The Impact of Digital Trade Development on the Technological Sophistication of Manufacturing Exports

Shanfei Zhang *

School of Business, Beijing Language and Culture University, Beijing, China, 100083

* Corresponding Author Email: shanfei_zsf02@163.com

Abstract. As a new trade model, digital trade has a significant impact on economic development. China attaches great importance to the development of digital trade, but the added value of export products lacks competitive advantages, and there is an urgent need to improve the technical complexity of exports. In this study, we sort out the research related to digital trade and export technical complexity, analyse its current situation and shortcomings, and test it by constructing double fixed model, mediation model and threshold effect model. The results show that digital trade can improve the export technology complexity and has regional heterogeneity. In addition, industrial structure upgrading plays an intermediary role and threshold effect in it. Based on the above research content and conclusions, this study puts forward a series of policy recommendations, aiming to provide reference for the development of digital trade and the enhancement of export technological complexity.

Keywords: Digital Trade, Export Technological Sophistication, Mediation Effects.

1. Introduction

Against the backdrop of the swift expansion of the global digital economy, digital trade is reconfiguring the landscape of international trade dynamics. This reconfiguration entails shifts in trade flows, value-creation mechanisms, and competitive advantages across nations. However, China's position within the global value chain remains confined to the middle-to-lower tiers, with its foreign trade being characterized by a large scale but lacking in both strength and comprehensive excellence. Most exports are low-end, leading to "low-end lock-in" and difficulty in enhancing product value. Despite a rising share of high-value-added exports, China still lags behind developed countries—for instance, high-tech exports accounted for around 30% in 2020, compared to over 40% in developed nations. Amid intensifying global trade competition, diversifying consumer demands, and tightening resource constraints, enhancing export technological sophistication is critical for China's foreign trade transition from "quantitative" to "qualitative" growth [1]. Digital trade, powered by digital technologies, can profoundly impact the construction of a higher-level open economy [2]. To become a strong trading nation, it is essential to explore digital trade's mechanism on export technological complexity and leverage it to promote technological upgrading and diversification, thereby securing a competitive edge and meeting market demands.

This study uses a fixed-effects panel model to test digital trade's direct effect on export technological complexity and, via a mediation model, concludes that industrial structure upgrading mediates this effect. A threshold effect model further reveals industrial structure upgrading's single threshold role in digital trade's promotion of export technology complexity. Based on these findings, the study offers targeted strategies for China's high-quality digital trade development. Theoretically, it enriches international trade and industrial economics by integrating digital elements. Practically, it aids enterprises in breaking "low-end lock-in," adapting to digital trade, optimizing production, and enhancing export competitiveness. It also supports regional synergistic development and informs national trade strategies and policies, guiding China toward trade power status.

2. Literature review

2.1. Impact effects of digital trade

Digital trade represents a novel form of trade that leverages the Internet and digital technologies to facilitate cross-border transactions and flows through digital platforms and services. Currently, there is no unified measurement methodology or statistical data available globally; however, the connotation and subject matters of digital trade are gradually expanding. Scholars hold differing views on the definition of digital trade: some scholars argue that digital trade is an extension and expansion of traditional trade in the digital economy era [3]; others explore its fundamental concepts by collating definitions and constructing dimensions [4]; some studies suggest that the definition of digital trade should be inclusive, understood in light of practical needs and specific objectives [5]. In terms of measuring the development level of digital trade, scholars have established multi-dimensional indicator systems. These evaluation frameworks encompass environmental, talent, infrastructure, industrial foundation, policy, and current situation aspects [6], or assess from four dimensions: digital technology application, trade methods, capabilities, and potential [7].

By capitalizing on its comparative strengths in data resources and information technology capabilities, digital trade is rapidly emerging as a novel and formidable driver in the evolution of global trade dynamics. In-depth analysis of its impact can facilitate sustainable trade development and provide support for policy formulation and corporate decision-making. Digital trade can enhance economic resilience and risk resistance [8], drive economic growth [9], promote the development of the digital economy and trade digitization [10], and provide opportunities for small and medium-sized enterprises (SMEs) to participate in international trade [11]. As traditional trade rule systems need to adapt to digital and networked characteristics, research on digital trade governance and regulation is attracting increasing attention [12]. Digital trade operates through pathways such as promoting technological innovation [13], fostering consumption demand growth [14], and upgrading industrial structures [15], with regional disparities evident in its development in China [16].

