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Research on the Theoretical Mechanism and Implementation Path of Digital New Quality Productivity Driving Rural Industrial Revitalization

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ABSTRACT
Digital new quality productivity has become an inherent driving force for rural industrial revitalization. This article conducts empirical tests based on panel data from 30 provinces and cities in China from 2012 to 2022. The results indicate that digital new quality productivity has a significant positive impact on rural industrial revitalization, and this impact still holds true after robustness and endogeneity tests; According to the threshold effect test, after crossing the threshold, the impact of digital new quality productivity on rural industrial revitalization is significantly enhanced; The heterogeneity test results show that the impact of digital new quality productivity on rural industrial revitalization varies in the eastern, central, western, and northeastern regions of China. Therefore, this article proposes targeted countermeasures and suggestions, and the government increases its investment in funds; Implement different policies tailored to different regions and develop new digital productivity; Adjust the industrial structure appropriately, develop emerging agricultural industries and supplementary industries, in order to achieve comprehensive driving of digital new quality productivity for rural industrial revitalization.

KEYWORDS
Digital new quality productivity; Rural industrial revitalization; panel threshold model

1 First Section

In December 2023, the Central Economic Work Conference pointed out that "we should promote industrial innovation through technological innovation, especially by using disruptive and cutting-edge technologies to stimulate new industries, new models, and new driving forces, and develop new quality productive forces. New quality productivity is a new concept proposed based on changes in China's economic development stage, factor resource endowment, and internal and external environment. Accelerating the development of new quality productivity mainly focuses on solving problems related to technological momentum, factor starting points, and industrial entities, and is a concrete manifestation of promoting productivity to move towards higher quality. [1] Developing new quality productive forces, cultivating new industries, promoting new models, and stimulating new driving forces should not only be based on the needs of agricultural and rural development, but also rely on the basic support of agriculture and rural areas. The primary task of rural revitalization is the prosperity of industries. The important lever to achieve this goal is to accelerate the development of new quality productivity, gather new driving forces, develop new business models, form new trends, significantly improve total factor productivity, and promote the

iterative upgrading of rural industrial productivity.

To this end, it is necessary to cultivate and shape high-quality workers, develop and apply labor materials containing new technologies, explore and develop a wider range of labor objects, promote the optimization and leap of the combination of various factors of productivity, and promote the industrial revitalization of rural areas. Data, as a new core element, empowers new quality productivity and forms digital new quality productivity. Digital new quality productivity can inject new vitality into the digital transformation of various industries and become an important foundation to support their development.

2 Literature Review

From the perspective of its connection with traditional productivity, Zhou Wen (2024) and others believe that the formation process of new quality productivity is a process of achieving key and disruptive technological innovation on the basis of inheriting traditional productivity. [2]From the practical significance of new quality productivity, [2] Dai Xiang (2023) believes that new quality productivity can effectively promote the endogenous requirements of "dynamic transformation", "efficiency transformation", and "quality transformation" for high-quality economic development, thus meeting the practical needs of high-quality economic development. [3] Wang Jue (2024) constructed a comprehensive evaluation index system for new quality productivity from three dimensions: laborers, labor objects, and means of production, based on the definition of the connotation of new quality productivity. [4]

Sun Liwei (2024) and others constructed an indicator system for new quality productivity from three dimensions: technological innovation, industrial upgrading, and development conditions. [5] Wang Yang (2024) measures digital new quality productivity from three dimensions: digital labor, digital labor materials, and digital labor objects. [6]

Secondly, existing research on rural industrial revitalization mostly focuses on the impact of the digital economy on it. Liu Xuexia (2024) pointed out that the deep integration of digital technology and rural industries provides strong support for promoting comprehensive rural revitalization and achieving agricultural and rural modernization. [7]

