Digital Economy Empowers Service Trade Management Innovation in China: Practices and Challenges in Digital Transformation

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ABSTRACT

As an emerging paradigm of economic development, digital economy has already become a pivotal force to drive the evolution for modern trade in services. Utilizing panel data from China spanning the years 2012 to 2022, the research organized a complex evaluation system for digital economy. It employs 2 empirical strategies: first, benchmark regression assess direct effect between digital economy and service trade in China; second, a panel moderation model investigates moderating effect of the industrial agglomeration between digital economy and services trade. Main findings in the study indicate that: (1) Digital economy made significant direct effect on the service trade. (2) Industrial agglomeration made a positive moderating effect as digital economy influencing service trade in China. Based on the conclusions, this study proposes several recommendations, emphasizing that governments enhance policy guidance and promote integrated digital economy and service trade. Research findings not only furnish empirical support for advancing digital transformation of service trade in China but also contribute theoretical and practical insights for digitalization and service trade reforms in developing countries and regions in the world.

Keywords: Digital Economy, Service Trade, Industrial Agglomeration, Management Innovation

1. Introduction

With the rapid evolution and pervasive integration of emerging information technologies, the global economic architecture has been shifting from an industry-centric paradigm toward a digitally driven paradigm (Wu & Yu, 2022; Di et al., 2023; Zhou et al., 2023). In China, the digital economy has become an important force for industrial upgrading, trade transformation, export resilience, and high-quality development rather than only a technological phenomenon (Di et al., 2023; Li et al., 2025; Tang et al., 2025; Yin et al., 2025). Recent studies further show that digital technologies reshape trade costs, market matching, delivery modes, digital service innovation, and the competitiveness of service exports (Zhang & Wang, 2022; Jiang et al., 2023; Khan et al., 2025). Within this broader context, the service sector has undergone accelerated digitalization, giving rise to innovative operational models and formats, including digital trade, platform-based economies, and remote service delivery, that are reconfiguring the landscape of services trade, value chains, and competitive dynamics.

As an essential component of international trade and an important field for global economic cooperation, service trade plays a major role in China's service industry upgrading and outward economic integration. However, conventional services trade is constrained by transaction costs, regulatory barriers, information asymmetry, and spatio-temporal limits on service delivery (Zhang & Wang, 2022; Jiang et al., 2023). The digital economy provides new technological and institutional channels for addressing these constraints by

improving digital infrastructure, lowering trade costs, expanding digital delivery, and strengthening service export competitiveness (Luo et al., 2023; Li & Wang, 2024; Yang et al., 2024; Yuan & Pan, 2025). These changes create a strong impetus for the sustainable development of China's service trade.

Consequently, a systematic investigation into how the digital economy affects service trade, together with the mechanisms underpinning this relationship, has become a critical research agenda with both theoretical significance and practical relevance.

To address this gap, this research uses panel data for 30 Chinese provinces from 2012 to 2022 to examine the effect of the digital economy on service trade. The study design comprises three principal components: first, the entropy method is used to construct a comprehensive index system for measuring the digital economy; second, benchmark regression evaluates the direct effect of the digital economy on service trade; and third, a moderation model investigates whether industrial agglomeration strengthens this relationship. The organization of this study is as follows: Chapter 2 introduces the research methodology, variables, and data; Chapter 3 develops the theoretical mechanism and hypotheses; Chapter 4 reports the econometric results; and Chapter 5 concludes with major findings and policy implications.

2. Research Methodology

2.1. Research Methods

2.1.1. Entropy Method

The entropy method objectively determines indicator weights according to the information contained in the observed data and is widely used in provincial digital economy measurement (Shan & Liu, 2023; Zeng et al., 2023; Zhu et al., 2023; Yuan et al., 2025). In this study, all indicators are first normalized to eliminate dimensional differences. For positive indicators, the normalized value is calculated as Xij=(xij-min xj)/(max xj-min xj); for negative indicators, it is calculated as Xij=(max xj-xij)/(max xj-min xj). The proportion of each normalized indicator is then calculated, followed by the entropy value, redundancy coefficient, and indicator weight. Finally, the weighted values of all indicators are aggregated to form the digital economy index. The entropy method is applied to the pooled provincial panel from 2012 to 2022, and the final index is aggregated across the three criterion layers: digital infrastructure, digital industrialization, and industrial digitalization.

