

Blockchain-Empowered Pathways for China's Cross-Border E-Commerce Exports: Enablers, Challenges, and Strategic Directions

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Abstract: *This study investigates the development landscape of China's cross-border e-commerce exports in the context of globalization and digitalization. It systematically analyzes enabling factors across macroeconomic, policy, and technological dimensions, while also identifying critical bottlenecks including inefficient information collaboration, deficient credit guarantee mechanisms, and underdeveloped comprehensive services. Building on blockchain technology's enabling role, the paper outlines strategic directions for future innovation, specifically targeting digitalized full-chain information synergy, a tailored credit management framework, and an enhanced platform service ecology. The analysis provides both theoretical contributions and actionable guidance for the sector's transition toward higher-quality development.*

Keywords: Cross-border e-commerce, Export trade, Blockchain technology, Development pathways, China.

1. INTRODUCTION

Cross-border export e-commerce refers to the business activities that display export trade information, conduct customer communication, and streamline the transaction process online through e-commerce platforms to achieve cross-border sales and transactions (Peng Shiyin, 2022). It is of great significance in facilitating the country's export upgrade and transformation, industrial structure adjustment, and economic growth model transformation (He Qun and Zhou Ruifang, 2022). Driven by multiple favorable factors such as the continuous improvement of the trade environment, strong policy support, and the efficient empowerment of digital technologies, in recent years, China's cross-border export e-commerce has successfully evolved from the initial platform construction to the expansion of transaction services, and then to the rapid expansion of channels, platforms, and product categories. After nearly 30 years of development and precipitation, it has entered an era of three-dimensional, standardized, and high-quality development, and the market scale is still expected to continue to climb (Yin Ming and Xu Xiaojun, 2020).

It is worth noting that cross-border export e-commerce involves many links and a long chain. Affected by factors such as the internal environment of enterprises, policies and facilities, external market environment, and the level of supporting services, it still faces problems such as asymmetric transaction information, lack of security in cross-border payments, low efficiency and high costs in cross-border logistics, obstacles to product traceability, and product quality loopholes, which seriously hinder the high-quality development process of cross-border export e-commerce. As a decentralized distributed ledger technology, blockchain has advantages such as immutability, transparency, and security. Through functions such as distributed ledgers, timestamp technologies, consensus mechanisms, and smart contracts, it can effectively enhance the security and traceability of transaction data information (Kuang Zengjie and Yu Ti, 2021). These advanced concepts and technologies provide new possibilities for solving the above problems of cross-border export e-commerce. Therefore, how to make full use of blockchain to empower the high-quality development of cross-border export e-commerce has become an important theoretical topic worthy of discussion.

2. CURRENT SITUATION AND DILEMMAS OF CROSS-BORDER EXPORT E-COMMERCE

2.1 Current Situation of Cross-border E-commerce Exports

The cross-border export environment has been continuously improving. Due to the continuous fermentation of inflation, prices in most countries in the European and American regions have risen rapidly. Coupled with the successive implementation of macro-favorable policies such as the Regional Comprehensive Economic

Partnership Agreement (RCEP), China's cross-border export environment has been continuously improving in recent years, and the volume of foreign trade has accelerated. At the same time, after the implementation of RCEP, the depth of cooperation between China and important partners in foreign trade exports has been further strengthened. After 2021, the growth rate of trade volume has shown a significant positive increase, and the growth resilience has been further enhanced, which provides a rare development opportunity for the development of China's new round of cross-border e-commerce industry. The "foreign trade + e-commerce" model will gain a broader development space. At the same time, with the improvement of China's digital technology level and the expansion of overseas demand gaps, the proportion of high-value-added export products in China is expected to further increase, the profit margin is gradually opening up, more domestic brands have the opportunity to go global, and the awareness of domestic brands overseas is gradually increasing.