Zhao Wanfu (2024) believes that in the era of digital economy, relying on digital technology, introducing data elements, and building digital infrastructure can promote the upgrading of rural industrial structure, improve the operational efficiency of rural industries, enhance the driving force of rural industries, and promote the revitalization of rural industries. [8] Regarding the construction of the index system of rural industry revitalization, Shen Yun et al. (2020) believe that the evaluation index system of rural industry revitalization is a multi-level and compound organic whole, and regards the agricultural product industrial system, agricultural multifunctional industrial system and agricultural support industrial system as the organic unity of rural industry revitalization and development.[9]

Liang Shengkai (2023) and others constructed four primary indicators based on national authoritative policies, theoretical basis, and practical basis, including agricultural development, industrial integration, green innovation, and urban-rural integration. [10] Wu Yun (2024) and others believe that the new quality productivity is the endogenous driving force for the revitalization of rural industries, and is an inevitable choice to achieve technological innovation, ecological civilization, labor quality improvement, and factor circulation in rural industries based on productivity standards. [11]

Xin Yuan (2024) proposed that in order to promote the high-quality development of rural industries through new quality productivity, it is necessary to increase the empowerment of modern

technology in the industrial chain, promote the digitization and intelligence of industries, and accelerate the transformation of agricultural scientific and technological achievements.[12]

3 Theoretical mechanisms and research hypotheses

3.1 The direct impact of digital new quality productivity on rural industrial revitalization

With the integration of digital new quality productivity, rural industries have ushered in unprecedented opportunities. The widespread application of intelligent devices and technologies, such as satellite positioning systems, unmanned aerial vehicles for crop protection, and automated irrigation in precision agriculture, has greatly changed traditional agricultural production methods. Intelligent production can also achieve full traceability of agricultural products, ensure food safety, and enhance the market competitiveness of agricultural products.

Secondly, the emergence of new digital productivity has given rise to new industries and formats. The aggregation of digital technology has given rise to new technological inventions, giving birth to new industries, formats, and models such as rural e-commerce, rural tourism, and rural live streaming, bringing new growth points to rural economic development. Digital new quality productivity can break geographical limitations, enabling the flow and aggregation of resources such as information, talent, technology, and capital in a wider range, achieving optimized resource allocation, and enhancing the competitiveness of rural industries.

Finally, China has a vast territory with different geographical factors and natural conditions in various regions, resulting in uneven agricultural development. For economically developed areas such as the eastern region with complete infrastructure and abundant human resources, digital new quality productivity can be integrated into rural industries faster and more deeply. These regions often have better digital infrastructure, such as high-speed and stable network coverage, advanced logistics and distribution systems, which provide strong support for the application of digital technology.

At the same time, the abundant talent resources also make the promotion and application of new technologies smoother, which can quickly promote the intelligence of agricultural production, the development of agricultural product e-commerce, and the digital marketing of rural tourism, thus greatly promoting the revitalization of rural industries. However, in regions with relatively backward economies, weak infrastructure, and a shortage of talent, the role of digital new quality productivity may be limited to some extent. The lagging construction of digital infrastructure may lead to unstable network signals, delayed logistics distribution, and restrict the development of new formats such as e-commerce.

Based on this, the following hypothesis is proposed.

H1: Digital new quality productivity has a positive promoting effect on the revitalization of rural industries.

H2: The impact of digital new quality productivity on rural industrial revitalization exhibits regional heterogeneity.

3.2 Threshold effects of economic development level, digital new quality productivity, and advanced industrial structure

In the initial stage of economic development, the technological level is relatively low, and rural areas often have problems such as weak infrastructure, shortage of technical talents, and low degree of informatization, which makes it difficult for digital new quality productivity to fully play its

role. The upgrading of industrial structure means that industries are shifting from low value-added, labor-intensive to high value-added, technology intensive, and knowledge intensive. Before reaching a certain level of development, rural industries may find it difficult to effectively undertake and adapt to this structural change due to a lack of funds, technology, talent, and other factors, leading to development obstacles.

