Digital Economy's Contribution to Sustainable Trade in Services: Empirical Evidence from China

Zhang Ning, Zhou Jiexuan*

College of Business, Yancheng Teachers University, Yancheng, Jiangsu 224000, China

Abstract: The Digital Economy has added new momentum to the long-term development of Trade in Services. Based on the panel data of China's provinces from 2011 to 2022, this paper studies the effect of the digital economy on trade in services empirically. Research shows that the digital economy has promoted the development of trade in services, and this effect is still evident after correcting for endogeneity and carrying out other checks. Based on the mechanism analysis, the two main ways that the digital economy promotes trade in services are changing the structure of industry and developing new high-quality productive forces. Based on the results of the heterogeneity test, there is a positive effect that is relatively stronger in the eastern coastal area and developed economically. Research has found that the effect of the digital economy on trade in services is non-linear and different at different levels of new quality productive forces. To promote the development of cross-border and regional trade in services, it is necessary to accelerate the construction of a digital economy infrastructure system, speed up industrial upgrading to promote the emergence of new competitive advantages, prioritise the development of new high-quality productive forces as an innovation engine, and implement regionally differentiated joint construction plans.

Keywords: Digital Economy; Empirical Evidence from China

0. Introduction

The Digital Economy is now one of the main forces of the world economy. With the development of advanced digital technologies such as the Internet of Things, cloud computing and artificial intelligence, changes have begun to spread in many parts of the world's economy. At this time, the widespread application of digital technology in all sectors and its close integration with the traditional sector have been driving a new era of development. Trade is a vital way to promote economic development; thus, it has been growing. With the development of the digital economy, the structure of China's trade has been changing significantly. With the development of the global digital economy, trade in services has become a vital component of international trade and is undergoing digital transformation. According to data from the United Nations Conference on Trade and Development (UNCTAD), global trade in services grew by approximately 7% in 2024, accounting for roughly half of the total growth in world trade, and its economic importance continues to rise. Against this backdrop, China has also vigorously promoted the development of its trade in services.The "14th Five-Year Plan for High-Quality Development of Foreign Trade" has stated that it will strengthen the integration of digital technology with the development of services trade, promote upgrading in the traditional service trade towards high quality, and explore new models for digital trade.

As the world's second-largest economy, China can fully leverage its strong strengths in the digital economy and the vigorous development of new quality productive forces to drive the sustained advancement of trade in services. As a typical developing country, China has collected data from 30 provincial-level administrative regions nationwide and conducted an empirical study to analyze the relationship between the digital economy and the sustainable development of trade in services. This research explores the underlying influencing factors, provides theoretical support for the future sustainable development of China's trade in services, and offers valuable reference insights for other developing countries to formulate policies promoting the transformation of trade in services..

1. Literature review

The Development of the digital economy is changing the shape of world trade. At present, domestic studies on the digital economy and trade have made some achievements, and the main directions are as follows.

First, some studies at home and abroad have begun to explore the links between the digital economy and trade. The first is that the development of the digital economy is changing the mode of globalisation in trade. By optimising the use of resources and promoting efficient trade, it has strengthened the overall strength of export-oriented enterprises and promoted high-quality development of foreign trade [1]. The development of the digital economy has promoted some progress in agricultural trade efficiency. It has had a good and relatively large positive effect on the country's export performance, and some spread has also occurred spatially [2][3]. The Digital Economy has also had various impacts on trade in the developing world, and especially in Africa, improvements in digital infrastructure have provided a good environment for the development of trade [4]. Therefore, developing countries need to make considerable investments in the construction of digital infrastructure and promote the development of their digital economy [5]. At the same time, the digital economy has promoted green development in trade [6]. Empirical studies show that the development of the digital economy has reduced China's per capita carbon emissions and enhanced the competitiveness of low-carbon manufacturing trade [7]; at the same time, it has optimised the industrial structure and reduced regional trade dependence [8][9][10]. Research shows that the digital economy and carbon emissions in the G7 countries are correlated; under the conditions of trade opening up, development of the digital economy has promoted cross-border energy trade, effectively reduced per capita carbon emissions, and thus promoted sustainable development [11]. The Digital Economy around the world has had many impacts on trade in services. It has improved the competitiveness of service exports and increased the amount of service trade [12]. It should be noted that in high-income countries, the development of digitalisation has shown more significant positive effects on service trade [13] and has thus promoted the expansion of global services trade [14].

Research at home and abroad on promoting the development of trade in services has focused on the following areas: First, trade agreements are affecting the growth of services trade. Tariffs, so high, may increase the cost of doing business; Therefore, we would be forced to sell [15][16]. Provisions on the flow of data are also needed to promote the development of services trade, [17]. Second, the expansion of economic freedom will affect the level of foreign services trade. Generally speaking, an increase in economic freedom will promote the growth of bilateral services trade [18], and enterprises will be more willing to export services to places with fewer restrictions [19]. However, the restraining effect of services trade barriers on large-scale enterprises is relatively weak, and therefore it is expected that the size of the firm will reduce this constraint on foreign trade. In addition, firm heterogeneity is also related to the development of foreign services trade. According to empirical research, the production efficiency of enterprises in services trade is generally higher than that in merchandise trade [20]. At the same time, religious factors have also been found empirically to affect the level of international services trade; thus, it can be concluded that culture and society are essential to the shape of the world economy [21]. Analysis of services trade in the Common Market for Eastern and Southern Africa shows that national GDP, trade distance and time differences are all correlated with services trade. Development of digital information technology will promote the further expansion of service trade [22]. Research on the services trade in the Association of Southeast Asian Nations has found that restrictions on this trade are a barrier to participating in global value chains and have had a negative impact on the countries that are members of the association. Therefore, it is urgent to reduce services trade barriers to improve the economic power of the region in the global economy [23].

