

Research on the Mechanism of E-commerce Model Innovation Driven by Digital Technology

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Abstract: Driven by digital technology, the digital transformation of global trade has given rise to a new type of digital trade characterized by reconstructing commodity forms, breaking through temporal and spatial limitations, and promoting the flow of data elements, becoming a key driving force for global economic recovery and the construction of a trading power. This study focuses on the correlation mechanism between digital trade and foreign direct investment (FDI) at the provincial level, and constructs a digital trade indicator system covering six dimensions: basic environment, logistics network, technological innovation, talent reserve, industrial digitization, and digital industrialization. By using the entropy method to quantitatively measure the development level of multi regional digital trade from 2012 to 2022, and combining the fixed effects model, mediation effects model, and heterogeneity analysis framework, this study systematically explores the impact path and regional differences of digital trade on FDI. Research has found that digital trade has a significant positive driving effect on FDI - each unit of digital trade expansion can drive an average of 0.731 units of FDI growth, mainly through two intermediary mechanisms: reducing transaction costs and increasing residents' disposable income. Heterogeneity analysis further reveals that regions with higher levels of digital infrastructure have stronger information flow efficiency and service supporting capabilities, and their role in driving FDI through transaction cost compression and income effect amplification is more significant; as digital infrastructure upgrades and open policies deepen, areas with relatively weak infrastructure will gradually release and continuously strengthen their promoting effects. The study reveals from both theoretical and empirical dimensions that digital trade attracts foreign investment by restructuring trade forms, optimizing resource allocation, reducing institutional costs, and enhancing consumption capacity. Regional infrastructure differences lead to a gradient distribution of effects. At the practical level, it serves as the core mechanism to promote the coordinated development of digital trade and FDI, optimize investment strategies, assist in high-quality economic development and the construction of a "dual circulation" pattern, highlighting the key role of digital technology driven trade digitization in the development of an open economy.

1. Introduction

Under the deep driving force of digital technology, the expansion of global information and communication technology^[1] and the digital transformation of trade have given rise to new forms of digital trade. Technologies such as big data, digital twins^[2], knowledge graphs, RPA, AI, etc. have reconstructed the form of commodity trade. Cross border e-commerce, as the core carrier, has become a new engine for global foreign trade growth. Digital trade achieves digitalization of trade modes, objects, platforms, customization of services, and globalization of supply chains by breaking the limitations of time and space. Data, as a core production factor, is driving the transformation of international trade and becoming a key pivot for global economic recovery and the construction of a trading powerhouse. This study focuses on the provincial level and deeply analyzes the correlation mechanism between digital trade and foreign direct investment (FDI). It constructs a digital trade indicator system that covers the entire process indicators such as basic environment, logistics network, technological innovation, talent reserve, industrial digitization, and digital industrialization. The system characterizes the level of regional digital trade development and provides quantitative support for exploring the impact path of digital trade on FDI. The entropy method is used to measure the development level of digital trade in multiple regions from 2012 to 2022. Combined with fixed effects model^[3], mediation effect model, and heterogeneity analysis, the direct impact of digital trade on FDI, the mediation mechanism by reducing transaction costs and increasing residents' disposable income, and the moderating effect of digital infrastructure level are systematically explored. Innovatively filling the research gap in the digital trade system from a regional perspective, this study introduces refined indicators such as the proportion of ICT product/service exports and the digital service trade restriction index to comprehensively evaluate the development potential.

2. Correlation Theory

2.1. Research on the Relationship between Digital Trade and Foreign Direct Investment

As a new form of trade relying on Internet, big data, AI and other digital technologies, digital trade^[4] covers digital product and service transactions, cross-border e-commerce, digital delivery trade and so on. Academics often use a multi indicator comprehensive system (such as infrastructure, industrial scale, policy environment, innovation ability and other dimensions) to measure its development level. The measurement method has not yet been unified, but the comprehensive evaluation method has been widely recognized. The research on the impact of digital trade focuses on enhancing international competitiveness, improving global value chain status, promoting exports, upgrading industrial structure, and technological innovation. For example, high-quality economic development can be achieved through reducing transaction costs, optimizing factor allocation, and promoting technology diffusion. The connotation of foreign direct investment (FDI) emphasizes cross-border capital flows and sustainable benefit acquisition. The measurement methods include actual investment amount and the ratio to GDP/per capita. Its impact effects involve technological innovation, export scale expansion, industrial structure upgrading, and economic growth. The influencing factors include business environment, digital economy level, tax policies, etc. Existing literature mostly explores the one-way effects of digital trade and FDI separately, with relatively few studies focusing on the direct correlation between the two. The research mainly focuses on the relationship between traditional trade forms such as free trade zones and trade facilitation and FDI. However, the interactive mechanisms between new forms of digital trade and FDI, such as direct effects, intermediary effects, and regional heterogeneity, still need to be further explored. The literature review points out that there are problems with the diversity of

measurement methods, fragmented impact paths, and insufficient cross disciplinary correlation research in current research. It is necessary to fill the gap by constructing a unified indicator system, integrating impact effect paths, and expanding regional comparative research, in order to provide theoretical support for the coordinated development of digital trade and FDI.

