

Research on The Impact of The Development Level of Digital Trade on China's New Quality Productivity

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Abstract. Against the dual backdrop of the digital economy becoming the core engine of global economic growth and the rise of new quality productivity construction as a national strategy, this article focuses on the empowering effect and mechanism of digital trade on new quality productivity. Firstly, based on the connotation and essence of new quality productivity, a four-dimensional evaluation index system covering new quality workers, new quality labor objects, new quality labor materials, and economic support system is constructed. The entropy method is used to measure the level of new quality productivity in 30 provinces in China from 2014 to 2022; Secondly, using the bidirectional fixed effects model and mediation effects model, systematically examine the relationship and internal logic between digital trade and new quality productivity. Research has found that digital trade has a significant positive promoting effect on the improvement of regional new quality productivity, while digital technology innovation plays a partial mediating role in the relationship between the two, that is, digital trade indirectly empowers the development of new quality productivity by promoting digital technology innovation; Heterogeneity analysis shows that digital trade has a more significant promoting effect on new quality productivity in the eastern and western regions, as well as in areas with higher urbanization levels, optimized industrial structures, and abundant talent resources.

Keywords: Digital trade, new quality productivity.

1. Introduction

Innovation driven is a huge driving force for the development of productivity. The history of technological revolution and productivity development shows that relying on technology to promote rapid development of productivity is a universal law. Since the reform and opening up, China has made significant progress in cutting-edge, fundamental, and original technological innovation and its capabilities, promoting the rapid development of productivity. However, as China's economy shifts from high-speed growth to high-quality development, the current level of productivity is no longer sufficient to meet the growing demand for a better life among the people. At the same time, some developed Western countries, relying on their technological advantages, have constrained the pace of China's scientific and technological innovation and industrial development through strategic containment, technological decoupling, and regulatory suppression.^[1] In this context, the Party Central Committee attaches great importance to the important role of "new quality productive forces" and has made important decisions and deployments. In January 2024, General Secretary Xi Jinping emphasized during the 11th collective study session of the Political Bureau of the 20th Central Committee of the Communist Party of China that the new quality of productive forces is based on the leap of laborers, labor materials, labor objects, and their optimized combinations. Its core symbol is the significant improvement of total factor productivity, characterized by innovation, key quality, and essentially advanced productive forces.

Currently, the digital economy, with its extensive influence and radiation range, has become an important direction for global economic development. According to International Data Corporation (IDC), by 2025, nearly half of global GDP will be contributed by the digital economy. In recent years, China's digital economy has flourished. By 2023, the scale of China's digital economy has reached 53.9 trillion-yuan, accounting for 42.8% of GDP and contributing 66.45% to GDP growth. In 2024,

the digital economy will once again be included in the Government Work Report, proposing to accelerate the innovative development of the digital economy, promote the "artificial intelligence+" action, promote the open development and circulation of data, and create a digital industry cluster with international competitiveness. As an important component of the digital economy, digital trade, as a new form of trade, with digital services and digital delivery as its core, can promote technology and knowledge sharing between industries through data flow, promote industrial synergy and integration, and drive the digital transformation of traditional industries.

Does digital trade contribute to the improvement of new quality productivity in such a large scale of digital trade? Against the backdrop of promoting the growth of new quality productivity through national strategy, how to effectively utilize digital trade to enhance new quality productivity has become an important issue that urgently needs to be addressed.

This article starts from the connotation of new quality productivity, combines existing literature to expand it, and constructs a first level indicator evaluation system for four aspects: new quality workers, new quality labor objects, new quality labor materials, and economic support system. It measures the new quality productivity in 30 regions of China from 2014 to 2022. Meanwhile, empirical analysis is conducted on the impact of digital trade on new quality productivity.