2.1.2. Moderating Effect Model

The testing of moderating effects generally unfolds in two sequential stages. The first phase specifies a direct-effect model to evaluate the effect of the digital economy on service trade in China. In the second phase, the moderating variable is introduced to examine whether industrial agglomeration alters the extent to which the digital economy facilitates service trade development and innovation. In accordance with the hypotheses, a baseline model was first constructed to assess the direct relationship between the digital economy and service trade across China.

$$ST_{i,t} = \alpha_0 + \alpha_1 DE_{i,t} + \alpha_n CV_{i,t} + \mathcal{E}_{i,t} \quad (1)$$

Then, constructing a moderating effect model.

$$ST_{i,t} = \alpha_0 + \alpha_1 DE_{i,t} + \alpha_2 IA_{i,t} + \alpha_3 DE \cdot IA_{i,t} + \alpha_n CV_{i,t} + \mathcal{E}_{i,t} \quad (2)$$

In formula 2, i represents *i-th* region, t represents *t-th* year, $ST_{i,t}$ represents service trade; $DE_{i,t}$ represents digital economy; $IA_{i,t}$ represents industrial agglomeration; $CV_{i,t}$ represents the total effect of control variables; $\varepsilon_{i,t}$ represents random error.

2.2. Variables and Data Resource

2.2.1. Variables

The dependent variable. This study measures service trade through the export market share of service trade (ST), calculated as the ratio of a province's service trade exports to national service trade exports in the same year. This indicator captures the relative export position of each province in China's service trade system.

The independent variable. Digital economy (DE) is measured as a comprehensive index based on three perspectives: digital infrastructure, digital industrialization, and industrial digitalization. Following existing provincial digital economy measurement studies, this research uses the entropy method to assign indicator weights and aggregate the index (Shan & Liu, 2023; Zeng et al., 2023; Xu & Xu, 2023; Yuan et al., 2025).

Table 1: Indicators System for Digital Economy

Objective Layer	Criterion Layer	Indicator Layer
Digital Economy	Digital Infrastructure	Broadband access rate
		Broadband penetration rate
		Scale of mobile phone facilities
		Optical cable length
		Number of webpages
		Number of domain names
	Digital Industrialization	Per capita telecommunications services
		Mobile phone penetration
		Number of legal entities in the information service industry
		Employment in the information software industry
		Patent application and authorization
		Patent application acceptance
	Industrial Digitization	Digital inclusive finance
		E-commerce enterprises
		E-commerce sales
		Websites numbers per 100 enterprises
		Added value of the secondary and tertiary industries
		Investment in scientific and technology innovation
		Express delivery volume

Control variables. This study selects openness (OPEN), marketization index (MARKET), aging (OLD), and transportation (TRA) as control variables. OPEN is measured by the degree of external economic openness; MARKET is represented by the regional marketization index; OLD is measured by the share of the elderly population; and TRA is proxied by the scale of transportation infrastructure after logarithmic treatment.

Moderating variable. Industrial agglomeration (IA) describes the concentration of identical, similar, or related industries in a particular geographic region. This research measures IA using a location-quotient logic: IA equals the ratio of the regional service industry share to the corresponding national service industry share. A higher value indicates a stronger degree of industrial agglomeration and a more concentrated service-related industrial base.

2.2.2. Data Resource

The research collected original data from 30 provincial regions in China from 2012 to 2022. Data sources include the Wind database, government work reports, and statistical yearbooks. The raw data were cleaned and preprocessed to ensure suitability for quantitative analysis. Missing values for certain provinces and years were addressed through interpolation methods, and variables with large scale differences were treated consistently before regression analysis. Descriptive statistics are shown in Table 2.

Table 2: Descriptive Statistics

Variables	Obs	Mean	SD	Min	Max
ST	330	0.017	0.028	0.000	0.146
DE	330	0.139	0.112	0.020	0.702
IA	330	0.965	0.211	0.324	1.528
TRA	330	11.714	0.852	9.437	12.913
OPEN	330	0.265	0.268	0.008	1.354
MARKET	330	8.250	1.915	3.359	12.864
OLD	330	0.202	0.077	0.077	0.469

3. Theory and Reviews

As the global transition into the digital era accelerates, the digital economy has become a powerful driver for reallocating resources, reshaping production and delivery modes, and transforming trade competitiveness (Di et al., 2023; Zhou et al., 2023; Zhao & Gao, 2024). Against this backdrop, China's service trade sector faces both pressure for transformation and opportunities for upgrading. Digital technologies inject new momentum into trade in services by changing how services are produced, matched, delivered, and governed (Zhang & Wang, 2022; Jiang et al., 2023; Khan et al., 2025).

