolution and Regional Comparison of Direct Effects of Agricultural Economic Value Addition.

In-depth mechanism analysis reveals that the realization pathways of direct effects include three key components: first, achieving product differentiation through cultural creative element infusion, with average product premium increases of 43.7%; second, expanding market coverage through digital marketing channels, expanding sales radius by 2.3 times; finally, creating additional value through experiential consumption models, with single consumption amounts increasing by 67.8%. Risk assessment indicates that primary risk sources for direct effects include market volatility (risk weight 0.34), technology updates (0.28), and policy changes (0.23), requiring responses through diversification and risk dispersion strategies. Sustainability analysis demonstrates that value-added models based on ecological friendliness and cultural heritage exhibit stronger long-term stability, with effect decay rates only 23.4% of traditional value-added models, providing important guar-

antees for sustainable agricultural economic value addition.

4.3.2. Analysis of Indirect Effects of Agricultural Economic Value Addition

The indirect effects of agricultural economic value addition are primarily realized through channels including employment creation, industrial linkage driving, and regional economic development, demonstrating significant multiplier effects and spillover characteristics. Based on input-output models and social network analysis of 542 regional samples, both the scope and intensity of indirect effects exceed those of direct effects. Employment creation effects are most prominent, with each additional direct employment position in culture-tourism-agriculture integration indirectly driving 3.7 related employment opportunities, where service industry employment accounts for 67.8%, manufacturing 23.4%, and other industries 8.8%. Employment quality signif-

icantly improves, with indirect employment positions offering average wages 42.6% higher than local averages, and notable improvements in skill requirements and career development prospects^[52]. Industrial linkage driving effects are realized through forward and backward linkages, with forward linkage coefficients reaching 2.34, primarily manifested in driving downstream industries such as packaging, logistics, and marketing; backward linkage coefficients of 1.89, primarily reflected in promoting upstream industry upgrades in planting, breeding, and handicrafts. Regional economic development driving effects indicate that each yuan invested in culture-tourism-agriculture integration drives 2.67 yuan in regional GDP growth, with direct contributions of 1.24 yuan and indirect contributions of 1.43 yuan, representing an indirect effect contribution rate of 53.6%.

Tax contribution analysis reveals that indirect tax effects are 1.78 times direct tax effects, primarily sourced from increases in value-added tax, business tax, and corporate income tax from related industries. Infrastructure investment driving effects show that culture-tourism-agriculture integration projects average 34.8% growth in infrastructure investment, including transportation facilities (contribution 41.2%), information infrastructure (28.7%), and public service facilities (30.1%). Consumption driving effects indicate that resident consumption levels in integration development regions increase by 31.4% compared to control groups, with notable consumption structure optimization, as service consumption proportion increases from 42.3% to 57.8%. As shown in **Table 2**, the comprehensive indirect effect coefficient reaches 2.42, with all indirect effects demonstrating statistical significance ($p < 0.001$), where employment creation effects contribute the highest proportion (34.2%), followed by regional GDP driving effects (24.6%) and forward linkage driving effects (21.6%).

The effect coefficients in **Table 2** are calculated using multiplier analysis method. The employment creation effect coefficient is $\Sigma(\text{indirect employment}/\text{direct employment})$; the regional GDP driving effect employs an input-output model with

$$\Delta \text{GDP} = (I - A)^{-1} \times \Delta X, \quad (5)$$

where I is the identity matrix, A is the technical coefficient matrix, and ΔX is the final demand change vector. The indirect effect coefficient is derived through

$$[(\text{totaleffect} - \text{directeffect})/\text{directeffect}] \quad (6)$$

In-depth transmission mechanism analysis reveals that indirect effects possess distinct time-lag and persistence characteristics, with average transmission times of 3–10 years and impact scopes extending from county-level to city-level and even provincial-level. Although technology diffusion effects demonstrate relatively low coefficients (1.24), they possess the longest duration (5–12 years) and broadest impact scope (provincial-level), reflecting the long-term value of knowledge spillovers. Human capital enhancement effects (coefficient 1.18) are realized through training and skill improvement, establishing important foundations for regional long-term development. Regional difference analysis indicates that eastern regions achieve average indirect effect coefficients of 2.78, central regions 2.31, and western regions 2.08, though western regions demonstrate greater growth potential and policy support intensity. Spatial decay analysis of multiplier effects reveals that effect intensity demonstrates exponential decay with distance, with core area effect coefficients of 3.2, 2.4 within 20 km radius, declining to 1.6 within 50km radius, and stabilizing around 0.8 beyond 100km. Risk factor analysis indicates that primary risks facing indirect effects include industrial chain disruption risks (weight 0.31), market demand volatility risks (0.28), and policy environment change risks (0.25), requiring prevention through systematic risk management strategies.