2.2. Theoretical Basis of Digital Trade and Foreign Direct Investment

The transaction cost theory^[5] was proposed by Coase (1937), emphasizing that all exchange activities have transaction costs (such as search, information, negotiation, supervision, etc.), and digital trade reduces these costs by breaking the limitations of time and space, thereby affecting foreign direct investment; Williamson (1975) further subdivided transaction costs into pre - and post costs, pointing out that improving digital technology and legal systems can reduce information asymmetry and default risks, and enhance investment attractiveness. The theory of free trade originated from Adam Smith, advocating for international division of labor through absolute and comparative advantages. Scholars such as Ricardo, Heckscher Ohlin, and Krugman supplemented factor endowments, economies of scale, and competitive effects, believing that free trade can expand national income, optimize resource allocation, and reduce monopolies, providing new channels for foreign direct investment. The theory of market internalization was proposed by Buckley, Casson, and Rugman (1976), emphasizing that multinational corporations reduce transaction costs by internalizing the market, and digital trade improves regional innovation efficiency by optimizing factor allocation and technological progress, promoting foreign investment inflows. The International Production Compromise Theory was constructed by Dunning (1977, 1981), which integrates ownership advantages, internalization advantages, and location advantages. It points out that enterprises need to possess all three at the same time to engage in international direct investment. Digital transformation can strengthen enterprise advantages, enhance internalization motivation, overcome external disadvantages, and promote outward direct investment. This chapter provides theoretical support for the study of the relationship between digital trade and foreign direct investment by reviewing the above theories.

3. Research Method

3.1. The Growth of Global Digital Trade and the Evolution of Cross-Border Investment Patterns

The growth rate from 2019 to 2023 continues to be higher than the growth rate of digital service exports during the same period; E-commerce also shows strong potential, with global cross-border e-commerce reaching \$360 billion in 2023 and an expected compound annual growth rate of 7% from 2023 to 2028. The scale is expected to reach \$5 trillion by 2028. The digital technology infrastructure is constantly improving, with a global number of 469 submarine cables that will continue to expand in the future. The number of ultra large scale data centers will reach 992 by the end of 2023, and is expected to increase to 1500 in the next four years; The average growth rate of cross-border data flow from 2020 to 2022 exceeds 30%, and it is expected to contribute \$11 trillion to economic growth by 2025, driving a surge in demand for data centers and computing power. The global digital trade governance is advancing in depth, with an increase in the number of relevant agreements, expansion of topics, and continuous improvement of rules, covering emerging fields such as cross-border data flow, digital technology governance, and digital platform governance. In December 2023, the WTO Joint Statement on E-commerce proposed that 90 participants reach consensus on 13 topics, involving trust between enterprises and consumers, open digital environment, trade facilitation, etc. The participation of developing economies continues to increase.

From 2019 to 2023, the proportion of developing economies in the top 30 global digital delivery export economies increased from 13.2% to 16.3%, and the proportion of developing economies and emerging markets in the top 30 import economies increased from 14.6% to 16%, jointly promoting the development of global digital trade, as shown in Table 1.

Table 1. Global Digital Express Trade Import and Export Data

Year	Goods Export (Trillion USD)	Goods Export Growth Rate	Service Export (Trillion USD)	Service Export Growth Rate	Digital Delivery Service Export (Trillion USD)	Digital Delivery Service Export Growth Rate
2019	19.0180	-2.7%	6.2372	3.3%	2.8193	5%
2020	17.6529	-7.2%	5.1898	-16.8%	3.2054	13.7%
2021	22.3190	26.4%	6.2507	20.4%	3.7623	17.4%
2022	24.9175	11.6%	7.1940	15.1%	3.9001	3.7%
2023	23.7835	-4.6%	7.8397	9%	4.2504	9%

