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ARTICLES

Risks and Challenges of China Customs' Response to Global Green Trade Barriers

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Green trade barriers (GTBs) have emerged as an increasingly rising instrument of trade protectionism in the context of international commerce. This study conducts a comprehensive analysis of the green trade provisions embedded within the three principal global economic and trade agreements. By employing a comparative analysis methodology, the research elucidates the current landscape and distinctive characteristics of GTBs confronting China Customs. Focusing on China's smart customs modernisation and customs-driven supply chain governance, the research proposes synergistic governance model integrating customs authorities and exporters to mitigate GTBs risks while advancing the nation's 'dual carbon' objectives. The research reveals that while GTBs are reshaping China's foreign trade landscape, they are also catalysing a paradigm shift in the developmental trajectory and philosophical orientation of China Customs. Consequently, this dual effect significantly contributes to the green and high-quality development of China's foreign trade.

1. Introduction

Against the backdrop of global cooperation in addressing climate change, green trade has emerged as a vital engine driving sustainable economic development, with its vigorous growth momentum being irreversible. The *AR6 Synthesis Report: Climate Change 2023*, released by the Intergovernmental Panel on Climate Change (IPCC), specifically emphasises that actions to mitigate and adapt to climate change cannot be delayed (IPCC, 2023). In the same year, the 28th Conference of the Parties (COP28) to the United Nations Framework Convention on Climate Change (UNFCCC) conducted the first global stocktake of *The Paris Agreement*, further consolidating the international community's consensus on jointly addressing the climate crisis (United Nations Climate Change, n.d.). Part of this process involves the rapid integration of rules with high standards for green trade into the global economic and trade system. However, significant differences among countries in terms of economic development levels, industrial structures and technological capabilities have made it difficult for some countries to meet these high standards in the short term. Such imbalances in development and internal structural contradictions have contributed to the increasingly prominent issue of GTBs (Zhao & Gao, 2025).

GTBs encompass a range of direct or indirect trade restriction measures, and even outright trade bans implemented by certain countries under the pretext of safeguarding domestic ecosystems and public health. Against the backdrop of escalating trade disputes and protectionism, GTBs have emerged as significant non-tariff trade barriers. Notably, within the multifaceted global trade landscape, GTBs are not static but dynamic and continuously evolving. The European Union (EU) Carbon Border Adjustment Mechanism (CBAM), for instance, has as its principal objective the mitigation of carbon leakage and the advancement of environmental protection. Nonetheless, its trade ramifications render its operational function analogous to a tariff, specifically, levying charges contingent upon the carbon intensity embedded within imported products. Consequently, CBAM constitutes a distinctive manifestation of GTBs, amalgamating facets of both tariff and non-tariff instruments, necessitating dialectical analysis across diverse contexts.

As the world's largest goods trading nation (Xinhua News, 2025c), China has a relatively high proportion of high-carbon products in its export structure and an unbalanced development in industrial low-carbon transformation, which exposes it to profound impacts from GTBs. From the perspective of international policy dynamics, on 20 January 2025, the new United States (US) administration announced its withdrawal from *The Paris Agreement* (Xinhua News, 2025b) and continued to advance the implementation of the *Clean Competition Act* (CCA) (C. Yang & Yan, 2023). Meanwhile, the EU CBAM will officially launch the 'carbon tariff' in 2026 (Bellora & Fontagné, 2023). Such trade policy tools based on carbon emissions will inevitably have an impact on China's high-carbon-emission export products, pushing the rule-based game in the field of international trade into a new stage centred on GTBs. Faced with this complex situation, the Chinese government clearly stated in its *2025 Government Work Report* that it will actively respond to GTBs and enhance industrial green competitiveness through measures such as strengthening international cooperation, aligning with international carbon accounting standards, and promoting the development of green and low-carbon industrial chains and supply chains (Q. Li, 2025).

From a long-term perspective, although the high-standard rules of green trade impose pressure on some countries in the short term, they objectively play a positive role in forcing green technological innovation and improving green development mechanisms. Academic circles hold different views on this. On the one hand, it is believed that GTBs have in effect become non-tariff barriers to protect domestic enterprises. In particular, the gaps in technical levels and standards between different countries hinder the export of low-tech goods from developing countries, thereby exerting a trade-inhibiting effect to a certain extent (Guo, 2024). On the other hand, it is argued that GTBs have objectively accelerated the green and low-carbon transformation of global trade (C. Liu, 2024).

Faced with the ongoing strengthening of global high-standard rules for green trade, China faces multiple challenges in the field of cross-border green trade. A key issue here is that its discourse power in formulating international green trade rules remains relatively insufficient, a gap that limits its influence within the global environmental governance system. Constrained by traditional regulatory concepts, China Customs also faces efficiency bottlenecks in responding to increasingly complex green trade rules. Furthermore, compared with developed countries, China's carbon emission rights trading market mechanism remains to be improved (Kong et al., 2025), and the construction of China's Carbon Emission Accounts and Datasets (CEADs) started relatively late (Yue et al., 2024), which to a certain extent restricts the enhancement of the green competitiveness of its export products.

To effectively address global climate change and trade risks, the Chinese government is actively participating in the development of international green economic and trade rules through measures such as strengthening international cooperation and aligning with advanced international carbon accounting standards (Böhringer et al., 2022). Meanwhile, China Customs is committed to advancing the dual transformation of 'greenisation' and digitalisation, deepening Customs-enterprise cooperation, accelerating the development of green and low-carbon industrial chains and supply chains, and continuously promoting green trade development through enhanced international cooperation (Qi, 2025).