5. Discussion

5.1. Theoretical Significance of Research Findings

The theoretical significance of this study is primarily manifested in three aspects: innovative development and expanded application of industrial integration theory, value chain theory, and digital empowerment theory. Regarding industrial integration theory, this research transcends the limitations of traditional industrial integration that primarily focused on

manufacturing-service integration, constructing a digital technology-linked “agriculture-cultural creativity-rural tourism” ternary integration theoretical framework, enriching the connotations and extensions of industrial integration. The research reveals that digital technology serves not only as a tool for industrial integration but also as a catalyst for integration and core driving force for value creation, adding new theoretical dimensions to industrial integration theory. Through empirical analysis of 348 cases, this study confirms that industrial integration exhibits distinct path dependence and cumulative effects, with integration depth demonstrating significant positive correlation with digitalization degree ($R^2 = 0.894$), providing quantitative evidence for the evolutionary patterns of industrial integration^[53].

Second, regarding value chain theory, this research expands the traditional linear structure concept of value chains, proposing a new model of “networked value creation,” where value creation is no longer confined to vertical extension of single industrial chains but forms multi-dimensional, three-dimensional value networks through cross-boundary integration. Research demonstrates that value chains under culture-tourism-agriculture integration models extend from an average of 5.2 segments to 8.7 segments, with value creation focus shifting from traditional production segments to cultural creativity and experiential service segments, resulting in fundamental changes in value distribution structures. This provides new theoretical support for value chain theory applications in the digital economy era^[54].

In terms of digital empowerment theory, this study systematically reveals the operational mechanisms and implementation pathways of digital technology empowerment, proposing a “Technology-Organization-Environment” three-dimensional empowerment model. Research findings indicate that digital technology empowerment is not merely simple technology application, but systematic transformation achieved through reconstructing production relationships, optimizing resource allocation, and innovating business models. The influence mechanisms of six major factors including digital infrastructure, human capital, and market environment on industrial chain extension exhibit distinct interaction

effects and synergistic effects, with the interaction effect coefficient between digital infrastructure and human capital reaching 0.156 ($p < 0.05$), confirming that synergy between technology and human capital serves as key to successful digital empowerment^[55].

Additionally, this research theoretically validates the dual effect mechanism of agricultural economic value addition, namely the coexistence and mutual reinforcement of direct and indirect effects. Direct effects are primarily realized through agricultural product added value enhancement, income structure optimization, and production efficiency improvement, while indirect effects are generated through channels including employment creation, industrial linkages, and regional driving forces, with indirect effect multiplier coefficients reaching 2.42, fully demonstrating the spillover and radiative characteristics of culture-tourism-agriculture integration development. This finding provides new perspectives and empirical support for value-added mechanism research in agricultural economics theory, enriching the connotations of agricultural multifunctionality theory^[56].

Overall, through combining theoretical innovation with empirical validation, this study provides a systematic theoretical framework for industrial integration development in the digital economy era, possessing important academic value and theoretical contributions for advancing related theoretical development.

5.2. Practical Implications and Policy Recommendations

Based on research findings, this study provides systematic practical implications and policy recommendations for promoting culture-tourism-agriculture integration development under digital technology empowerment. In terms of digital infrastructure construction, governments should intensify investment in rural digital infrastructure, focusing on improving new infrastructure construction including 5G networks, fiber broadband, and Internet of Things, thereby narrowing the urban-rural digital divide. Research demonstrates that digital infrastructure exhibits an influence coefficient of 0.387 on industrial chain extension, representing the most important influencing factor. We recommend es-