2. Theoretical analysis and research hypotheses

2.1. The Impact Mechanism of Digital Trade on New Quality Productivity

Based on the research of Li Dan and Zhou Ying (2024)^[2], digital trade, as an important component of the digital economy, can promote technological innovation and efficient allocation of resource factors, thereby promoting the improvement of new quality productivity. Wang Kaike et al. (2020)^[3] pointed out that the digital economy enhances the overall production efficiency of society by improving enterprise efficiency, optimizing production organizational structure, and promoting the optimal allocation of production factors. Therefore, digital trade not only promotes the integration of global markets by enhancing technological exchanges and resource sharing between industries, but also drives the formation and development of new quality productivity. Jiao Yong and Qi Meixia (2024)^[4] believe that the key to empowering new quality productivity with the digital economy lies in the interaction of factors such as data elements, digital technology, digital infrastructure, and digital governance. As a part of the digital economy, digital trade is an important way for these factors to circulate and optimize their allocation. Zhou Ziyu (2024)^[5] emphasized that the digital economy empowers the development of new quality productive forces by improving the efficiency of the allocation of workers, labor materials, and labor objects. Especially under the promotion of digital trade, the optimized allocation and efficiency improvement of these resource elements will further accelerate the improvement of productivity levels. Therefore, based on existing literature, this article proposes research hypothesis H1.

Research hypothesis H1: Digital trade significantly promotes the development of new quality productivity.

2.2. The Mechanism of Digital Trade on New Quality Productivity

As an important component of the digital economy, digital trade not only provides new growth drivers for the market, but also promotes the flow of global knowledge and technology, and drives the optimization and upgrading of industrial structure. By promoting business model innovation, strengthening intellectual property protection, and facilitating cross-border flow of research and development factors, digital trade provides strong support for regional digital technology innovation, and on this basis, promotes the improvement of new quality productivity.

Firstly, digital trade promotes business model innovation, providing new scenarios for the application and development of digital technology. Zhao Tao et al. (2020)^[6] found that the digital economy cultivates more entrepreneurial opportunities by influencing market size, knowledge spillovers, and

factor combinations, thereby accelerating the promotion and application of new technologies. This innovative model provides a continuous stream of application scenarios for digital technology innovation, promoting the continuous updating and application of technology. Secondly, digital trade provides legal protection for the application and development of new technologies by strengthening intellectual property protection. Li Yuhao (2021) ^[7] pointed out that the products and services of digital trade are mostly knowledge intensive, and the strengthening of intellectual property protection provides strong support for technological innovation. In addition, digital trade promotes the cross-border flow of research and development factors, which further enhances resource support for technological innovation. Liu Bin and Zhen Yang (2022) ^[8] indicate that digital trade reduces the cost of cross-border data flow, enhances spatial knowledge spillovers, and promotes the cross-border flow of research and development factors, thereby accelerating technological innovation.

In this context, digital technology innovation has become a key factor in promoting the development of new quality productivity through digital trade. The innovation of digital technology not only improves the efficiency of resource allocation, but also optimizes the industrial structure and promotes the upgrading of new quality productivity. Therefore, digital technology innovation plays an important intermediary role between digital trade and new quality productivity. This article argues that digital technology innovation achieves a positive impact of digital trade on new quality productivity by optimizing resource allocation, enhancing productivity, and accelerating industrial upgrading. So, this article proposes the research hypothesis H2.

Research hypothesis H2: Digital technology innovation plays a mediating role in the impact of digital trade on new quality productivity.

3. Model establishment and variable description

3.1. Model establishment

In order to verify the relationship between digital trade and new quality productivity, and to control for the impact of provinces and years on the model, a two-way fixed effect was used to establish the following benchmark regression results:

$$NQP_{it} = \alpha_1 + \alpha_2 DT_{it} + \alpha_3 \mathbf{N}_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

Where i is the city, t is the year, the dependent variable is the level of new quality productivity, and the independent variable is the level of digital trade development. \mathbf{N}_{it} for a series of control variables, μ_i for a fixed effect of year, δ_t for a fixed effect of province, and ε_{it} for a random perturbation term.

To investigate the indirect effects of digital trade on new quality productivity and test whether the advantage of digital technology innovation is a mediating variable. Referring to the approach of Wen Zhonglin et al. (2004) ^[9], based on model (1), a regression model is constructed between the level of digital trade development and the mediating variable of digital technology innovation advantage. The model is set as follows:

$$DTI_{it} = \beta_1 + \beta_2 DT_{it} + \beta_3 \mathbf{N}_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

$$NQP_{it} = \theta_1 + \theta_2 DT_{it} + \theta_3 DTI_{it} + \theta_4 \mathbf{N}_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (3)$$

If β_2 is significant, it indicates that digital trade will have an impact on the advantages of digital technology innovation; If θ_2 and θ_3 are significant, it indicates that the advantage of digital technology innovation plays a partial mediating role in the impact of digital trade on new quality productivity; If only θ_3 is significant, it indicates that digital technology innovation and industrial

structure optimization play a fully mediating role in the relationship between digital trade and new quality productivity.