Academic research on China's response to GTBs mainly focuses on the following issues:

1. the role of green technological innovation in promoting low-carbon transformation (Acemoglu et al., 2012)
2. the alignment with high-standard international economic and trade rules (Han & Liu, 2022)
3. the impact of CBAM (Dong & Tang, 2023)
4. the issue of GTBs forcing the green transformation of export industries, such as: analysing the impact of natural resource dependence on industrial green transformation based on regional data (X. Yang et al., 2023), exploring the role of China's free trade zones (FTZs) in promoting green technological innovation of enterprises (Bi et al., 2023), and discussing the practical paths for digital technologies to drive green transformation from the perspective of smart port construction (Su et al., 2024).

Overall, most research perspectives focus on the rivalry of international trade rules and the response strategies of export enterprises. In fact, many studies argue that GTBs established by developed countries based on high-

tech have an obvious tendency towards trade protectionism (Cha & Koo, 2021). Admittedly, while GTBs restrict the export of low-tech goods from developing countries to a certain extent, they have objectively promoted the green and low-carbon transformation of global trade. It is worth noting that existing research has generally neglected the role of China Customs, as the regulatory authority for China's import and export trade[1], in addressing GTBs and promoting the development of green trade. In particular, there is a lack of discussion on the implementation paths regarding how China Customs can enhance regulatory efficiency through digital and intelligent transformation, strengthen Customs-to-Business partnerships, expand international cooperation networks, as well as the methods for systematically helping export enterprises break through GTBs.

Therefore, this article focuses on the core functions of China Customs and innovatively adopts a dual perspective of synergistically advancing smart customs development and the green and low-carbon transformation of industrial chains and supply chains. It aims to conduct an in-depth analysis of how China Customs can effectively help export enterprises respond to the risks and challenges posed by GTBs through strategies such as optimising regulatory models, building Customs-enterprise collaboration mechanisms, and participating in the formulation of international rules. It is believed that this research not only fills the gaps in existing studies but also improves the theoretical system of green trade, while putting forward policy recommendations for China Customs to strengthen the practice of the 'dual carbon' strategy and achieve green and low-carbon transformation.

2. Context of international GTBs

The frameworks of the three major global economic and trade agreements – the World Trade Organization (WTO), Regional Comprehensive Economic Partnership (RCEP), and Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) (Wang, 2022) – collectively constitute the cornerstone of modern international green trade rules. As a matter of fact, these agreements, to varying degrees, underscore the imperative of achieving a balance between 'environment and trade'. By formulating corresponding policies, these frameworks consolidate the synergistic mechanisms of global environmental governance and create a binding institutional architecture (Wen et al., 2024). However, due to disparities in economic development levels and environmental governance capacities among countries, coupled with the inherent complexity and

1 In China, the Ministry of Commerce (equivalent to the 'Ministry of Trade') and specialised ministries (e.g., National Health Commission, Ministry of Science and Technology, Ministry of Industry and Information Technology) mainly take the lead in formulating green trade-related regulations, standards and policies. China Customs, as the frontline supervision and law enforcement body for import and export trade, is primarily responsible for enforcing these regulations.

adaptive flexibility of these rules, most developing nations encounter formidable challenges in surmounting barriers to international green trade within a short timeframe.

2.1. Provisions related to GTBs in global economic and trade rules

Following the establishment of WTO rules, the standards governing GTBs became more clearly defined, primarily through the *Agreement on Technical Barriers to Trade* (*TBT*) and the *Agreement on Sanitary and Phytosanitary Measures* (*SPS*) (Bernard & Petros, 2015). Notably, the *SPS Agreement* introduced a special 'precautionary clause', which allows importing countries to implement stricter provisional health inspection and quarantine measures under exceptional circumstances, even in the absence of definitive scientific evidence. Consequently, countries with advanced inspection and quarantine technologies, particularly for agricultural products such as fruits and vegetables, have adopted more stringent quarantine standards. While these measures are ostensibly aimed at protecting national ecosystems and ensuring human health and safety, they also objectively impede trade facilitation, thereby creating substantial GTBs (J. Xu et al., 2018).

The RCEP and the CPTPP, as two regionally influential international economic and trade agreements, emphasise the promotion of sustainable development and the advancement of green trade to varying degrees. The CPTPP, in particular, emphasises climate governance and environmental protection through the establishment of specialised environmental agencies, thereby fostering the integration of ecological considerations into international trade frameworks (Vo et al., 2020).

The RCEP explicitly establishes the principle of environmental provisions in its preamble. The agreement incorporates trade-related environmental measures across multiple dimensions, including: (1) SPS measures, (2) environmental exceptions in investment and labour mobility provisions and (3) environmental linkage mechanisms. Significantly, the incorporation of the WTO's General Exceptions, which constitute the bulk of the RCEP's environmental provisions, may provide a legal basis for countries implementing controversial carbon tariffs (Bashir et al., 2022).

The CPTPP incorporates a dedicated 'Environment' chapter, which not only reaffirms signatories' commitments to Multilateral Environmental Agreements (MEAs), but also establishes a comprehensive framework for environmental protection and sustainable development. This framework encompasses several key provisions: (1) enhanced conservation measures for endangered species, (2) standardised protocols for environmental impact assessment transparency, (3) promotion of clean energy technology innovation and technology transfer and (4) trade facilitation mechanisms for environmental goods and services (New Zealand Ministry of Foreign Affairs and Trade, 2021). It is important to note that while stringent environmental

standards and high-standard technical measures are essential for environmental protection, they may also be objectively susceptible to misuse as GTBs.

