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A Study on the Pathways Through Which Digital Technology Empowers the Development of International Trade

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Abstract. The swift advancement of digital technologies is exerting a profound reshaping effect on the global trading framework. The present treatise conducts a systematic analysis of the underpinning mechanisms and practical routes via which digital technologies confer empowerment upon cross-border commerce. Digital technologies have brought about a fundamental transformation of the operational logic of cross-border commerce through four core mechanisms: the lowering of transaction expenditures, the restructure of trust-building frameworks, the enlargement of trade scopes, and the advancement of value chains. Drawing upon the theory of dynamic capabilities, this treatise identifies collaborative routes spanning four tiers—enterprises, platforms, industries, and nations—to deliver policy directions for the governance of digital commerce. It uncovers the manner in which digital technologies confer empowerment upon cross-border commerce through four inherent mechanisms: the lowering of transaction expenditures, the restructure of trust-building frameworks, the enlargement of trade scopes, and the advancement of value chains. It additionally identifies that the materialization of these mechanisms calls for coordinated advancement across these four tiers. On the basis of this groundwork and in consideration of the December 2024 conclusion of the WTO Agreement on E-Commerce, this treatise puts forward policy suggestions for the governance of digital commerce.

Keywords: digital technology, cross-border commercial exchange, expenses of transaction, digitalized credibility, cross-border e-commerce

1. Introduction

With the arrival of the third decade of the 21st century, digital techniques including big data, artificial intelligence, and blockchain have stepped into a stage of accelerated iteration. As a critical tie that connects the economies of different nations, cross-border commerce is experiencing deep-seated shift from conventional trade modes to digital-led frameworks. On the basis of statistical data released by the United Nations Conference on Trade and Development (UNCTAD), from 2020 to 2024, the overall worldwide exports of digitally deliverable services rose from $4.59 trillion to $7.23 trillion, registering an average yearly growth rate of 12.1%, which is significantly higher than the growth rate of global goods trade over the corresponding period (2.3%) [1]. This contrast

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indicates that the emerging patterns of trade propelled by digital technologies have turned into a central driver of the growth of the global economy.

Nevertheless, a pivotal inquiry necessitates a response: Via what specific routes do digital technologies endow cross-border commerce with enhanced capabilities? Can long-standing predicaments in conventional trade—such as information imbalance, elevated transaction expenses, and the absence of transnational credibility—be tangibly addressed via digital technologies? Current scholarly works largely center on individual digital techniques and disconnected occurrences—such as the employment of blockchain in cross-border payment settlement and the evolutionary tendency of transnational electronic commerce—but are unable to methodically uncover the internal working framework via which digital technologies restructure the foundational rationale of global commerce. Ghosh, relying on the dynamic capabilities theoretical framework, contends that the digital restructuring of manufacturing firms calls for the cultivation of three core competencies: "digital sensing, digital capturing, and digital reconfiguration." Yet this academic investigation chiefly concentrates on the internal operational procedures of corporations and has not received adequate expansion to the cross-organizational dimension of global commerce [2]. Zhou and colleagues supply empirical proof from the standpoints of digital commerce and pollution-carbon coordinated administration, plus digital global value chains and embodied carbon in export activities, yet are unable to methodically combine the internal functioning mechanisms of technology-driven restructuring with multi-faceted practical routes [3, 4].

The present manuscript endeavors to bridge this existing research void via the adoption of an analytical schema of "intrinsic mechanisms-practical pathways-typical practices", so as to conduct systematic clarification of the concrete routes through which digital technologies facilitate the development of cross-border commerce. This inquiry has conducted selection of global instances encompassing the electronic bills of lading of COFCO Group, iMile Logistics, SHEIN, LianLian International, and the Keqiao Textile Cluster, and has integrated the theory of dynamic capabilities alongside the theory of global value chains to guarantee the preciseness of argumentation and the trustworthiness of research findings.

2. Key manifestations of digital technology empowering international trade

The influence exerted by digital technological tools on cross-border commercial exchange has already become apparent across a diversity of aspects. The subsequent discourse conducts an exploration of this effect from four distinct angles: modes of commercial transaction, cooperating counterparts in trade, stakeholders engaging in trading activities, and the performance level of trade operations.

Digitization of Trade Methods. Conventional cross-border commerce depended on suboptimal operation patterns that encompass offline trade fairs, electronic mail correspondence, and hard-copy document processing workflows. The incorporation of digital techniques has facilitated the digital transformation and web-based handling of trade dealings. The emergence of cross-border electronic commerce portals serves as the foremost representative instance, in which purchasers and vendors fulfill a sequence of operational steps—including product showcasing, information consultation, order submission, and remittance—via these portals. In addition, the widespread deployment of digital tools such as electronic bills of lading and electronic letters of credit is progressively supplanting conventional hard-copy document circulation procedures.