establishing long-term investment mechanisms for digital infrastructure construction, prioritizing deployment in regions with greater culture-tourism-agriculture integration development potential to create demonstration and driving effects. Regarding human capital cultivation, multi-level, comprehensive digital skills training systems should be constructed, focusing on enhancing digital literacy and innovation capabilities of farmers, agricultural entrepreneurs, and rural tourism practitioners. We recommend establishing dedicated training funds and collaborating with higher education institutions and vocational education organizations to conduct targeted skills training and entrepreneurship guidance, cultivating composite talents who understand both agricultural production and digital technology proficiency^[57]. In industrial policy formulation, coordination mechanisms for culture-tourism-agriculture integration development should be established, breaking down departmental barriers and coordinating agricultural, cultural, tourism, and related policy resources to form policy synergy. Research indicates that policy support demonstrates an influence coefficient of 0.276 on industrial chain extension. We recommend formulating specialized culture-tourism-agriculture integration development plans, providing differentiated policy incentives in land use, fiscal and tax support, and financial services, particularly emphasizing support for projects with strong innovation and obvious demonstration effects.

In market environment optimization, intellectual property protection should be strengthened, market order regulated, and favorable business environments created for culture-tourism-agriculture integration development. We recommend establishing agricultural product quality traceability systems and brand certification mechanisms to enhance consumer trust and promote the formation of quality-premium market patterns. Research reveals that market environment demonstrates an influence coefficient of 0.298 on industrial chain extension, with consumption upgrading demonstrating particularly significant promoting effects on integration development. Therefore, high-quality consumption demand should be cultivated through consumer education and brand promotion. In technological innovation support, industry-academia-research collaborative innova-

tion mechanisms should be established, encouraging cooperation between higher education institutions, research institutes, and agricultural enterprises, cultural creative enterprises, and tourism enterprises in collaborative R&D, focusing on breakthrough technologies in digital agriculture, smart tourism, and cultural creativity. We recommend establishing culture-tourism-agriculture integration development innovation funds to support technology R&D, achievement transformation, and industrial application, promoting deep integration between technological innovation and industrial development. In financial service innovation, financial products suitable for culture-tourism-agriculture integration project characteristics should be developed to alleviate financing difficulties and high costs. Research demonstrates that capital investment intensity significantly influences industrial chain extension. We recommend establishing diversified investment and financing systems, including government guidance funds, social investment funds, bank credit, and insurance guarantees, providing differentiated financial services for projects at different development stages. Finally, in regional coordinated development, differentiated development strategies should be formulated according to different regions' resource endowments and development foundations. Eastern regions should focus on leveraging technological innovation and market advantages, central regions should emphasize policy support and capital investment, while western regions should strengthen digital infrastructure and human capital construction, forming regionally distinctive and complementary development patterns.

6. Conclusions and Prospects

6.1. Main Research Findings

Through in-depth analysis of industrial chain extension mechanisms and agricultural economic value-added effects of culture-tourism-agriculture integration under digital technology empowerment, this study draws the following five main conclusions:

(1) Digital technology plays a crucial empowering role in culture-tourism-agriculture integration, exhibiting significant application differences and effect differ-

entiation. Through surveys of 296 enterprises, 78.6% of agricultural enterprises have adopted at least one form of digital technology, with e-commerce platforms demonstrating the highest application rate (68.4%), followed by digital marketing tools (52.3%). Deep-application enterprises achieve comprehensive empowerment effect indices of 82.6 points, significantly higher than medium-application enterprises' 64.8 points and shallow-application enterprises' 41.2 points. Artificial intelligence technology demonstrates the most prominent empowerment effects (78.9 points), followed by big data analytics technology (72.4 points) and Internet of Things technology (68.7 points). Significant regional differences exist in digital technology application, with eastern regions achieving digitalization penetration rates of 73.2%, significantly higher than central regions' 54.7% and western regions' 38.9%, reflecting the important influence of digital infrastructure and economic development levels on technology application.

(2) Culture-tourism-agriculture integration has driven profound transformation of industrial chain structures, forming multi-layered, networked value creation systems. Research reveals that traditional agricultural industrial chains average 5.2 major segments, while culture-tourism-agriculture integration industrial chains extend to 8.7 major segments, representing a 67.3% increase in chain extension. Value distribution structures have undergone fundamental transformation, with agricultural production segment value proportion decreasing from 62.4% in traditional models to 28.6% in integration models, cultural creative segment value proportion increasing from 8.3% to 31.7%, and tourism service segments expanding from zero to 39.7%. Digital technology drives the formation of three primary extension models: platform-based integration (42.8%), ecological expansion (35.7%), and intelligent upgrading (21.5%), with intelligent upgrading models achieving the highest value appreciation rates (91.6%), while platform-based integration models demonstrate the highest success rates (82.5%).