2.2. Export Sophistication

Export technological sophistication is a crucial indicator for measuring the technological content and competitiveness of a country's exported products. The early-established Export Similarity Index (ESI) assesses technological gaps by comparing export structure similarities, revealing a positive correlation between trade competition intensity and technological position. The per capita GDP-weighted EXPY index method is widely applied to quantify the technological content of a country's exports, highlighting the dominant role of high-income economies in exporting complex technological products [17]. Subsequent studies, by stripping out the added components of imported intermediates using input-output tables, have constructed the Domestic Technological Content (DTC) index to correct measurement biases [18].

The influencing factors of export technological sophistication can be categorized into three groups: Firstly, basic production factors, where the accelerated flow of production factors, driven by new quality productivity, optimizes the organizational efficiency of export industries and drives their improvement [19]; Secondly, innovation levels, where increased human capital investment, innovation inputs, and foreign capital inflows can enhance corporate innovation capabilities and promote their advancement [20-22]; Thirdly, external environments, where financial openness, improved legal systems, and new infrastructure construction can all contribute to its enhancement [23-25].

There are significant regional disparities in export technological sophistication, with developed regions forming technological barriers in fields such as the digital economy and high-end equipment, while central and western regions, constrained by factors such as a weak innovation ecosystem, still concentrate exports on resource-intensive and labor-intensive products, facing bottlenecks in technological sophistication improvement [26].

Based on existing literature, digital trade and export technological sophistication, as important research directions in the field of international trade, have yielded rich results. However, current research has deficiencies: the internal mechanisms between digital trade and export technological sophistication are not thoroughly explored, and regional heterogeneity analysis needs strengthening; research on how digital trade affects export technological sophistication through intermediary variables such as industrial structure upgrading is scarce; there is a lack of systematic exploration of the pathways to enhance export technological sophistication under the backdrop of digital trade, and the theoretical framework needs further refinement.

3. Influence Mechanisms and Research Hypotheses

3.1. The Impact of Digital Trade on Export Technological Sophistication

The rapid development of digital technology has not only transformed traditional trade patterns but also given rise to digital trade, a new form of trade. Leveraging its unique digital characteristics, digital trade can effectively drive the enhancement of export technological sophistication. On the one hand, digital trade promotes the upgrading of export technological sophistication by "reducing costs and increasing efficiency." As the manifestation of digital trade in foreign trade, the digital economy can drive the continuous upgrading of export technological sophistication by decreasing the intensity of enterprises' human capital and R&D expenditure [27]. On the other hand, digital trade advances export technological sophistication through "innovation leadership." By expanding market boundaries and intensifying market competition, digital trade prompts enterprises to continuously seek technological innovations to enhance their competitiveness [28]. Additionally, digital trade facilitates the digital transformation and upgrading of associated industries, thereby propelling the extension of industrial chains toward higher-value-added segments. This process incentivizes relevant enterprises to collaboratively enhance the technological sophistication of their products and services, fostering a competitive edge in the global marketplace [29]. Based on the above analysis, this study proposes the following hypothesis:

Hypothesis 1 Digital trade has a positive impact on export technological sophistication.

3.2. The Path Mechanism of Digital Trade in Promoting Export Technological Sophistication

Among the various factors that influence the effect of digital trade on the technological sophistication of exports, industrial structure upgrading serves as a crucial intermediary, constituting an important transmission mechanism. The expansion of digital trade activities propels the digital transition of conventional industries at an accelerated pace [30]. This transformation is marked by improvements in the industrial structure, resource allocation, and the innovation capacity and efficiency of the entire industrial chain. This upgrading process strengthens enterprises' competitiveness in the international market [31] and enables them to produce higher-quality, high-tech products, thereby promoting the upgrading of export technological sophistication. Furthermore, digital trade further advances the high-end and intelligent transformation of the industrial structure through technology spillover effects and the sharing of innovative resources. Consequently, the process of industrial structure upgrading functions as an intermediary mechanism that bridges the relationship between digital trade and the technological sophistication of exports. This intermediary role is instrumental in fostering the development of international trade by promoting technological advancement and industrial efficiency. Based on the above analysis, this study proposes the following hypothesis:

Hypothesis 2 Digital trade can promote the upgrading of export technological sophistication by enhancing the degree of industrial structure upgrading.