Digitization of Trade Objects. The utilization of advanced digital technologies has already reconstituted the modes of trade, while also expanding the boundary of cross-national commercial exchange. Beyond conventional tangible commodities, digitalized services and digital-based goods

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have emerged as fresh impetuses for the advancement of global trade activity. The volume of cross-border trade operations covering non-physical offerings — including Software-as-a-Service (SaaS), cloud services, data services, and digital content (games, films, and music) — is undergoing sharp expansion. In 2024, the digital service trade surplus of China amounted to $55.37 billion, which reveals the robust developmental impetus of outbound digital service supplies [5].

Inclusive Participation of Trade Participants. In conventional commercial exchange practices, the scope of involvement has been largely restricted to sizable cross-border corporate entities, whereas small and medium-sized enterprises (SMEs) have encountered a series of unfavorable obstacles including limitations of capital, asymmetry of information, and restrictiveness of market entry. The pervasive assimilation of digital technological solutions has brought about a noticeable reduction of these hindrances. With Yiwu, China, selected as an illustrative case, more than 30,000 individual traders regularly employ artificial intelligence-based instruments to carry out cross-border commercial operations, a large proportion of whom are independent business owners or operators of small family-managed ventures. The linkage impacts generated by the platform-based economic system have turned "trade for all" into an existing actuality.

The influence of digital technology on trade performance stands out as the most pronounced. The digitization of workflows encompassing document processing, customs clearance, shipment tracing and financial reconciliation has drastically reduced transaction durations and brought down operational expenditures. Electronic bills of lading have condensed the procedure of cargo ownership transfer — which previously required weeks — to merely several days; smart logistics frameworks have markedly curtailed cross-border shipping periods; and cross-border remittance portals facilitate swift fund transmission. These efficiency improvements exert a substantial accumulative impact throughout worldwide supply networks, allowing a greater number of firms to engage in global commerce with reduced expenditures.

3. The underlying mechanisms of digital technology empowering international trade

Beneath the advancement of these technological evolutions, digital technical systems have reshaped the underlying operational rationale of cross-border commercial exchanges across four core dimensional aspects. We have completed the systematic dissection of these operating mechanisms and lend support to our theoretical propositions via the adoption of concrete case analyses and empirically derived data sets.

3.1. Mechanisms for reducing transaction costs

The theoretical framework of transaction cost puts forward the viewpoint that cross-border commercial exchange brings about multiple categories of transaction-related expenditures, which encompass the expenses of information searching, the outlays of bargaining processes, and the costs of contract execution. Digital technical tools have completed the mitigation of these kinds of expenditures via multiple functional pathways.

Diminishment of Search Expenditures. Under the conventional commercial framework, purchasers and vendors are required to allocate considerable time and financial resources to the identification of appropriate transaction counterparts, for instance through participation in global trade expos or cooperation with foreign intermediaries. Digital platforms make use of retrieval algorithms, large-scale data recommendation systems, and artificial intelligence-enabled pairing mechanisms to facilitate fast and precise connection between purchasers and vendors. The instance of Shanghai Opec Machinery Equipment Co., Ltd. is illustrative: The firm introduced an AI-driven

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automatic response function on Alibaba International, which gave automated replies to consultation requests from a Saudi purchaser at approximately 1:00 a.m. Beijing time. Following five to six rounds of profound communication, the firm obtained the customer and finally secured a procurement contract valued at more than $20 million. The AI support tool runs nonstop around the clock with a degree of professional competence equivalent to that of an experienced sales executive, greatly lowering the cost of manual information retrieval [6]. Cutting of Coordination Outlays. Cross-border commercial activities involve alignment of work among multiple stakeholders, encompassing manufacturing, freight delivery, payment settlement, and customs clearance. Digital technologies optimize cross-border information exchange via cloud-based cooperative tools, real-time interaction frameworks, and data sharing portals. The practical experience of Yiwu trader Fu Jiangyan indicates that through employment of AI-produced multilingual digital figure videos, the promotion of goods targeting 44 language regions can be finalized in only several minutes; traders who adopt AI on a wide scale have witnessed a rise of more than 30% in their order quantities [7].