2.2. Analysis of the causes of GTBs in global economic and trade rules

Firstly, there are differences in environmental standards. Developed economies typically maintain more stringent environmental standards and sophisticated regulatory frameworks, whereas developing countries often confront limitations in both environmental policy implementation and institutional capacity. This divergence is further exacerbated by substantial differences in economic development levels and environmental governance capabilities. Within this context, exported goods from regions with relatively low environmental standards fail to meet more stringent environmental protection requirements. This phenomenon has objectively led to the emergence of GTBs, which disproportionately affect developing economies. A prominent manifestation of this trend is the EU CBAM, which represents a systematic attempt to address carbon pricing disparities between imported goods and intra-EU products through the implementation of carbon tariffs (Bellora & Fontagné, 2023). However, the implementation of this mechanism has raised significant concerns regarding its equitable application. Most developing nations face substantial challenges in meeting the EU's stringent environmental criteria within the immediate implementation timeframe (Khalique et al., 2025). Consequently, if the response strategy is inappropriate, CBAM will not only affect the foreign trade and carbon governance of developing countries but may also exacerbate various development risks (Eicke et al., 2021).

Secondly, these measures possess a degree of legal legitimacy within the existing international trade framework. The General Exceptions of the WTO and the environmental provisions of the RCEP and CPTPP allow member states to enact measures for environmental protection. These measures are legally justifiable when pursuing legitimate objectives, including national security, protection of human, animal, and plant life and health, and environmental conservation. Therefore, this legal framework has enabled mechanisms such as CBAM to acquire formal legitimacy, despite instances of potential misuse. While their environmental aims could be argued, these GTBs are seen by many of its trading partners as a potential contravention of core WTO rules, chief among them the principle of non-discrimination embodied by Most-Favored-Nation (MFN) treatment (Abel, 2025). Furthermore, they conflict with the principle of 'common but differentiated responsibilities' (CBDR) established under the UNFCCC, thereby raising substantial apprehensions regarding equity and fairness in their implementation (Overland & Sabyrbekov, 2022).

Thirdly, the inadequacy of international cooperation and coordination mechanisms is conspicuous. Despite the significant progress made by multilateral and regional trade agreements, including the WTO, RCEP and CPTPP, in elucidating the intrinsic relationship between environmental

Table 1. Peak carbon goals for China's key export sectors.

Industry	Peak carbon goal
Iron and steel	First to peak carbon emissions by 2025
Electricity	Peak carbon emissions by 2030
Automotive	Peak ahead of national carbon reduction commitments in 2028
Building materials	The building materials industry is fully carbon neutral by 2025, with a 3% reduction in the level of combined energy consumption per unit of product for cement clinker[a]
Petrochemicals	By 2025, the ratio of refined oil production to crude processing capacity of new refining and chemical integration projects will be reduced to 40%.
Non-ferrous metals	By 2025, more than 90% of direct alloy content in aluminium liquids; by 2023, the proportion of renewable energy used in aluminium electrolysis increased to more than 30%
Paper	By 2025, the top 30 companies in the paper industry will have a concentration of 75%; the share of energy recycling technologies will reach 70%

Notes: a, a material produced during the manufacture of cement.
Source: Based on the Chinese government website https://www.gov.cn/.

protection and international trade, the establishment of unified green trade rules remains challenging. This predicament primarily stems from two fundamental factors: (1) divergent national interests among member states, particularly between developed and developing economies, regarding environmental standards and implementation timelines and (2) the inherent complexity of achieving international consensus and coordination in environmental governance frameworks (Michael, 2023). These challenges are further exacerbated by varying national capacities for environmental regulation enforcement and differing economic development priorities, resulting in fragmented approaches to green trade policy implementation across the global trading system (K. Tian et al., 2022). Furthermore, the discrepancies and conflicts inherent in various regional trade agreements serve to compound the formation of GTBs. The divergent environmental provisions and green governance policies embedded within the RCEP and CPTPP frameworks engender disparate standards and requirements for member countries during the implementation process, thereby contributing to the escalating abuse of GTBs (Han & Liu, 2022).

3. China Customs' green practices and customs supervision risks

As the world's largest developing country, China has been implementing a comprehensive array of proactive measures to promote the vigorous development of green trade. The *2025 Government Work Report of the State Council of China* (The State Council of the People's Republic of China, 2025) explicitly emphasised the need to actively respond to GTBs. Notably, 2025 will represent a significant milestone as it marks both the fifth anniversary of China's 'dual carbon' goals initiative, signalling a new phase in the development of green trade in China (Xinhua News, 2025d). Table 1 outlines the peak carbon targets for several key sectors in China.

While China has emerged as the world's second-largest economy (US Bank, 2025), the nation remains in a developmental phase characterised by ongoing industrialisation, informatisation and urbanisation. Consequently,

the pressure on ecological and environmental protection persists without substantial alleviation, and the foundation for achieving a comprehensive green transformation remains relatively weak (Y. Liu et al., 2022). Confronted with multifaceted practical challenges, China Customs has implemented a series of initiatives to facilitate the achievement of 'dual carbon' goals and enhance global GTBs responsiveness.