Multi-dimensional policies escort healthy development. Macro policies escort the cross-border e-commerce industry in China. Departments such as the Ministry of Finance, Ministry of Commerce, Ministry of Industry and Information Technology, and General Administration of Customs have issued various types of policies on taxation, logistics, marketing, supervision, and settlement to encourage and support the standardized and orderly development of the cross-border e-commerce industry. For example, in terms of taxation, the Announcement on Tax Policies for Returned Goods in Cross-border E-commerce Exports issued by the Ministry of Finance and other departments in August 2023 clearly states that enterprises of some returned goods entering the country will be provided with convenience and preferential treatment through exemption from customs duties and export tax rebates. Another example is at the logistics level. In January 2024, the Ministry of Commerce proposed at a press conference held by the State Council Information Office that it will introduce "Several Measures to Expand Cross-border E-commerce Exports and Promote the Development of Overseas Warehouses" to provide more policy support and convenience for cross-border e-commerce exports. In addition, marketing measures such as using digitalization to assist enterprises in overseas marketing and regulatory measures such as launching cross-border e-commerce B2B export supervision pilots have effectively contributed to escorting the healthy development of China's cross-border e-commerce industry.

Digital technology empowers the entire link operation. The cross-border export e-commerce industry involves many industries, wide-ranging fields, and a long self-link. It often faces problems such as insufficient adaptability of marketing methods, low payment efficiency, high logistics costs, and information asymmetry in the customs clearance process. With the increasing maturity of digital technology, the "Digital + E-commerce" model can effectively empower the entire link operation of cross-border export e-commerce. For example, in the marketing field, by using automated marketing tools such as Active Campaign and Pardot, and by capturing, organizing, and analyzing potential customer data information to clarify customer preferences, accurate and intelligent recommendations can be achieved; in terms of payment, the cross-border payment system built by digital technology can effectively link the cross-border payment system with partner banks and e-commerce platforms. The system monitors the transaction process in real time, greatly improving the efficiency of fund arrival, exchange rate query, and foreign exchange settlement operations; at the logistics level, the integration of new intelligent means such as intelligent order consolidation, full-link collaboration, and intelligent warehousing can effectively reduce the logistics costs of merchants, improve the service standardization level, and achieve efficient and convenient management. At the customs clearance level, the emergence of the "full-link traceability system" saves a large amount of manpower, material resources, and financial resources for merchants from order placement to customs declaration, and can also trace the original data at any time, facilitating data visualization and efficient supervision.

2.2 Development Dilemmas of Cross-border Export E-commerce

Low information coordination efficiency. Among all the operational links of cross-border export e-commerce, logistics and customs clearance are key indicators determining the service efficiency and quality of cross-border e-commerce. Although many regions have built cross-border e-commerce customs clearance service platforms and public service platforms in comprehensive e-commerce pilot zones and pioneer areas for "Silk Road E-commerce" cooperation, which have played a certain role in improving the processing efficiency of customs declaration, examination, and clearance processes for cross-border export e-commerce enterprises, the information coordination among relevant management departments and the information coordination construction in cross-border logistics and payment links are still relatively backward (Ma Shuzhong et al., 2023). Specifically, in the operation of cross-border export e-commerce, enterprises need to process a large amount of data and information, including order information, logistics information, customer information, etc. However, due to the lack of compatibility and interoperability between information systems in each link, the phenomenon of

information silos is likely to occur, and information cannot be effectively shared and circulated, affecting enterprise decision-making efficiency and customer service levels. Taking cross-border logistics as an example, there are still many deficiencies in the construction of intelligent logistics facilities, big data empowerment, and the cultivation of compound talents in cross-border export e-commerce, directly affecting the operation efficiency of cross-border e-commerce enterprises.

Lack of credit guarantee system. Given that the credit uncertainty of transaction participants will bring risks and challenges to cross-border export e-commerce business in terms of intellectual property rights, product quality, transaction security, etc., building a credit system is the key to ensuring the safe development of cross-border export e-commerce. First, there are risks in cross-border payment. The virtuality and globality are significant characteristics of cross-border export e-commerce transactions, and cross-border payment is a key link in e-commerce transactions. However, currently, cross-border payment faces many risks such as multiple payment links, large exchange rate risks, and payment security issues. At the same time, credit risk problems such as credit card fraud also occur from time to time, increasing the uncertainty of transactions. Second, the credit evaluation system is 不完善. Although some platforms such as Alibaba have launched a credit guarantee system (Trade Assurance), these systems often rely on internal data and evaluation mechanisms of the platform and lack internationally recognized credit evaluation standards, limiting the credibility and universality of credit information (Li Xiaoping and Yu Juanjuan, 2023). Third, the quality supervision mechanism is not 健全. With the rapid development of cross-border e-commerce, the existing laws, regulations, and standards have not been updated in a timely manner to adapt to new business models and technological changes, resulting in ineffective supervision covering all emerging export goods and services. At the same time, lacking a full-process information traceability and quality supervision mechanism, the real-time monitoring and traceability capabilities of cross-border export e-commerce products also need to be improved, resulting in the transfer of a large number of inferior goods or counterfeit products among multiple trading entities.