Through the analysis of existing research at home and abroad, it has been found that while there is a large amount of study on the impact of the digital economy on trade, few scholars have

focused specifically on the mechanisms by which the digital economy affects services trade and have conducted in-depth analyses. Given that China is both the world's largest digital economy and is vigorously advancing the development of the country's trade in services, this paper takes China as an example to explore in depth the intrinsic links between the digital economy and trade in services. Based on data from the 30 provinces of China in 2011-2022, this paper will explore how the development of the digital economy in each province has influenced its regional trade in services. Through this study, it will add to the current research on the digital economy and trade in services, and also provide a practical reference for promoting the development of trade in services, as well as theoretical and practical guidance for understanding the changes and developments of trade in services under the background of the development of the digital economy.

2. Analysis of the Mechanism for the Development of the Digital Economy in Promoting the Development of Trade in Services.

2.1. Direct Effects of the Digital Economy on the Development of Trade in Services

Released in July 2024, the *White Paper on Global Digital Economy* by the China Academy of Information and Communications Technology (CAICT) noted that China's digital industry revenue reached 3124.7 trillion yuan in 2024, representing a year-on-year growth of 5.4%. As the world's second-largest economy, China accounts for a considerable share of global trade in services. Meanwhile, the digital economy has attracted widespread attention from all sectors of society, and relevant overseas research is also advancing steadily.Digital technology helps lower the costs of information in trade, increases the scale of trade, improves supply chain management, and so on; it can also spread trade knowledge. Secondly, the digital economy is based on modern information technology, which can spread knowledge and attract the concentration of technology and talent in a country. By improving the level of informatisation, it will attract high-tech industries and digital service agglomerations and provide support for various sectors. Thirdly, based on the analysis of the International Market Share (IMS) index, Revealed Comparative Advantage (RCA) index and Trade Competitiveness (TC) index, it can be seen that the digital economy is enhancing China's international competitiveness in trade of services and improving quality [24], reorganising the industrial system and promoting high-value-added development of industries[25]. Fourthly, due to deep-seated changes in the global economy, the traditional model of manufacturing has given way to a service-based system and reformed the old ways of trade. Most scholars have agreed that the digital economy has promoted the rapid growth of digital trade, driven the digitalisation of traditional industries and changed the structure of world trade. New technologies and the Internet will increase productivity in the service industry further by improving information flow.

Based on the research and analysis mentioned above, scholars believe that the digital economy can promote the development of trade in services in four ways: technological progress, information infrastructure, improvement of international competitiveness, and promotion of industrial structure adjustment. Based on the above results, we have constructed an initial system to explore how the digital economy promotes services trade. Therefore, research on the path through which development of the digital economy affects the expansion of services trade is needed. Based on the above research results, the hypothesis of this paper is as follows:

2.2. The Mediating Effect of Industrial Structure Upgrading in the Relationship between the Digital Economy and Trade in Services Development.

The changing of the structure of the industry is to shift from low-end, labour-intensive industries to high-end, high-tech, knowledge-intensive industries. The change is usually reflected in the ratio of tertiary to secondary industry output to show the level of industrial development and its economic effect after structural change [26]. The improvement will boost the general economic

strength of the industry and build a high-quality foundation for the development of trade in services.

With the development of the digital economy and its integration with the real economy, companies' digital capabilities have been gradually enhanced. Digital technology can help improve production efficiency, stimulate the development of new ideas, and reorganize the organization. It also provides some technical support for the transformation of traditional enterprises.

To enhance the utilization efficiency of resources and promote the free flow of factors, the digital economy will help rationally reform industrial structures. [27]. It will also change the proportion of inter-industry structures. Industrial structure upgrading is a typical case of this optimisation and will have some good promoting effects on the development of services trade. At the same time, due to technological progress, there has been an improvement in the structure of industry; thus, now we can (1) digitise cross-border delivery of traditional services, (2) break the spatial and temporal limitations of space and time with digital platforms, and (3) introduce new types of trade, such as data analysis and artificial intelligence applications. With the development of these high-end service areas, total output has risen and a good industrial foundation for the services trade has been laid by shifting resources from traditional sectors to new-era, high-value-added industries. At the same time, to boost the cost efficiency of the value chain, an improvement in the industrial structure can be made, integrating global industrial resources and expanding green models such as R&D outsourcing and remote collaboration to increase the integration of services trade in global value chains. In essence, the upgrade of industrial structure is to make full use of the technological advantage in the digital economy for service trade competitiveness. Based on the above mechanism, we put forward the following hypothesis:

2.3. The Mediating Effect of New Quality Productive Forces in the Relationship between the Digital Economy and Trade in Services Development

The digital economy will promote the development of trade in services and indirectly boost the formation of new high − quality factors of production. As an emerging type of economic system, the digital economy can enhance the economy's productivity through technological innovation and digital infrastructure, facilitate the transformation from traditional to high − quality factors of production, and foster the formation of high − end productive forces.

According to Marxist thought, digitalization has reformed the three main elements of the labor process: workers, tools, and subjects; thus, it has brought about an organized change in traditional factors of production.