3.2. Variable selection

3.2.1. Explained variable: New quality productivity

The new quality productivity system is a complex system that involves multiple aspects such as new quality workers, new quality labor materials, new quality objects, and trends in the economic support system. At present, scholars have constructed a measurement index system for new quality productivity based on different understandings, but the evaluation indicators have not yet been unified. Based on the measurement index system proposed by Wang Jue and Wang Rongji (2024)^[10], Dong Qingqian (2024)^[11], Wu Wensheng et al. (2024)^[12], this article constructs a new quality productivity measurement index system from four dimensions: new quality workers, new quality labor objects, new quality production materials, and economic support system (Table 1). Specifically, the development of new quality productivity requires strengthening the support of new quality workers, new quality labor materials and new quality objects, and the construction of an economic support system. Among them, the economic support system plays a primary and decisive role in the development of new quality productivity. To ensure the accuracy of index estimation, it is necessary to process the positive and negative indicators mentioned above to make them horizontally comparable and have practical application value.

Table 1: Indicator System of New Productive Forces

First-level indicator	Secondary indicator	Symbol	Third-level indicator	Unit	Direction	
New quality workers	New Quality Human Capital Investment	X1	The number of research and development personnel in the government's annual financial expenditure on education	RMB100 mn	positive	
		X2	Number of R&D personnel	person	positive	
	The quality of new-type labor	X3	The proportion of students in regular higher education institutions to the total population	%	positive	
		X4	Per capita years of education	Year	positive	
	New Worker Concept	X5	X5	Private enterprise personnel/overall employed personnel	%	positive
			X6	Third industry personnel/overall employed personnel	%	positive
New quality labor objects	Industrial upgrading	X7	Proportion of urban employment in information transmission, software, and information technology services industry	%	positive	
		X8	Mobile phone penetration rate	Department/100 people	positive	
		X9	Value added index of the tertiary industry	Last year=100	positive	
	New energy	X10	New energy power generation/total power generation, including hydro, nuclear, wind, and solar energy, can measure the level of new energy supply	%	positive	
New quality labor materials	Technological support	X11	RD investment/GDP	%	positive	
		X12	Patent authorization quantity/permanent population	Item/person	positive	
	Technological innovation	X13	Number of domestic patent applications authorized/number of domestic patent applications accepted	%	positive	
		X14	R&D funds/regional GDP of industrial enterprises above designated size	%	positive	
	New infrastructure construction	X15	X15	Length of optical cable line	Ten thousand kilometers	positive
			X16	Highway mileage of highway level	Ten thousand kilometers	positive
Economic support system	Market demand	X17	Total retail sales of consumer goods/total population	%	positive	
	Per capita economic level	X18	GDP/total population	Yuan per person	positive	

3.2.2. Explanatory variable: Digital trade

Digital trade is a complex system that involves various aspects such as digital trade potential, digital trade structure, digital trade technology, and digital trade environment. At present, scholars have constructed a measurement index system for new quality productivity based on different understandings, but the evaluation indicators have not yet been unified. Based on the measurement index system proposed by Ma Shuzhong et al. (2022) [13], this article constructs a digital trade measurement index system from four dimensions: digital trade potential, digital trade structure, digital trade technology, and digital trade environment (see Table 2), and measures it using the entropy method.