The comprehensive service capabilities of cross-border e-commerce are insufficient. The lagging trade service level can severely restrict the development of cross-border e-commerce. On the one hand, the business capabilities of cross-border export e-commerce enterprises are single, and their innovative concepts and business extension capabilities in market positioning, product categories, service models, logistics and supply chain management, technological capabilities, customer service, etc. are significantly insufficient. In fact, with the rapid development of China's cross-border export industry, cross-border export e-commerce, as a bridge connecting sellers and buyers, is becoming increasingly prominent, and its comprehensive strength in aspects such as logistics and financial services is crucial. However, currently, in the logistics service field, restricted by factors such as insufficient infrastructure and professional capabilities, the external dependence of China's international freight logistics reaches 70%. Most domestic logistics enterprises only provide single domestic transportation services, and high-value-added services such as international transportation, insurance, and customs declaration are basically handled by foreign-related enterprises. This is extremely unfavorable for the transformation and upgrading of China's cross-border export e-commerce industry and the enhancement of its discourse power, and will also 无形中 increase the risk of supply chain disruption in China (Liu Bin and Gu Cong, 2022). On the other hand, the policy environment and the support of supporting services are insufficient. First, the construction of laws and regulations related to cross-border export e-commerce lags behind, and there are no targeted regulatory measures. For example, it is difficult to define some commodities, resulting in difficulties in customs clearance and taxation; the existing laws lack effective protection for consumers' rights and interests, and cross-border transactions face legal disputes; there is no clear specification for quality supervision, and the quality and safety of customs-cleared products are difficult to guarantee. Second, the supporting services are not mature. Cross-border e-commerce involves multiple links such as payment, logistics, taxation, after-sales, and management, and the problems existing in these links are gradually emerging during the rapid development of cross-border export e-commerce. For example, in terms of payment, there are problems such as high commission fees of third-party payment platforms, low capital turnover rate, and difficult payment security guarantee; in terms of logistics, international logistics distribution takes a long time, has high costs, and is difficult to return or exchange goods; in terms of taxation, it is difficult to define the taxable objects and transaction behaviors, and it is difficult to obtain taxation information; in terms of after-sales service, the time and cost for returning or exchanging goods are long, it is difficult to provide repair services, and there is a lack of dispute resolution mechanisms.

3. BLOCKCHAIN EMPOWERS THE HIGH-QUALITY DEVELOPMENT PATH OF CROSS-BORDER E-COMMERCE EXPORTS: INNOVATION

3.1 Analysis of the Coupling between Blockchain and the Cross-border E-commerce Export Industry

Blockchain is a brand-new Internet database technology that arranges data in a block shape end to end in chronological order to form a chain data structure and uses an asymmetric cryptography form to ensure the data in the blockchain system cannot be tampered with or forged. The greatest advantage of the integration of blockchain and the cross-border e-commerce export industry lies in reconstructing the value chain of the cross-border e-commerce export industry. From supply chain management to payment processing, and then to data security and consumer trust, blockchain has the potential to bring revolutionary improvements to cross-border e-commerce, thereby enhancing the value of the cross-border e-commerce export industry. First, blockchain technology can be used to record and verify the whole process of goods from production to sales, including raw material procurement, processing, transportation, warehousing and final sales. This whole-process traceability ability helps to improve the transparency of the supply chain, reduce counterfeit and shoddy goods in the cross-border e-commerce export industry, and enhance consumer trust; Second, smart contracts are an important application of blockchain technology. In cross-border e-commerce, smart contracts can be used to automatically handle transactions such as orders, payments, and refunds, reduce manual intervention, and improve transaction efficiency (Sun Li and Zhang Chi, 2023); Third, blockchain technology can simplify the cross-border payment process, reduce transaction costs, and improve payment speed. Through a decentralized payment system, it is possible to bypass traditional banks and financial institutions and achieve point-to-point fast payments; Fourth, in terms of data security and privacy protection, the encryption characteristics of blockchain can protect the security of transaction data and prevent data from being tampered with or leaked, which is particularly important for cross-border e-commerce export trade activities involving sensitive information; Fifth, in terms of customs clearance, blockchain technology can help simplify the customs clearance process, improve the customs clearance efficiency through real-time shared and tamper-proof transaction records, and reduce the operating costs of enterprises; At the same time, blockchain technology can help enterprises better comply with international trade regulations, reduce the risk of violations through automated compliance inspections and records, and complete customs clearance more smoothly.

