



Research on the Impact of Digital Trade Rules on China's Digital Service Export Sophistication

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Abstract. Against the backdrop of the accelerated restructuring of global digital trade rules and the high-quality development of China's digital services trade, this paper selects 26 economies that have signed regional trade agreements with China containing digital trade provisions from 2012 to 2024 as research samples. Using balanced panel data, this study conducts a quantitative empirical analysis to systematically investigate the impact, transmission mechanisms, and heterogeneous characteristics of the depth of digital trade rules on the sophistication of China's digital services exports. Regression estimates from this study show that deeper digital trade rules significantly raise the export sophistication of China's digital services. This result is robust to alternative depth measures, to excluding special-year observations, and to winsorizing outliers. Heterogeneity analysis reveals the quality effect is strongest for e-commerce, cross-cutting, and digital IP provisions. Rule dividends significantly benefit lower-income and middle-income economies with weaker industrial bases, but turn insignificant for high-income ones with mature regulatory systems. Mechanism tests confirm two mediating channels: lowering cross-border information costs and improving partner countries' regulatory governance quality. Based on the above empirical findings, three targeted policy recommendations are put forward: cut cross-border rule negotiation costs, optimize the cross-border institutional operation environment, and consolidate core industrial competitiveness.

Keywords: Digital Trade Rules; Digital Service Export Sophistication; Regional Trade Agreements.

1 Introduction

The interplay between digital technologies and cross-border commerce has triggered a fundamental transition of traditional trade models toward digitalized and intelligent operations. Regulatory frameworks governing digital trade now function as a central lever in reconfiguring the global economic landscape and simultaneously form the institutional underpinning for competition among national economies. In recognition of the surging volume of digital cross-border transactions, the World Trade Organization introduced its Electronic Commerce Work Program in 1998 to erect a multilateral governance architecture. Nevertheless, the multilateral approach has long suffered from

cumbersome coordination procedures, inefficient decision-making, and outdated rule provisions that cannot keep pace with technological advances. This institutional obsolescence leaves a persistent void in global digital governance. Given these constraints, many economies have pivoted toward bilateral and regional free trade agreements as alternative venues for negotiating digital provisions. The outcome, however, is a highly fragmented and geographically varied rule landscape. According to the 2025 Annual Report on Global Digital Economic and Trade Rules, by September 2025, 138 free trade agreements (FTAs) featuring dedicated digital chapters had been concluded, involving more than 110 economies and accounting for 37 percent of all worldwide FTAs. Such figures highlight that digital clauses have become an integral feature of contemporary regional trade pacts.

The continuous evolution and enforcement of these digital rules have not only restructured global trade governance, but also profoundly altered the operational modalities and quality dimensions of digital services trade. International competitive dynamics are increasingly defined by quality enhancement and value-chain repositioning, rather than by sheer trade volume. China's digital services trade, a key force propelling the nation's high-quality trade expansion, has shown steady and robust growth. Official statistics from China's Ministry of Commerce indicate that from January to August 2025, the combined import and export value of digitally deliverable services reached 2 trillion RMB, representing an 8.5 percent year-on-year increase and establishing a new peak. This segment now acts as a critical engine for the transformation, structural upgrading, and high-quality development of China's foreign trade. Within the analytical framework of trade quality upgrading, the sophistication level of digital services exports precisely reflects a country's digital services industry in terms of technological content, value-added generation, and positioning within global value chains. Hence, it constitutes a pivotal benchmark for appraising industrial competitiveness and assessing the overall developmental performance of digital trade.

