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Department of Sociology, Economic
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GRADUATION THESIS

on

Problems and development of Chinese foreign trade under green barriers

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Department of Sociology, Economic Theory and International Processes
Field of study 38.04.01 Economics,
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ASSIGNMENT
FOR THE GRADUATION THESIS OF

Master's degree student Chen Yue, group 24ЭЭВам1, full-time mode of study

1 The topic of the graduation thesis: "Problems and development of Chinese foreign trade under green barriers"

was approved by the university order

dated «____» _____ 20____ no. _____

2 The deadline for the Master's degree student to complete the graduation thesis is 15.06.2026.

3 The input data for the graduation thesis is the regulatory and legal framework, scientific literature and reference books, and Internet data.

4 The list of issues to be studied includes characteristics and international implementation mechanisms of green barriers; the multidimensional impact and core challenges of green barriers on china's foreign trade; strategies for addressing green barriers to China's foreign trade.

5 The list of visuals contains tables and figures.

6 The date of setting the assignment is 8.10.2024.

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Schedule for completing the graduation thesis

№ п/п	Content of the thesis	Deadline for completion	Due date, signature of the academic adviser
First year of study			
1	Substantiating of the research topic and methodology, subject and object of research	1.09.2024 – 31.10.2024	
2	Framing the scientific concept of research	1.11.2024 – 18.12.2024	
3	Collection of scientific literature for the thesis	19.12.2024 – 15.01.2025	
4	Substantiating the relevance, concept, and novelty of the research	16.01.2025 – 19.02.2025	
5	Framing of a detailed plan and layout of the research	20.02.2025 – 12.03.2025	
6	Studying new literature sources within the topic of the thesis	13.03.2025 – 26.03.2025	
7	Conducting theoretical research within the first chapter of the thesis	27.03.2025 – 30.04.2025	
8	Preparing the first chapter of the thesis	1.05.2025 – 30.06.2025	
Second year of study			
9	Conducting analytical research within the second chapter of the thesis	1.09.2025 – 22.10.2025	
10	Preparing the second chapter of the thesis	23.10.2025 – 24.12.2025	
11	Conducting analytical research within the third chapter of the thesis	25.12.2025 – 25.02.2026	
12	Preparing the third chapter of the thesis	26.02.2026 – 21.04.2026	
13	Preparing the introduction and conclusion	22.04.2026 – 12.05.2026	
14	Completing the graduation thesis	13.05.2026 – 27.05.2026	
15	Handing in the thesis for compliance control and antiplagiat	28.05.2026 – 11.06.2026	
16	Getting acquainted with the feedback and review	13.06.2026	
17	Presenting the written thesis	15.06.2026	

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Summary

The graduation thesis comprises 78 pages, 3 chapters, 14 figures, 8 tables, 62 sources. GREEN BARRIERS, FOREIGN TRADE, IMPACT, CHINA ECONOMY, EXPORT, IMPORT, COUNTERMEASURES, GOVERNMENT, ENTERPRISES, CONSUMERS

The research object of this paper is the impact patterns and mechanisms of green trade barriers on China's foreign trade, as well as the core dilemmas and strategic responses of China's foreign trade sector to these barriers.

The goal of the research is to systematically define the core connotations and evolutionary trends of contemporary green trade barriers, comprehensively reveal their multidimensional impact mechanisms on China's foreign trade, identify key challenges in China's response capacity, and construct a coordinated response strategy system involving government, industry, and enterprises to support China's foreign trade green transformation and enhance its discourse power in global green trade rule-making.

The main research methods used in this paper are as follows: literature research method, quantitative analysis and empirical research method, comparative analysis method, and case study method. Through the literature research method, this study systematically reviews academic literature, industry reports, and international organization research to clarify the research context and existing gaps, laying a solid theoretical foundation. Based on authoritative statistical data from 2018 to 2025, the quantitative analysis and empirical research method uses panel data fixed effect models, the GTAP model, and dynamic general equilibrium analysis to quantitatively test the impacts of green trade barriers. The comparative analysis method horizontally compares green trade regulations in major developed economies and vertically compares the evolutionary stages of green barriers, while also examining heterogeneous effects across industries and enterprise scales. Finally, the case study method selects typical green trade barrier cases and corporate practices to analyze actual impact paths and successful response experiences, enhancing the practical relevance of the research conclusions.

Novelty of this study lies in four key aspects. First, it adopts a timely and frontier perspective focusing on the composite green barrier system formed by multiple EU regulations implemented since 2022, analyzing the nonlinear superimposed effects of policy linkages and explaining the evolution from “end-product control” to “whole lifecycle + supply chain closed-loop regulation”. Second, it presents a highly systematic research

framework covering theoretical connotation sorting, global trend judgment, macro impact analysis, industry heterogeneity examination, core dilemma identification, and strategy formulation, addressing deficiencies in existing research. Third, it constructs a synergistic strategy system based on the functional positioning and collaborative logic of government, industry, and enterprises, forming a closed-loop system of mutual support. Fourth, it employs cutting-edge data from 2018 to 2025 and practical cases from the EU green regulation transition period, combined with advanced empirical methods to provide more robust and practically relevant conclusions.