Table 2 Digital trade indicator system

First-level indicator	Secondary indicator	Symbol	Third-level indicator	Unit	Direction	
The Potential of Digital Trade	Economic status	X1	Regional Gross Domestic Product	RMB100mn	positive	
	Consumption expenditure	X2	Per capita consumption expenditure of all residents	yuan	positive	
Digital trade environment	Industrial digitalization	X3	express delivery volume	ten thousand pieces	positive	
		X4	Number of websites per hundred enterprises	a	positive	
		X5	E-commerce sales revenue	RMB100mn	positive	
		X6	E-commerce procurement amount	RMB100mn	positive	
	Digital Industrialization	X7	Total telecommunications business volume	RMB100mn	positive	
		X8	Software business revenue	RMB100mn	positive	
	Digital infrastructure	X9	Mobile phone penetration rate	Department/100 people	positive	
		X10	Length of optical cable line	kilometer	positive	
		X11	Number of Domain Names	ten thousand	positive	
		X12	Number of Internet broadband access ports	ten thousand	positive	
		X13	Number of Internet broadband access users	ten thousand	positive	
	Digital Trade Structure	Digital knowledge structure	X14	Scientific research and technology service industry urban employment personnel/urban employment personnel	%	positive
	Digital Trade Technology	Digital talent	X15	Urban employment personnel in the information transmission, software, and information technology service industries	ten thousand people	positive
Digital R&D		X16	Patent application authorization quantity	item	positive	

3.2.3. Mediating variable: Innovation in Digital Technology

Using digital technology innovation (IV), the digital technology innovation capability of the region is measured by the domestic patent authorization situation, technology achievement promotion ability, and scientific research investment. The entropy method is used to calculate the digital technology

innovation capability index of each province. The specific indicator system construction is shown in Table 3.

Table 3: Digital technology innovation indicator system

Mediating variable	Indicator level	Symbol	Computational method
Innovation in Digital Technology	Domestic Patent Authorization Status	Z1	Number of domestic patent applications authorized/number of domestic patent applications accepted (%)
	Ability to promote technological achievements	Z2	Technology market transaction volume (10000 yuan)
	Research investment intensity	Z3	R&D expenses of industrial enterprises above designated size/regional GDP (%)

3.2.4. Control variables

Referring to existing research, this article controls for the following variables: logarithm of scientific research institute (IE); The logarithm of the total investment amount of foreign-invested enterprises (FIEI) and the logarithm of the local population in that year (LP); The ratio of local fiscal expenditure to regional gross domestic product (LF); The logarithm of the total import and export volume (IEV) at the location of the operating unit; Urbanization (UL) is represented by the proportion of town residents to regional residents; Industrialization level (IL), expressed as the proportion of industrial added value to GDP.

4. Empirical Analysis

4.1. Descriptive Statistics

As shown in Table 4, the total sample observations amount to 270, with the maximum value of digital trade (DT) in China being 0.796 and the minimum value being 0.018, indicating disparities in the development of digital trade across the country.

Table 4 Descriptive statistics of variables

Variable	N	mean	p50	sd	min	max
NPQ	270	0.221	0.190	0.106	0.0780	0.606
DT	270	0.143	0.0970	0.131	0.0180	0.796
IE	270	10.12	10.17	1.125	7.189	12.67
FIEI	270	11.73	11.63	1.414	8.038	15.55
LP	270	8.215	8.283	0.742	6.356	9.448
LF	270	0.260	0.230	0.109	0.105	0.753
IEV	270	17.82	17.84	1.602	12.71	20.97
UL	270	0.620	0.605	0.110	0.403	0.893
IL	270	0.317	0.322	0.0730	0.100	0.499

4.2. Benchmark regression analysis

Table 5 shows the impact of regional digital trade level on regional new quality productivity. The first column does not include control variables and fixed effects, the second column does not include control variables but includes fixed effects, and the third and fourth columns gradually add two types of fixed effects and control variables. All four regressions indicate that the level of regional digital trade has a significant positive impact on regional new quality productivity. After adding control variables and fixed effects, when other variables remain constant, for every unit increase in regional digital trade level, the average regional new quality productivity will increase by 0.3846. This conclusion is significant at the 1% statistical level, verifying hypothesis H1.