3.1. China Customs' green practices

To achieve a dual transformation towards green and digital paradigms, China Customs, in conjunction with other governmental agencies, is advancing the reform of foreign port management systems (Valioniene et al., 2024). Promoting the green transformation of ports and realising the objectives of smart port construction through digital technologies constitutes a pivotal initiative in facilitating China's transition towards sustainable development (Su et al., 2024). Tianjin Port, as outlined in a case study by Feng and Wang (2024), has actively collaborated with Tianjin Customs through a 'smart collaborative supervision model' to pursue the world's first 'intelligent zero-carbon' port automation transformation, with a particular focus on advancing comprehensive process automation upgrades at traditional container terminals. This initiative has ensured the successful implementation of fully automated live ship operations and achieved preliminary replication and promotion of the Tianjin Port Automated Container Terminal 2.0 program. Regarding smart port construction, Tianjin Customs and Tianjin Port have collaborated to promote terminal construction and the deployment of customs supervision equipment, conducted five on-site surveys and tests on the installation of large customs supervision equipment such as the mobile H986 X-ray-based container scanning machines, and radiation detectors, and identified 124 installation locations for various types of equipment. These developments have resulted in substantial improvements in both port automation and digitalisation capabilities (X. Feng & Wang, 2024). Simultaneously, guided by the *14th Five-Year Plan (2021–2025) for Customs Development*, Tianjin Customs and Tianjin Port have consistently spearheaded the development of zero-carbon port infrastructure and low-carbon port zones, thereby contributing sustainable solutions to green port construction (Cai, 2021). Significantly, in 2021, the world's first 'intelligent zero-carbon' terminal commenced operations at Tianjin Port, marking a landmark achievement in green port development (Tianjin Port, 2022). As of 2024, Tianjin Port has commissioned a total of 15 wind turbines and two photovoltaic power stations with capacities exceeding the megawatt scale, achieving an annual electricity output of 180 million kWh. Cumulative wind power generation has surpassed the 200 million kWh milestone, sufficient to meet the annual energy consumption demands of 260 quay cranes. The green collaboration between Tianjin Customs and Tianjin Port has effectively operationalised the imperatives of 'green port' development, yielding significant

contributions to enhancing the efficient and sustainable operation of ports while facilitating the intensive utilisation of port resources (Zhang, 2024).

In addition to the green transformation of port areas, China's FTZs are actively pursuing green technological innovations, aiming to achieve the development objectives of 'carbon peaking' and 'carbon neutrality' (Bi et al., 2023). The Qingdao Area of the Shandong FTZ (the Qingdao Area), under the continuous impetus of Qingdao Customs, has pioneered China's first 'Green FTZ' indicator system, focusing on green development. This system comprises 40 indicators across 12 categories, with over 80 per cent of the indicators related to the application of big data in shipping and logistics, as well as the added value of emerging marine industries. It is particularly noteworthy that the Green Development Indicators of Qingdao Area represent the world's first 'green-centred' indicator system for FTZs, serving as a benchmark to guide Qingdao Area in aligning with global green trade standards (Ministry of Ecology and Environment, 2022).

As one of the most significant domestic and global trade ports, Shanghai Port has consistently prioritised the advancement of green trade and the development of a green, low-carbon supply chain system. These efforts, supported by Shanghai Customs, align with its ambition to establish itself as a globally influential international trade and shipping hub. A key milestone was reached on 27 May 2025 with the launch of the Shanghai International Shipping Sustainable Fuel Certification System, an initiative facilitated by Shanghai Customs that marks a major step forward in China's development of green governance rules for international shipping (Xinhua News, 2025e). Notably, Shanghai Yangshan Port, ranked first globally in annual container throughput, has, with customs support, integrated and optimised its bonded Liquid Natural Gas import operations while advancing the synergistic development of green methanol projects and other clean energy initiatives within the shipping industry's green low-carbon supply chain. It is projected that by 2030, annual demand for green methanol refuelling at Shanghai Port will reach 400,000 to 500,000 tonnes (Shanghai Municipal Development and Reform Commission, 2024).

3.2. The risks of GTBs encountered by China Customs in import and export trade supervision

In fact, as a novel form of non-tariff barrier with formal legitimacy (Tang et al., 2024), GTBs have imposed rigid constraints on the development of China's foreign trade and economic cooperation, presenting new challenges to the traditional supervision model of China Customs (Gao, 2024).

3.2.1. Green tariffs

The concept of green tariffs refers to taxes or duties imposed on imported goods based on their environmental impact – usually aimed at discouraging products made in ways that harm the environment and encouraging cleaner, more sustainable production. Consequently, the implementation of green tariffs is anticipated to not only intensify risks within global sustainable

supply chains but also fundamentally reshape the existing patterns of international trade and industrial value chains (Babiker, 2005). In June 2022, the US unveiled a draft of the CCA, which proposes to adopt the average carbon emission level of US products as a benchmark and levy a carbon tax on both imported and domestic products whose emission levels exceed this threshold. In May 2023, the EU CBAM officially came into effect and announced that it would start imposing 'carbon tariffs' in 2026 (W. Li et al., 2023). The EU is poised to become the world's first regional entity to implement a comprehensive carbon border adjustment mechanism, establishing a precedent for cross-border carbon pricing regulations in international trade (Chen et al., 2025). The EU CBAM places China Customs at risk of being unable to accurately verify the carbon emissions of exported products and effectively meet cross-border carbon regulatory requirements, owing to inadequate carbon footprint accounting capabilities and the delayed development of carbon emissions databases (X. Li et al., 2025).

