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The Impact of Digital Services Trade Restrictions on Export Competitiveness

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Abstract
As the digital economy becomes increasingly integrated with international trade, digital services trade has emerged as a new engine of global trade growth. However, measures introduced by various countries, such as data localization requirements and restrictions on cross-border data flows, have made institutional barriers to digital services trade increasingly prominent. This paper uses export technology complexity to measure export competitiveness and systematically examines the impact of digital services trade restrictions on export technology complexity, while also exploring the moderating role of institutional quality, based on cross-country panel data from 49 countries from 2014 to 2023. The findings are threefold: First, digital services trade restrictions have a significant negative impact on export technology complexity, a conclusion supported by robustness tests. Second, institutional quality plays a negative moderating role, meaning that higher institutional quality strengthens the inhibitory effect of restrictive policies. Third, heterogeneity analysis shows that the negative effect of digital services trade restrictions is significant in developed countries and EU countries, but not significant in developing countries and non-EU countries. This paper provides empirical evidence and policy references for balancing openness and security and for optimizing the governance system of digital services trade.

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Keywords: Digital Services Trade Restrictions, Export Competitiveness, Export Technology Complexity, Institutional Quality

1. Introduction

As the digital economy becomes increasingly integrated with international trade, digital services trade is gradually emerging as a new engine of global trade growth. Export technology complexity, a core indicator of a country's trade competitiveness, relies heavily on the free flow of digital elements and the adaptability of the institutional environment for its enhancement. However, in recent years, driven by considerations such as data security and industrial protection, various countries have successively introduced restrictive measures including data localization requirements, cross-border data flow restrictions, and discriminatory access provisions. Consequently, the Digital Services Trade Restrictiveness Index (DSTRI) published by the Organisation for Economic Co-operation and Development (OECD) has continued to climb, making institutional barriers to global digital services trade increasingly prominent. This trend poses potential constraints on the in-depth development of digital services trade and the enhancement of export technology content.

Against this realistic backdrop, the institutional constraints facing China are particularly pronounced. The latest OECD data shows that China's DSTRI score stood at 0.35 in 2024, significantly higher than the OECD average of 0.11, remaining at a persistently high level among major economies. This figure contrasts sharply with China's globally leading position in digital economy scale, raising a critical question that demands an urgent response: How exactly do digital services trade restrictions affect a country's export competitiveness? Do they have a significant inhibitory effect on the improvement of export technology content?

The quantitative measurement of digital services trade restrictions forms the foundation for empirical research. The Digital Services Trade Restrictiveness Index (DSTRI), constructed by the Organisation for Economic Co-operation and Development (OECD) has become a core indicator widely adopted in academic circles. This index systematically assesses the degree of digital services trade restrictions across countries from five policy areas: infrastructure and connectivity, electronic transactions, payment systems, intellectual property rights, and other barriers (Ferencz, 2019) [1].

Export technology complexity is a core indicator for measuring the quality of a country's export competitiveness. Hausmann *et al*. (2007) [2]. were the first to construct an export sophistication index, weighting per capita GDP by the revealed comparative advantage of products to measure the technological level of different countries' exports. A higher index value indicates a higher position for the country in the international division of labor. Subsequently, Mishra *et al*. (2011) [3]. extended this methodology to the services trade sector. With the deepening of global value chain research, some scholars advocate for revising export technology complexity by introducing a value-added perspective to exclude the technological contribution of foreign intermediate inputs, thereby more accurately reflecting the domestic technological content of a country's exports (Cheng Dazhong *et al*., 2017) [4].

Research on the economic effects of digital services trade restrictions has primarily unfolded along two dimensions. The first dimension concerns the impact of digital services trade restrictions on trade scale. Ferracane *et al*. (2020) [5], focusing on data flow regulation measures, demonstrated that stringent cross-border data flow restrictions curb digital services exports. Qi Junyan *et al*. (2021) [6], using DSTRI data from 42 countries and trade data from six digitally-enabled service sectors for 2014–2018, discovered that digital services trade restriction measures hinder bilateral services export scale by increasing trade costs. Research by Wei Qianqing and Liu Min (2025) [7], based on data from 2014–2021, also confirms that bilateral cross-border data flow restrictions inhibit digital services exports, with trade cost serving as the core transmission channel.