First, new high − quality productive forces are upgrading the digital skills of workers. Service trade professionals will develop new services through the cultivation of interdisciplinary digital talent. Secondly, the intelligent upgrading of tools will expand the application scope and strengthen the international exchange capacity of service trade.Thirdly, there will be various types of labor subjects and forms. Big data analysis can help the company better understand its customers' needs, conduct targeted marketing, provide personalized services, introduce new service forms, etc., to offer technical support for cross − border delivery [28].By strengthening the new high − quality productive forces, the digital economy will enhance the efficiency and quality of services in digital platforms, cross − border outsourcing, e − commerce, etc., thus promoting the digitalization and globalization of trade in services.Therefore, there will be a positive transmission effect of the digital economy on new high − quality productive forces and services trade. Based on the above analysis, we put forward the following hypothesis:

2.4. Threshold Effects of the Digital Economy on the Development of Trade in Services.

The formation of the new quality productive forces is in a state of continuous, irregular change. The path of change at various times is not uniform, and there have been no sudden large jumps.

First, the production system should continue to attract high-quality talents and increase investment in top-tier research and development to expand the construction of the base. These are relatively new reasons, and their effect on production by means of innovation is not yet known. Although digitalisation and intelligentisation have started to appear in the services trade, overall upgrading is still in the process of gradual accumulation.

At the present time, general-purpose technologies such as big data and artificial intelligence are being used in all parts of the service trade. It will alter the old way of service provision and establish a new type of service, such as cross-border data service and cloud platform solution. The rate of increase in trade in services is relatively slow at this time, and there are few industrial chain synergies resulting from technology spillovers or economies of scale and scope that would promote non-linear growth in value creation. The crucial factor in qualitative breakthroughs of productivity's enabling effects on services trade is that the institutions, market ecosystems and technology for innovation must be in harmony. Therefore, it is necessary to identify the bottlenecks at different stages of the project accurately and distribute resources accordingly. Based on the above, we propose:

3. Model Setting and Variable Description

3.1. Variable Description

3.1.1 Explanatory Variables

TS The explained variable of this study is trade in services . Regarding related studies[26] [30], the total import and export volume of trade in services published in the China Commerce Yearbook will be used as the indicator to measure the development level of China's trade in services. Linear interpolation is used to add data for the missing parts and thus increase the completeness and consistency of the data.

3.1.2 Primary Explanatory Variables

DE The level of development in the digital economy is used as the main explanation in this study. Based on the previous studies[31][32][33], we will build a comprehensive index system that includes the three main parts of digital users, digital industries and digital transactions. The dimension of digital users indicates the development level of the digital economy in provinces across the country and is composed of four specific indicators: fibre-optic cable density, number of internet access ports, mobile telephone exchange capacity and internet penetration rate. The Digital Industry component refers to the development of information technology and telecommunications, and its three indicators are: the proportion of urban employment in information transmission, software and IT services; mobile phone penetration rate; and total volume of telecommunications business. Finally, the extent of digitalisation in terms of business scope refers to how widely digital technologies are employed in daily life; it is measured by four indicators: the scale of e-commerce procurement, the breadth of digital financial services coverage, the depth of use for digital finance, and the digitalisation level of financial services.

Table 1. Digital Economy Index System.

Level 1 indicators	Secondary indicators	Tertiary indicators	Indicators nature
Digital economy	Digital users	Fiber-optic cable density (kilometer/ ten thousand people)	+
		Number of internet access ports (ten thousand units)	+
		Mobile telephone exchange capacity (ten thousand subscriber units)	+
		Internet penetration rate	+
	Digital industries	The proportion of urban employment in information transmission, software, and IT services (%)	+
		Mobile phone penetration rate (units per people)	+
		Total telecommunications business volume (hundred million yuan)	+
	Digital transactions	E-commerce procurement value (hundred million yuan)	+
		Coverage breadth of digital finance	+
		Usage depth of digital finance	+
		Digitalization level of financial services	+

3.1.3 Control Variables

The development of China's trade in services is affected by many reasons, so this study will control for some of the factors that could influence trade in services. Based on the existing literature [1][30], the main control variables are: level of economic development (*GDP*), level of financial development (*Fdl*), local fiscal expenditure (*Expenditure*), tertiary industry employment (*Employment*), and foreign capital inflow (*Investment*). The level of economic development will change the scale, structure and foundation conditions for trade and thus affect the development speed of service trade. Regional financial development can promote the expansion of trade in services by strengthening financing for enterprise development and utilisation of resources. Local fiscal expenditure affects trade in services potential through infrastructure construction, improvement of the business environment, policy support and guidance from the government, etc. An increase in tertiary industry employment shows an expansion of the labour force in the service sector, and these people are needed to support industrial development and market expansion. At the same time, the inflow of foreign capital has increased the overall competitiveness of trade in services by introducing funds, new technologies and management experience.

3.1.4 Mediating Variables

Based on the above theoretical analysis, this paper will take industrial structure upgrading and the development level of new quality productive forces as mediating variables. For the upgrade of industrial structure, based on the research by Luo [34], it is shown by the ratio of the output value of the tertiary industry to that of the secondary industry. In terms of new quality productive forces, based on the previous research [35][36][37], this paper develops an index system in three dimensions: new quality labourers, new quality means of labour and new quality objects of labour. The specific selections of indicators are shown in Table 2.

Table 2 New Quality Productive Forces Indicator System.