Table 5 Benchmark Regression

Variable	(1)	(2)	(3)	(4)
DT	0.7500***	0.4467***	0.5119***	0.3846***
	(0.0403)	(0.0325)	(0.0478)	(0.0351)
Control variable	NO	NO	YES	YES
Constant	0.1134***	0.1284***	0.4027	-0.9272**
	(0.0049)	(0.0036)	(0.2952)	(0.4348)
Observations	270	270	270	270
R-squared	0.8549	0.9496	0.9117	0.9534
Number of ids	30	30	30	30
Province FE	NO	YES	YES	YES
Year FE	NO	YES	NO	YES

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

4.3. Endogeneity issue

From both theoretical and practical perspectives, the impact of digital trade on the new quality productivity of enterprises may be disrupted by the following potential endogenous issues. Firstly, the problem of reverse causality. In the context of the digital economy, the level of new quality productivity of enterprises may encourage them to participate more actively in digital trade. This reverse causal relationship is particularly significant in the impact of enterprises' participation in digital trade on their new quality productivity, as their demand for efficient and intelligent production directly drives their participation in digital trade. For the reverse causality problem of upstream and downstream enterprise transmission, on the one hand, it is weakened in network effects, and on the other hand, due to the independence of enterprise decision-making, this impact is relatively small. Due to the benchmark conclusion indicating a positive correlation between digital trade and new quality productivity of enterprises, while reverse causality may lead to a negative correlation, the true causal effect may be overestimated. Secondly, omitted variables are biased. Due to the inability to comprehensively cover all factors that may affect enterprise digital trade, this article may have overlooked important control variables. For example, factors such as a company's own management level, technological innovation capability, and market environment may all affect its enthusiasm and effectiveness in participating in digital trade. If these important factors are not included in the model, it may lead to biased estimation results, thereby affecting the true judgment of the relationship between digital trade and enterprise new quality productivity.

Based on the consideration of endogeneity issues mentioned above. Therefore, this paper selects the first order lag term of digital trade and the interaction term (IV) between the total amount of post and telecommunications services and the number of Internet broadband access users in 1984 as the instrumental variable ^[15], and uses the two-stage instrumental variable least squares method (2SLS) to test the endogenous problem. The results are shown in Table 6. The coefficients of L. DT and IV

are positively significant at the 1% level, satisfying the correlation condition, and Kleibergen Paap rk LM and the Kleibergen Paap Wald rk F statistical measures were all significant and passed the unidentifiable test and weak instrumental variable test. The second stage regression results show that the coefficient of DT is positively significant at the 1% level, indicating that after properly addressing potential endogeneity effects, digital trade still plays a significant promoting effect on new quality productivity in various regions of China.

Table 6 Endogeneity test

	The first stage of regression	Second stage regression	The first stage of regression	Second stage regression
	DT	NQP	DT	NQP
L.DT	0.9007*** (0.0369)			
IV			0.0000*** (0.0000)	
DT		0.4154*** (0.0338)		0.3909*** (0.0328)
Control variable	YES	YES	YES	YES
Constant	-0.4014 (0.4835)	-0.5718 (0.4060)	-3.2693*** (0.4964)	-0.8855** (0.3625)
Kleibergen-Paap rk LM	28.61***		12.54***	
Kleibergen-Paap Wald rk F statistic	60.16*** [16.38]		99.378*** [16.38]	
Provnice FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
R-squared	0.9433		0.9156	
N	240	240	240	240

4.4. Robust testing

4.4.1. Replace the core dependent variable

This article replaces the entropy method with the principal component analysis method and the new quality productivity index system for the development of the new quality productivity index. The regression results are shown in columns (1) and (2) of Table 7, where the DT coefficient is significantly positive at the 1% level, confirming hypothesis H1.

4.4.2. Removing Extreme Values

Perform 1% truncation on the dependent variable of new quality productivity and the core explanatory variable of digital trade development level data, and then use the processed data for regression analysis. The regression results are shown in column (3) of Table 7, with a DT coefficient of 0.4043, which is significantly positive at the 1% level, once again verifying hypothesis H1 and indicating the robustness of the baseline regression results.

4.4.3. Adjusting the research sample

Considering that the four municipalities directly under the central government have higher political status, economic strength, education, and scientific research resources compared to other regions, this article conducts regression analysis again after excluding relevant sample data from Beijing, Tianjin, Shanghai, and Chongqing. The regression results are shown in column 4 of Table 7, with a DT

coefficient of 0.4413, which is significantly positive at the 1% level, once again verifying hypothesis H1 and indicating the robustness of the baseline regression results.