Reduction of the costs associated with order fulfillment. The execution procedure of trade fulfillment encompasses the performance of contractual obligations, the dispatching of purchased commodities, and the finalization of payment settlements, domains in which disagreements and procedural lags are prevalent within conventional operational frameworks. The deployment of self-executing smart contracts and distributed ledger technology has facilitated the automated execution of contractual stipulations, cutting down the requirement for human operational interference. A research initiative focusing on electronic lading bills jointly carried out by COFCO Group and the Singaporean authority has realized the digitization of the circulation process for more than 20 categories of trade-related documentation, elevating the efficiency of document handling by 80% and decreasing the expenses of daily operation by over 30% [7]. These notable cuts in fulfillment-related expenditures make it feasible for a larger number of small and medium-sized business entities to take part in cross-border commercial exchanges.

From the viewpoint of dynamic competences, the abovementioned cost-cutting mechanisms correspond to the "Digital Seizing" capability put forward by Ghosh, in which firms embed digital techniques into trade procedures via rapid prototyping, organizational restructuring, and agile policy-making to capture efficiency gains [8].

3.2. Pathways for reconstructing trust mechanisms

Matters of confidence within cross-border commerce have for an extended period constituted a foremost obstacle. Purchasers and vendors are situated in distinct sovereign states, with divergent judicial frameworks and commercial norms, as well as pronounced asymmetries of information. In conventional practice, the establishment of reliability has been achieved via extended collaborative partnerships, documentary credits, or examinations undertaken by external entities; yet such approaches carry elevated expenses and excessive time expenditure. As an illustrative case, across the regions of the Middle East, imprecise systems of addressing and limited uptake of cash-on-delivery transaction modalities have made inadequacy of mutual trust a direct limiting factor for the advancement of electronic commerce activities.

Digital technological tools provide novel routes for the establishment of transactional trust. Distributed ledger technology, via its tamper-proof decentralized recordkeeping system, facilitates complete trackability and authentication validity across the entirety of the transaction workflow. The traceability platform of blockchain technology developed by the SCO International Green Agricultural Products Expo and Trading Center has carried out documentation of over 200 data metrics—encompassing soil examination reports and pesticide utilization records—for every

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consignment of exported chili peppers, with all information permanently saved on the decentralized ledger as dependable proof of authenticity. This observation clearly indicates the beneficial influence of digitized trust frameworks on transaction-related decision-making processes.

Intelligent self-executing agreements, in the interim, guarantee the existence of trust at the layer of operation. Once predetermined clauses are met, the agreement undergoes automatic fulfillment absent any human interference, thus reducing the risks of contract breach. The credit scoring frameworks of platforms carry equal significance; reciprocal assessments between purchasers and vendors amass reputation assets, forming a market scheme that provides incentives for honest conduct. Shackelford further has identified that the "fair and equitable treatment" provision and the investor-state conflict resolution mechanism contained within Bilateral Investment Treaties (BITs) are capable of offering an institutionalized trust structure for the safeguarding of trade confidentialities and the addressing of cyber incursions in cross-border digital trade activities [9].

One comparatively cross-border instance is the joint initiative launched between China and Singapore. Through the interlinkage of Singapore's IMDA TradeTrust platform with China's "Xinmao Chain", a multitude of stakeholders — encompassing China Nonferrous Metals International Trading Co., Ltd., Jiangxi Copper, Singapore's Pacific International Lines, DBS Bank, OCBC Bank, and the Jiangxi Branch of the Bank of China — have taken part in the full-process digitalization of anode copper import operations. OCBC Bank has pointed out that the utilization of electronic lading documents cuts down the hazards of fraud and the expenditures of verification, while simultaneously lending support to sustainable development frameworks. This instance demonstrates that digital trust-building systems are capable of surmounting heterogeneous legal regimes and economic actors to enable high-efficiency cooperation.

3.3. The logic behind the expansion of trade boundaries

Digital technological tools have substantially extended the frontiers of cross-border commerce, as demonstrated by advancements across three distinct dimensions: geography, commodities, and time.

Expansion of Geographical Boundaries. Digital intermediary platforms build connections between purchasers and vendors on a global scale, facilitating companies located in outlying regions to acquire entry to cross-border commerce spaces. iMile Logistics, with its foundational origins in the Middle Eastern region, currently carries out operational activities across 30 economic entities, encompassing Saudi Arabia, the United Arab Emirates, Mexico, Brazil, Australia and New Zealand. Within the territories of the Middle East, iMile has resolved the persistent issue of unclear residential location data, reducing the duration of end-to-end parcel distribution by 24 hours through its intelligent location coding system; in the Mexican market, the enterprise has allocated more than USD 100 million for the construction of a country-spanning logistics infrastructure network; in the markets of Australia and New Zealand, the daily rate of successful delivery completion reaches 99.5%. The breakdown of spatial delimitation between regions indicates that the slogan "distance is dead" is no longer merely a promotional phrase [10].