3.2 Path Strategies for Blockchain Empowering the Development of Cross-border E-commerce Exports

Improve the digital and intelligent level of full-chain information collaboration. Under the background of the trend of industrial digitalization, cross-border e-commerce exports need to accelerate the integration of blockchain and the layout of intelligent sectors in the full-chain operation. Taking the logistics link as an example, in response to the current high cross-border logistics transportation costs such as transportation, warehousing, and customs declaration, as well as the low efficiency of manual product selection, picking, and data supervision operations, cross-border e-commerce exports need to: First, continuously increase the investment in blockchain in smart logistics, optimize functions and conduct regular maintenance. Based on a clear understanding of the platform's positioning and customer needs, increase capital and human input, build a smart logistics information platform, design the overall platform architecture, functional modules, and databases. After the platform is built, it needs to be tested and optimized multiple times to ensure the safe and stable operation of the platform. After the platform is launched, a user satisfaction survey should be conducted in a timely manner to continuously optimize the user operation process and improve user satisfaction; Second, make full use of the powerful functions of blockchain in big data collection, analysis, sharing, integration, and screening to collect, preprocess, store, manage, analyze, and mine logistics data, and improve the application level of the latest smart logistics technologies such as multimodal transport, dynamic cargo tracking, unmanned warehouses, drones, and intelligent express cabinets in the logistics supply chain, and enhance the utilization rate of logistics resource elements (Ding Baogen et al., 2020); Third, pay attention to the cultivation of blockchain talents and build a high-quality composite talent team. Cross-border e-commerce export enterprises can strengthen cooperation with universities offering majors such as blockchain, smart logistics, and big data, update the enterprise's blockchain talent pool and expert database in a timely manner, regularly carry out internal talent training within the enterprise, improve the comprehensive quality and application ability of employees in blockchain technology, and gradually replace traditional human input by means of smart contracts, intelligent product selection, and data supervision of digital information systems.

Build a credit management system for cross-border e-commerce export trade. Regarding the payment security, product traceability and credit supervision issues in cross-border e-commerce export trade. First, a decentralized cross-border payment process should be established based on blockchain. This process is carried out in sequence according to the steps of "selecting a blockchain platform - creating a digital identity - establishing a smart contract - recharging funds - initiating a payment - transaction verification - transaction record - currency exchange - fund transfer - recipient cash withdrawal". The decentralized payment process means there is no single control point, reducing intermediary fees and improving the speed and transparency of cross-border e-commerce export trade

(Zhang Yanbin, 2018). It is worth noting that this process also faces potential problems such as regulatory challenges, technical complexity and market fluctuations. However, with the continuous development and maturity of blockchain technology, the decentralized cross-border payment process will be gradually improved and popularized. Secondly, by using blockchain technology to improve the credit management system, a decentralized credit information database can be built (see Figure 1), which has the characteristics of openness, tamper-proof and traceability. Cross-border e-commerce exporters can use this credit information database to create an international credit assessment system and confirm the reputation of exporters with the help of the verification mechanism of blockchain. The government needs to promote the establishment of a credit assessment agency based on smart contracts, integrating internationally recognized quality standards and industry guidelines into the platform to assess the credit status of merchants. At the same time, the government should provide necessary support and guarantee measures, such as establishing an international credit service system to enable overseas consumers to conveniently query the credit records of merchants. Finally, to assist in the information tracking of cross-border e-commerce export products, an information traceability system can be established relying on blockchain (see Figure 2). This system integrates digital technologies such as blockchain and the Internet of Things, and can integrate key information such as the raw material source, production time, transportation status, customs clearance location and time, and quality inspection results of export products into the database, facilitating e-commerce platforms and their upstream and downstream enterprises as well as relevant regulatory departments to obtain logistics node information in a timely manner, so as to trace the entire transaction and logistics process of cross-border e-commerce products, reducing the cumbersome data collection work, saving the operating costs of multiple links in the cross-border e-commerce operation process, promoting the double improvement of product traceability efficiency and quality, and ultimately benefiting the customer experience at the consumer end.