The second dimension examines the impact of digital services trade restrictions on export technology complexity. Su *et al*. (2020) [8] were among the first to focus on the relationship between services trade restrictions and manufacturing export technology complexity, finding that services trade restrictions negatively affect manufacturing export technology complexity by inhibiting technological innovation. Qi Junyan *et al*. (2021) [9], based on panel data from 37 countries across 18 service sectors, discovered that digital services trade barriers significantly impede the enhancement of services export technology complexity, with the technological innovation inhibition effect serving as the core mechanism. Diao Yufan and Xue Xuedan (2025) [10], selecting data from 43 economies for 2014–2022, empirically tested and found that digital services trade barriers have an inhibitory effect on export technology complexity, with the impact being more pronounced in developed countries compared to developing ones. Liu Haiyan and Yang Yanlin (2025) [11], using cross-country panel data from 82 economies, further verified that digital services trade barriers negatively affect export competitiveness by inhibiting technological innovation effects, human capital spillover effects, and value-added effects.

A review of the existing literature reveals that significant progress has been made in research on digital services trade restrictions and export technology complexity. However, there remains room for further expansion: most existing studies focus on either the manufacturing or services sector in isolation, and the data are largely concentrated in the period before 2018. Systematic examinations of the overall export technology complexity of digital services trade and the moderating mechanisms involved require further deepening. Based on this, the present paper employs panel data from 49 countries over the period 2014–2023 to systematically investigate the impact of digital services trade restrictions on export technology complexity, aiming to provide new empirical evidence for the existing body of research.

2. Mechanism Analysis

The impact of digital services trade restrictions on export technology complexity is primarily realized through the following pathways. First, the trade cost effect. Policies such as data localization and cross-border flow restrictions compel firms to invest additional resources to comply with diverse regulatory requirements, with rising compliance costs directly increasing the cost of digital services trade. The increase in trade costs not only inhibits the expansion of trade scale but, more importantly, hinders firms from acquiring technology spillovers through the import of diverse intermediate goods, thereby suppressing the enhancement of export technology content. Second, the technology effect. A stringent regulatory environment increases the sunk costs and uncertainty associated with firms' digital transformation, weakening their motivation for R&D and innovation. Concurrently, restrictive policies impede cross-border R&D collaboration and technology transfer, reducing firms' opportunities to access cutting-edge international technologies. The slowdown in technological innovation is directly transmitted to the export product level, manifesting as a decline in export technology complexity. Based on this, the following hypothesis is proposed:

H1: Digital services trade restrictions have a significant negative impact on export technology complexity.

Institutional quality plays a moderating role in the process through which digital services trade restrictions affect export technology complexity. Theoretically, a high-quality institutional environment can enhance policy transparency and predictability, reduce corporate compliance costs, and incentivize technological innovation through intellectual property protection, thereby buffering the negative impact of

restrictive policies. However, there exists another possibility regarding the direction of this moderation: in countries with higher institutional quality, digital services trade may be more sensitive to the regulatory environment, potentially amplifying the compliance costs and technology inhibition effects brought by restrictive policies. Furthermore, countries with high institutional quality often possess higher technological levels and more complex value chain divisions in the field of digital services trade, exhibiting greater dependence on data flows. Consequently, the same restrictive policy might generate a stronger marginal inhibitory effect. Based on this, a competing hypothesis is proposed:

H2: Institutional quality exerts a negative moderating effect in the process where digital services trade restrictions impact export technology complexity; that is, the higher the institutional quality, the stronger the negative impact of digital services trade restrictions.

