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The Impact of Deepening Digital Trade Rules on the Upgrading of Trade Structure in Developing Countries

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Abstract: The digital technological revolution has reshaped global trade rules, with all countries racing to formulate digital trade regulations. Existing research mostly adopts the perspective of the world or developed economies, while paying insufficient attention to the impacts on developing countries. Based on the perspective of developing countries, this paper studies how the deepening of digital trade rules affects the upgrading of their trade structures. By sorting out the course of developing countries' participation in global digital service trade governance, this paper constructs an indicator to measure the depth of digital trade rules and conducts empirical analysis based on a cross-border dynamic panel data model. The study finds that the deepening of digital trade rules significantly boosts the development of digital service trade in developing countries, thereby driving the upgrading of their trade structures, and this effect is more pronounced in high-income developing countries. Mechanism analysis shows that the deepening of rules realizes structural upgrading mainly through two paths: cutting trade costs and elevating regulatory standards. Accordingly, suggestions are put forward for developing countries: take an active part in global governance, prioritize the formulation of cross-border data flow rules, strengthen the construction of domestic digital infrastructure and laws related to data classification, and seize opportunities to realize the upgrading of trade structures.

Keywords: Digital trade rules; Digital service trade; Developing countries; Upgrading of trade structure

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1. Introduction

The robust growth of digital service trade has become a vital component of global service exports. Faced with the new landscape of the digital era, all countries have formulated a series of digital trade rules with varying depths to safeguard their own interests, explore new markets or strengthen international discourse power. For example, the United States tends to promote the free flow of data and open markets, while the European Union imposes restrictions on cross-border data flow to protect data security and personal information. Restrictive clauses embedded in such digital trade rules will hinder the development of digital service trade [1].

At present, the impact of digital trade rules on a country's economic and trade development has become

a hot academic topic. Existing studies indicate that the establishment of digital trade rules has provided an institutional foundation and source of competitive advantages for the upgrading of trade structures in European and American countries [2,3]. However, digital trade rules exert varying degrees of influence across different nations [4,5]. Research by Zhou Nianli (2019) and Bao Xiaohua et al. (2018) demonstrates that Regional Trade Agreements (RTAs) significantly promote digital service trade in developing economies, and this effect grows stronger as the openness of agreements rises [6,7].

Nevertheless, few studies explore the impacts of deepening digital trade rules from the perspective of developing countries. Studies by Huang Sen et al. (2024) using economic data of RCEP member states show that restrictions on cross-border data flow exert negative impacts on digital trade [8]. Wang Liankun (2024) finds that although digital trade barriers implemented by developing countries increase export complexity, they may exert positive effects on their emerging service exports [9].

Overall, research outcomes focusing on developing countries remain relatively scarce. Therefore, this paper explores how the deepening of digital trade rules affects the scale of digital service trade in developing countries from their standpoint. Scholars including Zhou Nianli et al. (2012) and Peng Yu et al. (2021) have taken the scale of digital service trade as an explained variable and verified that improvements in the level of digital trade clauses can expand digital trade exports and further drive the upgrading of national trade structures [10,11]. On this basis, this paper further analyzes the impact of deeper digital trade clauses on the trade structure upgrading of developing countries from their perspective, and puts forward policy recommendations for developing countries to seize opportunities brought by the digital economy.

2. Measurement of the depth of digital trade rules

According to Hofmann et al. (2017), there are three main quantitative methods for digital trade rules: total depth, core depth, and Principal Component Analysis (PCA) depth [12]. In a study by Elsig and Klotz (2019), digital trade rules are thoroughly analyzed from six dimensions: scope, depth, consumer convenience, non-discrimination, and regulatory cooperation [13]. Drawing on the research of Mao Yanbing et al. (2023), this paper categorizes clauses in digital trade rules into four major types: market access and facilitation, free cross-border data flow, digital intellectual property rights, and privacy & data protection [14]. Representative clauses are selected and assigned scores ranging from 0 to 3 according to three tiers: whether included in the rules, whether binding, and whether strongly binding. The weighted average method is then adopted to calculate the depth of digital trade rules, with the formula as follows:

$$Depth_H = \frac{\sum_{i=0}^{n} Index_{Li}}{n\left(Index_L\right)}$$

Where $Depth_H$ denotes clause depth; $Index_{Li}$ refers to the specific score of the *i*-th indicator in an indicator group; $n(Index_L)$ represents the total number of indicators in this group.