The growth momentum of global cross-border investment has weakened. Affected by the COVID-19 in 2022, investors' willingness to invest across borders has declined, and cross-border investment flows to developed countries have declined by a record amount. According to data from the United Nations Conference on Trade and Development, the global cross-border investment flow in 2022 was \$1.3 trillion, a year-on-year contraction of 12.4%. Among them, cross-border investment flowing to developing countries reached 916.42 billion US dollars, accounting for 70.8% of the total global cross-border investment; The cross-border investment flowing to developed countries has decreased by 36.7% compared to previous years, showing a significant downward trend. At the same time, global cross-border investment competition is becoming increasingly fierce, and countries are attracting foreign investment through preferential policies. Developed countries adopt measures such as financial support, policy incentives, and subsidy upgrades - for example, the United States promotes the emerging development of chip and high-tech industries; Developing countries have also introduced a series of preferential policies to attract foreign investment. By 2022, the proportion of preferential policies to attract foreign investment worldwide has reached two-thirds, forming a "dual line competition" pattern. This trend reflects that in the global investment landscape, developing countries are accelerating their rise with policy advantages, while developed countries are maintaining competitiveness through industrial support, jointly shaping the current new ecology of cross-border investment.

3.2. The Three Major Paths through Which Digital Trade Directly Affects Foreign Direct Investment

Digital trade, as a new form of integration between digitalization and trade, directly affects foreign direct investment through three core paths. Firstly, a favorable business environment is the key attraction - providing investors with a safe and stable investment environment through policy guarantees, digital technology support, and default risk constraints, ensuring that capital inflows bring returns. Secondly, the release of development potential forms a sustained attraction - digital trade drives down transaction costs, increases employment opportunities, and boosts industrial income, enhancing consumer market vitality and economic development momentum, and attracting foreign investment. Finally, the enhancement of international competitiveness creates new opportunities - digital trade showcases institutional, technological, and market advantages in the

international market by optimizing resource allocation, improving technological innovation capabilities, and enhancing its position in the global value chain, providing a new platform for foreign direct investment. The above mechanisms collectively constitute the direct logic of promoting foreign direct investment through digital trade.solid data foundation for financial entity association mining and enterprise anomaly analysis as a whole.

3.3. Heterogeneous Graph Attention Method for Financial Feature Extraction and Experimental Validation

Digital trade affects foreign direct investment through two indirect pathways: firstly, by overcoming the distance, language, and temporal limitations of traditional trade, reducing search, information, bargaining, and regulatory transaction costs, and utilizing intelligent technology to optimize supply chain structure and production efficiency, it enhances cross-border investment returns for enterprises and attracts foreign investment inflows; Secondly, by promoting the increase of employment opportunities, the improvement of industrial income, and the upgrading of consumption structure, the disposable income of residents can be increased, the vitality of the consumer market and the momentum of economic development can be enhanced, and a broad market space can be provided for foreign direct investment. Affected by regional economic differences, digital infrastructure levels, and industrial structure differentiation, the driving effect of digital trade on FDI presents a significantly heterogeneous pattern - in mature digital infrastructure regions, its siphon effect on foreign investment is more significant by strengthening the efficiency of transaction cost reduction and increasing household income; In areas with weak infrastructure, this promotion effect may have a time lag, but with the iteration and upgrading of digital infrastructure and the deepening of open policies, its positive pull will gradually emerge and continue to strengthen. The above transmission paths and regional heterogeneity jointly construct a theoretical logic system for the indirect driving of foreign investment expansion by digital trade, revealing the dynamic evolution law of digital trade dividend distribution in different development stages of regions, and highlighting the key role of infrastructure upgrading and policy coordination in unleashing the potential of digital trade.

4. Results and Discussion

4.1. The Mechanism and Regional Heterogeneity of the Impact of Digital Trade on Foreign Direct Investment

Digital trade indirectly promotes foreign direct investment through two main paths: first, reducing transaction costs, enhancing cross-border investment returns for enterprises by overcoming traditional trade restrictions, optimizing supply chain structures, and improving production efficiency; The second is to increase residents' disposable income, stimulate market demand potential by promoting employment growth, industrial income improvement, and consumption structure upgrading. In terms of regional heterogeneity, areas with higher levels of infrastructure have a more significant effect on promoting foreign direct investment due to reduced transaction costs and increased income; Although the impact on areas with weak infrastructure lags behind, the effects will gradually be released as digital infrastructure improves and openness increases. This mechanism, together with heterogeneity characteristics, constitutes the core logic of the indirect impact of digital trade on foreign direct investment.