4.4.4. Two stage sample regression

In 2016, the G20 Hangzhou Summit listed the digital economy as an important topic for the first time and adopted the "G20 Digital Economy Development and Cooperation Initiative". In 2017, the digital economy was included in the government work report for the first time, which proposed to promote the in-depth development of "Internet plus" and the rapid growth of the digital economy. Since 2017, the government has issued a series of policies to support the digital economy, including "Internet plus" Action Plan, "National Big Data Strategy", "Made in China 2025" and other documents. These policies have greatly promoted the prosperity of the digital economy, which may have led to accelerated development of the digital economy. Therefore, these two stages are divided into 2014-2016 and 2017-2022 for two-stage analysis. The results are shown in Table 7, which indicates that both stages of regression are significant.

Table 7 Robustness Test

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
DT	0.4274***	4.1462***	0.4043***	0.4413***	0.2982***	0.3826***
	(0.1155)	(0.6184)	(0.0344)	(0.0265)	(0.0695)	(0.0646)
Control variable	YES	YES	YES	YES	YES	YES
Observations	270	270	270	234	90	180
R-squared	0.8497	0.9488	0.9488	0.9523	0.8402	0.9131
Number of ids	30	30	30	26	30	30
Province FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

4.5. Heterogeneity analysis

4.5.1. Regional heterogeneity

Due to differences in development level, infrastructure, natural resources, and policies among regions, digital trade will have varying degrees of impact on the level of new quality productivity in different regions. Therefore, this article refers to the classification criteria of the National Bureau of Statistics and divides the sample into eastern, central, and western regions. The regression results are shown in the table. According to Table 8, the DT coefficient in the central region is not significant, while the coefficient DT in the eastern and western regions is significant and positive. This indicates that digital trade has not had a significant impact on the improvement of new quality productivity in the central region, but has a significant positive effect on the new quality productivity levels in the eastern and western regions, with the most significant effect on the improvement of new quality productivity in the western region. The reason may be that the eastern and western regions may have received more policy support and market openness, such as tax incentives, funding support, etc., while the central region may have deficiencies in these areas. The eastern region has many high-quality talent resources, while the western region, due to the Western Development Strategy, has increased government investment in education and training, cultivating a large number of professional talents who can better understand and apply the new technologies and concepts brought by digital trade. However, the talent resources in the central region may be relatively scarce. These factors work together, resulting in the insignificant effect of digital trade on the improvement of new quality productivity in the central region, while the effect on the improvement of new quality productivity in the eastern and western regions is more significant.

4.5.2. Heterogeneity of Urbanization Level

Due to the heterogeneity of urbanization levels, there are differences in resource utilization, population and industrial agglomeration, and infrastructure improvement among different regions, which may affect the regression results of digital trade on regional new quality productivity. Therefore, based on the median level of urbanization, the 30 provinces were divided into two groups: regions with higher urbanization levels and regions with lower urbanization levels, and the test was re conducted. The regression results are shown in Table 8. From the table, it can be seen that the coefficient DT is significantly positive in areas with lower and higher levels of urbanization, while the promoting effect of areas with higher levels of urbanization is more significant compared to areas with lower levels of urbanization. The reason may be that areas with higher levels of urbanization usually have more complete infrastructure, including communication networks, power supply, transportation facilities, etc. These infrastructures provide excellent technical support for digital trade, improving the efficiency of data transmission and processing. Regions with higher levels of urbanization often attract more high-quality labor force. These laborers not only have a high level of education and professional skills, but also have strong learning and innovation abilities, which can better apply and promote digital technology. Residents in areas with higher levels of urbanization have stronger consumption power and market demand, which prompts enterprises to adopt more advanced digital technologies to improve the quality of products and services, thereby promoting the development of new quality productivity. Regions with higher levels of urbanization have obvious advantages in multiple aspects, and these factors work together to make the promotion of digital trade on new quality productivity more significant in these regions.