Current research on digital trade rules and digital service export sophistication falls into two major categories. The first stream investigates how digital trade rules affect trade volumes. Using the TAPED dataset, Burri & Polanco (2020) verify that open digital service clauses stimulate cross-border service exports ^[1]. From the angle of clause differentiation, Peng et al. (2021) build an index of digital trade rule stringency and find that such rules greatly boost bilateral digital service exports, with cross-border data provisions exerting the strongest driving effect ^[2]. Liu & Chen (2022) add that deeper rule coverage lifts both intensive and extensive margins of digital service exports ^[3]. Cao & Zhang (2026) hold that digital trade rules upgrade trade structures and narrow deficits in digital service commerce ^[4]. The second category explores drivers of export sophistication centering on digital resource endowments and institutional obstacles. Wang et al. (2022) illustrate that digital infrastructure lifts the sophistication level of emerging service exports ^[5]. Furthermore, Wang (2024) detects distinct cross-nation heterogeneity: digital trade barriers lift export sophistication in developing nations yet suppress it in advanced economies ^[6]. Zeng & Zhang (2025) note inflows of digital services remarkably improve the technical sophistication of domestic digital service exports ^[7].

There remains substantial room for further research. Despite a wealth of empirical studies investigating the effects of digital trade rules, most have gravitated toward quantity-based indicators such as aggregate trade magnitudes and bilateral account balances. By contrast, their implications for the sophistication of digital services exports, assessed through the lens of quality upgrading, remain largely underexplored. Comprehensive empirical evidence regarding the internal transmission channels and heterogeneous characteristics is still lacking. Accordingly, this paper utilizes the TAPED database to construct a segmented-provision index measuring bilateral digital trade rule depth. It empirically examines how rule depth affects China's digital service export sophistication, together with its transmission channels and heterogeneous characteristics. This study compensates for existing research neglect of trade quality, expands relevant theoretical analysis, and provides empirical evidence and targeted policy implications for China's digital trade negotiations, export structure optimization, and competitiveness enhancement.

2 Theoretical Analysis of Mediating Mechanisms

2.1 Mediating Channel: Reducing Information Cost

Given the immaterial nature of digital services and their strong reliance on information flows, divergent domestic regulatory standards and cross-border information asymmetries produce implicit transaction costs that hinder firms from supplying premium digital service offerings abroad. Digital trade provisions, by harmonizing rules on cross-border data transfers, intellectual property rights, and dispute settlement, remove such informational barriers and curtail enterprise information expenditure. Reduced information costs improve the matching efficiency between domestic suppliers and foreign buyers, enabling firms to accurately identify niche market demands overseas and adapt their technological and content strategies accordingly, thereby raising the value added of exported services ^[5]. The first hypothesis is thus formulated:

H1: Digital trade rule depth elevates China's digital service export sophistication through reducing information cost.

2.2 Mediating Channel: Improving Regulatory Quality

Regarding the second channel, inconsistent and opaque digital regulatory systems across trading partners create invisible obstacles to high-value digital service exports. Regulatory divergence restricts the free movement of digital production factors and keeps domestic industries locked into low-value segments of global value chains ^[8]. More comprehensive digital trade rules prompt signatory economies to converge governance standards, simplify supervisory procedures, and enhance transparency. Such regulatory optimization eliminates cross-border institutional frictions, facilitates the unrestricted global flow of high-end digital factors, drives domestic digital service sectors toward quality upgrading, and supports firms' upward mobility along value chains, ultimately improving the sophistication of service exports. Accordingly, the following hypothesis is proposed:

H2: Digital trade rule depth improves China's digital service export sophistication through improving regulatory quality.

3 Research Design

3.1 Cost Econometric Model Specification

The empirical analysis is based on a balanced panel comprising 26 economies that have established regional trade agreements (RTAs) with China, inclusive of digital trade provisions, with observations spanning the period 2012–2024. The objective is to estimate the effect of the depth of digital provisions on the export sophistication of China's digitally delivered services to these partner countries. The baseline econometric specification takes the following form:

$$\ln \text{expy}_{it} = \alpha_0 + \beta_0 \text{depth}_{it} + \beta_2 X_{it} + \mu_i + \lambda_i + \varepsilon \quad (1)$$

Where $\ln \text{expy}_{it}$ is the natural logarithm of the sophistication index for China's digital service exports to economy i in year t . depth_{it} captures the overall stringency of digital trade commitments under the RTAs signed between China and economy i as of year t . X_{it} denotes a set of control variables, μ_i and λ_i represent country fixed effects and year fixed effects, ε_{it} is the random error term.