The significance of this paper lies in both theoretical and practical aspects. Theoretically, it enriches and improves the theoretical research system of green trade barriers by expanding their connotation and classification based on the latest global developments, enhances the analytical framework for assessing impacts on developing countries by revealing nonlinear cumulative effects and heterogeneous paths, and constructs a multi-entity collaborative theoretical response system providing new directions for future research. Practically, it provides concrete operational guidance for Chinese export enterprises to reduce compliance costs and enhance green competitiveness, offers important decision-making references for government departments to improve relevant policies and participate in international rule-making, and clarifies implementation paths for industry associations to better fulfill their bridging role and promote industry-wide green transformation.

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Introduction

The accelerated advancement of global carbon neutrality has deeply integrated sustainable development concepts into the international trade system, driving fundamental changes in global trade rules centered on greening. Since 2023, the European Union has successively introduced landmark regulations such as the Carbon Border Adjustment Mechanism (CBAM), Corporate Sustainability Due Diligence Directive (CSDDD), and Critical Raw Materials Act (CRMA), transforming green trade barriers from single product environmental standards into a complex regulatory network covering the entire product lifecycle and supply chain. As the world's largest goods trading nation, China has been the primary target of technical trade barriers for twelve consecutive years, with nearly all core export industries facing rising market access thresholds and exponentially increasing compliance costs. Existing academic research predominantly focuses on individual barrier tools and macro-level impacts, neglecting the composite effects of overlapping regulations, industry-specific heterogeneity, and the need for coordinated multi-stakeholder responses. Effectively addressing green trade barriers is not only crucial for China's foreign trade high-quality development and "dual carbon" goals but also contributes to building a fairer global trade governance system, making this research highly relevant in both theoretical and practical terms.

The research object of this paper is the impact patterns and mechanisms of green trade barriers on China's foreign trade, as well as the core dilemmas and strategic responses of China's foreign trade sector to these barriers.

The subject of this research is the three core types of actors involved in the development and response to green trade barriers in China's foreign trade context: government regulatory

departments responsible for macro policy formulation and international rule negotiation, foreign trade industry associations serving as bridges between government and enterprises, and Chinese export enterprises directly undertaking compliance obligations and implementing green transformation.

The goal of the research is to systematically define the core connotations and evolutionary trends of contemporary green trade barriers, comprehensively reveal their multidimensional impact mechanisms on China's foreign trade, identify key challenges in China's response capacity, and construct a coordinated response strategy system involving government, industry, and enterprises to support China's foreign trade green transformation and enhance its discourse power in global green trade rule-making.

Tasks of this paper are:

- define the narrow and broad connotations of green trade barriers, establish a scientific classification system, deconstruct their international implementation mechanisms, and forecast future evolutionary trends of global green trade regulations;
- quantitatively measure the direct and indirect impacts of green trade barriers on China's foreign trade scale, costs, structure, and market distribution, as well as their transmission paths to macroeconomic indicators;
- systematically examine the differentiated impacts of green trade barriers on China's three core export industries and reveal industry-specific mechanisms and enterprise-level response difficulties;
- explore the core challenges and deep structural contradictions restricting China's foreign trade response capacity from multiple dimensions;
- develop actionable response strategies at the government, industry, and enterprise

levels, constructing a full-chain collaborative response system.

Novelty of this study lies in four key aspects. First, it adopts a timely and frontier perspective focusing on the composite green barrier system formed by multiple EU regulations implemented since 2022, analyzing the nonlinear superimposed effects of policy linkages and explaining the evolution from “end-product control” to “whole lifecycle + supply chain closed-loop regulation.” Second, it presents a highly systematic research framework covering theoretical connotation sorting, global trend judgment, macro impact analysis, industry heterogeneity examination, core dilemma identification, and strategy formulation, addressing deficiencies in existing research. Third, it constructs a synergistic strategy system based on the functional positioning and collaborative logic of government, industry, and enterprises, forming a closed-loop system of mutual support. Fourth, it employs cutting-edge data from 2018 to 2025 and practical cases from the EU green regulation transition period, combined with advanced empirical methods to provide more robust and practically relevant conclusions.

The main research methods used in this paper are as follows: literature research method, quantitative analysis and empirical research method, comparative analysis method, and case study method. Through the literature research method, this study systematically reviews academic literature, industry reports, and international organization research to clarify the research context and existing gaps, laying a solid theoretical foundation. Based on authoritative statistical data from 2018 to 2025, the quantitative analysis and empirical research method uses panel data fixed effect models, the GTAP model, and dynamic general equilibrium analysis to quantitatively test the impacts of green trade barriers. The comparative analysis method horizontally compares green trade regulations in major

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Chapter1. Overview of Green Barriers

1.1Definition and classification of green barriers

Green trade barriers, also referred to as environmental barriers to trade (ETB), describe tangible restrictions on cross-border trade activities enacted by the governments of importing nations or regional international bodies. These restrictive measures are put into practice via the development and enforcement of a range of regulatory documents and oversight mechanisms, with core priorities of safeguarding ecological environments, preserving natural resources, and upholding the health and safety of humans, animals, and plant life. Within international academic circles, the phrase “environment-related trade barriers” is widely adopted, highlighting the positive environmental protection focus of these rules; in Chinese academic research, combined with real-world foreign trade practices, these measures are widely acknowledged to hold dual characteristics of both environmental protection and trade restriction, and are classified as an innovative form of non-tariff barrier within the landscape of global sustainable development [18].