Level 1 indicators	Secondary indicators	Tertiary indicators	Indicators nature
New quality laborers	New-type human capital investment	Fiscal expenditure on science and technology (hundred million yuan)	+
		Local fiscal expenditure on education (hundred million yuan)	+
	New-type human capital output	Average years of schooling (years)	+
		Number of R&D personnel (full-time equivalent, person-years)	+
New quality means of labor	Tangible means of production	Number of internet domain names (ten thousand units)	+
		Patents per capita	+
	Intangible means of production	Technology market transaction value (ten thousand yuan)	+
New quality objects of labor	Green sustainability	Forest coverage rate (%)	+
		Investment in pollution treatment (ten thousand yuan)	+
	Pollutant emissions	Waste generation/GDP	−
		Wastewater discharge/GDP	−
		SO_2 emission in waste gas/GDP	−

3.2. Data Sources

30 provinces and autonomous regions in China will be the sample, and data will be collected from 2011 to 2022. The selection is to study the related economic phenomena in all places as much as possible, and to exclude regions with insufficient data or special circumstances – that is, Tibet, Hong Kong, Macau and Taiwan of China are not included. For the data sources: The main indicator of services trade volume is the China Commerce Yearbook; the digital financial inclusion index, usage depth index and digitalisation level index are taken from research results by the Institute of Digital Finance at Peking University. The rest of the data are mainly obtained from the official economic information platform of China, such as the China Statistical Yearbook, China Statistical Yearbook on Science and Technology, Wind Database and CEIC Database. To address the lack of some data in the set, this paper will use linear interpolation for data filling. Stata 16.0 software was used for the analysis of the data, and the analysis was carried out in Stata 16.0. Table 3 is as follows:

Table 3. Variable selection.

Variable Type	Variable Name	Measurement Method
Dependent Variable	Trade in services (*TS*)	Total import and export volume of trade in services (trillion USD)
Independent Variable	Digital economy (*DE*)	Composite index calculated from the digital economy indicator system
Control Variables	Economic development level (*GDP*)	Per capita regional GDP (ten thousand yuan)
	Financial development level (*Fdl*)	(Year-end deposit balance of financial institutions + loan balance of financial institutions)/regional GDP
	Local fiscal expenditure (*Expenditure*)	Local government general budget expenditure (hundred million yuan), log-transformed
	Tertiary industry employment (*Employment*)	Employment in tertiary sector (people), log-transformed
	Foreign capital inflow (*Investment*)	Actual utilized FDI (ten billion USD)

Mediating Variables	Industrial structure upgrading (*Upgrade*)	Tertiary sector output value/secondary sector output value
	New quality productive forces (*Npqf*)	Composite index calculated from the new quality productive forces indicator system

3.3. Descriptive Statistical Analysis

Table 4 is the description of the statistical parameters for some basic information in this paper. The mean of the trade in services variable is 0.0253, and its standard deviation is 0.0466; thus, there are relatively small fluctuations in the total amount of provincial service trade. The mean value of the digital economy index is 0.1881, and the standard deviation is 0.1031; these are relatively close, and the difference between the maximum and minimum values indicates that some regions have developed much better than others. The dataset is a balanced panel, and there are no missing values in any of the variables (N=360).

Table 4. Summary statistics.

Variable	N	Mean	S.D.	Min	Max
TS	360	0.0253	0.0466	0.0000	0.2496
DE	360	0.1881	0.1031	0.0372	0.6788
GDP	360	5.8719	3.0661	1.6024	19.0313
Fdl	360	3.4321	1.0963	1.6776	7.6095
Expenditure	360	8.4352	0.5989	6.5595	9.8273
Employment	360	6.7265	0.7560	4.7095	8.2306
Investment	360	1.0132	2.0105	0.0003	18.4002

3.4 Model Setup

3.4.1 Baseline Regression Model

Based on the above theoretical analysis, the following baseline regression model is employed to study the effect of the digital economy on the level of development of trade in services: $TS_{i,t} = \alpha_0 + \alpha_1 DE_{i,t} + \alpha_2 Controls_{i,t} + \sum id + \sum year + \varepsilon_{i,t}$ (1)

$TS_{i,t}$ As shown in Equation (1), Yt is the development level of trade in services for province in year t; Xt is the digital economy development level for province in year t; β is the constant term; Zt are the parameters to be estimated; Wt are the control variables; α represents the fixed effects of province; γ is the time fixed effects; and ε is the random error term.

$t\ t\ DE_{i,t}\ t\ t\ \alpha_1\ \alpha_1\ \alpha_2\ Conrtols,t\ id\ year\ \varepsilon_{i,t}$

3.4.2 Mediation Effect Model

The old mediation effect model cannot guarantee that the mediating variable is exogenous in reality; as a result, it may be biased by endogeneity and has low statistical power. In light of the above deficiencies, this paper will use the mediation effect test method proposed by Jiang [38] and establish independent linear regression equations to regress the explanatory variable digital economy on industrial structure upgrading and new quality productive forces. In equations (2) and (3), x denotes the industrial structure upgrading of the province in year t; y is the development level of new quality productive forces in the province in year t; and α, β are constant terms, while γ and δ are parameters to be estimated.

$$Upgrade_{i,t} = \beta_0 + \beta_1 DE_{i,t} + \beta_2 Controls_{i,t} + \sum id + \sum year + \varepsilon_{i,t} \quad (2)$$

$$Nqpf_{i,t} = \lambda_0 + \lambda_1 DE_{i,t} + \lambda_2 Controls_{i,t} + \sum id + \sum year + \varepsilon_{i,t} \quad (3)$$

3.4.3 Threshold Effect Model

To explore the various ways in which the development of the digital economy affects trade in services at different stages of the construction of new quality productive forces comprehensively, a single-threshold model is employed for empirical verification, and the following model is

constructed:
$$TS_{i,t} = \gamma_0 + \gamma_1 DE_{i,t} \times I(Nqpf_{i,t} \le \theta_1) + \gamma_2 DE_{i,t} \times I(Nqpf_{i,t} > \theta_1) + \gamma_3 Controls_{i,t} + \sum id + \sum year + \varepsilon_{i,t} \quad (4)$$

γ_2 γ_2 θ_1 $I(\cdot)$ As shown in equation (4), this is the impact coefficient of the digital economy on trade in services development at different thresholds; δ is the estimated threshold value; $I(\cdot)$ is an indicator function that takes the value of 1 if the condition in parentheses is met, and 0 otherwise. All other variable symbols are the same as in Equations (1) − (3).