3.2.2. Green standards

Among various categories of export commodities, electromechanical products represent one of the most carbon-intensive product types within the light industrial machinery sector. As the world's leading exporter of electromechanical products, China recorded a total export value of RMB15,124.57 billion in 2024, reflecting an 8.7 per cent year-on-year growth (Xinhua News, 2025a). A regional analysis reveals that in the first five months of 2025, Shandong Province exported electromechanical products worth RM 415.92 billion, with a year-on-year growth of 12 per cent and accounting for 48.1 per cent of the province's total export value during the same period (R. Feng et al., 2025). With the Association of Southeast Asian Nations (ASEAN), the EU, the US, and South Korea serving as Shandong's primary export markets for these products, compliance with the environmental standards of destination countries has become imperative.

The Federal Communications Commission (FCC) of the US mandates that all television sets imported into the US market must adhere to the digital television standards and comply with the technical specifications established by the Advanced Television Systems Committee (ATSC). Furthermore, the US government has implemented differentiated energy efficiency standards and emission regulations for household electronic appliances, accompanied by increasingly sophisticated measurement methodologies (Mi & Wang, 2021). Regarding energy efficiency regulations, the US Federal Trade Commission (FTC) mandates that common household appliances, including electric water heaters, air-conditioning units and refrigeration systems, must meet the minimum energy efficiency standards established by federal regulations and the US Code, while simultaneously requiring the display of standardised Energy Guide labels (S.

Liu & Wang, 2023). These green standards have undoubtedly increased the difficulty for Chinese electromechanical products to enter the US market.[2]

3.2.3. Green packaging and labelling

Appropriate green packaging and labelling policies not only facilitate customs control and target enterprises with high non-compliance risks, but the green packaging and labelling system itself also serves as a crucial mechanism to promote the harmonious development between packaging practices and environmental sustainability. However, it is noteworthy that this system can be potentially exploited by certain nations as a strategic policy instrument to impose import restrictions, thereby contributing to the formation of GTBs (Du & Cho, 2021). For instance, US Customs and Border Protection (CBP) conducts comprehensive inspections on electromechanical products imported from China, including verifying the presence of country-of-origin markings and required special labels, assessing the compliance of labelling methods with CBP regulations, and evaluating adherence to specific requirements mandated by relevant US government agencies (S. Liu et al., 2024).

3.3. Shortcomings in China Customs' response to GTBs

In recent years, several countries have established GTBs, including green tariffs, green standards and green packaging and labelling requirements (Bian et al., 2024). As the world's largest exporter and carbon emitter, China is confronting a highly challenging foreign trade environment. Overall, China Customs currently has limited regulatory capacity in addressing GTBs (Xinhua News, 2024).

3.3.1. Outdated traditional customs control concepts

With the rapid advancement of global green trade, green customs supervision, as a mode of customs oversight centred on environmental protection, is increasingly becoming a pivotal direction for the transformation of global customs supervision practices. Though China Customs is actively responding to and continuously advancing the *WCO Green Customs Action Plan* (WCO, n.d.), it continues to rely on traditional regulatory concepts and methods when addressing international GTBs, which hinders its ability to effectively adapt to GTBs in the evolving global trade landscape.

For instance, the *Regulation (Eu) 2023/1542 Of The European Parliament And Of The Council of 12 July 2023 Concerning Batteries And Waste Batteries* (EU, 2023) mandates that imported battery products must comply with specific carbon footprint limitations and requires the mandatory disclosure of carbon footprint information and other relevant data.

2 In 2018, China Customs underwent institutional reform, with the formulation and testing of import and export commodity standards constituting a key function of its services.

Currently, China Customs lags in the development of accounting methodologies and the construction of databases for product lifecycle carbon emissions, leading to a weak capacity for carbon footprint accounting (The State Council of China, 2025). This deficiency hampers the ability of relevant enterprises to swiftly respond to the stringent requirements of international GTBs (European Commission, 2023). Building on this, China Customs must optimise its supervision processes and enhance supervision efficiency to align with the evolving trends in global green trade (S. A. R. Khan et al., 2019).

3.3.2. Inadequate law enforcement environment and application scenarios

In June 2022, the US CBP officially launched its *Green Trade Strategy* (United States Government, 2022). By comparison, China Customs encounters significant challenges in addressing international GTBs, primarily due to inadequate enforcement environment and application scenarios. These challenges can be categorised into three main areas. First, the green legal framework remains incomplete. Although the Chinese government is accelerating the introduction of green trade laws and regulations, it still lags behind developed countries such as those in Europe, and the US. Second, the regulatory infrastructure for a response to GTBs requires strengthening. Currently, China Customs' regulatory systems for overseeing cross-border green trade are not fully developed. These systems include mechanisms for verifying compliance with foreign green standards and for identifying non-compliant, green-related practices, and coordinating with domestic interministerial green governance bodies. The underdevelopment of these systems leads to ambiguous enforcement boundaries. Third, there is a lack of awareness regarding GTBs compliance among enterprises. Most Chinese export enterprises lack a comprehensive understanding of diverse international GTBs requirements and have limited capacity to adapt their production and declaration processes to meet these demands. This situation makes it difficult for China Customs to establish an effective collaborative enforcement community with enterprises to tackle GTBs.