3.2 Variable Definitions and Data Sources

The explained variable. The logged sophistication index of China's digital service exports to each partner economy ($\ln \text{expy}$). Referring to the service sector classification of the WTO-OECD BaTIS database, this paper splits digital service trade into six branches: communications, computer and information services, financial services, insurance services, intellectual property charges, and other business services. This research follows the export sophistication calculation framework developed by Hausmann et al. (2007) [9]. Sector-specific sophistication values for each digital service category are initially derived from cross-country data on digital services trade flows, which encompass 86 economies globally. China's export proportion of every digital service to each sample economy acts as a weighting factor; we then carry out weighted summation to acquire the bilateral export sophistication indicator for each trading partner.

Core Explanatory Variable. Total digital trade rule depth (depth). Drawing on the TAPED database and the research of Peng et al. (2021), digital trade clauses are sorted into five major modules: e-commerce, cross-border data transmission, new data governance, horizontal cross-cutting terms, and digital intellectual property rules [2]. This paper implements a multi-tier scoring scheme for each clause: 1 point for simple clause inclusion, 2 points for legally enforceable obligations, 1 point for non-mandatory rules,

3 points for fully binding provisions, and 2 points for partially binding mixed clauses. Sub-index and aggregate depth are computed as below:

$$subindex_i = \sum_{k=1}^n \frac{provision_k}{n(provision_k)} \tag{2}$$

$$depth = \sum_{i=1}^6 \frac{subindex_i}{5} \tag{3}$$

Where $subindex_i$ is the sub-depth index of rule category i , $provision_k$ is the scoring result of sub-clause k .

Mediating Variables. Information cost (cost) is measured by the weighted WGI rule of law index based on service value-added share following Wang et al. (2022), where higher values correspond to lower corporate information costs ^[5]. Regulatory quality (regular) is proxied by the WGI regulatory quality index, with larger values indicating a more complete regulatory environment.

Control Variables. All sourced from WDI. Urban is defined as urban population share to capture industrial agglomeration, goods referring to the ratio of total trade to GDP as a proxy for trade openness, hr standing for tertiary enrollment rate to measure human capital, service denoting service employment share to reflect industrial foundation, and internet representing internet penetration rate for digital infrastructure.

4 Empirical Results

4.1 Descriptive Statistics

Table 1 summarizes descriptive statistics for all core variables. The key explanatory variable depth averages 0.623. Depth, the primary independent variable, yields a mean value of 0.623. The sample is free from conspicuous outliers, which establishes a sound foundation for the ensuing regression estimation.

Table 1. Descriptive Statistics.

Variable	Obs.	Mean	Std. Dev.	Min	Max
lnexpy	335	10.008	0.076	9.859	10.329
depth	335	0.106	0.189	0.000	0.623
urban	335	54.238	25.545	18.000	99.804
goods	335	77.206	70.438	18.195	419.962
hr	335	54.563	30.860	8.207	141.865
service	335	59.077	19.300	17.454	88.517
internet	335	63.447	28.028	4.940	99.687

4.2 Baseline Regression

This paper employs a two-way fixed-effects model to estimate how digital trade rule depth affects China's digital service export sophistication, as summarized in Table 2. Column (1) contains only the core variable; Column (2) adds controls excluding year fixed effects; Column (3) controls for both country and year fixed effects. Deeper digital trade rules significantly raise export sophistication by reducing institutional trade barriers. Host urbanization, service sector development, and internet penetration generate significantly positive effects, while goods trade volume and human capital have insignificant impacts, revealing export sophistication depends on both institutional rules and host industrial and digital infrastructure.