The extension of product boundaries. Conventional cross-border commerce has predominantly centered on tangible commodities, yet digital technology has given birth to an extensive spectrum of offerings and amenities that can be conveyed via digital channels. China's "new trio" of online games, online literature, and web series has achieved resounding global popularity. The Zhejiang-produced web series The Legend of the Hidden Sea claimed the leading position on the "Top 20 Overseas Dramas" ranking of the South Korean streaming platform Wavve on the very first day of its launch, accompanied by an IMDb score of 9.5. The 3D dental crown printer developed by Zhejiang Xunshi Technology commands more than 50% of the North American dental market share,

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making it possible for patients to complete scanning procedures and obtain crowns within the same day, with one individual crown produced in merely 10 minutes. These instances indicate that digital offerings and digital fabrication services are evolving into fresh growth impetuses for commercial exchanges.

The extension of temporal borderlines. Around-the-clock digital transactions have emerged as the prevalent standard, enabling purchasers and vendors to react to consumption needs at any given moment. Yiwu-based merchants employ AI-driven virtual personas to draw in Arab buyers for potential collaborative partnerships, attaining 24-hour customer interaction capability. This kind of disintegration of time-related restrictions has merged the worldwide market into a single integrated entity possessing uninterrupted operational functionality.

Scholarly work conducted by Wang and Chen further demonstrates that involvement in the Digital Global Value Chain (DGVC) is capable of substantially modifying the trade borders of a given nation—once the level of digitization surpasses a threshold of approximately 0.16, engagement with DGVC transitions from augmenting the embodied carbon emissions of exported goods to facilitating the reduction of carbon footprint. This phenomenon mirrors the border fluctuation characteristics of digital technology that evolves from "scale enlargement" to "efficiency enhancement" [4].

3.4. Pathways for value chain upgrading

Digitalized techniques have not only reshaped the borders of commercial exchange but have also exerted profound influences on the allocation of value increments across global value networks. This progression can be encapsulated as a two-fold mechanism encompassing the "carbon conduction effect" and the "technological innovation effect" [11].

Upgrading in R&D. Big data analytics helps enterprises gain precise insights into overseas market demands, guiding product innovation. The textile industry AI model "AI Bu" 2.0, released by the Keqiao China Light Textile City, allows designers to generate trendy patterns with a simple touch of the screen, significantly shortening the R&D cycle. From January to September 2025, the total transaction volume at the Keqiao China Light Textile City reached 329.185 billion yuan, a year-on-year increase of 10.01%, with AI-driven design innovation serving as a key driving force [12].

Digital Upgrades in Manufacturing. The promotion of intelligent manufacturing and flexible production systems empowers industrial entities to make adaptations to small-batch and high-frequency order frameworks. SHEIN leverages AI to generate design drafts and integrate them into a flexible supply chain, cutting the time-to-market of new products to merely seven days. Through the employment of 3D printing technology, Xunshi Technology carries out the production of dental crowns available for immediate on-site collection, which has fully brought about the transformation of the traditional fabrication process that demanded more than half a month of repeated back-and-forth trips to medical institutions.

Digital Upgrades in Marketing The adoption of targeted push alerts and customized content suggestions has considerably boosted the operational effectiveness of marketing campaigns. Alibaba International has completed the implementation of AI trial runs across more than 40 core scenarios of the full cross-border e-commerce value chain, rolling out AI utilities on platforms such as AliExpress, Lazada, and Trendyol, with coverage reaching 500,000 merchants and 100 million products. Insights-derived promotion practices have turned the vision of "customized content suggestions for every individual user" into an achieved outcome.

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Transition to Service-Oriented Business Models. Via utilization of internet of things technological solutions, enterprises are capable of delivering value-added offerings including remote surveillance, equipment upkeep, and data processing for already sold commodities, hence realizing the shift from product-focused transactions to service-centered vending. This service-focused reformation elevates the supplementary value along the value distribution chain and boosts the allegiance of consumers. Ghosh has carried out summarization of this transition as the "business model transformation" capability—the relocation of corporations from a product-prioritized to a service/outcome-prioritized framework, which serves as the core demonstration of digital restructuring [2]. In the meanwhile, small and medium-sized enterprises make use of digital platforms to incorporate themselves into global value chains, attaining "micro-transnationalization" and thus partaking in the proceeds of economic globalization.