These measures span a wide range of regulatory dimensions, including formal laws and regulations, technical benchmarks, certification frameworks, inspection and quarantine protocols, and market access regimes. Their core purpose is to lift the environmental entry requirements for imported goods, drive up compliance costs for exporting enterprises across the full production-to-distribution chain, and in turn shape adjustments to overall trade volume and structural composition. The dual nature of these measures is especially notable: green trade barriers that are scientifically sound and aligned with the non-discrimination principle can effectively restrict the cross-border movement of high-pollution, high-

emission goods. They push national production and trade systems toward green, low-carbon transformation, while delivering institutional support for global carbon neutrality targets and creating meaningful positive externalities. As early as 1992, Anderson K. noted in his work *Greening the World Trading System* that environmental safety and public health should serve as key evaluation metrics for trade policy, and that non-tariff trade control measures have inherent rationality. In real-world trade practices, however, developed economies frequently use their first-mover technological advantages and international regulatory influence to set strict standards that far exceed the technical capabilities and economic capacity of developing nations. Some even enforce discriminatory dual standards, reframing green trade barriers as hidden tools for trade protection. A 2009 study by Copeland B.R. and Taylor M.S. further validated this pattern, confirming that many trade restrictive measures framed as environmental protection lack sufficient scientific grounding, and are essentially designed to shield domestic industries from external competitive pressures. This dual nature creates a unique dilemma for developing countries, which must balance environmental protection obligations with trade development needs.

From the perspective of conceptual boundaries, green trade barriers can be divided into narrow and broad categories.

Figure 1 illustrates the conceptual structure of green trade barriers, distinguishing between narrow and broad definitions and their core components, as shown below:

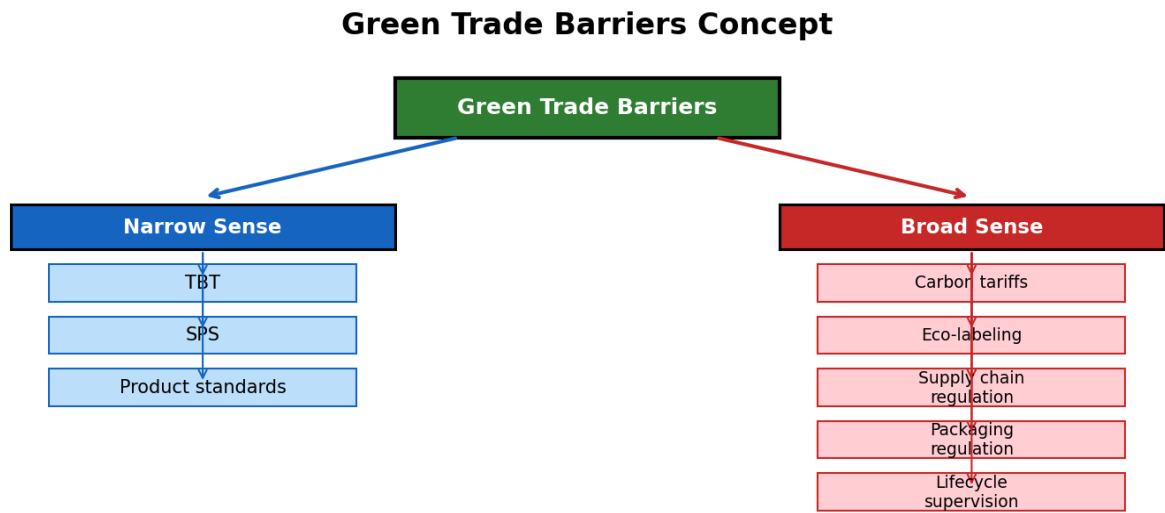


Figure 1-Conceptual structure of green trade barriers [18;44]

At the narrow level, they refer only to technical trade measures directly targeting the environmental attributes of products, corresponding to the core contents of the WTO's Agreement on Technical Barriers to Trade (TBT Agreement) and the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement), mainly focusing on the environmental performance and safety standards of the products themselves, such as limits on pesticide residues in food and energy efficiency standards for electromechanical products. At the broad level, they encompass a comprehensive regulatory system covering all dimensions and the entire supply chain. In addition to traditional environmental technical standards, they also include carbon border adjustment measures, green certification and Eco-labeling systems, supply chain environmental sustainability regulations, green packaging and waste recycling requirements, and environmental impact assessment access systems [57]. Their regulatory scope has extended beyond the entry point of terminal products to upstream stages such as raw material extraction, production and processing, packaging, and storage and transportation, as well as downstream stages like consumer use and recycling

and disposal, forming a complex trade barrier system that deeply integrates tariff and non-tariff measures with border control and domestic regulations. New regulations such as the EU Corporate Sustainability Due Diligence Directive (CSDDD) and the Critical Raw Materials Act (CRMA) clearly reflect this full-chain regulatory trend and place higher requirements on the compliance capabilities of Chinese export enterprises [56].

Based on the dynamics of international trade green regulations from 2022 to 2025 and actual cases of barriers encountered by Chinese export enterprises, and with reference to relevant domestic and international research findings, green trade barriers are classified into six core categories according to the implementation mechanisms of the measures, the scope of supervision, and the trade impact pathways, comprehensively covering the mainstream forms of barriers faced by China's export trade.