4. Experimental Results and Analysis

4.1. Baseline Regression Results

Table 5 shows the results of the baseline regression based on a two-way fixed-effects model to examine the effect of the digital economy on trade in services. According to the above results, the development of the digital economy has promoted services trade to a certain extent; either way, the effect is significant. Strongly speaking, many changes have occurred in the digital economy, and thus trade barriers have decreased significantly due to new technologies; at the same time, enterprises are more able to access foreign markets through digital platforms, spreading information and growing overseas faster, which has increased trade. At the same time, with the development of digital finance, it has been convenient to lower cross-border payment costs and exchange rate risks to create a stable and efficient payment system for overseas service trade. With the development of the digital economy, many new areas and types of services have emerged, such as digital finance, distance education, telemedicine, etc., and they are gradually being incorporated into the field of China's services trade.

Regarding the control variables, the level of local economic development is positively and significantly correlated with trade in services, which is consistent with the actual situation. Generally speaking, the service trade sector in areas with a relatively developed economy is more vibrant. The growth in China's services trade volume is mainly attributed to economic development. Therefore, to promote the development of the services trade, regional economic development should be promoted.Local fiscal expenditure is also positively correlated with the level of services trade. The progress of trade is bound to receive some support from the government. Thus, the government should actively increase investment in infrastructure construction and other necessary work. Fiscal allocations from the government will provide the basic material support and policy guidance for the development of the services trade and facilitate its growth.

Table 5. Benchmark Regression Results.

Variable	(1)	(2)
	TS	*TS*
DE	0.1778***	0.1172***
	(0.0385)	(0.0409)
GDP		0.0030**
		(0.0013)
Fdl		0.0034
		(0.0026)
Expenditure		0.0191***
		(0.0071)
Employment		0.0043
		(0.0041)
Investment		0.0004
		(0.0009)
Control variables	NO	YES
Province FE	YES	YES
Year FE	YES	YES
Constant	0.0782***	−0.1476**
	(0.0112)	(0.0604)
Observation	360	360
R^2	0.9705	0.9728

Note: ***, **, * refer to the 1%, 5% and 10% significance levels, respectively. Standard Errors are in parentheses.

4.2. Robustness Test

To verify that the above results are stable, a few robustness checks were carried out. First, given that the COVID-19 pandemic would have a significant impact on the world's services trade in 2020, we chose to limit the re-estimation period to 2011-2019 so as not to be affected by this external factor. Secondly, given that the four direct-controlled municipalities of China (Beijing, Shanghai, Tianjin and Chongqing) have a special administrative status, we have omitted them from this analysis to avoid skewing the results. Third, 1% winsorisation was used to deal with the problem of outliers and then the regressions were run again. As shown in Table 6, all robustness checks are in line with the results of our base estimates; thus, the conclusions are reliable.

Table 6. Robustness Test.

Variable	2011-2019	Excluding the direct-controlled municipalities	Winsorize
	(1)	(2)	(3)
	TS	*TS*	*TS*
DE	0.1455***	0.0982**	0.1103***
	(0.0477)	(0.0429)	(0.0307)
Control variable	YES	YES	YES
Province FE	YES	YES	YES
Year FE	YES	YES	YES
Constant	−0.1051	−0.1811**	−0.1068*
	(0.0806)	(0.0734)	(0.0568)
Observation	270	312	360
R^2	0.9812	0.9541	0.9763

Note: ***, **, * are at the 1%, 5%, and 10% significance levels, respectively. Standard Errors are

in parentheses.

4.3. Endogeneity Tests

Due to deficiencies in the data available and the authors' own understanding, it was not possible to add all possible reasons for the development level of trade in services to the model variables. Therefore, there may be omitted-variable bias in this study. To address this problem, we adopted the method put forward by Lei [39], delayed all explanatory variables except for the digital economy by one period, and then re-estimated. As shown in Table 7, after addressing the problem of endogeneity, the regression results still indicate that the digital economy has a positive and statistically significant impact on the development of service trade. This result can be added to support the above conclusions.

Table 7. Endogeneity test results.

Variable	(1)
	TS
DE	0.1305***
	(0.0483)
L.GDP	0.0017
	(0.0016)
L.Fdl	0.0048
	(0.0030)
L.Expenditure	0.0229***
	(0.0081)
L.Employment	0.0044
	(0.0045)
L.Investment	−0.0011
	(0.0010)
Control variables	YES
Province FE	YES
Year FE	YES
Constant	−0.1736**
	(0.0702)
Observation	330
R^2	0.9757

Note: ***, **, * refer to 1%, 5% and 10% significance levels. The Standard Error is in parentheses.

4.4. Mediating Effect

To study the impact of the digital economy on trade in services, this paper will use the theoretical framework of industrial structure upgrading and new quality productive forces as mediating variables, and the regression results are shown in Table 8. The research shows that the development of the digital economy is advancing the high-quality development of industries, and thus, with the widespread use of digital technology, traditional service industries are gradually being reformed and higher-value-added forms of business are emerging; therefore, trade in services is also expanding. In addition, the digital economy has been shown by statistics to boost the development of China's new quality productive forces. Artificial intelligence, big data and blockchain technology can be used to increase the total factor productivity of various sectors and raise the overall productivity of society, providing strong support for the development of the services trade. Therefore, the government will strengthen digital construction of traditional services, shift more resources to high-tech services, and speed up the industrial upgrading of the entire economy. At the same time, more funds need to be put into cultivating new high-quality

forces of labour to support the innovation-driven development of trade in services.