However, with the improvement of economic level, these constraining factors have gradually been improved. Infrastructure is constantly improving, network penetration is increasing, and logistics and distribution are becoming more convenient. At the same time, the cultivation and introduction of digital technology talents have been strengthened, and the digital literacy of rural residents has gradually improved.

The promotion effect of digital new quality productivity on rural industrial revitalization has also been significantly enhanced, and rural industries can better integrate resources. When rural areas have certain infrastructure conditions, such as transportation and communication, transaction costs can be reduced, more external investment and technology input can be attracted, thereby promoting the upgrading of industrial structure and the benign interaction of rural industrial revitalization.

Based on this, the following hypothesis is proposed.

H3: There is a threshold effect in driving rural industrial revitalization through digital new quality productivity itself, economic development level, and advanced industrial structure.

4 Model design and variable description

4.1 Model Design

Firstly, construct a direct effect model of digital new quality productivity on rural industrial revitalization

$$Rei_{it} = \alpha_0 + \alpha_1 Nqu_{it} + \alpha_2 Control_{it} + \lambda_t + \mu_i + \varepsilon_{it} \quad (1)$$

Among them, Rei represents rural industrial revitalization, Nqu represents digital new quality productivity, Control represents the set of control variables, i and t represent provinces and years respectively, λ _t represents fixed effects of years, μ _i represents fixed effects of provinces, and ε represents random disturbance term.

Secondly, construct a threshold regression model

$$Rei_{it} = \beta_0 + \beta_1 \mathrm{Nqu}_{it}.I\left(Rgdp \leqslant \gamma_1\right) + \beta_2 \mathrm{Nqu}_{it}.I\left(\gamma_1 Rgdp \leqslant \gamma_2\right) + \cdots + \beta_n \mathrm{Nqu}_{it}.I\left(\gamma_n Rgdp\right) + \beta Control_{it} + \varepsilon_{it} \quad (2)$$

$$Rei_{it} = \eta_0 + \eta_1 \mathrm{Nqu}_{it}.I\left(Nqu \leqslant k_1\right) + \eta_2 \mathrm{Nqu}_{it}.I\left(k_1 Nqu \leqslant k_2\right) + \cdots + \eta_n \mathrm{Nqu}_{it}.I\left(k_n Nqu\right) + \eta Control_{it} + \varepsilon_{it} \quad (3)$$

$$Rei_{it} = \delta_0 + \delta_1 \mathrm{Nqu}_{it}.I\left(OIS \leqslant \pi_1\right) + \delta_2 \mathrm{Nqu}_{it}.I\left(\pi_1 OIS \leqslant \pi_2\right) + \cdots + \delta_n \mathrm{Nqu}_{it}.I\left(\pi_n OIS\right) + \delta Control_{it} + \varepsilon_{it} \quad (4)$$

RGDP, Nqu, and OIS are threshold variables for economic development level, technological innovation level, and industrial structure upgrading, respectively

Spatial Durbin Model (SDM) as follows:

$$Rei_{it} = \delta_0 + \rho_0 \mathrm{WERPD}_{it} + \beta_1 \mathrm{Nqu}_{it} + \beta_2 \mathrm{Nqu}_{it} + \theta_x Wcontrol_{it} + \lambda_1 + \mu_2 + \varepsilon_{it} \quad (5)$$

W is the nested matrix of economic geography, where ρ 0 represents the spatial lag regression coefficient of Rei.

4.2 Dependent variable

Rural Industrial Revitalization (Rei). This article is based on the research of scholars such as Liu Hui (2023)[13] and Peng Hui (2023)[14], dividing rural industrial revitalization into four secondary indicators.