3.3 Accelerating the Ecological and In-depth Construction of Platform Services

Regarding the problems of single service capabilities and insufficient business model innovation of cross-border export e-commerce platforms. First, it is necessary to accelerate the ecological construction of platform services. Based on providing transaction services for upstream brands/sellers and downstream customers, cross-border export e-commerce enterprises can gradually expand new business segments such as product selection, marketing, logistics, and payment through two ways: horizontal expansion and vertical derivation, so as to continuously consolidate their core position in the cross-border e-commerce ecological chain. From a specific perspective, on the one hand, in terms of horizontal expansion, cross-border export e-commerce platforms can rely on their strong traffic advantages and market scale to continuously attract and gather more service providers, forming a more solid win-win cooperation relationship (Zhang Wenjing, 2022); at the same time, the platform can also use methods such as investment and mergers and acquisitions to continuously supplement and strengthen the weak links of its own business through capital operation, and gradually "compensate for and strengthen the chain" through chain expansion. On the other hand, in terms of vertical derivation, based on the actual needs of cross-border e-commerce exports in terms of logistics, payment, marketing, etc., the platform can strengthen the comprehensive service level of the platform through self-developed incubation, reduce cost losses, and enhance profitability. Second, it is necessary to provide institutional support for the in-depth development of cross-border e-commerce services. As mentioned above, blockchain technology can deeply empower the in-depth development of cross-border services in terms of payment security, logistics traceability, credit supervision, etc. However, to systematically solve the problems of insufficient policy environment and supporting service strength, it is necessary to attach importance to the supervision and management of the application of blockchain technology in the export link of cross-border e-commerce, so as to ensure that the development of this technology follows the norms and legal frameworks and truly 发挥 the technical empowerment effect of blockchain. Therefore, the government needs to formulate corresponding regulatory measures to provide guarantee for the application of blockchain, such as listing blockchain technology as a key supported by the national strategy, encouraging relevant enterprises to share application experience on the international stage, and further improving the legal systems such as the Electronic Signature Law and the Electronic Certification Law to provide a more solid legal foundation for the application of blockchain.

In summary, with the continuous evolution of globalization and digitalization, the cross-border export e-commerce industry has rapidly emerged and become an important part of international trade. While providing consumers with a more convenient and personalized shopping experience, it also strongly promotes the transformation and upgrading of the foreign trade development mode from "manufacturing-driven" to "service-driven". Firstly, based on reviewing the definition and development stage of cross-border export e-commerce, this paper puts forward that the potential of domestic cross-border export e-commerce will continue to be released. Secondly, this paper

analyzes the current development situation of the domestic cross-border export e-commerce industry from three aspects: the macro foreign trade environment, policy encouragement and support, and digital technology empowerment. It is found that under the background of macro-favorable policies such as RCEP, combined with a number of support policies introduced by the government in dimensions such as taxation, logistics, marketing, supervision, and settlement, as well as technological innovation and integration opportunities in fields such as marketing, payment, and logistics, the industry presents a high-quality, three-dimensional, and standardized development trend. Thirdly, this paper analyzes the main dilemmas faced by the current cross-border export e-commerce industry from three aspects: low information collaboration efficiency, lack of credit guarantee system, and insufficient comprehensive service capabilities of cross-border e-commerce. Finally, combining the coupling of blockchain and cross-border export e-commerce, this paper proposes innovative development paths for the cross-border export e-commerce industry from three levels: enhancing the digitalization level of full-link information collaboration, constructing a credit management system for cross-border e-commerce export trade, and accelerating the ecological and in-depth construction of platform services.

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