3.3.3. Low level of cross-border green trade facilitation

China Customs continues to encounter significant challenges in addressing GTBs. For instance, in carbon footprint accounting, while Shanghai has pioneered the introduction of the Green Supply Chain Carbon Footprint Calculator within the International Trade Single Window, this system has yet to be implemented on a national scale. The current system primarily focuses on accounting for carbon emissions during the shipping phase of goods and has not yet achieved comprehensive carbon accounting for the entire lifecycle of products (Shang, 2023).

In accordance with the WCO's *SAFE Framework of Standards* (WCO, 2021) to secure and facilitate global trade, China Customs primarily applies the Authorised Economic Operator (AEO) assessment system to safeguard

security and promote customs clearance efficiency. However, green trade rules have yet to be fully incorporated into the AEO framework. This oversight not only diminishes the internal motivation of export enterprises in the context of the emerging international green trade landscape but also results in a lack of green competitiveness for Chinese export products in the global market, rendering them susceptible to international GTBs.

3.3.4. Insufficient alignment with global green trade standards

Amid the ongoing global transition towards green and low-carbon economic development, green trade standards are progressively being applied to internationally traded commodities. Currently, the absence of unified rules and standards remains a challenge in international green trade, with carbon emission accounting being a prominent example. As a pivotal component and critical foundation of international green trade (Hong-Shuo et al., 2023), carbon emission accounting has prompted multiple Chinese governmental departments, including China Customs, to jointly implement a series of proactive measures aimed at establishing a standardised carbon emission accounting system (Peoples' Republic of China National Development and Reform Commission, 2024). Although China's carbon accounting methodology is generally consistent with international green trade mechanisms, significant disparities persist in areas such as the carbon footprint system, data support and quality assurance frameworks.

Currently, China primarily employs the emission factor method for carbon accounting, making the development of accurate emission factors and a robust database for exported products particularly crucial (Dong & Tang, 2023). Compared to the long-term investments in carbon accounting made by some countries, China's statistical carbon accounting system remains underdeveloped. As a result, China Customs and export enterprises often rely on default values or foreign databases for carbon emission factors when calculating the carbon footprint of export products. This approach tends to overestimate carbon emissions (Ma & Chen, 2020) thereby inadvertently reinforcing GTBs. Such overestimation undermines the competitiveness of Chinese exports in the international market (Hong-Shuo et al., 2023).

In fact, the scope of international GTBs is continuously expanding, and the impact on Chinese export-oriented enterprises is increasingly significant. Consequently, China Customs will actively promote trade compliance among export enterprises to enhance alignment with internationally recognised standards (Meckling & Nahm, 2019).

4. China Customs' strategy to cope with GTBs

Undoubtedly, green trade has emerged as a critical component of the international trade system, while the rise of potential risks, exemplified by GTBs, is exerting a profound influence on both China and the broader global trade landscape (Siy et al., 2023). To address this, China Customs is prioritising the enhancement of smart customs infrastructure and the

modernisation of the export industry's supply chain. By fostering a collaborative mechanism between Customs and enterprises, the aim is to dismantle GTBs and facilitate the sustainable growth of the green export sector, all while advancing the objectives of the 'dual carbon' goals.

4.1. Strengthening smart customs and promoting digital green dual transformation

A noticeable, mutually beneficial trend is emerging between digital empowerment and green low-carbon initiatives (Di et al., 2024). Since 2018, China Customs has been advancing the development of smart customs under the framework of 'Smart Customs, Smart Borders, Smart Connectivity'. Currently, the construction of smart customs has yielded significant results, marked by a series of landmark achievements such as the intelligent map review system, big data analysis platform, blockchain technology applications and intelligent robots. The year 2025 represents a pivotal milestone for the integration and consolidation of smart customs initiatives. Building upon the WCO's SMART project, China Customs will leverage advanced digital intelligence technologies, including DeepSeek and ChatGPT, to enhance practical applications of smart customs. (China Central Television News, 2025).

Firstly, centred around the customs big data analysis platform, a new generation of customs cloud computing platforms and customs network systems, along with other big data infrastructure, is being developed. Simultaneously, a knowledge base, a model base, a smart tag base, and a knowledge graph[3] with customs-specific characteristics are being established to enhance the level of intelligent application of customs big data.

Secondly, China Customs is establishing a 'platform + application scenario' framework, developing a thematic database and a matrix of big data application models, and implementing a customs AI big data model control system, aiming to achieve the dual objectives of 'enhancing regulatory efficiency' and 'precision risk prevention and control'. On the one hand, it optimises supervision and customs clearance processes, enhances the convenience of port customs clearance, and reduces the green compliance costs of market entities. On the other, it relies on in-depth AI algorithm mining and dynamic model iteration to strengthen risk perception and early warning, and to improve the accuracy and efficiency of identification and disposal of high-risk targets. For instance, Shenzhen Customs has constructed a technical support platform for solid waste attribute identification to address the import of large quantities of recycled plastics

3 China Customs is currently advancing the Smart Customs initiative, which primarily comprises the following components. The knowledge base is a structured framework built upon customs operational data, encompassing various business categories and regulatory elements. The model base consists of computer programs integrated into customs operational systems, which leverage big data technology and artificial intelligence algorithms. The smart tag base functions as a high-risk alert mechanism designed for automated monitoring of inbound and outbound goods and transport vehicles. The knowledge graph component involves the graph-based representation of customs resources, including documents and data, to construct visualised scenarios that support intelligent searching and application by customs personnel.

and used mechanical and electrical products. By leveraging key technologies such as big data mining and AI, the platform drives intelligent supervision and analyses characteristic indicators of solid waste, thereby establishing a predictive model for solid waste attribute identification (Song et al., 2024). Building on this foundation, the application of big data analytics will provide technical support for the realisation of addressing GTBs, thereby advancing the transformation of green trade regulation towards digital greening.