Table 1 Composition Index System of Rural Industrial Revitalization

First level indicator	Secondary indicators	Tertiary indicators	Indicator attribute
The level of rural industrial revitalization	Integration of rural industries and industries	Proportion of business income of agricultural product processing owners to total agricultural output value	+
		Proportion of added value of primary industry to gross domestic product	-
		The proportion of the total output value of agriculture, forestry, animal husbandry and fishery services to the total output value of the primary industry	+
	Agricultural output	grain yield	+
		Land productivity	+
		labour productivity	+
	Agricultural Science and Technology Innovation	Employment rate in the primary industry	-
		Number of agricultural technology patents	+
		Agricultural fixed assets investment	+
	Agricultural modernization level	Per capita total power of agricultural machinery	+
		Per capita disposable income of rural residents	+
		Proportion of effective irrigation area	+

4.3 Core explanatory variables

Digital New Quality Productivity (Npu) drives technological innovation through the deep integration of digital technology and the three elements of productivity, with a particular emphasis on the empowering effect of digital technology on productivity. Referring to existing research and the studies of scholars such as Wang Jue [15] and Sun Zhiyuan [16], this article constructs comprehensive indicators of digital new quality productivity from the aspects of digital infrastructure construction, digital workers, digital labor materials, and digital labor objects, and constructs 20 detailed three-level indicators. Using the entropy method to assign weights to indicators and determine the level of development of digital new quality productivity. The comprehensive system construction is shown in Table 2.

4.4 Threshold variable

The threshold variable of economic development level (RGDP) is measured using per capita regional GDP; The digital new quality productivity (Nqu) is measured by the comprehensive score obtained by the entropy method; The advanced industrial structure (OIS) is represented by the ratio of the tertiary industry to the secondary industry.

4.5 Control variables

To ensure the reliability of the regression results, this article controls for other factors that may affect the revitalization of rural industries. The level of urbanization (Urban) is measured by the ratio of urban permanent residents to the total population; The education level (EDU) of farmers, expressed as the average years of education per capita in rural areas; The financial service status (Lnjr) is represented by taking the logarithm of the balance of agricultural loans; The urban-rural income gap (Tri) is measured by the ratio of per capita disposable income of rural residents to per capita disposable income of urban residents; Rural per capita fixed assets investment (RFC) is expressed by rural per capita fixed assets investment.

Table 2 The indicator system for the composition of digital new quality productivity

First level indicator	Secondary indicators	Tertiary indicators	Indicator attribute
Digital new quality productivity	Digital infrastructure construction	Number of Internet access ports	+
		Number of Internet access users	+
		Number of Domain Names	+
		Fiber optic cable line density	+
		Mobile phone penetration rate	+
	Digital Workers	Per capita years of education	+
		Human capital structure of workers	+
		Per capita GDP yuan	+
		Entrepreneurial activity level	+
	Digital labor data	Highway mileage	+
		Renewable energy consumption	+
		Per capita number of patents	+
		R&D investment	+
		Digital Inclusive Finance Index	+
		Enterprise digitalization	+
	Digital labor objects	Robot installation density	+
		Environmental protection efforts	+
		Proportion of software business revenue to GDP	+
		Proportion of total telecommunications business to GDP	+
		Industrial waste gas treatment facilities	+

5 Empirical result analysis

5.1 Descriptive statistics

According to Table 3, the minimum value of Rural Industrial Revitalization (Rei) is 0.074, the maximum value is 0.506, and the standard deviation is 0.099, indicating that the overall data is relatively small; The minimum value of digital new quality productivity (Nqu) is 0.030, the maximum value is 0.615, and the standard deviation is 0.091, indicating that there are significant differences in the level of digital new quality productivity among regions, which are also concentrated in relatively small values.

Table 3 Composition Index System of Digital New Quality Productivity

Variable name	sample size	mean	standard deviation	minimum	maximum
Rei	330	0.251	0.099	0.074	0.506
Nqu	330	0.151	0.091	0.030	0.615
Rgdp	330	0.243	0.180	-0.110	1.000
OIS	330	1.384	0.751	0.611	5.283
Urban	330	0.607	0.117	0.363	0.896
EDU	330	8.000	0.857	5.861	12.600
Lnjr	330	3.862	0.379	3.002	4.817
Tri	330	0.404	0.057	0.274	0.547