3.3. The Non-linear Impact of Digital Trade on Export Technological Sophistication

Existing research indicates that the promotion of digital trade on export technological sophistication is not linearly increasing but exhibits a significant threshold effect. When the degree of industrial structure upgrading crosses a specific critical value, the technology spillover effect of digital trade will increase exponentially. This primarily stems from two aspects: firstly, in the initial stage, digital trade primarily enhances efficiency by reducing transaction costs and optimizing resource allocation, while its innovation catalysis is fully unleashed only after the industrial foundation is consolidated; secondly, the agglomeration of high-value-added industries generates externalities, causing the marginal benefits of digital technology to increase with the complexity of the industry [32]. Therefore, there exists a non-linear relationship of "scale threshold-efficiency leap" in the promotion of digital trade on export technological sophistication. Based on the above analysis, this study proposes the following hypothesis:

Hypothesis 3 When the degree of industrial structure upgrading crosses the threshold value, the promotion of digital trade on the upgrading of export technological sophistication is enhanced.

4. Empirical Research Design

4.1. Data Sources

This study employs provincial-level data to explore the impact of digital trade development on export technological sophistication. Given the significant data deficiencies for Tibet, the research sample selected in this study consists of panel data from 30 provinces in China spanning from 2012 to 2022. The primary data sources include Wind, CSMAR, the website of the National Bureau of Statistics, and the website of the National Intellectual Property Administration.

4.2. Variable Selection

4.2.1. Explanatory Variable

The explained variable in this study is Export Product Sophistication (Expy). Drawing on the methodologies of Hausmann et al. (2007) [17] and Yao Yang and Zhang Ye (2008) [33], we calculate the export product sophistication for each province, comprising a total of 12 categories of export products, after excluding the imported components (or raw materials) in export trade. Firstly, the formula for calculating the technological sophistication (PRODY) of each category of export products is as follows:

$$PRODY_j = \sum_i \frac{\frac{x_{ij}}{X_i}}{\sum_i \left(\frac{x_{ij}}{X_i}\right)} Y_i \# \quad (1)$$

Where i denotes the province; j denotes the export category of goods; X_{ij} denotes the trade volume of exported goods in province i for category j; Y_i represents the per capita GDP of each province or region, and the Consumer Price Index (CPI) is used for adjustment.

Secondly, the export technological sophistication for each province is calculated using a weighted formula, which is as follows:

$$Expy_i = \sum_j \frac{x_{ij}}{X_{ij}} PRODY_j \# \quad (2)$$

4.2.2. Explained Variable: Digital Trade Index (Dige)

The explained variable is the Digital Trade Index (Dige). Based on the essential concept of digital trade and with reference to the research by Feng Zongxian and Duan Dingyun (2022) [34], this study designs a digital trade evaluation system grounded in five aspects of digital trade (shown in Table 1). To avoid the drawbacks of subjective weighting assignment and the overlap among multiple indicator

data, the study adopts the entropy weight method to determine the weights of the evaluation indicators and accordingly calculates the development index of digital trade for each province.

Table 1. Digital Trade Indicator

First-Class Indicator	Second-Class Indicator	Third-Class Indicator	Indicator Properties
Digital Trade	Digital infrastructure	Internet penetration rate	+
		Mobile internet users	+
		Length of long-distance optical cable lines	+
	Digital innovation capability	Full-time equivalent of R&D personnel	+
		Number of patent applications by R&D institutions	+
		Internal expenditure on R&D funding	+
	Scale of digital trade	Proportion of ICT products exports in total product exports	+
		Proportion of ICT services exports in total service exports	+
		Proportion of digital services exports in total service exports	+
	Digital trade potential	GDP per capita	+
		Proportion of imports in GDP	+
	Digital trade barriers	Digital trade restriction index	

Note: + represents a positive indicator and − represents a negative indicator.

4.2.3 Control Variables

In this study, we select urbanization level, education quality, degree of marketization, level of openness and traditional financial development level as control variables. Specifically, urbanization level is measured by the urbanization rate (URBAN); education quality is characterized by the teacher-student ratio in basic education (EDU); degree of marketization is represented by the marketization index of each province (MARKET); level of openness is calculated as the ratio of total import and export trade volume converted into RMB at the current exchange rate to regional GDP (OPEN); and traditional financial development level is measured by the ratio of deposit and loan balances of financial institutions (FIN).

4.2.4 Mediating Variable and Threshold Variable

In this study, industrial structure upgrading is selected as both the mediating variable and threshold variable, measured by the ratio of added value of the tertiary industry to that of the secondary industry in each province (STR).