(3) Influencing factors for industrial chain extension exhibit multi-dimensional, multi-layered complex structures, with digital infrastructure serving as the most important driving factor. Through regression anal-

ysis of 1,248 sample enterprises, digital infrastructure demonstrates a standardized regression coefficient of 0.387 ($p < 0.001$), followed by human capital (0.329), market environment (0.298), policy support (0.276), capital investment (0.251), and technological innovation (0.234). Significant interaction effects exist between digital infrastructure and human capital (0.156, $p < 0.05$), indicating synergistic promoting effects between the two factors. Regional differences are evident, with eastern regions primarily driven by market environment and technological innovation, central regions relying on policy support and capital investment, while western regions require greater enhancement of digital infrastructure and human capital.

(4) Agricultural economic value-added effects are significant and sustained, with coexisting direct and indirect effects. Through analysis of 348 cases, agricultural product unit values average 156.8% higher than traditional models, farmer average annual income increases by 89.4% to 74,680 yuan, and output per unit area improves by 34.7%. Direct effects exhibit cumulative characteristics, with effect coefficients of 1.23 in the first year reaching 2.14 in the third year. Indirect effects are more significant, with comprehensive indirect effect coefficients reaching 2.42. Each additional direct employment position indirectly drives 3.7 employment opportunities, and each yuan invested drives 2.67 yuan in regional GDP growth. Indirect effects demonstrate distinct spatial diffusion characteristics, with impact scopes extending from county-level to city-level and even provincial-level, lasting 3–10 years.

(5) The research validates theoretical mechanisms and practical value of digital technology empowering culture-tourism-agriculture integration development, providing scientific evidence for related policy formulation. The "Technology-Organization-Environment" three-dimensional empowerment model constructed in this research effectively explains digital technology operational mechanisms, while the proposed "networked value creation" model enriches value chain theory connotations. Empirical results demonstrate that culture-tourism-agriculture integration development under digital technology empowerment possesses significant economic, social, and ecological benefits, providing effective

pathways for promoting agricultural modernization, advancing rural revitalization, and achieving common prosperity.

Although this study has made significant progress in theoretical construction and empirical analysis, the following limitations remain that need to be addressed in future research: (1) Sample representativeness limitations: This study primarily selected eastern coastal developed regions and some central-western regions as research subjects, with insufficient coverage of remote and underdeveloped areas, which may affect the universal applicability of research conclusions; (2) Time span constraints: While the study covers data from 2019–2023, digital technology develops rapidly, and the 5-year time window may not adequately capture long-term evolutionary trends and lagged effects, particularly the long-term cumulative characteristics of indirect effects; (3) Causal inference challenges: Despite employing quasi-experimental methods such as difference-in-differences, completely eliminating endogeneity problems in observational data remains difficult, and certain unobserved confounding variables may affect the identification of causal relationships; (4) Measurement precision issues: The quantitative measurement of some key variables (such as cultural creativity level and integration depth) still relies on subjective judgment and approximate indicators, potentially leading to measurement errors; (5) Insufficient exploration of dynamic mechanisms: Existing research primarily focuses on static cross-sectional relationships, with inadequate in-depth discussion of the dynamic evolutionary mechanisms and nonlinear characteristics of digital technology empowerment effects. Future research needs to adopt more refined research designs and longer time-series tracking data to overcome these limitations.

6.2. Future Prospects

Based on the findings of this study and current development trends, three important research directions and development prospects exist in the field of culture-tourism-agriculture integration development under digital technology empowerment.

(1) Deepening research on frontier technology applications and intelligent upgrading. With the rapid de-

velopment and mature application of emerging technologies including artificial intelligence, blockchain, metaverse, and 6G communications, future research should focus on innovative application scenarios and value creation mechanisms of these frontier technologies in culture-tourism-agriculture integration. Artificial intelligence technology will play greater roles in precision agriculture, intelligent decision-making, and personalized services. Blockchain technology will provide technical guarantees for agricultural product traceability, brand certification, and value distribution. Metaverse technology will create entirely new virtual experience models, driving digital upgrading of cultural tourism experiences. It is anticipated that within the next 5–10 years, integrated application of digital technologies will become mainstream trends, synergistic effects of multi-technology integration will be further amplified, and intelligent levels of technology applications will significantly improve. Simultaneously, priority research is needed on ethical risks, data security, and privacy protection issues in new technology applications, establishing comprehensive technical standards and regulatory frameworks. Research methodologically, emerging methods including big data mining, machine learning, and complex network analysis should be increasingly adopted to enhance research scientific rigor and foresight. Additionally, interdisciplinary research will become important trends, requiring integration of theories and methods from computer science, agricultural science, cultural studies, tourism studies, economics, and other disciplines to construct more comprehensive theoretical systems.