4.2. Deepening Customs-to-Business partnerships

To foster the advancement of green technological innovation among export enterprises and bolster the green competitiveness of export products, thereby addressing the challenges posed by GTBs (Hu et al., 2021), China Customs should establish a robust collaborative governance mechanism with export enterprises. On the one hand, leveraging key enterprises within the upstream and downstream sectors of the green and low-carbon industrial chain, China Customs should expedite the cultivation of green and low-carbon industrial chain enterprises (I. Khan et al., 2022). On the other, export enterprises should actively assume their role as the cornerstone of foreign trade, accelerate green technological innovation, cultivate professionals in emission reduction, and enhance their core competitiveness while adhering to international green trade regulations.

Currently, China Customs is expediting the optimisation of customs clearance and supervision procedures for export commodities subject to taxation. By fostering digital collaboration with qualified enterprises, China Customs will establish a digital carbon management platform, which will facilitate the seamless integration and interoperability of customs clearance data with external carbon-related tariff information. This will thereby construct a comprehensive three-dimensional supervision and service network that integrates origin management, enterprise management and commodity management, ensuring a robust and efficient regulatory framework (M. Liu et al., 2022). Taking the Nanjing FTZ as a case study, the establishment of a digital carbon management platform for local customs and enterprises enables the systematic collection of carbon footprint data, with the product's entire life cycle serving as the accounting boundary. These data are aggregated into a nationally recognised greenhouse gas accounting standard database, facilitating the comprehensive calculation of the product's life cycle carbon emissions. Subsequently, a third-party accounting organisation with professional qualifications is engaged to conduct carbon verification and carbon neutrality certification. For products that achieve carbon neutrality certification, the platform issues carbon neutrality labels and QR codes. End users can scan these codes to access detailed carbon emission data for each stage of the product's life cycle, thereby achieving the goal of product carbon neutrality. These data are securely stored using blockchain technology, ensuring transparency, permanence and immutability. This guarantees the traceability and

retrievability of carbon data for exported products, streamlining Customs' access to such data and supporting the efficient clearance of export enterprises.

4.3. Enhancing the effectiveness of customs supervision and precision cultivation of green export industry chains

Firstly, the export tax rebate rate has been strategically reduced, aligning with the broader objectives of trade liberalisation, which is widely recognised as conducive to carbon reduction and sustainable development (M. Li et al., 2021). The US government's recent – and some may say unreasonable – suppression of China's foreign trade has seriously disrupted the normal global economic and trade order. In response, the Chinese government has proactively adjusted its export policies, particularly by reducing the export tax rebate rate for high-carbon products. This policy shift aims to regulate the supply side, facilitate the transformation and upgrading of the manufacturing industry towards higher value-added segments of the industrial chain, and promote green and high-quality development (S. Tian et al., 2023). Consequently, China Customs is actively engaged in tariff research, refining tariff codes and numbers, revising tax calculation methods and developing a green tariff catalogue. These measures include lowering tariff rates for low-carbon products and optimising tariffs for green and low-carbon products (Hao et al., 2023).

Secondly, the optimisation of regulator services has been prioritised. Initially, leveraging the policy benefits inherent in special customs supervision zones, bonded supervision sites and processing trade, China Customs has streamlined the approval processes for green products, thereby establishing green industry service zones. Subsequently, the introduction of a negative list for high-carbon products has been implemented to serve as a policy guide, incentivising enterprises to engage in green and low-carbon export trade. Furthermore, China Customs has expedited the development of smart zero-carbon zones by actively incorporating green digital technologies such as cloud computing, mobile internet, big data, blockchain, and 5G to construct a comprehensive carbon monitoring system. Concurrently, industrial optimisation has been formulated based on actual conditions. Additionally, the acceleration of industrial transformation and upgrading has been emphasised, with the elimination of outdated production capacities and the avoidance of projects characterised by high energy consumption, high pollution and high-carbon emissions (Fernando et al., 2019).

Thirdly, China Customs focuses on targeted cultivation of low-carbon projects. China Customs not only provides policy guidance to exporters on overseas compliance requirements but also offers one-stop services, including technical trade counselling, inspection and appraisal, to help exporters reasonably circumvent GTBs through adherence to standards and norms. Recently, China Customs has been studying and implementing domestic

carbon market trading, green power trading and green certificate trading. Simultaneously, it encourages specialised and sophisticated enterprises to concentrate on the research, development and application of green and low-carbon technologies and products. It is noteworthy that China Customs actively leverages the AEO system to cultivate high-quality green export enterprises. On the one hand, it does this by reforming the AEO evaluation framework, introducing a carbon footprint declaration module and integrating green trade-related indicators into the AEO qualification assessment. On the other, China Customs utilises the AEO system as a 'green passport' for international trade, assisting export enterprises in reducing systemic costs.