The digital economy facilitates trade in services primarily through two mechanisms: cost reduction and efficiency enhancement, and business model innovation (Zhang et al., 2022; Zhou et al., 2023; Jiang et al., 2023; Zhang & Shang, 2022). Because services are often intangible and involve simultaneity between production and consumption, traditional service trade has long faced barriers to tradability. Digital technologies reduce information-search costs, matching costs, payment costs, and cross-border delivery costs, thereby improving transaction efficiency and expanding the feasible scope of service exports.

For instance, online professional service platforms connect service providers and consumers globally, enabling small and medium-sized enterprises to participate in international service markets at lower cost. Digital platforms also support remote delivery, data-based customization, cross-border e-commerce, and cross-border coordination, which expands both the scale and scope of services trade (Zhou et al., 2023; Li & Wang, 2024; Yang et al., 2024; Khan et al., 2025).

In addition to optimizing traditional service trade, the digital economy has catalyzed the emergence of digital service trade centered on data, platforms, and digital delivery (Zhang & Wang, 2022; Zhao & Gao, 2024; Yuan & Pan, 2025). Traditional services such as education, healthcare, consulting, entertainment, tourism, and professional services have become more tradable through online channels, while digital technologies themselves have also become tradable service products (Zhang & Shang, 2022). Empirical studies show that digital technology, digital infrastructure, digital industrialization, and digital trade rules can significantly promote digital service exports, export upgrading, and service trade competitiveness (Jiang et al., 2023; Xu & Xu, 2023; Li & Wang, 2024; Yuan & Pan, 2025).

Thus, this research posits the first hypothesis: H1: The digital economy has a positive effect on China's service trade.

The effect of industrial agglomeration on trade is theoretically grounded in knowledge spillovers, input sharing, labor pooling, and economies of scale. The geographic concentration of firms, skilled labor, service providers, and institutions facilitates knowledge exchange, technology diffusion, and market matching, thereby improving productivity and competitiveness within clusters. For service industries, agglomeration is particularly important because knowledge, information, and specialized human capital are key production factors. Recent studies further show that the digital economy reshapes industrial collaborative agglomeration and that digital industry agglomeration can influence resource allocation efficiency, innovation capacity, and sustainable development (Ma et al., 2024; Tang & Tong, 2025; Lu et al., 2025).

Furthermore, industrial agglomeration is likely to act as a catalyst in the process through which the digital economy enhances service trade. Agglomerated regions provide concentrated demand, richer application scenarios, thicker labor markets, shared digital infrastructure, and more mature industrial ecosystems, all of which facilitate the adoption, iteration, and commercialization of digital solutions (Chang et al., 2024; Ma et al., 2024; Tang & Tong, 2025). Consequently, the enabling effect of the digital economy should be stronger in regions with higher industrial agglomeration, because firms in such regions can convert digital infrastructure and platform resources into service trade competitiveness more efficiently.

Nonetheless, there remains a scarcity of research directly examining how industrial agglomeration moderates the relationship between the digital economy and service trade. This research addresses this gap by empirically analyzing whether industrial agglomeration strengthens the effect of the digital economy on service trade in China. The findings are expected to provide theoretical and empirical evidence for regionally differentiated policies that promote digital service trade. Accordingly, the study proposes a second hypothesis:

H2: Industrial agglomeration positively moderates the relationship between the digital economy and China's service trade.

4. Results and Discussion

4.1. Benchmark Regression Model

The benchmark regression model confirms a direct and positive relationship between the digital economy and service trade in China. The first column in Table 3 reports the estimated effect of the digital economy on service trade without control variables, while the second column reports the results with control variables. Regardless of the regression specification, the coefficient of the digital economy remains statistically significant.

The estimates indicate that a one-unit increase in the digital economy index is associated with a 0.112-unit rise in service trade volume. Similarly, a one-unit increase in the level of openness leads to a 0.068-unit growth in service trade. A one-unit improvement in transportation infrastructure corresponds to a 0.014-unit increase in service trade. In contrast, a one-unit increase in the aging index is associated with a 0.064-unit decline in service trade, suggesting a potential constraining effect due to labor supply shortages. Marketization level, however, does not exhibit a statistically significant impact on service trade, implying that further market-oriented reforms may still be necessary. The results verify empirical support for H1.