Table 2. Baseline Regression.

variable	(1) lnexpy	(2) lnexpy	(3) lnexpy
depth	0.207*** (0.015)	0.080*** (0.025)	0.029** (0.013)
urban		0.012* (0.006)	0.010* (0.005)
goods		0.000 (0.000)	0.000 (0.000)
hr		0.001 (0.001)	0.000 (0.000)
service		0.008** (0.003)	0.003* (0.001)
internet		0.003*** (0.000)	0.001* (0.000)
cons	9.986*** (0.002)	8.642*** (0.445)	9.130*** (0.393)
country & year	control	control	control
N	335	335	335
R ²	0.275	0.691	0.877

Note. ***, **, * represent significance at the 1%, 5%, 10% levels; clustered robust standard errors in parentheses.

4.3 Robustness Test

Different from the baseline method of stratified arithmetic averaging, Gao and Sheng (2018) measure an RTA's digital rule integration level relative to the full sample^[10]. The depth index is derived by summing provision scores and then scaling by the theoretical maximum across all agreements.

$$index_i = \frac{\sum_{k=1}^n provision_k}{\max(\sum_{k=1}^n provision_k)} \quad (4)$$

Three robustness tests are undertaken, covering replacement of the principal indicator, exclusion of the pandemic-affected years, and winsorization of the variables; the estimation outcomes are presented in Table 3. In column (1), an alternative proxy for the core measure is employed, and the resulting coefficient is positive and statistically significant. Column (2) drops observations from 2020 to 2022, and the coefficient of depth remains significantly positive. Column (3) applies winsorization to all variables without altering the sign or significance of the core explanatory variable. All three test groups reach identical conclusions to the benchmark regression, confirming the stable positive impact of digital trade rule depth on the sophistication level of digital service export.

Table 3. Robustness Test.

variable	(1) lnexpy	(2) lnexpy	(3) lnexpy
depth		0.039** (0.018)	0.029** (0.012)
index	0.022** (0.010)		
control variables	control	control	control
cons	9.132*** (0.393)	9.174*** (0.370)	9.157*** (0.357)
country & year	control	control	control
N	335	258	335
R ²	0.877	0.691	0.902

Note. ***, **, * represent significance at the 1%, 5%, 10% levels; clustered robust standard errors in parentheses.

4.4 Heterogeneity Analysis

Heterogeneity Analysis by Digital Trade Provisions. Table 4 shows distinct effects across different clauses. E-commerce, data flow, cross-cutting, and digital IP clauses all yield significantly positive coefficients at the 10% significance level or higher, all boosting digital service export sophistication. Cross-cutting and digital IP provisions exert stronger effects, highlighting the critical role of IP protection and cross-border regulatory cooperation. The new data clause shows no significance, likely due to limited coverage, weak binding force, and incomplete supporting mechanisms.

Table 4. Heterogeneity Analysis by Digital Trade Provisions.

variable	(1) ec	(2) data	(3) new data	(4) cross	(5) ip
depth	0.022* (0.012)	0.019* (0.009)	-0.005 (0.030)	0.028* (0.015)	0.021** (0.008)
variable	(1) ec	(2) data	(3) new data	(4) cross	(5) ip

control variables	control	control	control	control	control
cons	9.139*** (0.394)	9.130*** (0.394)	9.135*** (0.407)	9.133*** (0.397)	9.119*** (0.392)
country & year	control	control	control	control	control
N	335	335	335	335	335
R ²	0.876	0.877	0.874	0.876	0.878

Note. ***, **, * represent significance at the 1%, 5%, 10% levels; clustered robust standard errors in parentheses.