4.3. Descriptive Statistics

According to Table 2, the mean value of Export Product Sophistication (Expy) is 0.974, with a minimum of 0.623 and a maximum of 1.429, and a standard deviation of 0.214, indicating significant differences in export product sophistication among provinces. The average Digital Trade Index (Dige) is 3.116, ranging from a minimum of 0.188 to a maximum of 8.451, with a standard deviation of 1.925, showing that there are also differences in the level of digital trade development among provinces. Overall, the uneven development among provinces is relatively pronounced.

Table 2. Descriptive statistics

Variable	Variable name	Sample number	Mean value	Standard deviation	Median value	Minimum value	Maximum values
Expy	Export product sophistication	341	1.0954	0.0897	1.1102	0.9179	1.2707
Dige	Digital trade index	341	0.3219	0.1284	0.3661	0.0907	0.5785
URBAN	Urbanization level	341	0.0804	0.0219	0.0827	0.0112	0.1236
EDU	Education quality	341	0.2529	0.2661	0.1404	0.0114	1.2531
MARKET	Degree of marketization	341	0.8111	0.1552	0.8028	0.4474	1.1497
OPEN	Level of openness	341	0.5984	0.1257	0.5878	0.2887	0.8930
FIN	Traditional financial development level	341	0.4177	0.0547	0.4228	0.2981	0.5433
STR	Industrial structure upgrading	341	1.3831	0.7123	1.2235	0.6492	4.8940

4.4. Model Construction

4.4.1. Baseline Regression Model

To examine the direct impact of digital trade on export product sophistication, this study constructs a fixed-effects panel model as follows:

$$\mathrm{Expy}_{it} = \alpha_0 + \alpha_1 \mathrm{Dige}_{it} + \alpha \sum \mathrm{CONTROLS}_{it} + \mu_i + \theta_t + \varepsilon_{it} \quad (3)$$

where Expy_{it} represents export product sophistication; Dige_{it} denotes the digital trade index; $\sum \mathrm{CONTROLS}_{it}$ signifies the set of control variables; α_0 is the intercept term, α_1 and α are coefficients; μ_i stands for individual fixed effects, θ_t represents time fixed effects, and ε_{it} is the random disturbance term; i represents the province and t denotes time.

4.4.2. Mediating Effect Model

To explore the mediating role of digital trade in its impact on export product sophistication, this study refers to relevant literature (Wen Zhonglin et al., 2014) [35] and combines it with Model (3) to construct the following models:

$$\mathrm{STR}_{it} = \beta_0 + \beta_1 \mathrm{Dige}_{it} + \beta \sum \mathrm{CONTROLS}_{it} + \mu_i + \theta_t + \varepsilon_{it} \quad (4)$$

$$\mathrm{Expy}_{it} = \gamma_0 + \gamma_1 \mathrm{Dige}_{it} + \gamma_2 \mathrm{STR}_{it} + \gamma \sum \mathrm{CONTROLS}_{it} + \mu_i + \theta_t + \varepsilon_{it} \quad (5)$$

where STR_{it} is the mediating variable, set as industrial structure upgrading (STR) in this study.

4.4.3. Threshold Effect Model

Considering that the impact of digital trade on export product sophistication differs as the level of industrial structure upgrading increases, it remains to be verified whether there exists a nonlinear dynamic spillover effect, manifesting as threshold characteristics. Therefore, this study constructs a single-threshold panel model and further extends it to a multi-threshold panel model:

$$\mathrm{Expy}_{it} = \alpha_0 + \alpha_1 \mathrm{Dige}_{it} \cdot I(\mathrm{STR}_{it} \le \gamma) + \alpha_2 \mathrm{Dige}_{it} \cdot I(\mathrm{STR}_{it} > \gamma) + \alpha \mathrm{Control}_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (6)$$

where STR_{it} is the threshold variable, γ is the threshold value to be estimated, and other variables are defined as in Equation (1); γ divides the provincial sample data into two intervals with different regression coefficient values for the two sample intervals. $I(\cdot)$ is an indicator function, taking a value of 1 when the condition is met and 0 otherwise. Equation (6) assumes the presence of only one threshold value; panel threshold models considering multiple threshold values will not be shown here.

5. Empirical Testing and Result Analysis

5.1. Baseline Regression Analysis

Table 3 displays baseline regression results, with Dige showing a significant positive impact at the 1% level, confirming that digital trade enhances export technological sophistication and supporting Hypothesis 1. Digital trade reduces information asymmetry and transaction costs, allowing for agile market responses and technological upgrades in exports. Digital technology in production drives intelligent and refined changes, increasing product technological content and value. Digital trade also expands international market access, enhancing competitiveness and motivating product and technology optimization. Through spillover effects and innovative resource sharing, it accelerates advanced technology circulation, further elevating export technological sophistication.