4.2. Model Experiment

This study conducted an empirical analysis using panel data from multiple regions spanning 2012 to 2022. Data sources included regional statistical yearbooks, digital trade development bulletins, foreign investment monitoring reports, and authoritative databases, with missing values addressed through linear interpolation. The variable quantification framework adopted a three-dimensional structure: the dependent variable, foreign direct investment, was measured by the ratio of actual utilized foreign capital to regional GDP to mitigate statistical bias from economic scale differences. The core explanatory variable, digital trade, was assessed via a composite development index encompassing six dimensions—foundational environment (e.g., internet domain counts, broadband user scale), logistics environment (e.g., cargo turnover, express business revenue), technological environment (e.g., patent authorizations, R&D investment intensity), industrial digitization (e.g., e-commerce transaction volume, digital finance indices), digital industrialization (e.g., proportion of software business income), and development potential (e.g., per capita output value, total trade volume, digital service restriction indices)—to holistically capture digital trade development levels. Control variables incorporated economic structure and growth drivers, including industrial structure (tertiary-to-secondary industry ratio), urbanization rate (urban population proportion), human capital density (university students per 10,000 people), industrialization level (industrial added value ratio), and technology market activity (technology transaction volume ratio). For intermediary mechanism analysis, transaction costs were gauged by marketization indices (integrating dimensions like product market development, non-state economy share, and market service completeness), while residents' disposable income was represented by per capita disposable income. This indicator system adhered to principles of systematicity, typicality, scientificity, and quantifiability, leveraging multidimensional indicators to ensure academic rigor and policy relevance, thereby providing robust quantitative support for unraveling the interaction dynamics between digital trade and foreign direct investment.

4.3. Effect Analysis

This study is based on panel data from multiple regions and explores the impact mechanism of digital trade on foreign direct investment (FDI) through a two-way fixed effects model^[6]. In the model setting, FDI is measured by the ratio of actual utilization of foreign capital to GDP, while digital trade (DT) is evaluated through a comprehensive development index, controlling variables including industrial structure, urbanization level, human capital, industrialization level, and technology market development, and incorporating time and regional fixed effects to control heterogeneity. Descriptive statistics show that the FDI mean is 4.705 (standard deviation 1.197) and the DT mean is 11.728 (standard deviation 1.218), indicating significant regional development differences; In the correlation analysis, the correlation coefficient between DT and FDI was 0.524 ($p < 0.01$), and the mean VIF was 1.910, excluding multicollinearity issues. The benchmark regression results indicate that the DT coefficient is 0.731 ($p < 0.01$), which means that for every 1 unit increase in digital trade, the average increase in FDI is 0.731 units, confirming a significant promoting effect. The analysis of intermediary mechanisms shows that transaction costs and disposable income of residents play an intermediary role: the coefficient of DT on transaction costs is 0.367 ($p < 0.05$), indicating that digital trade promotes FDI by reducing transaction costs; The coefficient of DT for residents' disposable income is 0.067 ($p < 0.01$), indicating that indirectly attracting FDI by increasing income and expanding the consumer market. Heterogeneity analysis shows that the strength of the impact effect of infrastructure level is more significant in areas with high infrastructure level (coefficient 0.959) and areas with medium infrastructure level (1.624) due to the improvement of infrastructure; Low infrastructure level areas (0.532) have not yet shown

their effects due to weak infrastructure. The robustness test was conducted by endogeneity treatment, adding control variables, changing dependent variables, and adjusting sample intervals. The DT coefficients were all significantly positive, confirming the robustness of the results. As shown in Table 2

Table 2. Heterogeneity Analysis of Digital Trade's Impact on FDI by Infrastructure Level

Region Type	DT Coefficient	t-value	R-squared
High Infrastructure Level	0.959	2.77	0.58
Medium Infrastructure Level	1.624	4.70	0.41
Low Infrastructure Level	0.532	1.23	0.48

The research conclusion shows that digital trade significantly promotes foreign direct investment through reducing transaction costs and increasing residents' income, and the effect shows heterogeneity due to regional differences in infrastructure levels, providing empirical support for policy-making.

5. Conclusion

Digital trade, as a new form of trade, plays a key supporting role in promoting the construction of a strong trading nation, expanding trade scale, and building a new development pattern of "dual circulation"; Foreign direct investment (FDI) has a positive impact by driving economic growth, enhancing its position in the value chain, and strengthening its openness. Research shows that digital trade as a whole maintains a high-speed growth trend - although developed economies still occupy a large market share, developing countries show strong growth potential; Although the growth rate of foreign direct investment has slowed down due to the impact of the epidemic, the scale of investment attraction in China continues to steadily expand and the structure continues to optimize, gradually unleashing the development potential of the central and western regions. Based on this, policy recommendations include: improving the digital trade infrastructure system, accelerating the construction of 5G networks, the Internet of Things, data centers, and cloud computing platforms^[7], and enhancing network speed and data security capabilities; Deepen international cooperation mechanisms, actively participate in bilateral and multilateral negotiations^[8] on digital trade agreements, attract international digital talents^[9], and cultivate new growth poles for digital trade; Expand the areas of foreign investment openness, optimize the negative list management for foreign investment access, guide foreign investment to gather in high-tech industries and green low-carbon fields^[10], improve the regulatory and policy system and preferential policies, enhance the specialization level of foreign investment services, and promote high-quality economic development.

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