3. Empirical Analysis

3.1. Model Construction

Following the approach of Lu Huixin *et al*. (2020) [12], this paper employs country-level panel data, selecting 49 countries over the period 2014–2023 as the research subjects to empirically examine the impact of cross-border data flow restrictions on the export technology complexity of China's digital services trade. The following two-way fixed effects model is constructed:

$$ESI_{it} = \alpha_0 + \alpha_1 DSTRI_{it} + \alpha_2 X_{it} + \mu_i + \delta_t + \varepsilon_{it}$$

Furthermore, to test the moderating effect of institutional quality, this paper introduces institutional quality (RQ) and its interaction term with DSTRI based on the benchmark model, constructing the moderating effect model as follows:

$$ESI_{it} = \beta\gamma_0 + \beta_1 DSTRI_{it} + \beta_2 RQ_{it} + \beta_3 DSTRI_{it} * RQ_{it} + \beta_4 X_{it} + \mu_i + \delta_t + \varepsilon_{it}$$

3.2.Variable Selection

3.2.1.Explanatory Variable:Digital Services Trade Restrictions

The Digital Services Trade Restrictiveness Index ($DSTRI_{it}$) is obtained from the OECD Statistics database. It encompasses five categories of restrictive measures: infrastructure and connectivity, electronic transactions, payment systems, intellectual property rights, and other business services. A higher score indicates stricter restrictive policies in a given country.

3.2.2.Explained Variable: Export Technology Complexity

Following the methodology of Hausmann *et al*. (2007) [2] and drawing on previous scholarly research, this paper calculates the export technology complexity of digital services (PSI_j) using the following formula:

$$PSI_j = \sum_i \frac{e_{ij}/e_i}{\sum_i e_{ij}/e_i} Y_i$$

After determining the export technology complexity of sub-categories, the export technology complexity of digital services trade for a specific country is calculated as follows:

$$ESI_i = \sum_j \frac{e_{ij}}{e_i} PSI_j$$

he data are sourced from the UNCTAD database, with per capita GDP data coming from the WDI. A higher ESI_i value indicates that a country's digital services exports are more concentrated in areas with high technological complexity and high added value.

3.2.3. Control Variables

In addition to the core explanatory variables, the control variables in this paper include the number of internet users per 100 people (INF), service trade export value (lnEXP), urbanization rate (lnURBAN), service trade as a share of GDP (OPEN), net inflows of foreign direct investment (lnFDI), and total population (lnPOP).

3.2.4. Moderating Variable: Institutional Quality

Institutions, as important formal and informal social arrangements, perform crucial functions such as coordinating social relations, reducing transaction costs, and increasing output. Measuring institutional quality presents certain challenges due to the multitude of concepts involved, its broad scope, and the often-subjective nature of quantification. Synthesizing various scholarly studies, this research adopts regulatory quality (RQ) from the Worldwide Governance Indicators (WGI) as a proxy variable for institutional quality.

3.2.5. Baseline Regression

Table 2 presents the benchmark regression results examining the impact of cross-border data flow restrictions (DSTRI) on the export technology complexity of digital services trade (ESI). In column (1), without the inclusion of any control variables, the estimated coefficient for cross-border data flow restrictions (DSTRI) is negatively signed and statistically significant at the 5% level. Following the stepwise inclusion of a series of control variables, the coefficient of the core explanatory variable, DSTRI, remains consistently negative and significant at either the 5% or 1% level.

Regarding the control variables, the majority of their estimated coefficients align with theoretical expectations, further validating the appropriateness of the model specification. The R-squared values are consistently around 0.98, indicating an excellent overall goodness of fit. The benchmark regression results robustly support the central thesis of this paper: cross-border data flow restrictions constitute a significant barrier to enhancing a country's export technology complexity in digital services trade.

Table 2: Baseline Regression Results

Variables	(1)	(2)
	lnESI	lnESI
DSTRI	-0.0975**	-0.106***
	(-2.435)	(-2.837)
INF		0.000898***
		(4.081)
Ln EXP		0.0153***
		(2.674)
Ln URBAN		0.200**
		(2.313)
OPEN		-0.0175***
		(-4.053)
Ln FDI		-0.000159***
		(-2.628)
Ln POP		-0.0879
		(-1.478)
Constant	10.43***	10.21***
	(1,927)	(11.23)
Observations	490	490
R-squared	0.978	0.982
Country/Year FE	Yes	Yes

Notes 1: and indicate significance at the 10%, 5%, and 1% levels, respectively;
2: standard errors are in parentheses, and the same applies below.