Table 3. Basic regression results

Variable	(1)	(2)	(3)	(4)
	Mixed regression	**Mixed regression**	**Two-way fixed effect**	**Two-way fixed effect**
	Expy	**Expy**	**Expy**	**Expy**
Dige	0.592***	0.539***	0.434***	0.402***
	(0.017)	(0.018)	(0.021)	(0.023)
MARKET		0.025*		0.049***
		(0.013)		(0.015)
OPEN		0.121***		0.0063
		(0.014)		(0.007)
FIN		0.046***		0.0280
		(0.015)		(0.021)
URBAN		0.107***		0.151*
		(0.036)		(0.079)
EDU		0.123***		0.172***
		(0.043)		(0.042)
Time/ individual fixed effect	No	No	Yes	Yes
CONS	-0.102***	0.972***	0.268***	0.124
	(0.006)	(0.036)	(0.012)	(0.074)
N	341	341	341	341
R^2	0.798	0.860	0.923	0.925

Note: * and *** indicate P<10% and P<1%, respectively, standard errors are shown in parentheses.

5.2. Regional Heterogeneity Analysis

This study divides samples into Eastern, Central, Western, and Northeastern regions using the National Bureau of Statistics classification for heterogeneity testing. China's digital trade development is generally positive, but regional resource disparities cause significant differences in its impact. Table 4 indicates the strongest driving effect of digital trade on export technological sophistication is in the Eastern region, with a coefficient of 0.492 significant at 1%. The Central region has a coefficient of 0.381, significant at 10%, while coefficients in the Western and Northeastern regions are insignificant. This variation is mainly due to uneven digital infrastructure, industrial structure, and resource distribution. The Eastern region, with advanced digital infrastructure, concentrated high-tech industries, and talent and capital advantages, fully leverages digital trade. Efficient information processing and transmission connect enterprises to high-end industrial chains, accelerating technological innovation and product upgrading, and significantly enhancing export technological sophistication. Coastal enterprises rapidly respond to international markets via digital trade and launch high-value-added products. In contrast, the Central region's limited digital infrastructure, monotonous industrial structure, and insufficient innovation capacity restrict digital trade's driving effect. The Western region's digital trade development is low, and the Northeastern region's high proportion of traditional industries and slow digital transformation weaken digital trade's promoting effect on export technological sophistication. Regional digital trade development disparities directly affect export technological sophistication enhancement effectiveness.

Table 4. Results of regional heterogeneous effects

Variable	(1)	(2)	(3)	(4)
	Eastern	Central	Western	Northeast
	Expy	Expy	Expy	Expy
Dige	0.492***	0.381*	0.194	0.109
	(0.018)	(0.2142)	(0.151)	(0.492)
CONTROLS	Yes	Yes	Yes	Yes
CONS	0.878***	1.243***	1.034***	1.472***
	(0.044)	(0.187)	(0.135)	(0.606)
N	132	66	110	33
R^2	0.892	0.898	0.874	0.898
Time/ individual fixed effect	Yes	Yes	Yes	Yes

Note: * and *** indicate P<10% and P<1%, respectively, standard errors are shown in parentheses.

5.3. Analysis of Mediating Effects

Table 5 shows digital trade boosts export technological sophistication via industrial structure upgrading, confirming Hypothesis 2. Digital trade accelerates advanced technology dissemination through spillover effects, driving traditional industries toward high-tech, high-value-added sectors. Widespread digital technology use optimizes resource allocation, enhances efficiency, and directs production factors to high-value-added industries. Digital supply chain management breaks geographical barriers, fostering collaboration and elevating industrial chain efficiency and technology. Innovation-wise, digital trade offers enterprises platforms and resources, speeding up product and technological advancements. Market expansion-wise, it aids international market entry, compelling enterprises to optimize product structure and technology for global competition.

Table 5. Regression results of the mediating effects

Variable	(1)	(2)	(3)
	Expy	STR	Expy
Dige	0.4023***	0.3400***	0.3995***
	(0.0138)	(0.0941)	(0.0140)
STR			0.0080***
			(0.0020)
CONTROLS	Yes	Yes	Yes
CONS	0.124***	0.130	0.123***
	(0.030)	(0.364)	(0.029)
N	341	341	341
R2	0.925	0.437	0.929
Time/ individual fixed effect	Yes	Yes	Yes

Note: *** indicates P<1%, standard errors are shown in parentheses.