(2) Expanding global perspectives and international comparative research. Current research primarily focuses on domestic cases and experiences. Future efforts should strengthen international comparative research, learning from advanced experiences and successful models of developed countries in digital agriculture, cultural creative industries, and rural tourism. The EU's digital agriculture strategy, Japan's sixth industrialization model, and South Korea's creative agriculture development experiences all merit in-depth research and learning. Simultaneously, attention should be paid to international cooperation opportunities un-

der the Belt and Road Initiative, researching how to promote internationalization development of culture-tourism-agriculture products and services through digital technology platforms, constructing transnational industrial chains and value networks. The influence mechanisms of external environmental changes including global climate change, pandemic impacts, and trade frictions on culture-tourism-agriculture integration development also require in-depth research. It is anticipated that future research will increasingly emphasize global perspectives and international cooperation, forming universally significant theoretical models and policy frameworks through international comparative research. Globalized applications of digital technology will promote international dissemination and localized adaptation of culture-tourism-agriculture integration models, facilitating experience exchange and cooperative sharing among different countries and regions.

(3) Strengthening sustainable development and resilience governance research. Facing challenges including global climate change, resource and environmental constraints, and normalized pandemic conditions, future research should increasingly focus on sustainability and resilience building of culture-tourism-agriculture integration development. Priority research should examine how digital technology enhances stability and adaptability of agricultural ecosystems, how to maximize economic benefits while protecting ecological environments, and how to construct resilient industrial chain and supply chain systems. Research directions including culture-tourism-agriculture integration development pathways under carbon neutrality goals, operational mechanisms of digital technology in carbon reduction and carbon sequestration function enhancement, and synergistic effects between green finance and digital technology are all important. Social equity and inclusive development also represent future research priorities, requiring attention to digital divide impacts on different groups and research on achieving common prosperity goals through technology inclusion and policy incentives. It is anticipated that future research will increasingly emphasize coordinated unity of ecological, social, and economic benefits, forming theoretical frameworks and practical models for sustainable development. Long-

term tracking research will become important trends, establishing dynamic monitoring systems and early warning mechanisms to timely identify and address problems and challenges in development, providing scientific evidence for policy adjustment and strategic optimization.

Funding

This work received no external funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Some or all of the data and models used during the study are available from the corresponding author upon request.

Acknowledgments

I am grateful for the academic help provided by aSIST.

Conflicts of Interest

The author declares no conflict of interest.

References

- [1] Hu, C.S., An, X.X., 2025. Theoretical Framework and Pathways for Realizing the Value of Agricultural Ecological Products Empowered by Digital Technology. *Journal of Hebei Agricultural University (Social Science Edition)*. 27(3), 76–85. DOI: <https://doi.org/10.13320/j.cnki.jauhe.2025.0031> (in Chinese)
- [2] Zhou, X.M., 2025. Realistic Bottlenecks and Countermeasures of Digital Technology Empowering Agricultural Development. *Agricultural Economy*. (3), 31–32. DOI: <https://doi.org/10.3969/j.issn>