The empirical investigation conducted by Zhou has delivered further quantification of the mechanisms underpinning the advancement of value chain upgrading: digital commerce has achieved notable elevation of the efficiency pertaining to pollution-carbon co-control, via the consolidation of regional innovation competence (which contributes 13.33% of the total effect) and the mitigation of misalignments within factor markets (accounting for 24% of the overall effect) [3]. This finding indicates that the elevation of value chain performance prompted by digital techniques is manifested not solely in the growth of economic value addition, but also in the concurrent enhancement of ecological operation outcomes.

4. Practical pathways for digital technology to empower international trade

At the organizational level of commercial entities, enterprises have to nurture operational capacities in the domains of "digital perception, information capture, and structural reconfiguration", carry out integration of data via information systems encompassing ERP and CRM, secure market expansion through utilization of cross-border e-commerce platforms, and foster inter-disciplinary personnel who hold specialized proficiencies in "logistics operations, information technology, and indigenous cultural awareness". For the operators of digital service platforms, service providers must deliver end-to-end service portfolios covering transaction matchmaking and payment clearing, construct a collaborative ecological system with participation from diversified stakeholders, and capitalize on the effects of inter-connected networks to realize the magnification of operational value. In terms of the broader industrial landscape, prioritized endeavors should be directed towards advancing the digital shift of conventional industry agglomerations (such as the "Keqiao Light Textile City Brain"), building up exhibition and trade networks operating in overseas markets, and attaining the sharing of intelligence resources as well as coordinated promotion activities. When it comes to the national governance dimension, administrative authorities ought to boost the construction of digital foundational facilities, put in place regulatory frameworks governing trans-border data circulation and digital tax imposition, and foster a steady operational environment via multilateral collaborative schemes (such as the E-Commerce Agreement) to unleash the underlying potential of digital enablement and facilitate the elevation of carbon efficiency levels in trade activities.

5. Conclusion

The present dissertation has completed systematic investigation of the latent functional mechanisms and implementation routes through which digital technical systems facilitate the advancement of cross-border commercial exchange, and has derived the core concluding points as stated below.

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Global digital trade has entered a period of rapid growth, while digital technologies are reshaping trade logic through four core mechanisms-reducing transaction costs, establishing trust mechanisms, expanding trade boundaries, and upgrading value chains-thereby lowering operational costs by over 30%, building digital trust, expanding reach to 30 countries (e.g., iMile's 99.5% delivery success rate in Australia and New Zealand), driving R&D and manufacturing (e.g., SHEIN's 7-day product launch cycle), and enhancing collaborative efficiency by boosting innovation capabilities and alleviating distortions in factor markets. The realization of these mechanisms requires coordination across four levels: enterprises, platforms, industries, and nations. Enterprises must pursue internal digitization and external connectivity. And platforms must build ecosystems and leverage network effects; industries must upgrade through clustering while distinguishing between domestic and international digital resources, and governments should improve digital infrastructure, formulate institutional rules, and strengthen international cooperation, among which regulatory openness acts as a core influencing factor. With the 2024 WTO Agreement on E-Commerce and China's planned pilot implementation in 2025 marking the implementation of governance frameworks, we must remain vigilant against the "digital rebound effect." Once a threshold is crossed, emphasis should shift to internalizing green technologies to drive sustainable development.

When viewing future development trajectories, the underlying promise of digital technological solutions is nowhere close to full manifestation. The United Nations Conference on Trade and Development has completed projection activities indicating that artificial intelligence systems will shift from a category of "efficiency-enabling tools" to an "operating framework for entire ecological systems", facilitating the advancement of global digital commerce toward development trajectories that are intelligent, inclusive, and regulation-aligned. Commercial entities ought to engage in proactive adoption of digital transformation, elevate the volume of technological input, and place focused emphasis on the cultivation of adaptive capabilities within the "digital perception-capture-reconstruction" domain; digital platform operators ought to carry out optimization of ecosystem governance protocols, guarantee the fairness of transaction processes, and enhance the influence of cross-border network effects. Industrial sectors ought to propel the digital upgrading of industry clusters, and advance the two-directional circulation and collaborative effect of digital resources from both domestic and international contexts. National governments ought to take active part in the drafting and refinement of global digital trade regulatory frameworks, and work toward the achievement of a balanced common agreement on core subjects encompassing cross-border movement of data, privacy safeguarding, and digital tax administration.

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