Table 8. Results of the Mediation Effect Test.

Variable	(1)	(2)
	Upgrade	*Nqpf*
DE	0.7063**	0.2552***
	(0.3585)	(0.0568)
Control variable	YES	YES
Province FE	YES	YES
Year FE	YES	YES
Constant	2.3618**	−0.2515*
	(0.9335)	(0.1295)
Observation	360	360
R^2	0.9716	0.9753

Note: ***, **, * represent 1%, 5% and 10% significance levels, respectively. The standard error is in parentheses.

4.5. Heterogeneity Analysis

Given that the regions are quite different, we will perform a heterogeneity analysis. The first is to divide China into the east, the centre and the west for comparison. Based on the above empirical results, although the digital economy has been promoting the development of China's services trade at all levels nationwide, it has done so to different extents in various areas. The regression coefficient of eastern China is significantly higher than that in central and western China; it may be that the eastern region has a more developed economy and mature industrial structure, so it can better utilize the digital economy for trade facilitation. Drawing on the research of others [40], we have divided the 30 provinces of China into economically developed and less - developed areas. As expected, the regression coefficients are relatively large in developed areas, which suggests that these regions have witnessed more significant developments in infrastructure construction, technological innovation, policy support, etc., which can boost the synergy of digital trade. Based on the above results, to promote the all - around development of the trade in services across China, it is recommended that relevant authorities strengthen support policies for the digital economy in central, western and other areas, and make full use of the demonstration effect of eastern and developed regions to drive the integrated growth of all regions.

Table 9. Results of Heterogeneity Analysis.

Variable	Eastern China	Central China	Western China	Developed regions	Less developed regions
	(1)	(2)	(3)	(4)	(5)
	TS	*TS*	*TS*	*TS*	*TS*
DE	0.1379**	0.0263***	0.0487***	0.1520**	0.0396***
	(0.0544)	(0.0086)	(0.0110)	(0.0631)	(0.0075)
Control variable	YES	YES	YES	YES	YES
Province FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Constant	−0.2872***	−0.0582**	−0.0175	−0.4878***	0.0072
	(0.0923)	(0.0250)	(0.0303)	(0.1637)	(0.0179)
Observation	156	72	132	96	264
R^2	0.9717	0.9321	0.8382	0.9687	0.8550

Note: ***, **, * are at the 1%, 5%, and 10% significance levels, respectively. The Standard Errors

are in parentheses.

4.6. further analysis

In order to examine the non-linear relationship among the digital economy and trade in services, a new quality productive force will be introduced as the threshold variable, and bootstrap tests will be used to determine whether a threshold effect exists. As shown in Table 10, according to the test results, there is a single-threshold effect with statistical significance; however, both the double-threshold and triple-threshold effects are not statistically significant. Based on the above results, it can be concluded that the effect of the digital economy on trade in services is non-linear, and the threshold factor for this non-linearity is new quality productive forces.

Table 10. Threshold Effect Test.

Number of thresholds	F value	P value	10% critical value	5% critical value	1% critical value
Single threshold	58.76	0.0000	19.7584	25.6997	32.5529
Double threshold	17.77	0.1000	17.5396	22.0183	32.5589
Triple threshold	8.68	0.6467	28.1328	36.5739	66.5521

Table 11 is the result of threshold regression with new quality productive forces as the threshold variable. Based on the above results, it was found that the upper limit was about 0.5027. If the lower bound of the new level of high-quality production forces is lower than this threshold, the digital economy will reduce trade in services. However, after the new quality productive forces exceed 0.5027, the digital economy will have a positive effect on the growth of services trade. There are the following reasons for the non-linear relationship. In areas where the development level of new quality productive forces is relatively low, there may be a lack of good digital infrastructure and a shortage of high-end technical talents to fully take advantage of the digital economy for trade expansion. At the same time, at the level of the development of high-end new quality productive forces, innovation capacity, construction of industrial chains and advanced technological ecosystems will jointly reduce transaction costs and expand market coverage through the application of digital technology. In addition, areas that have developed a relatively large number of new quality productive forces are usually open to foreign investment and have strong institutions supporting the digital economy; thus, the growth of service trade in these regions has been promoted.

Table 11. Threshold Model Parameter Estimates.

	Coefficient
Nqpf≤0.5027	−0.0026
	(0.0216)
Nqpf>0.5027	0.0534*
	(0.0275)

Note: ***, **, * represent 1%, 5% and 10% significance levels, respectively. Standard Errors are in parentheses.

5. Conclusion and Policy Recommendations

Based on the panel data of the 30 provinces in China from 2011 to 2022, this paper thoroughly studies the impact of the digital economy on trade in services and draws the following conclusions. First of all, the development of the digital economy is positively related to trade in services, and this result is still valid after a series of robustness tests and addressing endogeneity. Second, industrial structure upgrading and new quality productive forces are also important mediators in the process of the digital economy promoting the growth of trade in services. Thirdly, the impact

of the digital economy on trade in services is not uniform across all regions, and it has been more positive in eastern coastal areas and economically developed areas. Finally, using the new quality productive forces as a threshold variable in the threshold effect model, it was found that the promoting effect of the digital economy on trade in services is nonlinear.

Based on the research results above, the following targeted policy recommendations are put forward in this paper. First, it is necessary to strengthen the foundation and support system of the digital economy to ensure continuous development and good health of trade in services. The government should increase investment in the development of the digital economy and enhance its all-round development at the national level. Priority should be given to the construction of 5G networks in the economically developed eastern parts of China, and at the same time, efforts to improve the digital infrastructure in the central and western regions need to be strengthened to narrow the gap in development and prevent the occurrence of a "digital divide". In addition, policies and regulations should be adjusted to encourage service-related enterprises in the trade to proactively use digital technologies to boost their international competitiveness and promote the continuous development of China's service trade.