4. Robustness Tests

4.1.Replacement of the explained variable.

Referring to the methodology of Dai Kuizao (2018), this paper introduces the standard export technology complexity. The standard export technology complexity accounts for the variation of export technology complexity over time with changes in per capita income, which can, to some extent, mitigate the issue of intertemporal instability in export technology levels. The measurement formula is as follows:

$$S\_PSI_j = 100 \times \left(\frac{PSI_j - PSI_{min}}{PSI_{max} - PSI_{min}}\right)$$

$$S\_ESI_i = \sum_j \frac{e_{ij}}{e_i} S\_PSI_j$$

Based on the calculation of the export technology complexity of digital services trade in the first section of this chapter, the standard export technology complexity of digital services trade (S_ESI_i) for the sample countries is re-calculated. Its logarithmic form is then incorporated into the model as the new explained variable, with country and year fixed effects controlled for in the regression.

The results are shown in Table 3, column (1). The coefficient of DSTRI is -0.712, which is significantly negative at the 5% level, consistent with the benchmark regression results. This indicates that the core conclusion is not affected by the measurement method of the indicator.

4.2. Shortened sample period.

Considering that uncertain factors such as the COVID-19 pandemic in 2019 may affect digital services exports, the sample period is shortened to 2014–2019 to conduct a robustness test again. The test results, shown in Table 2, column (2), indicate that the coefficient of DSTRI is -0.117, which is significantly negative at the 5% level. This suggests that the benchmark regression results are robust.

Table 3: Robustness Test Results

Variables	(1)	(2)
	S_lnESI	lnESI
DSTRI	-0.712**	-0.117**
	(-2.463)	(-2.479)
INF	0.00428**	1.22e-05
	(2.277)	(0.0280)
lnEXP	0.0254	-0.00961
	(0.516)	(-0.765)
lnURBAN	2.040**	0.378***
	(2.556)	(2.738)
OPEN	-0.0370	-0.00127
	(-1.412)	(-0.111)
lnFDI	-0.000799*	-9.11e-05
	(-1.956)	(-0.963)
lnPOP	-0.247	0.0369
	(-0.546)	(0.331)
Constant	-3.691	8.550***
	(-0.518)	(5.396)
Observations	490	294
R-squared	0.950	0.985
Country/Year FE	Yes	Yes

4.3. Moderating Effect Test

Table4, column (3) reports the results of the moderating effect test. The coefficient for DSTRI is -0.228 (significant at the 1% level), the coefficient for RQ is 0.0192 (significant at the 5% level), and the coefficient for the interaction term DSTRI×RQ is -0.151 (significant at the 1% level). The significantly negative coefficient for the interaction term indicates that institutional quality strengthens the inhibitory effect of digital services trade restrictions; that is, the higher the institutional quality, the stronger the negative impact of the restrictions. Thus, H2 is verified. A possible explanation is that countries with high institutional quality have stronger policy enforcement, leading to stricter implementation of restrictive regulations. This results in higher compliance costs for firms, which crowd out resources for research and development, thereby amplifying the inhibitory effect.

Table 4: Robustness Test Results

	(1)	(2)	(3)
VARIABLES	**Ln ESI**	**Ln ESI**	**Ln ESI**
DSTRI	-0.106***		-0.228***
	(-2.837)		(-4.364)
RQ		0.00675	0.0192**
		(0.903)	(2.430)
DSTRI RQ			-0.151***
			(-4.175)
INF	0.000897***	0.000996***	0.000905***
	(4.080)	(4.778)	(4.220)
Ln EXP	0.0153***	0.0138**	0.0196***
	(2.674)	(2.540)	(3.573)
Ln URBAN	0.200**	0.164**	0.129
	(2.313)	(2.093)	(1.630)
OPEN	-0.0175***	-0.0180***	-0.0146***
	(-4.053)	(-4.041)	(-3.418)
Ln FDI	-0.000159***	-0.000129**	-0.000130**
	(-2.628)	(-2.140)	(-2.177)
Ln POP	-0.0879	-0.0578	-0.0932*
	(-1.478)	(-0.869)	(-1.724)
Constant	10.21***	10.01***	10.47***
	(11.23)	(10.16)	(12.86)
Observations	490	490	490
R-squared	0.982	0.981	0.983
Country/Year FE	Yes	Yes	Yes