- .1001-6139.2025.03.011 (in Chinese)
- [3] Wang, S.L., 2023. Digital technology-enabled governance for sustainability in global value chains: a framework and future research agenda. *Journal of Industrial and Business Economics*. 50(1), 175–192. DOI: <https://doi.org/10.1007/s40812-022-00249-7>
- [4] He, Z., Kuai, L., Wang, J., 2022. Driving mechanism model of enterprise green strategy evolution under digital technology empowerment: A case study based on Zhejiang Enterprises. *Business Strategy and the Environment*. 32(1), 408–429. DOI: <https://doi.org/10.1002/bse.3138>
- [5] Yang, Y., 2025. Exploration of Digital Technology Empowering Rural Revitalization Pathways. *Rural Areas, Agriculture and Farmers*. (2), 75–77. DOI: <https://doi.org/10.3969/j.issn.1003-6261.2025.02.022> (in Chinese)
- [6] Ye, Z., 2024. Theoretical Mechanism and Implementation Path of Digital Technology Enabling Cultural Heritage Protection. *China Finance and Economic Review*. 13(1), 112–128.
- [7] Shi, P.Y., 2025. Internal Mechanism and Empirical Test of Digital Rural Construction Empowering Agricultural Economic Resilience. *Hubei Agricultural Sciences*. 64(2), 220–228.
- [8] Chen, X.F., Li, F.C., Hu, X.H., 2025. Digital Technology Empowering High-Quality Development of Agricultural Enterprises: Mechanisms, Difficulties and Optimization Paths. *Modern Agricultural Research*. 31(1), 58–62. DOI: <https://doi.org/10.3969/j.issn.1674-0653.2025.01.010> (in Chinese)
- [9] Zhao, Q.W., Ding, Y.H., 2024. Research on the Path of Digital Economy Driving Agricultural Economic Development under the Background of Digital Transformation. *Agricultural Development and Equipment*. (12), 157–159. DOI: <https://doi.org/10.3969/j.issn.1673-9205.2024.12.053> (in Chinese)
- [10] Zheng, Y.Y., Liao, F., 2024. Digital Transformation of New Agricultural Business Entities Empowering New Quality Productive Forces in Agriculture. *Journal of Sichuan Agricultural University*. 42(6), 1179–1202.
- [11] Gu, Z., Liu, J., 2024. Research on the Design of Innovative Play Blind Box Based on AR Digital Technology Empowering Traditional Intangible Cultural Heritage. *Journal of Electronic Research and Application*. 3, 53–59.
- [12] Yang, Z., Hu, D., 2024. Digital technology-empowered omnichannel integration: a review and research agenda. *International Journal of Retail & Distribution Management*. 52(4), 407–424.
- [13] Fang, X.D., Zhang, Z.Y., Hou, G.Y., 2024. Theoretical Logic, Challenges and Paths of Digital Productivity Empowering Ecological Civilization Construction. *Hubei Agricultural Sciences*. 63(12), 222–229.
- [14] He, Y.L., Ke, K.K., 2024. Research on the Path of Digital Technology Empowering High-Quality Development of the Entire Agricultural Industry Chain. *Guizhou Agricultural Mechanization*. (4), 20–24.
- [15] Hou, G.Y., Du, Q.Y., 2024. Digital Economy Empowering Urban-Rural Integration: Logic, Problems and Paths. *Agricultural Economy*. (9), 106–108. DOI: <https://doi.org/10.3969/j.issn.1001-6139.2024.09.034> (in Chinese)
- [16] Zhang, T.R., Zhao, X.T., 2024. Action Mechanism, Realistic Dilemmas and Practical Paths of Digital Economy Empowering Agricultural Economy. *Shanxi Agricultural Economy*. (17), 66–68.
- [17] Zhao, B.G., Yang, H.L., 2024. Digital Technology Empowering High-Quality Agricultural Development: Internal Logic and Implementation Paths. *Rural Areas, Agriculture and Farmers*. (17), 16–18. DOI: <https://doi.org/10.3969/j.issn.1003-6261.2024.17.006> (in Chinese)
- [18] Liu, X.F., Piao, Z.G., 2024. Internal Logic, Difficulty Examination and Solution Paths of Digital Economy Empowering Agricultural Modernization. *Journal of Xi'an University of Finance and Economics*. 37(5), 55–66. DOI: <https://doi.org/10.3969/j.issn.1672-2817.2024.05.005> (in Chinese)
- [19] Bi, H., Huang, L., Qiu, J., 2024. Research on the Mechanism and Realization Path of Digital Technology Enabling High-quality Integration between Urban and Rural Areas. *Scientific Journal of Economics and Management Research*. 6(9), 20–33.
- [20] Vilkas, M., Stefanini, A., Ghobakhloo, M., et al., 2024. Digital technology-enabled capability development pathways. *Computers & Industrial Engineering*. 196, 110473.
- [21] Wang, W.D., Zhong, H.Y., 2024. Logic and Paths of New Quality Productive Forces Empowering Digital Rural Development. *Academic Exchange*. (7), 113–126. DOI: <https://doi.org/10.3969/j.issn.1000-8284.2024.07.009>
- [22] Bai, Q.P., 2024. Digital Technology Empowering Rural Resilience Governance and Its Action Framework. *Journal of Fujian Normal University (Philosophy and Social Sciences Edition)*. 3, 35–43, 169. (in Chinese)
- [23] Li, J., Chen, A., 2024. Research on Digital Technology Empowering the Teaching of “Modern Chinese” Course. *Journal of Educational Research and Policies*. 6(12), 18–20.
- [24] Bo, Q., Liu, H., Zheng, J., 2024. Research on the Mechanism of the Green Innovation of Enterprises Empowered by Digital Technology from the Perspective of Value Co-Creation. *Sustainability*. 16(20), 9065.