Heterogeneity Analysis by Economy Income Level. Following the World Bank's income classification, we split the 26 sample economies into high-income and lower-middle-income groups for grouped two-way fixed-effects regressions (Table 5). The coefficient of depth is 0.027 and significantly positive at the 10% level for lower-middle-income economies (Column 2), meaning deeper digital trade rules raise the sophistication of China's digital service exports to these markets. In the estimation for high-income economies (Column 1), the coefficient on depth is estimated at 0.019 and falls short of conventional significance levels, indicative of no appreciable enhancing influence over the period examined. Such results reflect an evident catch-up effect. For less developed economies, high-standard digital trade agreements greatly cut institutional barriers and lift export sophistication. For high-income economies with mature domestic digital rule frameworks, further deepening trade rules yields insignificant gains.

Table 5. Heterogeneity Analysis by Economy Income Level.

variable	(1) high-income	(2) lower-middle-income
depth	0.019 (0.017)	0.027* (0.015)
control variables	control	control
cons	9.730*** (0.235)	8.787*** (0.395)
country & year	control	control
N	140	195
R ²	0.955	0.925

Note. ***, **, * represent significance at the 1%, 5%, 10% levels; clustered robust standard errors in parentheses.

4.5 Mechanism Test

Table 6 presents the mechanism estimation results. Column (2) shows that the coefficient of depth is 0.070 and significantly positive at the 1% level, revealing that deeper digital trade rules cut firms' costs of information search, processing, and contract fulfillment, thus creating cost advantages for upgrading digital service export

sophistication. Column (3) reports a significantly positive depth coefficient of 0.167 at the 5% level, which implies high-standard digital trade rules improve destination countries’ regulatory systems, enhance the transparency and predictability of cross-border digital services trade, and optimize the institutional environment for China’s digital service exports. Consistent with the theoretical framework, digital trade rule depth functions through two channels. First, it reduces information costs and trade uncertainty to facilitate corporate technological progress and spillovers, raising export sophistication. Second, it lifts regulatory quality to mitigate institutional barriers, encourages import substitution of high-tech digital intermediate inputs, and upgrades export technical composition. This result matches the theoretical deductions and hypotheses presented in the prior section.

Table 6. Mechanism Test.

variable	(1) lnexpy	(2) cost	(3) regular
depth	0.029** (0.013)	0.070* (0.037)	0.167** (0.073)
control variables	control	control	control
cons	9.130*** (0.393)	9.385*** (0.353)	3.185*** (1.061)
country & year	control	control	control
N	335	335	335
R ²	0.877	0.249	0.329

Note. ***, **, * represent significance at the 1%, 5%, 10% levels; clustered robust standard errors in parentheses.

5 Conclusion

Empirical results confirm that deeper digital trade rules significantly raise China’s digital service export sophistication, which holds across all robustness tests. Mechanism tests identify two transmission channels: cutting information costs and improving host-country regulatory quality. Heterogeneity analysis reveals IP and cross-border supervision clauses deliver the strongest effects. The institutional dividends identified in this analysis are observable solely among lower-middle-income economies that demonstrate substantial catch-up potential; in contrast, their high-income trading counterparts yield no further marginal gains.

Based on these findings, three policy directions are suggested, with emphasis placed on reducing rule-negotiation costs, upgrading the institutional environment, and strengthening industrial competitiveness. Firstly, carry out differentiated RTA digital rule negotiations. Prioritize pushing forward clauses on cross-border data mobility, digital intellectual property rights, and cross-border regulatory coordination. Launch tailored cooperation frameworks for low-income and middle-income trade partners to fully unlock institutional upgrading dividends; for high-income economies, focus on regulatory standard alignment to mitigate cross-border institutional frictions. Secondly,

cut cross-border transaction costs by upgrading digital supporting facilities. Upgrading domestic digital infrastructure and cross-border public service platforms helps minimize the expenditures on overseas information acquisition and regulatory compliance borne by digital service providers. Thirdly, consolidate the core technical advantages of domestic digital service exports. Scale up fiscal and policy support for independent digital technology R&D, foster high-value-added digital service sectors, and continuously lift the technical sophistication and international competitiveness of China's digital service exports.

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Disclosure of Interests

The authors have no competing interests to declare that are relevant to the content of this article.

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