3. Relevant theories and research hypotheses

In the digital economy era, data factors have become key production factors, and their comparative advantages are mainly reflected in data abundance and the perfection of digital infrastructure. To leverage the comparative advantages of data transactions, coordinated and unified digital trade rules are required, alongside enhanced

facilitation of cross-border data flow and technological innovation [15].

Scholars have found that the more digital-trade-friendly clauses a country signs, the more significantly its digital service exports expand, and the more obviously the national trade structure transforms toward high-value-added sectors [16].

Based on the above discussion, this paper puts forward the following hypotheses:

(1) Hypothesis 1: Improvements in the depth of digital trade clauses can boost the development of digital service trade and the upgrading of trade structures in developing countries.

Significant disparities exist in digital infrastructure among developing countries. Generally, high-income developing countries enjoy relatively high internet penetration, stable broadband speeds and complete supporting facilities. Under digital trade clauses of equal depth, such countries witness stronger growth effects in digital service trade. In contrast, low-income developing countries suffer from underdeveloped network services, resulting in weaker clause efficiency.

Accordingly, the second hypothesis is proposed:

(2) Hypothesis 2: The signing of digital trade rules generates a stronger promoting effect on trade structure upgrading in high-income developing countries, and a weaker effect in low-income developing countries.

From the perspective of influence channels, digital trade clauses function mainly through two mechanisms: trade costs and regulatory standards. In terms of the trade cost channel, deeper digital trade clauses can effectively manage policy divergences among contracting parties, reduce non-tariff barriers and information costs arising from inconsistent supervision, and thus cut trade costs.

Hence Hypothesis 3:

(3) Hypothesis 3: Deeper digital trade clauses can boost the development of digital service trade in developing countries by reducing their trade costs.

In terms of the regulatory standard channel, digital trade clauses serve as unified regional standards that clarify regulatory obligations for contracting parties, encourage developing countries to learn advanced experience, perfect relevant laws and upgrade enforcement and supervision capacity to guarantee the orderly development of digital trade.

Hence Hypothesis 4:

(4) Hypothesis 4: Deeper digital trade clauses can elevate the supervision standards of developing countries and advance their digital service trade.

4. Model setting and data processing

Scholars widely adopt dynamic panel data models to examine relationships between explained variables and core explanatory variables. To study the impacts of the signing and depth of digital trade rules on the trade structure upgrading of developing countries, this paper constructs two dynamic panel data models as follows:

$$Y=a_0+a_1Dummy+a_2GDP+a_3EDU+a_4SR+a_5City+a_6W+\varepsilon \quad (1)$$

$$Y=a_0+a_1Depth+a_2GDP+a_3EDU+a_4SR+a_5City+a_6W+\varepsilon \quad (2)$$

In Model (1), the explained variable refers to the ratio of digital service export volume to total trade volume of a developing country, which measures trade structure upgrading. The core explanatory variable indicates whether the country signed a digital trade agreement in a given year. Control variables include logarithmic GDP of the country (GDP), the share of education expenditure in GDP (EDU), national income

level (SR), urbanization rate (City), and internet penetration rate (W). stands for the random disturbance term. The core explanatory variable in Model (2) represents the calculated depth of digital trade clauses, while all other settings remain consistent with Model (1). Data are mainly sourced from the World Bank, WDI, CEPII and TAPED databases.

5. Empirical results and analysis

Cross-border panel data with a sample size of 2069 are adopted in this research. Descriptive statistics show that the mean value of the trade structure indicator is 0.176, the mean of the digital trade agreement dummy (Dummy) is 0.471, and the mean of rule depth (Depth) is 0.097.