5.2 Benchmark Regression Analysis

Table 4 shows the benchmark regression results of the impact of digital new quality productivity on rural industrial revitalization, controlling for provincial and yearly effects. The R2 values are all

above 0.5, indicating high interpretability of the model. Column (1) shows the regression results without adding control variables. It can be found that the regression coefficient of digital new quality productivity is 0.609 and significantly positive at the 1% level, indicating that digital new quality productivity will have a positive impact on rural industrial revitalization. Column (2) reports the regression results after adding control variables, with a regression coefficient of 0.306 and a significant positive value at the 1% level. This indicates that the impact of digital new quality productivity on rural industrial revitalization still has a clear positive correlation after adding control variables.

Table 4 Benchmark Regression Analysis Results

Variable name	(1) Rei	(2) Rei
Nqu	0.609***	0.306***
	(0.027)	(0.032)
Urban		0.067
		(0.084)
EDU		-0.007***
		(0.024)
Lnjr		0.057**
		(0.024)
Tri		0.864***
		(0.124)
Constant	0.159***	-0.351***
	(0.004)	(0.059)
YEAR	Yes	Yes
Province	Yes	Yes
N	330	330
R^2	0.633	0.778

The * * *, * *, and * in all tables indicate significance at the 1%, 5%, and 10% levels, respectively, with cluster robust standard errors in parentheses.

5.3 Regional Heterogeneity Analysis

As shown in Table 5, there are regional differences in the impact of digital new quality productivity on rural industrial revitalization. Among them, the impact coefficients in both the eastern and western regions are significantly positive at the 1% level, indicating that the impact of digital new quality productivity on rural industrial revitalization has a promoting effect in the eastern and western regions, while the impact coefficients in the central and northeastern regions are not significant. The reason may be that the construction and application level of digital economy infrastructure in the central region is not as good as that in the eastern region, and the scale of agricultural production, rural infrastructure, and government support for rural areas are relatively poor compared to the western region; The Northeast region has abundant mineral resources and is the largest heavy industry base in China. It is relatively dependent on industry and lacks agricultural talents; The digitalization level in the eastern region is relatively high, and the level of agricultural mechanization is also high, resulting in higher agricultural production efficiency; The coefficient of

0.401 in the western region is the highest among several regions, which may be due to the large space for digital economy construction and solid rural infrastructure in the western region, providing sufficient development space for rural industry revitalization. In addition, the western region has certain advantages in characteristic industries such as resources, tourism, and agriculture and animal husbandry.

Table 5 Heterogeneity Analysis and Regression Results of the Impact of Digital New Quality Productivity on Rural Industrial Revitalization

Variable name	(1) Eastern	(2) Central	(3) Western	(4) Northeastern
Nqu	0.216*	0.141	0.401*	-1.274
	(2.49)	(0.34)	(2.98)	(-2.82)
Urban	0.262	-0.353	0.0208	0.840
	(1.14)	(-0.73)	(0.15)	(1.37)
EDU	-0.0121**	-0.00989	-0.00193	-0.0152
	(-4.60)	(-0.96)	(-0.85)	(-3.02)
Lnjr	0.0450	0.261*	0.0197	0.0396
	(0.41)	(2.75)	(0.89)	(1.00)
Tri	1.523**	0.377	0.915**	1.200**
	(3.91)	(8.61)	(4.05)	(23.31)
Constant	-0.644	-0.685*	-0.269*	-0.724
	(-2.07)	(-2.71)	(-3.14)	(-3.95)
N	110	66	121	33
R^2	0.3417	0.7486	0.6761	0.8795