5.4. Threshold Effect Analysis

The threshold effect test can further investigate the nonlinear impact of the digital economy on the technological sophistication of manufacturing exports. Initially, the sample was repeatedly sampled 500 times, and the resulting threshold number, F-value, P-value, and other relevant statistics are presented in Table 6. According to Table 6, when the degree of industrial structure upgrading is used as the threshold variable, the F-value for export technological sophistication is 20.65, passing the single threshold significance test at the 10% level, with a threshold value of 0.178.

Table 6. Threshold test results

Number of threshold	F-statistic	P-value	BS times	Threshold value			Threshold value
				1%	5%	10%	
Single	20.65	0.060	500	29.008	22.652	19.610	0.951*
Double	10.78	0.330	500	27.076	20.729	16.742	1.287

Note: * indicates P<10%.

The regression results using the single threshold are shown in Table 7. The threshold effect of Model (1) indicates that when the degree of industrial structure upgrading is below 0.178, the estimated coefficient of digital trade is 0.041, significant at the 1% level, suggesting that digital trade can promote the enhancement of export technological sophistication. When the degree of industrial structure upgrading exceeds 0.178, the estimated coefficient of digital trade increases to 0.052, still significant at the 1% level, indicating an enhanced promoting effect of digital trade on the enhancement of export technological sophistication. Thus, Hypothesis 3 is validated.

Table 7. Threshold regression results

Variables	Expy
$Dige \cdot I(STR_{it} \leq 0.951)$	0.122***
	(0.041)
$Dige \cdot I(STR_{it} \geq 0.951)$	0.164***
	(0.048)
CONTROLS	Yes
CONS	1.137***
	(0.013)
N	341
R2	0.824

Note: *** indicates P<1%, standard errors are shown in parentheses.

5.5. Robustness Tests

This study performs robustness checks using various methods, with results shown in Table 8. Excluding central government-administered municipalities, the results remain significantly positive after re-running the regression. Similarly, excluding data from 2020 to 2022 due to pandemic-induced economic downturns yields consistently positive results. A winsorization treatment also maintains positive significance, and the System GMM method, addressing potential endogeneity, continues to yield significantly positive results, all passing robustness checks.

Table 8. Robustness test

Variable	(1)	(2)	(3)	(4)
	Excluding municipality samples	Excluding time samples	Winsorization treatment	System GMM
	Expy	Expy	Expy	
L.Expy				0.118***
				(0.123)
Dige	0.424***	0.383***	0.473***	0.541***
	(0.065)	(0.103)	(0.147)	(0.164)
CONTROLS	Yes	Yes	Yes	Yes
CONS	1.281**	1.229**	-0.727*	0.231*
	(0.461)	(0.451)	(0.364)	(0.128)
AR(1)				0.001
AR(2)				0.741
Hansen				0.935
N	297	248	330	310
R2	0.887	0.957	0.934	-
Time/ individual fixed effect	Yes	Yes	Yes	Yes

Note: *, **, and *** indicate P<10%, P<5%, and P<1%, respectively, standard errors are shown in parentheses.

6. Conclusions and Recommendations

Based on panel data from 31 provinces in China between 2012 and 2022, this study empirically investigates the impact of digital trade on export technological sophistication using various models. The findings are as follows: First, digital trade can effectively enhance export technological sophistication, and the results are robust. Second, the impact of digital trade on export technological sophistication exhibits regional heterogeneity, with the eastern region showing the strongest promoting effect. Third, industrial structure upgrading plays a positive intermediary role in the impact of digital trade on export technological sophistication.

Based on the research conclusions, this study puts forward the following policy recommendations: First, it is necessary to improve the digital trade regulatory framework, actively engage in international rule-making, and leverage platforms such as the Belt and Road Initiative to foster a fair and inclusive new trading environment. Efforts should also be made to accelerate domestic regulatory pilots and promote China's proposed solutions. Second, regional synergies should be strengthened through deeper collaboration between eastern and western regions, promoting market integration and establishing pilot free trade zones in suitable central and western areas to facilitate coordinated opening-up between coastal and inland regions. Third, differentiated development strategies tailored to local conditions should be formulated. Central and western regions should focus on enhancing infrastructure development and transportation connectivity, while eastern regions need to optimize

resource allocation, relax market access restrictions, and guard against excessive competition. Additionally, improvements in social security and talent recruitment mechanisms are essential to address the shortage of skilled professionals in enterprises, thereby supporting the growth of digital trade and the enhancement of export value-added.

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