Collinearity tests reveal that the VIF value of every variable is less than 10, indicating no serious multicollinearity in the models.

Baseline regression results show that signing digital trade rules exerts a significant positive impact on digital service trade of developing countries (coefficient = 0.0148, $p < 0.01$), and deeper digital trade rules also significantly promote digital service trade (coefficient = 0.0690, $p < 0.01$), which verifies Hypothesis 1.

To address endogeneity, the two-stage least squares (2SLS) instrumental variable method is adopted, with lagged one-period Dummy and Depth taken as instrumental variables. Results prove the instrumental variables satisfy correlation assumptions and reverse causality does not exist. The Kleibergen-Paap rk LM statistic and Cragg-Donald Wald F statistic are both significant, which confirms the rationality of the selected instrumental variables.

Robustness tests include lag effect regression and sub-indicator regression. Digital trade clauses with one or two lags still exert significant positive effects on digital service trade. Regression results of sub-indicators including market access & facilitation, free cross-border data flow, digital intellectual property rights, and privacy & data security all show significant positive correlations with digital service trade.

For heterogeneity analysis, the full sample is divided into low-income and high-income developing countries based on the median of national income level (SR). The results indicate that trade clause depth generates a stronger boosting effect on digital trade in high-income developing countries (coefficient = 0.0762 vs 0.0524), and the inter-group difference is statistically significant ($p = 0.020$).

Mediating effect tests demonstrate that deeper digital trade clauses significantly improve regulatory quality (RQ), which further promotes digital service trade. Regulatory quality acts as a mediating variable between deepened digital trade rules and trade structure upgrading. High-standard digital trade clauses can boost the digital service trade and trade structure upgrading of developing countries by cutting trade costs and lifting supervision standards.

In summary, high-standard digital trade clauses deliver substantial positive benefits to the digital service trade of developing countries. On the one hand, such clauses reduce costs for digital service trade and create superior conditions for developing country enterprises to participate in international competition. On the other hand, high-standard digital trade clauses push developing countries to perfect domestic legal and supervision systems and upgrade regulatory capacity by imposing stricter legal supervision requirements, ultimately increasing digital service export volume and comprehensively advancing trade structure upgrading in developing countries.

6. Conclusions and suggestions

By constructing an indicator measuring the depth of digital trade rules and conducting regression and robustness tests on relevant panel data, this paper finds that deepening digital trade rules can drive the upgrading of trade structures in developing countries. Firstly, there exists a significant positive correlation between the depth of digital trade clauses and the scale of digital service exports; deeper digital trade clauses correspond to more remarkable growth in digital service trade and industrial added value. Secondly, the effects vary significantly across countries at different economic development levels. High-income developing countries witness greater trade structure upgrading thanks to sound network infrastructure and law enforcement capacity, while low-income developing countries achieve relatively limited upgrading due to insufficient infrastructure and supervision capacity. Thirdly, digital trade rules function through two core channels: first, reducing institutional trade costs via unified and simplified supervision standards as well as lower information uncertainty; second, promoting the alignment of domestic laws and construction of supervision capacity to create a fair, transparent and predictable institutional environment for digital service trade.

To maximize the functions of digital trade rules, developing countries may adopt the following measures: First, actively speak up in negotiations at the WTO and regional agreements, rally multi-party forces to gain a say in rule-making, and put forward practical and feasible proposals for trade rules. Second, adopt a tiered and categorized management model to facilitate cross-border data flows. Meanwhile, strengthen differentiated reviews and protection measures based on data sensitivity, refine data protection and privacy laws and regulations, set up dedicated regulatory bodies and review mechanisms, and strike a balance between national security and commercial efficiency. Third, increase investment in digital infrastructure including broadband networks, mobile payment systems and data center construction, raise internet penetration rates and network quality, cut the costs of digital services trade, and amplify the driving role of digital rules in the upgrading of trade structures. Ultimately, this will help developing countries seize opportunities in the digital economy era and achieve high-quality transformation of their trade structures.

Disclosure statement

The authors declare no conflict of interest.

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