1. Technical environmental standards and inspection-quarantine measures represent the most widely used foundational form of green barriers. At their core, these measures establish clear limits for product environmental performance, energy consumption, pollutant emissions, and food safety and hygiene via mandatory technical regulations, product benchmarks, and conformity assessment processes. Professional testing bodies are commissioned to carry out import inspections, and products that fail to meet requirements are either banned from entering the market or subject to mandatory return. Japan's Positive List System, the Eu's REACH regulation, and U.S. energy efficiency access standards for mechanical and electrical' products all sit within this category [28]. Official statistics show that annual export losses for China due to non-compliance with these measures exceed 30 billion USD, with agricultural products making up more than 60 % of these losses, making the sector the most heavily impacted.

2. Carbon border adjustment measures, commonly known as carbon tariffs, have emerged as one of the most rapidly expanding new trade barriers in recent years. Their core operating logic is to impose additional tariffs on imported goods based on the embedded carbon emissions across the full production chain, aligned with the carbon pricing benchmarks of the importing country. These measures are designed to address the risk of “carbon leakage”, while simultaneously mandating that companies submit comprehensive carbon footprint accounting reports. The European Union's Carbon Border Adjustment Mechanism (CBAM) entered its transitional phase in 2023 and is set for full implementation in 2026. It will initially cover five high-energy-consuming industries including steel and aluminum, with plans to gradually expand to additional sectors in the coming years [4]. Industry estimates indicate that the annual compliance costs for Chinese exports of related goods to Europe will rise by more than 10 billion euros.

3. Green certification and eco label access systems operate on a voluntary basis, yet carry de facto market entry restrictions. Administered by independent third-party bodies, products that do not secure certification are not formally banned from entering a market, but routinely face barriers to accessing mainstream retail channels and large supermarket chains, ultimately eroding their competitive edge in the market. The EU Eco label, PEF certification framework, and ISO14067 carbon footprint accounting standard all fall within this category [55]. These barriers have a disproportionate impact on small and medium-sized export enterprises: high certification costs and limited technical capacity mean these firms often struggle to meet strict certification requirements, leaving them at risk of being pushed out of the market entirely.

4. Supply chain environment and sustainability regulations have emerged as complex

barriers since 2024. Their core is to impose mandatory requirements on the environmental sustainability and social responsibility of the entire product supply chain, extending the regulatory scope to upstream raw material extraction and production and processing stages, requiring enterprises to conduct supply chain environmental due diligence and disclose relevant information. The Eu's Critical Raw Materials Act (CRMA) and Corporate Sustainability Due Diligence Directive (CSDDD) reflect this trend, forcing Chinese export companies to restructure their supply chain systems and strengthen environmental management of upstream suppliers.

5. Green packaging and waste recycling regulations mainly impose mandatory requirements on packaging materials, recyclability, recycled material content, and waste recycling responsibilities. They prohibit the use of highly polluting or non-degradable packaging materials, while also requiring companies to undertake obligations for packaging waste recycling. The Eu's Packaging and Packaging Waste Regulation (PPWR), WEEE Directive, and RoHS Directive all fall into this category [58]. As a result, influenced by these regulations, Chinese export companies have seen compliance costs increase by an average of 10 %-15 % due to packaging material upgrades and recycling system setup, with some small and medium-sized enterprises unable to bear the burden.

6. Environmental Impact Assessment and Market Access Ban: Through mandatory environmental impact assessments, the environmental impact of imported products during production, use, and disposal is comprehensively evaluated, directly prohibiting products that do not meet environmental requirements from entering the country. The Eu's Sustainable Products Regulation (SPR) and the U.S. import ban on raw logs and forest products fall into this category [56]. Some of China's high-pollution chemical products and

primary forest products are banned from entering European and American markets for failing to pass environmental impact assessments, severely restricting export channels. Table 1 summarizes the core mechanisms, representative regulations and main impacts of these six types of green trade barriers, as shown in the following data:

Table 1- Classification of green trade barriers [5;7;8]

Type	Core Mechanism	Representative Regulation	Main Impact
Technical standards	Product compliance	REACH	Increase testing costs
Carbon tariffs	Embedded carbon pricing	CBAM	Raise export costs
Eco-labeling	Green certification	EU Ecolabel	Market exclusion
Supply chain regulation	Due diligence	CSDDD	Supply chain restructuring
Packaging regulation	Recycling obligation	PPWR	Packaging upgrade
Environmental access	Lifecycle assessment	SPR	Market prohibition

1.2 Characteristics and International Implementation Mechanisms

Based on the international trade practices from 2022 to 2025 and the actual impact of green barriers on China's foreign trade, the core features of green trade barriers are concentrated in six aspects. These features are intertwined and mutually reinforcing, together forming a real obstacle to the high-quality development of China's foreign trade.

1. First, the dual attributes of green barriers are highly prominent, with the coexistence of legitimate environmental protection goals and hidden trade protectionism serving as their most fundamental characteristic. Green trade barriers draw their legitimacy from the global consensus on ecological and environmental protection, and when designed appropriately, can guide enterprises to optimize production processes, reduce environmental pollution, and support the delivery of global carbon neutrality targets. However, as rule-making authority has long been concentrated in the hands of developed economies, these barriers are frequently embedded with hidden trade protection functions. Leveraging their leading technological advantages, developed economies set standards that far exceed the technical and economic capacity of developing nations, creating what are effectively “trade barriers hidden behind a veneer of legal legitimacy.” The environmental standards set by the European Union, for example, are framed as measures to advance global environmental protection, yet in practice are designed to shield its domestic high-energy-consuming industries and restrict competitive exports from developing countries. This dual nature makes it extremely difficult for developing nations to clearly define the legitimacy of specific measures when formulating responses, often leaving them in a reactive, passive position.