Secondly, the restructuring and upgrading of industry will increase the volume of service trade exports. Promoting the digitalisation, intelligence and environmental friendliness of traditional industries will boost their competitiveness in the international market and provide high-quality products and services to support trade in services. Also, full support needs to be provided to the new industries closely linked to the digital economy, such as IT service companies, educational institutions, financial institutions and others, to give new life to the development of trade in services.

Finally, cultivating and utilising the new quality productive forces is to promote harmonious development of trade in services in the region. Through the advancement of new quality productive forces, a favourable economic environment for the development of service trade can be created. At the same time, efforts should also be made to nurture high-quality talent and improve the professional skills of workers to provide high-quality human resources for the digital economy and service trade sectors. According to the characteristics of different regions and industries, personalised strategies should be formulated to take advantage of the leading role of the eastern and more developed areas and promote the development of the central, western and less-developed areas to achieve balanced progress of trade in services across the country.

To ensure the good operation of the above measures, institutional and policy reforms need to be implemented. The relevant departments of the government should provide important support and participate in formulating global digital trade rules to help China strengthen the quality of its trade in services as it expands in scale and achieve leapfrog sustainable development.

References:

[1]Yuan H, Peng G, Song C, Wang L, Lu S. Enhancing digital economy: Optimizing export enterprise markup and resource allocation efficiency. Journal of the Knowledge Economy. 2024 Jun; 1-36. https://doi.org/10.1007/s13132-024-02142-1

[2]Xiao Y, Abula B. Examining the impact of digital economy on agricultural trade efficiency in RCEP region: A perspective based on spatial spillover effects. Journal of the Knowledge Economy. 2024 Sep; 15(3):9907-9934. https://doi.org/10.1007/s13132-023-01484-6

[3]Liu Y, Dong Y, Qian W. Digital economy and China's agricultural exports: based on trade cost and market competition effect. China Agricultural Economic Review. 2024 Jul; 16(3):489-506. https://doi.org/10.1108/CAER-08-2023-0213

[4]Bunje MY, Abendin S, Wang Y. The multidimensional effect of financial development on trade in Africa: The role of the digital economy. Telecommunications Policy. 2022 Nov; 46(10): 102444.

https://doi.org/10.1016/j.telpol.2022.102444

[5]Herman PR, Oliver S. Trade, policy, and economic development in the digital economy. Journal of Development Economics. 2023 Sep; 164:103135. https://doi.org/10.1016/j.jdeveco.2023.103135

[6]Xu Y, Chen Y, Shi X. Does the digital economy empower the green development of foreign trade? Environmental Science and Pollution Research. 2023 Nov; 30(51):110395-110416. https://doi.org/10.1007/s11356-023-30076-9

[7]Ou X, Zhao W, Zheng Z, Mohiuddin M. Towards Green Trade: Digital Economy and Export Quality of Green Products. Research in International Business and Finance. 2025 Mar; 75:102777. https://doi.org/10.1016/j.ribaf.2025.102777

[8]Ma Q, Khan Z, Tariq M, IŞik H, Rjoub H. Sustainable digital economy and trade adjusted carbon emissions: Evidence from China's provincial data. Economic research-Ekonomska istraživanja. 2022 Feb; 35(1):5469-5485. https://doi.org/10.1080/1331677X.2022.2028179

[9]ian Y, Hu J, Yang Z, Chen J. THE IMPACT OF DIGITAL ECONOMY ON THE LOW-CARBON TRADE COMPETITIVENESS OF CHINA'S MANUFACTURING INDUSTRY. Environmental Engineering & Management Journal (EEMJ). 2024 Aug; 23(8):1699-1710. https://doi.org/10.30638/eemj.2024.137

[10]Luo Q, Zhang D, Wang H. Digital economy, industrial structure, and regional trade dependence: Mechanism analysis based on Chinese City Data. Sustainability. 2023 Aug; 15(17):13055. https://doi.org/10.3390/su151713055

[11]Wang Q, Cheng X, Li R. Does the digital economy reduce carbon emissions? The role of technological innovation and trade openness. Energy & Environment. 2023 Sep; 0958305X231196127. https://doi.org/10.1177/0958305X231196127

[12]Li H, Han J, Xu Y. The effect of the digital economy on services exports competitiveness and ternary margins. Telecommunications Policy. 2023 Aug; 47(7): 102596.https://doi.org/10.1016/j.telpol.2023.102596

[13]Yin ZH, Choi CH. How does Digitalization Affect Trade in Goods and Services? Evidence from G20 Countries. Journal of the Knowledge Economy. 2024 Jun; 1-25. https://doi.org/10.1007/s13132-024-02029-1

[14]Jiang M, Jia P. Does the level of digitalized service drive the global export of digital service trade? Evidence from global perspective. Telematics and Informatics. 2022 Aug; 72:101853. https://doi.org/10.1016/j.tele.2022.101853

[15]Chen Q, Shen Y. Deep trade agreements and services trade: An analysis based on service trade provisions. The World Economy. 2024 Mar; 47(7):2909-2946. https://doi.org/10.1111/twec.13563

[16]Wu J, Luo Z, Wood J. How do digital trade rules affect global value chain trade in services? —Analysis of preferential trade agreements. The World Economy. 2023 Apr; 46(10):3026-3047. https://doi.org/10.1111/twec.13412

[17]Ma S, Shen Y, Fang C. Can data flow provisions facilitate trade in goods and services? —Analysis based on the TAPED database. The Journal of International Trade & Economic Development. 2024 Feb; 33(3):343-368. https://doi.org/10.1080/09638199.2023.2179860

[18]Kimura F, Lee HH. How does economic freedom affect international trade in services? Journal of Korea Trade. 2008 Apr; 12(3):1-28.