Table 8 Heterogeneity test of regions and urbanization

	(1)	(2)	(3)	(4)	(5)
Variable	Eastern region	Central China	Western region	Areas with lower levels of urbanization	Areas with high levels of urbanization
DT	0.3686*** (0.0398)	0.2256 (0.1412)	0.3935*** (0.0791)	0.3079** (0.1089)	0.3369*** (0.0505)
Control variable	YES	YES	YES	YES	YES
Constant	0.1560 (1.2537)	-2.8971** (0.9010)	0.2390 (1.0705)	-0.3332 (0.5248)	-1.7331 (1.7030)
Observations	108	81	81	157	113
R-squared	0.9514	0.9869	0.9731	0.9263	0.9787
Number of ids	12	9	9	22	18
Province FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.5.3. Heterogeneity of industrial structure

The improvement of industrial structure level helps to facilitate the flow of production factors between different industries, further promoting industrial integration. Therefore, the sample was divided according to the level of industrial structure in the city. The level of industrial structure is measured by the proportion of the added value of the tertiary industry in the regional gross domestic product. As shown in columns (1) - (2) of Table 9, in provinces with higher levels of industrial structure, digital trade can significantly promote the development of new quality productivity, while in provinces with lower levels of industrial structure, the promotion effect of digital trade on new

quality productivity is not as good as in provinces with higher levels of industrial structure. This may be due to the high proportion of primary and secondary industries in provinces and cities with poor industrial structure, unreasonable industrial structure, relatively weak digital infrastructure, high-quality talent reserves, and technological application capabilities, making it difficult to fully tap the potential of digital trade. As a result, the promotion of new quality productivity by digital trade is not as good as in provinces and cities with better industrial structure.

4.5.4. Heterogeneity of Talent Resources

As a new form of trade that is technology intensive and rapidly iterating, the development and application of digital trade cannot be separated from the promotion of talents. Talent resources are an important guarantee for ensuring the economic benefits of digital trade. The heterogeneity test results are shown in columns (3) - (4) of Table 9, where the DT coefficients for regions with less and more talent resources are significantly positive at the 1% level. Moreover, the more abundant the talent resources, the more significant the promotion effect of digital trade on new quality productivity. The reason may be that these regions have more high-quality talents who can better apply new technologies, promote innovation, and optimize industrial structure.

Table 9 Heterogeneity test of industrial structure and talent resources

	(1)	(2)	(3)	(4)
Variable	High level of industrial structure	Poor level of industrial structure	Lack of talent resources	Abundant talent resources
DT	0.4442***	0.3813***	0.3865***	0.4555***
Control variable	YES	YES	YES	YES
Constant	-0.9637* (0.4936)	-0.9876 (0.7568)	0.0267 (0.8416)	-2.2158*** (0.6170)
Observations	171	99	148	122
R-squared	0.9648	0.9765	0.9239	0.9665
Number of ids	26	22	23	27
Province FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

4.6. Mechanism Analysis

According to the previous analysis, digital trade can enhance the level of new quality productivity by promoting digital technology innovation. To prove this theoretical hypothesis, regression tests were conducted using equations (2) and (3), and the results are shown in Table 10 (1) - (3). As shown in the table, the regression coefficient of the development level of digital trade in column (2) is 83.573, which is significantly positive at the 1% level, indicating that the development of digital trade can effectively promote digital technology innovation. According to the results in column (3), the regression coefficient of the impact of digital trade on new quality productivity is 0.2418, and the regression coefficient of the impact of digital technological innovation on new quality productivity is 0.0017. Both are significantly positive at the 1% level, indicating that digital technological innovation plays a partial mediating role in the impact of digital trade on new quality productivity. Hypothesis H2 is validated.

Table 10: Mechanism Analysis

	(1)	(2)	(3)
VARIABLES	NQP	IV	NQP
DT	0.3846***	83.5730***	0.2418***
	(0.0351)	(16.0792)	(0.0326)
IV			0.0017***
			(0.0002)
	YES	YES	YES
Constant	-0.9272**	-52.3201	-0.8378**
	(0.4348)	(126.6595)	(0.3877)
Observations	270	270	270
R-squared	0.9534	0.9047	0.9644
Number of ids	30	30	30
Province FE	YES	YES	YES
Year FE	YES	YES	YES

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5. Conclusion and Suggestions for Countermeasures