2. Highly covert and not easily triggering international countermeasures, this is significantly different from traditional trade restriction measures such as tariffs and quotas. Green trade barriers are hidden under legitimate titles such as 'environmental protection' and 'public health,' and their trade-restricting effects are indirectly reflected through technical standards and certification requirements, making them difficult to detect and hard to classify as illegal trade protection measures. When developed countries revise product

environmental standards, it may seem like normal policy adjustments, but in fact, it is aimed at raising market access thresholds. If developing countries attempt countermeasures, they are often accused of 'ignoring environmental protection,' putting them at a disadvantage in public opinion. Data from China's Ministry of Commerce show that China has been the country with the highest number of special trade concerns in the WTO regarding TBT/SPS for 12 consecutive years, fully highlighting the impact of this covert discrimination on China's foreign trade [47;61].

3. The trend toward systematization and complexity is obvious, with prominent superimposed effects. Currently, green trade barriers are no longer merely a single technical standard or quarantine measure; instead, they have formed a complex system with multiple policy linkages and full-dimension coverage. Developed economies such as the European Union have established a green trade regulatory system covering the entire product life cycle through coordinated regulations, including carbon tariffs, supply chain management, product standards, and certification systems. This superimposed effect exponentially increases the compliance difficulty and costs for enterprises. When Chinese photovoltaic companies export to the EU, they must simultaneously meet technical standards, carbon footprint certification, supply chain sustainability requirements, and prohibitions on forced labor. The accumulation of multiple compliance requirements significantly raises export costs and market access difficulty.

4. The pace of dynamic upgrades is fast, and compliance costs continue to rise. With the global awareness of environmental protection increasing and technology continuously advancing, the green trade standards in developed economies are continuously tightening, and the frequency of revisions is accelerating. The European Union revises more than 300

environmental technical standards each year; Japan's "Positive List System" is constantly increasing the types of pesticides and residue limits under control; the United States is also continuously updating energy efficiency standards for electromechanical products. This dynamic upgrading requires China's export enterprises to continuously invest resources, track, and adapt to new standards, which not only increases compliance costs but also faces export risks caused by untimely updates of standards. Some small and medium-sized enterprises are gradually being pushed out of the international market because they find it difficult to keep up with the pace. [8]

5. Country-specific heterogeneity and discrimination are significant, and the issue of imbalanced rule-making power is prominent. There are obvious country-specific differences in green trade barrier standards, and standards set by developed economies have not fully taken into account the development stages and technological levels of developing countries, with discriminatory characteristics being very pronounced. For example, the Eu's carbon footprint requirements for our photovoltaic products are much higher than those for its domestic enterprises, and Japan's pesticide residue limits for our agricultural products are stricter than those of other developed countries. At the same time, the power to set global core rules for green trade is highly concentrated in developed economies such as the EU and the US, and developing countries like ours lack a voice and can only passively adapt to existing rules, which further exacerbates trade injustice.

6. Finally, these measures are backed by strong legal enforceability and full lifecycle supervision, creating highly tangible binding effects on exporters. Green trade barriers are underpinned by formal domestic legislation in importing countries, granting them significant legal enforceability. Enterprises that fail to comply with these regulations face

severe penalties, including the return of goods, heavy fines, permanent market bans, and even permanent exclusion from the target market. The scope of regulatory oversight has expanded to cover the entire lifecycle of products, from raw material extraction, production and processing, packaging and transportation, through to end-of-life recycling and disposal, with clear environmental requirements set for every stage of the process. This places significantly higher demands on the end-to-end compliance management of China's manufacturing supply chains. The EU CSDDD, for example, explicitly requires enterprises to conduct full due diligence on the environmental performance of upstream raw material suppliers. If suppliers are found to have committed environmental violations, downstream exporting enterprises can be held directly and jointly liable for those breaches.[7]

The implementation of green trade barriers relies on a multi-level, multi-entity linked institutional system, mainly composed of four core parts: national domestic legislation, regional trade agreements, multilateral international rules, and the behavior of market entities. This forms a comprehensive, multi-level implementation mechanism, where each mechanism works in coordination and support with others to ensure the effective implementation of green trade barriers.

1. Domestic Law Enforcement Mechanisms at the National Level

This is the core source of rigidity in the green trade barrier system and the key guarantee for the barrier's eventual implementation. Major developed economies have all incorporated green trade regulations into their domestic legal systems through formal legislative procedures, establishing a complete enforcement and regulatory closed loop. EU regulations such as CBAM, CRMA, and CSDDD are issued in the form of EU regulations and have direct legal effect in all member states without requiring separate national legislation; the

United States, on the other hand, has established a comprehensive green barrier legal system through a series of laws including the Clean Air Act, the Toxic Substances Control Act, and the Food, Drug, and Cosmetic Act, clearly defining the standards for implementing various measures and the rules for penalties. In the enforcement process, the customs, environmental protection authorities, and market regulation departments of the importing countries work together to form a closed loop of 'entry inspection – process supervision – violation punishment': customs are responsible for entry compliance review and sampling inspections, environmental protection authorities assess the environmental impact of products, and market regulatory authorities conduct follow-up supervision after the products enter the market. If Chinese exporting enterprises fail to meet the domestic legal requirements of the importing country, they will directly face consequences such as returned goods, heavy fines, and market bans, resulting in significant economic losses. [5;7]