4.4. Heterogeneity Analysis

The results are presented in Table 5. From the perspective of economic development level, the coefficient of DSTRI is significantly negative for developed countries (-0.194), while it is not significant for developing countries. From the perspective of regional integration, the coefficient of DSTRI is significantly negative for EU countries (-0.274), but not significant for non-EU countries. This indicates that developed countries and regions with a high degree of integration are more sensitive to digital services trade restrictions, as they are deeply embedded in global value chains and have a stronger dependence on data flows.

Table 5: Heterogeneity Analysis Results

Variables	**(1)**	**(2)**	**(3)**	**(4)**
	Developed	**Developing**	**EU**	**Non-EU**
DSTRI	-0.194***	-0.0316	-0.274***	-0.0530
	(-2.993)	(-0.925)	(-2.657)	(-1.521)
Constant	10.32***	11.17***	9.825***	10.93***
	(8.498)	(7.071)	(4.925)	(10.67)
Observations	370	120	210	280
R-squared	0.981	0.986	0.979	0.986
Country/Year FE	Yes	Yes	Yes	Yes

5. Results and Discussion

5.1. Research Conclusions

This paper systematically investigates the impact of digital services trade restrictions on export technology complexity using cross-country panel data from 49 countries over the period 2014–2023. The main conclusions are as follows:

First, digital services trade restrictions have a significant negative impact on export technology complexity. This conclusion is supported by both the benchmark regression and robustness tests. The underlying mechanisms are primarily the trade cost effect and the technology effect: restrictive policies raise corporate compliance costs, hindering technology spillovers from intermediate goods; simultaneously, they dampen the motivation for R&D and innovation, reducing opportunities for international technology transfer.

Second, institutional quality exerts a negative moderating effect in the relationship between digital services trade restrictions and export technology complexity. The moderating effect test shows that the coefficient of the interaction term between DSTRI and institutional quality is significantly negative at the 1% level (-0.151), indicating that

higher institutional quality actually strengthens the inhibitory effect of digital services trade restrictions. This finding may stem from the fact that countries with high institutional quality have a greater dependence on data flows and are more sensitive to changes in the regulatory environment, causing the same restrictive policy to generate a stronger marginal inhibitory effect.

Third, the impact of digital services trade restrictions exhibits heterogeneity. The negative effect of DSTRI is significant in the developed country sample but not in the developing country sample; the negative effect is significantly stronger in EU countries than in non-EU countries, confirming that regions with high institutional quality are more sensitive to regulatory changes.

5.2. Policy Recommendations

First, coordinate openness and security to promote institutional opening-up in digital services trade in an orderly manner. China's DSTRI score has long been above the OECD average. It is recommended that, while ensuring national security, a "whitelist" mechanism for cross-border data flows be explored, and a negative list management model be piloted in free trade zones to gradually reduce institutional barriers.

Second, balance the improvement of institutional quality with the optimization of rule design to guard against the "high-institution sensitivity" trap. When improving the digital trade governance system, attention should be paid to rule transparency and predictability, and regular communication mechanisms between the government and enterprises should be established to avoid amplifying the inhibitory effect of restrictive policies through over-regulation.

Third, strengthen coordination in international rules and actively participate in global digital governance. Accelerate the process of joining high-standard agreements such as the Digital Economy Partnership Agreement (DEPA), and strive to build consensus on rules with major trading partners in areas such as cross-border data flows and digital taxes, thereby creating a stable external environment for enterprises to participate in the global division of labor.

Fourth, implement precise policies in specific areas and strengthen technological innovation support. Prioritize aligning with high international standards in areas such as intellectual property protection and electronic transaction facilitation, increase policy support for R&D and innovation by digital services enterprises, and encourage enterprises to offset the negative impact of rising institutional costs through technological upgrades.

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