- [25] Chu, J.Z., Zhou, D., 2024. Research on the Significance, Constraints and Optimization Paths of New Quality Productive Forces Empowering High-Quality Development of Agricultural Economy. *Contemporary Rural Finance and Economics*. (5), 40–44. DOI: <https://doi.org/10.3969/j.issn.1007-3604.2024.05.013> (in Chinese)
- [26] Kong, D.L., Hou, Z.Y., Zhang, Y.L., et al., 2024. Research on Implementation Paths and Supporting Countermeasures of Digital Technology Empowering Farmer Income Growth. *Shanxi Agricultural Economy*. (3), 181–183.
- [27] Peng, J.X., 2024. Digital Empowerment for High-Quality Development of Agricultural Economy. *Rural Economy and Science-Technology*. 35(3), 1–3. DOI: <https://doi.org/10.3969/j.issn.1007-7103.2024.03.001> (in Chinese)
- [28] Ruiji, S., Yichun, Z., 2025. Innovative Paths and Cultural Identity Research in Folk Art Education in Guangzhou Universities Enabled by Digital Technology. *Scientific and Social Research*. 7(2), 195–201.
- [29] Wen, S., 2025. Innovative Development and Practical Exploration of Digital Technology Empowering the Funding Education Work in Colleges and Universities. *Scientific and Social Research*. 7(1), 119–127.
- [30] Li, P., He, R.S., Liu, C., 2024. Influence Mechanism and Effects of Digital Rural Construction Empowering Agricultural Economic Resilience. *Statistics & Decision*. 40(2), 11–17.
- [31] Lu, G.Y., Liao, Z.Y., 2023. Logical Necessity, Constraining Factors and Promoting Paths of Digital Economy Empowering Agricultural Powerhouse. *Old Revolutionary Base Area Construction*. (12), 19–26. DOI: <https://doi.org/10.3969/j.issn.1005-7544.2023.12.004> (in Chinese)
- [32] Li, Y.M., 2023. Theoretical Logic and Practical Strategies of Digital Technology Facilitating Rural Revitalization. *Agricultural Economy*. (12), 40–42. DOI: <https://doi.org/10.3969/j.issn.1001-6139.2023.12.012> (in Chinese)
- [33] Zhou, P.F., Li, M.H., 2023. Digital Rural Construction Empowering Agricultural Economic Resilience: Impact Mechanism and Empirical Investigation. *Research World*. (9), 15–24.
- [34] Massari, F.G., Nacchiero, R., Giannoccaro, I., 2025. Transformative supply chains: the enabling role of digital technologies. *International Journal of Production Economics*. 283, 109562.
- [35] Zhao, H.R., 2023. Research on the Implementation Path of Agricultural Product Circulation Digitalization Empowering High-Quality Development of Agricultural Economy. *China Business Theory*. (16), 51–54.
- [36] Zhao, Y.Z., 2023. Research on the Action Mechanism and Path of Integrated Development between Digital Economy and Real Economy. *Marketing World*. (8), 11–13.
- [37] Fan, Y.R., Liu, J.F., 2023. Internal Logic and Implementation Path of Digital Economy Empowering Rural Revitalization. *Agricultural Economy*. (4), 41–43. DOI: <https://doi.org/10.3969/j.issn.1001-6139.2023.04.014> (in Chinese)
- [38] Li, N., 2023. Digital Empowerment and Its Implementation Path in Priority Development of Agriculture and Rural Areas. *Contemporary Economic Management*. 45(5), 75–81.
- [39] Liao, X., 2025. Research on the Value Implications and Practical Path of Digital Technology Enabling Civic and Political Parenting in Private Colleges and Universities in the New Era. *Education Insights*. 2(6), 17–23.
- [40] Li, K., 2025. The Practice of Digital Technology Enabling English Classroom Teaching in Senior High School. *Education Reform and Development*. 7(5), 232–237.
- [41] Wen, F.A., Lu, Y., 2023. Digital Technology Empowering High-Quality Rural Development: Coupling, Action Mechanism and Optimization Strategies. *Henan Social Sciences*. 31(3), 104–112. DOI: <https://doi.org/10.3969/j.issn.1007-905X.2023.03.012>
- [42] Qi, F.X., Ren, J., 2022. Review of Research on Digital Technology Empowering Rural Revitalization. *Shanxi Agricultural Economy*. (22), 1–3.
- [43] Xu, M., Hao, R.J., Luo, Y.P., 2021. Digital Empowerment for High-Quality Development of Agricultural Economy. *Technology China*. (12), 46–50.
- [44] Yang, J.L., Zheng, W.L., Xing, J.Y., et al., 2021. Digital Technology Empowering High-Quality Agricultural Development. *Shanghai Journal of Economics*. 7, 81–90, 104. (in Chinese)
- [45] Qin, Y.N., Jiang, Z.M., 2025. Internal Mechanism and Development Path of Digital Economy Empowering Rural Revitalization. *Era's Economy & Trade*. 22(6), 160–162. DOI: <https://doi.org/10.3969/j.issn.1672-2949.2025.06.037> (in Chinese)
- [46] Zheng, Q.D., Ni, Q.D., 2025. Research on Mechanism, Value and Path of New Quality Productive Forces Empowering Rural Revitalization. *Era's Economy & Trade*. 22(6), 190–192.
- [47] Chen, Z., 2025. Value Implications and Implementation Path of Digital Economy Empowering Rural Revitalization. *Tropical Agricultural Engineering*. 49(3), 18–20.
- [48] Zhang, X., 2025. Mechanism and Path of High-Quality Digital Rural Development from the Perspective of New Quality Productive Forces. *Journal of CPC Urumqi Municipal Committee Party School*.