2. Coordinated Implementation Mechanisms under Regional Trade Agreements

As regional economic integration continues to deepen, regional trade agreements have emerged as a key vehicle for the global expansion of green barrier rules, and a primary channel for developed economies to export their domestic green regulatory frameworks. Today, every high-level regional trade agreement worldwide includes dedicated chapters on environment and sustainable development, cementing green trade rules as a core component of modern trade governance. Some agreements even go so far as to make the alignment of environmental standards a non-negotiable precondition for signing free trade agreements (FTAs). While the European Union constructs a unified internal green regulatory system, it also positions its domestic environmental standards and certification frameworks as a core prerequisite for signing FTAs with third countries, actively driving the global export of its

green rule set. High-level FTAs including the United States-Mexico-Canada Agreement (USMCA) and the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) contain stringent environmental provisions, covering areas including carbon emission reduction, biodiversity protection, and waste recycling and management. For China, the TBT/SPS measures coordination mechanism established under the Regional Comprehensive Economic Partnership (RCEP) has delivered tangible facilitation for exports to ASEAN and other member states, reducing the obstacles created by green trade barriers within the region. At the same time, the high-level environmental provisions embedded in the CPTPP and the EU's bilateral FTAs create elevated regulatory pressure on China's foreign trade, forcing China to accelerate the alignment of its domestic green rules with high-level international standards.

3. Multilateral Regulatory Mechanism under the WTO Framework

The WTO's TBT Agreement and SPS Agreement are the core multilateral legal bases for the implementation of global green trade barriers. They provide basic guidelines for countries to implement green trade measures and offer channels for developing countries to respond to illegal green barriers. The TBT Agreement specifies three main principles for members when formulating and implementing technical regulations and standards: non-discrimination, necessity, and transparency. It requires that technical measures should not impose unnecessary restrictions on international trade and must be notified in advance with a reserved period for comments. The SPS Agreement makes specific provisions for food safety and animal and plant health measures, allowing members to take necessary actions, but these must be based on scientific principles and must not restrict trade disguisedly. The core of this mechanism includes a notification system and a dispute settlement mechanism:

the notification system requires members to notify drafts of TBT/SPS measures in advance through the WTO e ping system, reserving at least a 60-day period for comments, during which other members can raise objections; the dispute settlement mechanism provides a legal channel for members to respond to illegal barriers. If a member believes that another member's green trade measures violate WTO rules, it can bring a lawsuit to the WTO dispute settlement body [23]. However, since the WTO agreements are relatively vague in defining the legality of environmental measures, and developing countries lack professional technical support and funding in dispute settlements, this mechanism has very limited restraining effect on developed countries' abuse of green barriers. This is also one of the key reasons why China's foreign trade frequently encounters barrier shocks.

4. Soft Implementation Mechanisms Led by Market Entities

Beyond government-led mandatory regulations, soft implementation mechanisms driven by multinational corporations, global brand owners, and industry associations have become an increasingly influential component of the green barrier system. In some sectors, these market-led mechanisms create entry requirements that are even stricter than official government regulations. Large multinational enterprises including Walmart, Apple, and Volkswagen have established their own internal green procurement standards and sustainable supply chain guidelines, which mandate that upstream suppliers meet stringent environmental, carbon emission, and social responsibility requirements. Suppliers that fail to meet these requirements face removal from the approved vendor list [26]. For instance, Apple requires all its global suppliers to power their production with 100 % renewable energy, while Walmart mandates that all suppliers submit detailed product carbon footprint reports, with non-compliant suppliers losing access to purchase orders. Industry associations

also drive the implementation of green trade rules by developing industry self-regulatory standards. For example, the environmental standards for photovoltaic products set by the European Solar Industry Association are more rigorous than the official EU regulatory standards. This category of soft market mechanism has a disproportionately broad impact on China's small and medium-sized export enterprises. These firms must not only comply with the formal mandatory regulations of importing countries, but also adapt to the private voluntary standards set by downstream global brand owners. This dual compliance requirement further intensifies the pressure on these enterprises, while also accelerating the global spread and adoption of green trade barrier rules. Figure 2 depicts the hierarchical structure of this international implementation mechanism and its impact on Chinese export enterprises, as shown below:

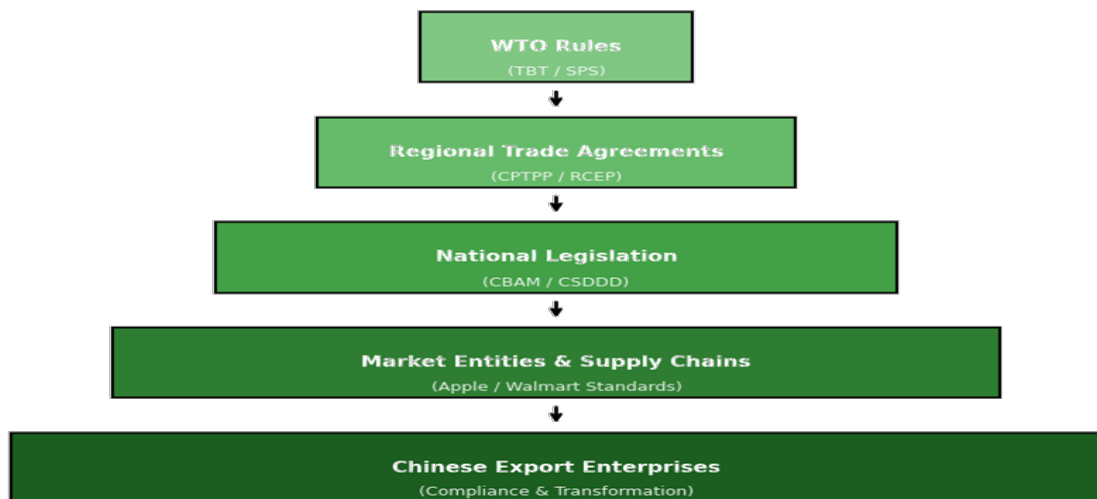


Figure 2-International implementation mechanism of green grade barriers[6]