Table 3: Results for Benchmark Regression

	(1)	(2)
Variables	ST	ST
DE	0.191***	0.112***
	(0.009)	(0.010)
OPEN		0.068***
		(0.005)
TRA		0.014***
		(0.001)
OLD		-0.064***
		(0.014)
MARKET		0.001
		(0.001)
Constant	-0.009***	-0.171***
	(0.002)	(0.014)
R^2	0.567	0.773
F-value	431.49	225.1
N	330	

*Noted:***, **, and * indicate significance at 1%, 5%, and 10%.*

4.2. Robustness test

To verify the stability of the benchmark regression results, this study conducts two robustness tests. First, the dependent variable is replaced: the export market share of service trade is substituted by the revealed comparative advantage index (RCA), calculated as the ratio of a province's service-export share in its total exports to the corresponding national service-export share. Second, the sample is restricted to 2016-2022 and the four direct-controlled municipalities, Beijing, Shanghai, Tianjin, and Chongqing, are excluded. In Table 4, columns (1) and (2) report the alternative-dependent-variable test based on the full sample (N=330), while columns (3) and (4) report the restricted-sample test (N=182). The coefficients of the digital economy remain positive and statistically significant, indicating that the benchmark finding is robust.

Table 4: Robustness Test

	RCA test		Reduced sample	
Variables	RCA	RCA	ST	ST
DE	0.648***	0.815***	0.230***	0.148***
	(0.208)	(0.264)	(0.007)	(0.010)
OPEN		0.510***		0.094***
		(0.145)		(0.007)
TRA		-0.174***		0.003**
		(0.032)		(0.001)
OLD		0.305		-0.036***
		(0.384)		(0.011)
MARKET		-0.080***		-0.002**
		(0.021)		(0.001)
Constant	0.409***	2.880***	-0.021***	-0.034***

	(0.037)	(0.378)	(0.001)	(0.013)
R^2	0.029	0.297	0.857	0.941
F-value	9.67	27.42	1084.44	557.29
N	330		182	

4.3. Moderating Effect

Estimation results regarding the moderating effect are reported in Table 5. Both industrial agglomeration and the interaction term between industrial agglomeration and the digital economy are statistically significant, regardless of whether control variables are included. The results indicate that industrial agglomeration has a positive moderating effect on the relationship between the digital economy and service trade in China, thereby providing empirical support for H2.

Table 5: Moderating Effect Results

	(1)	(2)
Variables	ST	ST
DE	0.186***	0.124***
	(0.008)	(0.007)
IA	0.023***	0.028***
	(0.004)	(0.003)
DE • IA	0.231***	0.266***
	(0.030)	(0.018)
OPEN		0.075***
		(0.004)
TRA		0.008***
		(0.001)
OLD		-0.038***
		(0.010)
MARKET		-0.002***
		(0.001)
Constant	-0.031***	-0.117***
	(0.004)	(0.010)
R^2	0.677	0.891
F-value	230.69	387.20
N	330	

5. Conclusions

This research examines the influence of the digital economy on service trade in China and yields two principal conclusions. First, the digital economy has a positive effect on service trade. Second, industrial agglomeration positively moderates this relationship, indicating that the effect of digital development is stronger in regions with a more concentrated industrial and service-related base. Based on these findings, this study proposes policy recommendations focused on digital infrastructure, service trade digitalization, institutional openness, and regional industrial coordination.

First, governments and enterprises should construct more inclusive and collaborative digital infrastructure. This includes strengthening broadband and data infrastructure, improving digital public services, supporting data governance mechanisms, and enhancing the foundational conditions for digital service delivery and cross-regional service trade.

Second, policy interventions should facilitate the digital transformation of service trade by supporting platform-based service delivery, remote service exports, digitalized business processes, cross-border e-commerce, and service-trade-oriented digital innovation (Yang et al., 2024; Khan et al., 2025). Enterprises should be encouraged to use digital tools to reduce transaction costs, improve matching efficiency, and expand tradable service categories.

Third, China should deepen institutional openness in digital service trade. Policy efforts may focus on improving digital trade governance, reducing unnecessary regulatory frictions, aligning digital trade rules, and strengthening international cooperation in cross-border data flows and digital service standards. These recommendations should be understood as broader policy implications consistent with the empirical evidence rather than direct estimates from the regression model.

Fourth, regional policy should encourage the development of service-oriented and digital industrial clusters. Regions with stronger industrial agglomeration can better transform digital infrastructure into service trade competitiveness, while less developed regions should improve digital infrastructure, human capital, and industrial support systems to narrow regional gaps.

This study also has limitations. The provincial-level indicators may not fully capture firm-level mechanisms or industry-level heterogeneity in service trade; the construction of the digital economy index is sample-dependent; and the measurement of service trade at the provincial level may be constrained by data availability. Future research could use firm-level or industry-level data, spatial econometric models, dynamic panel models, and more granular digital service trade indicators to further examine the mechanisms identified in this study.

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