5.4 Threshold Effect Analysis

According to the regression results of the threshold effect in Table 6, it can be seen that the level of economic development (RGDP) is set at 0.4055 as the threshold for its impact on rural industrial revitalization. In different threshold intervals, the impact of digital new quality productivity on rural industrial revitalization is significantly positive at the 1% level. When RGDP≤0.4055, the impact coefficient is 0.141, and when RGDP>0.4055, the impact coefficient is 0.266. It can be seen that with the improvement of economic development level, the promotion effect of new quality productivity on rural industrial revitalization increases and shows phased characteristics; The threshold for advanced industrial structure(OIS)is 0.9718. When OIS≤0.9718, the impact coefficient is 0.113, which is significantly positive at the 10% level. When OIS>0.9718, the impact coefficient is 0.277, which is significantly positive at the 1% level. It can be seen that the promotion effect of digital new quality productivity is significantly enhanced after crossing the threshold for advanced industrial structure; When the threshold variable of digital new quality productivity (Nqu) is used, the impact coefficient is -0.0871 when Npu≤0.1650,0.0382 and not significant when Npu (0.1650＜Npu≤0.2231), and 0.165 and significantly positive at the 1% level when Npu>0.2231. It can be seen that in the primary stage of development of new quality productivity, digital new quality productivity has a certain hindering effect on rural industrial revitalization, but it is not obvious. With the development of digital new quality productivity, the effect between the two begins to show a promoting trend but not significant. After reaching a certain stage of development of digital new quality productivity, there is a significant positive promoting effect between the two.

Table 6 Results of Threshold Effect Regression Analysis

Variable name	(1)	(2)	(3)
Urban	0.168	0.125	-0.0103
	(0.132)	(0.0877)	(0.114)
EDU	-0.00932***	-0.00865***	-0.00674***
	(0.00200)	(0.00139)	(0.00189)
Lnjr	0.0624	0.0869**	0.0606*
	(0.0381)	(0.0321)	(0.0322)
Tri	0.881***	0.930***	0.952***
	(0.160)		
Rgdp(≤0.4055)	0.141***		
	(0.0498)		
Rgdp(＞0.4055)	0.266***		
	(0.0427)		
Npu(≤0.1650)		-0.0871	
		(0.0803)	
Npu(0.1650＜Npu≤0.2231)		0.0382	
		(0.0724)	
Npu(＞0.2231)		0.165***	
		(0.0418)	
OIS(≤0.9718)			0.113*
			(0.0598)
OIS(＞0.9718)			0.277***
			(0.0440)
Constant	-0.400***	-0.471***	-0.346***
	(0.0899)	(0.0854)	(0.0793)
Observations	330	330	330
Number of id	30	30	30
R-squared	0.796	0.811	0.795

6 Suggestions for countermeasures

Therefore, this article proposes countermeasures and suggestions:

Firstly, the government will increase its investment in funds. The government should fully leverage the leading role of planning, integrate various agricultural related funds, and concentrate investment on key projects such as rural infrastructure, rural landscape improvement, and development of characteristic industries to enhance the efficiency of fund utilization. Build a platform for the flow of urban and rural factors, guide the flow of funds to agriculture and rural areas, fully implement the assessment and constraint mechanism that rural financial institution deposits are mainly used for agricultural and rural development, implement differentiated monetary policies, improve the agricultural credit guarantee system covering cities and counties, reform the collateral guarantee system, improve the collateral disposal mechanism, and expand the scale of agricultural loans. Secondly, implement different policies tailored to different regions and develop new digital productivity. For the eastern region, policies can focus on encouraging the research and application of cutting-edge digital technologies, promoting the deep integration of the digital economy with high-end manufacturing and modern service industries. The policies in the central region should focus on promoting the digital upgrading and transformation of traditional industries, strengthening the construction of digital infrastructure, undertaking industrial transfer and digital technology radiation from the eastern region, and cultivating and strengthening digital industry clusters. The western region should pay attention to utilizing digital technology to improve the efficiency of resource development and utilization, and develop characteristic digital agriculture. Thirdly, adjust the industrial structure appropriately and develop emerging agricultural

industries. In terms of emerging agricultural industries, such as smart agriculture, modern information technologies such as the Internet of Things, big data, and artificial intelligence are utilized to achieve intelligent monitoring, precise operations, and scientific management of agricultural production, thereby improving agricultural production efficiency and quality.

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