1.3 Global trends in environmental regulations affecting trade

Currently, developed economies have completely moved beyond the limitations of single environmental technical standards, centering on carbon regulations to build a composite green trade rule system with multi-regulatory interaction and full-chain coverage. The synergy and binding nature of the rules continue to strengthen, becoming the core development direction of global green trade barriers. As the leader of this system, the European Union, with the “European Green Deal” as its top-level design, has formed a complete policy matrix centered on the Carbon Border Adjustment Mechanism (CBAM), the Critical Raw Materials Act (CRMA), and the Corporate Sustainability Due Diligence Directive (CSDDD), showing a clear step-by-step implementation feature and gradually achieving green control over the entire industrial chain [4;21].

In terms of implementation pace, the EU launched the CBAM transition period in October 2023, requiring six high-energy-consuming industries including steel, aluminum, and cement to complete carbon emissions reporting, laying the foundation for subsequent carbon tariff collection; in 2026, CBAM will be formally implemented, collecting carbon tariffs on relevant imported products based on actual carbon emissions and EU carbon market prices, and will gradually expand to downstream manufactured products; from 2026 to 2030, the Digital Product Passport (DPP) will be promoted to achieve digital traceability of full-life-cycle environmental data of products, further improving the full-chain regulatory system. This step-by-step approach not only ensures the feasibility of policy implementation but also continuously raises market access thresholds, placing higher requirements on the compliance capabilities of exporting enterprises.

Although the United States has not established unified federal-level carbon barrier

legislation, it has built a uniquely characteristic green trade barrier system through the coordinated linkage of legislative proposals and industrial policies. Its proposed Clean Competition Act (CCA) focuses on the carbon intensity of high-carbon products and plans to impose a carbon tax on imports and domestic products that exceed the U.S. industry average, gradually extending coverage from primary products to downstream manufactured goods. The Inflation Reduction Act (IRA), on the other hand, effectively forms protective measures for the green industry through massive subsidies for domestic clean energy and electric vehicle industries, indirectly constituting non-tariff trade barriers. In addition, the U.S. and Europe have promoted coordination of carbon rules through cooperative frameworks such as the U.S.-EU Green Steel and Aluminum Alliance, attempting to form a regional green trade rule alliance and further strengthen their dominance over global trade. [6]

The construction of such a composite rule system has made the cumulative effect of green trade barriers increasingly prominent. Chinese export enterprises, especially those in high-energy-consuming industries, must simultaneously meet multiple compliance requirements such as carbon footprint accounting, supply chain due diligence, and green certification. This significantly increases compliance difficulty and costs, severely weakening traditional price competition advantages. It also compels enterprises to accelerate low-carbon technology upgrades and the construction of compliance systems in order to adapt to changes in global green trade rules. Table 2 presents the detailed implementation timelines, issuing bodies, core contents and main affected Chinese industries of major global green trade regulations from 2023 to 2030, as shown in the following data:

Table 2- Below presents the implementation timelines of major global green trade regulations from 2023 to 2030 [5;6;53]

Time	Regulation / Measure	Issuing Body	Core Content	Main Affected Industries in China	Data Source
Oct 2023	CBAM Transition Period	European Union	Carbon emission reporting for six high-energy-consumption industries	Iron and steel, aluminum, chemical industry	European Commission Official Website
Jan 2024	Critical Raw Materials Act (CRMA)	European Union	Requirements for local proportion and dependency reduction of critical raw materials	New energy, electronics, automotive	Official Journal of the EU
Jan 2025	Corporate Sustainability Due Diligence Directive (CSDDD)	European Union	Full supply chain environmental and human rights due diligence	All export manufacturing	Official Journal of the EU
Jan 2026	Full implementation of CBAM	European Union	Formal carbon tariff collection, certificate surrender system	Iron and steel, aluminum, cement, fertilizer	European Commission Official Website
2026–2030	Digital Product Passport (DPP)	European Union	Digital traceability of environmental data over product lifecycle	Electronics, textiles, automotive	European Commission Proposal

Time	Regulation / Measure	Issuing Body	Core Content	Main Affected Industries inChina	Data Source
2028	CBAM expansion to downstream products	European Union	Coverage extended to auto parts, home appliances, etc.	Automotive, home appliances, machinery	European Commission Roadmap
2030	Full implementation of Packaging and Packaging Waste Regulation (PPWR)	European Union	50% recycled content in plastic packaging	Food, light industry, electronics	Official Journal of the EU

The regulatory boundaries of global environmental governance are continuously breaking through the limitations of traditional end-product control, gradually forming a closed-loop regulatory model of “full lifecycle + full supply chain”. At the same time, green trade rules are showing a global expansion trend, but the issue of polarized rule-making authority remains prominent, constituting the current dual pattern of global green trade governance.