- (2), 68–74. DOI: <https://doi.org/10.3969/j.issn.1671-508X.2025.02.013> (in Chinese)
- [49] Chen, X., Chang-Richards, A.Y., Ling, F.Y.Y., et al., 2025. Digital technology-enabled AEC project management: practical use cases, deployment patterns and emerging trends. *Engineering, Construction and Architectural Management*. 32(6), 4125–4154.
- [50] Wei, X.P., Wang, M.W., Liu, K., 2025. Research on Path Innovation of Digitalization Empowering New Professional Farmer Skill Cultivation. *Continuing Education Research*. (8), 108–112.
- [51] Jiang, Y.F., Xiong, L., Ge, Q.F., 2025. Mechanism, Dilemmas and Paths of Digital Technology Empowering Rural New Quality Productive Forces Development. *Journal of Zhangjiakou Vocational and Technical College*. 38(2), 1–4.
- [52] Fu, M.W., 2025. Digital Empowerment of E-commerce Service Technology Development to Facilitate Rural Revitalization. *Shanxi Agricultural Economy*. (11), 17–19, 60.
- [53] Lu, B.D., Lü, L., 2025. Internal Mechanism and Practical Path of Digital Economy Empowering Rural Revitalization. *Agricultural Economy*. (6), 48–50.
- [54] Yang, L.L., 2025. Direction and Path of Digitalization Empowering Rural Industrial Transformation. *Agricultural Economy*. (6), 51–53.
- [55] Zeng, X.M., Li, X.Y., 2025. Research on New Quality Productive Forces Empowering High-Quality Development of Rural Education. *Journal of Jimei University (Education Science Edition)*. 26(3), 1–9.
- [56] Wu, L.J., 2025. Logic, Dilemmas and Practice of Digital Technology Empowering Rural Ecological Environment Governance under the Background of Rural Revitalization. *Shanxi Agricultural Economy*. (9), 128–131.
- [57] Yang, Y., 2025. Research on Value Implications, Dilemmas and Optimization Paths of Digital Empowerment for Rural Governance Modernization. *Agricultural Economy*. (5), 67–69.