[19]Benz S, Rouzet D, Spinelli F. Firm heterogeneity in services trade: Micro-level evidence from eight OECD countries. The World Economy. 2020 Sep; 43(11):2905-2931. https://doi.org/10.1111/twec.13031

[20]Morikawa M. Firm heterogeneity and international trade in services. The World Economy. 2018 Jul; 42(1):268-295. https://doi.org/10.1111/twec.12699

[21]Lee CW. Does religion affect international trade in services more than trade in goods? Applied Economics Letters. 2013 Mar; 20(10):998-1002. https://doi.org/10.1080/13504851.2013.770120

[22]Majune SK, Kaaria JK, Kihiu EN. Determinants of intra-COMESA trade in services. African Development Review. 2023 Oct; 35(4):416-428. https://doi.org/10.1111/1467-8268.12715

[23]Findlay C, Roelfsema H. Services trade in the ASEAN region and participation in GVCs. Journal of the Asia Pacific Economy. 2023 Jul; 28(3):986-1006. https://doi.org/10.1080/13547860.2021.1920658

[24]Agmon T. The new distributed digital technology world trade and MNEs: Another step in the inventive process. European Journal of International Management. 2020 Dec; 15(1):135-145. https://doi.org/10.1504/EJIM.2021.111945

[25]Di C, Tang D, Xu Y. Impact of digital economy on the high-quality development of china's service trade. Sustainability. 2023 Aug; 15(15):11865. https://doi.org/10.3390/su151511865

[26]Chen Y, Bao H. An empirical analysis of the impact of the development of science and Technology Finance on the upgrading of industrial structure. Statistics & Decision. 2017 Aug; 15,170-173. https://doi.org/10.13546/j.cnki.tjyjc.2017.15.041

[27]Wang Y, Li L. Digital economy, industrial structure upgrading, and residents' consumption: Empirical evidence from prefecture-level cities in China. International Review of Economics & Finance. 2024 Apr, 92:1045-1058. https://doi.org/10.1016/j.iref.2024.02.069

[28]Wagner J. Big Data Analytics and Exports—Evidence for Manufacturing Firms from 27 EU Countries. Open Economies Review. 2024 Jun; 1-10. https://doi.org/10.1007/s11079-024-09777-2

[29]Xu G, Xue T, Liu P. Digitalization and Service Trade - A Study Based on China's Provincial Panel Data. Journal of Shandong University (Philosophy and Social Sciences). 2024 Apr; (03):105-115. https://doi.org/10.19836/j.cnki.37-1100/c.2024.03.010

[30]Breinlich H, Criscuolo C. International trade in services: A portrait of importers and exporters. Journal of International Economics. 2011 Jul; 84(2):188-206. https://doi.org/10.1016/j.jinteco.2011.03.006

[31]Pan W, Xie T, Wang Z, Ma L. Digital economy: An innovation driver for total factor productivity. Journal of Business Research. 2022 Feb; 139:303-311. https://doi.org/10.1016/j.jbusres.2021.09.061

[32]Zhang W, Zhao S, Wan X, Yao Y. Study on the effect of digital economy on high-quality economic development in China. PloS One. 2021 Sep; 16(9):e0257365. https://doi.org/10.1371/journal.pone.0257365

[33]Wang J, Dong K, Dong X, Taghizadeh-Hesary F. Assessing the digital economy and its carbon-mitigation effects: The case of China. Energy Economics. 2022 Sep; 113:106198. https://doi.org/10.1016/j.eneco.2022.106198

[34]Luo J, Sun Y, Li R. Reexamination of the Economic Differentiation between North and South China: A Dual Perspective on the Movement of the Economic Dividing Line and the

Decomposition of the Contribution to Growth Rate. South China Journal of Economics. 2024 Mar; (05):51-74. https://doi.org/10.19592/j.cnki.scje.412446

[35]Huang Q, Guo W, Wang Y. A Study of the Impact of New Quality Productive Forces on Agricultural Modernization: Empirical Evidence from China. Agriculture. 2024 Oct; 14(11):1935. https://doi.org/10.3390/agriculture14111935

[36]Liu Y, He Z. Synergistic industrial agglomeration, new quality productive forces and high-quality development of the manufacturing industry. International Review of Economics & Finance. 2024 Jul; 94:103373. https://doi.org/10.1016/j.iref.2024.103373

[37]Chen X, Wu Y. A Study on the Mechanisms of New Quality Productive Forces Enabling the Upgrading of the Modern Tourism System: Evidence from China. Sustainability. 2025 Mar; 17(5):2232. https://doi.org/10.3390/su17052232

[38]Jiang T. Mediating Effects and Moderating Effects in Causal Inference. China Industrial Economics. 2022 Jun; (05):100-120. https://doi.org/10.19581/j.cnki.ciejournal.2022.05.005

[39]Lei H, Jin M. Digital Inclusive Finance of Banks, Bank Competition and Firms' Financial Constraints. The Theory and Practice of Finance and Economics. 2021 Nov; 42(06):2-9. https://doi.org/10.16339/j.cnki.hdxbcjb.2021.06.001

[40]Tang Y, Lv T. The impact of digital economy development on urban employment in China. Urban Problems. 2022 Jul; (03):66-75. https://doi.org/10.13239/j.bjsshkxy.cswt.220307