Based on the relevant data on the comprehensive development level of digital trade and the level of new quality productivity in 30 provinces of China (excluding Xizang, Hong Kong, Macao and Taiwan) from 2014 to 2022, this paper uses the two-way fixed effect model to study and analyze the impact of digital trade on new quality productivity, and uses methods such as replacing core explanatory variables, removing extreme values, adjusting research samples, and two-stage sample regression to conduct robustness tests. Finally, it conducts intermediary effect tests and heterogeneity tests. Research shows that: (1) Digital trade can significantly promote the improvement of regional new quality productivity levels. (2) Digital technology innovation can play a partial mediating role in the impact of digital trade on new quality productivity. (3) The impact of digital trade on new quality productivity will be enhanced with the improvement of financial development level, that is, financial development plays a positive regulatory role in the relationship between digital trade and new quality productivity. (3) Due to differences in regional factor endowments, urbanization levels, industrial structure levels, talent resources, etc., the impact of digital trade on the development of new quality productivity in different regions also varies significantly.

Based on the above research conclusions, the following suggestions are proposed:

(1) Accelerate the construction of digital infrastructure and enhance the development environment of digital trade. At the macro level, the government should establish digital economy development demonstration zones or smart cities to build an open digital infrastructure platform, promote information interconnection and data sharing between regions, and enhance the infrastructure support capacity for digital trade. The government should increase investment in cutting-edge technology infrastructure such as 5G, big data, artificial intelligence, and blockchain, and promote the upgrading and transformation of digital infrastructure to ensure the rapid development of the digital economy in various regions. At the micro level, enterprises should actively participate in the construction of digital infrastructure, especially large enterprises should play a leading role in demonstration, invest in the construction of digital platforms and cloud computing services, and enhance the digital level within the enterprise. Small and medium-sized enterprises should leverage policy support provided by the government to gradually promote their digital transformation. By introducing intelligent devices and improving network security facilities, they can optimize business processes and increase production efficiency, creating favorable conditions for digital trade.

(2) Promote the optimization and upgrading of industrial structure, and enhance the productivity and efficiency of digital trade. At the macro level, the government should promote the transformation of traditional industries towards digitization and intelligence through policy guidance and financial support, especially by promoting the application of technologies such as big data, the Internet of Things, and cloud computing in traditional manufacturing to enhance the added value and competitiveness of the industry. At the same time, the government should encourage the development of high-tech and green industries, and promote the formation of a virtuous cycle of industrial structure upgrading and digital transformation. At the micro level, enterprises, especially leading manufacturing companies, should increase their R&D investment, promote the digital transformation of production processes, build intelligent factories, intelligent supply chains, etc., and enhance the digitalization level of the entire industrial chain. Small and medium-sized enterprises should promote their digital transformation by utilizing government technology support and tax incentives, and enhance the efficiency of industrial chain collaboration through technologies such as big data analysis and cloud computing, to help optimize and upgrade the industrial structure.

(3) Strengthen regional coordinated development and narrow regional differences in the development of digital trade. At the macro level, the government should promote balanced development of digital trade in different regions through regional development policies, especially through digital infrastructure construction and technological support, to narrow the digital divide between the eastern and central western regions. We should encourage developed regions in the east to radiate their digital technology and financial support to the central and western regions, promote the coordinated development of industrial chains in various regions, and promote regional coordinated development. At the micro level, enterprises should implement differentiated digital development strategies based on regional characteristics. Enterprises in developed eastern regions can drive the digital transformation of central and western regions, promote regional industrial complementarity and complementary advantages through technology output, cooperation and co construction. Enterprises in the central and western regions should actively seek government support, accelerate the construction of digital infrastructure, enhance the digitalization level of the local market, and create broader market space for digital trade.

(4) Improve the legal and regulatory system for digital trade to ensure security and compliance. At the macro level, the government should accelerate the formulation and improvement of laws and regulations related to digital trade, such as cross-border data flow, digital payments, network security, etc., to ensure the compliance and security of digital trade. At the same time, international cooperation should be strengthened to play an active role in the formulation of global digital trade rules and create a favorable legal environment for the international expansion of Chinese enterprises. At the micro level, enterprises should strengthen compliance management, especially in cross-border digital trade, to ensure compliance in data protection, privacy protection, intellectual property, and other aspects. Enterprises should enhance their competitiveness and compliance in global digital trade through technological means and compliance management systems, and reduce legal risks. Especially for small and medium-sized enterprises, they should reasonably avoid legal risks and smoothly carry out international business under the policy and legal guidance provided by the government.

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