4.4. Strengthening international exchanges and cooperation, exploring new silk roads for green and low-carbon development

Deepening multilateral and bilateral regional cooperation to uphold the common values of humanity is a prerequisite for advancing the development of global green trade. On 8 October 2022, Singapore and Australia signed the world's first bilateral green economy agreement, reaching a consensus on key areas such as reducing GTBs, enhancing mutual recognition of green standards and technical regulations, supporting the international carbon market, and promoting clean energy and decarbonisation technologies (Department of Foreign Affairs and Trade, 2022). As a sponsor of the UNFCCC and its *Paris Agreement*, China has consistently strengthened cooperation with the EU, ASEAN, Australia and other countries and international organisations to deepen collaboration in the field of green trade (S. Xu et al., 2023). Guided by the development of the 'Green Silk Road', China Customs has intensified exchanges and cooperation with countries along the 'Belt and Road' in areas such as green energy exports, technology transfer of green equipment, intellectual property rights protection and cross-border green digital trade. This initiative aims to contribute to the establishment of a sustainable global green trade system.

5. Conclusion

GTBs, characterised by the concealed nature of their institutional design, regulatory legitimacy and governance complexity, are profoundly restructuring both the environmental regulatory regime and trade rule system within global value chains. From the perspective of the policy instrument spectrum, such barriers can be categorised into two institutional forms: first, technical regulation-based non-tariff measures, including green standards, ecological packaging requirements and eco-labelling systems and second, tariff-based environmental policies represented by the CBAM. Faced with the complex and volatile international economic and trade landscape, China Customs is in urgent need of reforming and innovating its regulatory systems to effectively address the systemic risks and challenges posed by GTBs.

This study aims to address the gaps in existing literature within the field of cross-border green regulatory coordination by focusing on the institutional dilemmas from the perspective of China Customs supervision. Empirical research indicates that constructing customs supervision innovation mechanisms based on dynamic capability theory holds significant policy relevance for resolving the non-neutral effects of green trade systems (Cui & Li, 2023).

Against the backdrop of the ongoing evolution of the global green trade rule system, GTBs are posing institutional risks to China Customs' supervision through multiple channels, primarily manifested in three types of risks: the imposition of green tariffs, the implementation of green standards and the enforcement of green packaging and labelling requirements. In the realm of green tariffs, policies such as the EU CBAM and the US CCA are not only reshaping the landscape of international trade value chains but also imposing significant carbon cost pressures on Chinese export enterprises. Consequently, China Customs urgently needs to establish a tariff supervision mechanism compatible with cross-border carbon pricing. Meanwhile, regarding green standards, the increasing standardisation continues to raise market access barriers for export-oriented enterprises. China Customs' current commodity inspection system is inadequate to effectively address the risks emerging in this complex trade environment. Furthermore, regarding green packaging and labelling, certain countries are utilising requirements related to origin marking, eco-labels and packaging materials to create more subtle trade barriers. China Customs must therefore accelerate efforts to enhance trade compliance among export-oriented enterprises, thereby preventing export disruptions caused by non-compliant labelling or environmentally unfriendly packaging. Overall, these GTBs not only exacerbate compliance risks for exporters but also place more demanding requirements on China Customs in terms of regulatory capacity building, technical standard harmonisation and alignment with international rules.

Based on the theory of institutional change and the perspective of global value chain governance, China Customs' governance system is facing institutional challenges triggered by three types of risks: the imposition of green tariffs, the implementation of green standards, and the enforcement of green packaging and labelling requirements. This deep-seated structural contradiction is mainly manifested in two dimensions. The first is insufficient institutional supply for green trade compliance. Currently, cross-border environmental regulations are becoming increasingly 'institutionally hollowed out', mainly manifested in the following aspects: the lack of a national standard system for carbon accounting of export products based on Life Cycle Assessment (LCA) has led to the formation of data silos in China Customs' supervision of green trade, thereby generating institutional transaction costs. At the same time, the existing environmental regulatory

tools have not been effectively internalised as a driving force for green technology innovation in enterprises, which is not conducive to scientific supervision.

The second dimension is lagging institutional innovation in smart customs development. In the era of digital trade, customs supervision is confronted with the dilemma of 'technology-institution' co-evolution: firstly, the application of intelligent regulatory technologies such as blockchain traceability and AI early-warning remains at the tool level, failing to achieve a digital transformation of the regulatory paradigm. Secondly, there exist institutional barriers of 'fragmented authoritarianism' in interdepartmental environmental information sharing. Thirdly, in the framework of global climate trade rules, the work of China Customs in the development of green standards and conformity assessment systems, participation in the formulation and revision of international green standards, and the alignment and mutual recognition of rules such as carbon footprint still urgently needs to be advanced.

Against this backdrop, China Customs should pursue innovative reforms from the following two dimensions. First, at the technical governance level, relying on the development of smart customs, it should establish an integrated regulatory model of 'carbon account + green certification' and embed carbon footprint verification into the AEO system and the international trade 'Single Window' system. Second, at the institutional coupling level, it should leverage the Green Silk Road framework to deepen international mutual recognition cooperation and build a cross-departmental collaborative governance model for green supply chains. These measures will not only substantially improve the utilisation efficiency of green elements in customs business data but also achieve the synergistic goals of optimising compliance costs and enhancing trade resilience.

Based on the dual perspectives of global environmental governance and strategic trade theory, the core conclusions of this paper are as follows. With the exponential growth of global green trade scale, environmental regulation elements have profoundly reconstructed the international trade competition paradigm. As the world's largest economy in goods trade for eight consecutive years, China Customs' governance system's institutional capacity to respond to GTBs is not only directly related to the stability of the global trade system, but also of great significance to the realisation of the sustainable development goals advocated by the United Nations.

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