In terms of regulatory boundary extension, traditional environmental regulations have mostly focused on the inspection and quarantine of end products and environmental performance review. However, current global environmental regulations have achieved coverage of the entire process and all entities, from raw material extraction, production and

processing, packaging and transportation to recycling and disposal, with clear environmental requirements set for each link, while also transmitting regulatory responsibilities to upstream suppliers. The EU's CSDDD explicitly requires exporting companies to conduct environmental due diligence throughout the supply chain, thoroughly checking the environmental compliance of upstream raw material suppliers [55]. If suppliers have environmental violations, downstream exporters must bear joint responsibility. The PEF certification system forces companies to calculate the carbon footprint of products across their entire lifecycle, ensuring that environmental impacts of products are traceable and verifiable. China's manufacturing industry is deeply embedded in the global value chain, with long supply chains and a large number of small and micro upstream enterprises. Such a closed-loop regulatory model not only increases the compliance difficulty for individual companies but also raises the risk of supply chain disruptions, compelling Chinese exporters to strengthen environmental management of upstream suppliers and promoting a green transformation of the entire supply chain.

In terms of the global diffusion of rules, with the widespread popularization of the concept of sustainable development, green trade regulations have extended from developed economies such as the European Union and the United States to the global level. An increasing number of emerging economies and developing countries are beginning to actively participate in the construction of green trade rules. ASEAN is promoting the establishment of a regional carbon labeling system and creating a unified carbon footprint accounting standard within the region; RCEP member countries, through the TBT/SPS measures coordination mechanism, are promoting the coordination of green rules within the region and reducing trade barriers; emerging economies such as Brazil and India are also

gradually introducing their own green technology standards and certification systems, strengthening the environmental control of imported products, and actively integrating into the global green trade governance system [13].

At the same time, however, the authority for formulating global core rules for green trade remains highly concentrated in developed economies such as the European Union and the United States. Leveraging their technological advantages, financial strength, and international influence, they dominate the formulation of core rules such as carbon accounting methods, green certification standards, and product sustainability requirements, without fully considering the technological levels and development stages of developing countries. As a result, developing countries like China can only passively adapt to existing rules, and compliance costs continue to rise. In addition, developed economies, through regional trade agreements such as the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) and the United States-Mexico-Canada Agreement (USMCA), make their own green rules a central part of the agreements, promoting the regional spread of rules. This further reinforces the polarization of rule-making authority, exacerbates the unfairness of global trade, and poses a severe challenge to the long-term stable development of China's foreign trade.

It is worth noting that digitalization and intelligence have become important supports for the implementation of green regulations. Initiatives such as the EU CBAM digital declaration platform and digital product passports have significantly improved regulatory efficiency and accuracy, while also placing higher demands on the environmental data management capabilities of our export enterprises, promoting the deep integration of green transformation and digital transformation, and becoming an inevitable choice for our export

enterprises to cope with changes in global green trade rules.

Chapter 2. The Multidimensional Impact and Core Challenges of Green Barriers on China's Foreign Trade

2.1 The Macroeconomic Overall Impact of Green Barriers on China's Foreign Trade

The global trade rules system is rapidly being reconstructed in a greener direction. Climate change issues, through tools such as carbon tariffs, carbon footprint certifications, and green technology standards, have deeply embedded themselves into the international trade rules system. For China, the world's largest trader in goods, the tightening of external green regulations is no longer a distant background constraint, but a reality that must be faced.

The evolution of the European Union's Carbon Border Adjustment Mechanism (CBAM) is quite emblematic—its transition period began in 2023, and it officially enters the substantive levy phase in January 2026, marking the global first systematic carbon border adjustment tool's leap from institutional design to practical implementation. Almost simultaneously, the EU's Critical Raw Materials Act (CRMA) came into effect in 2024. CBAM constitutes an explicit tariff constraint, while CRMA creates implicit non-tariff barriers in the raw material acquisition stage; the two are not simply parallel but form a mutually reinforcing composite regulatory network, whose cumulative effect on Chinese exports far exceeds the linear addition of a single policy. More importantly, the nature of carbon footprint management is undergoing a leap. The EU Battery and Waste Battery Regulation, effective in 2023, is a watershed, transforming the carbon footprint from a

previously voluntary label into a mandatory entry threshold for the EU market. This section intends to analyze from three dimensions: export scale and trade costs, trade structure and market layout, and macroeconomic related indicators. [24]

The direct impact of green barriers on China's exports is first reflected in the rigid increase of enterprises' compliance costs. Existing studies mostly focus on measuring the total amount of compliance costs, but generally neglect the fact that the cost generation logic of different green regulatory instruments essentially differs. Among them, implicit compliance costs not only last longer but are often underestimated by many enterprises due to their difficulty to quantify.

Regarding carbon tariffs, the CBAM requires importers to purchase certificates based on the embodied carbon emissions of products, and the certificate price is dynamically linked to the carbon price of the European Union Emissions Trading System (EU ETS) — settled at the quarterly average in 2026, and from 2027 onwards, changed to the weekly average. This means that Chinese enterprises face not a fixed tax rate but a fluctuating cost that varies with the European internal carbon market. Based on simulations using a global trade analysis model, when the EU carbon price difference reaches \$120/tCO₂, the export costs of China's basic metals industry to Europe increase by approximately 11.84%. Other studies estimate that during the initial implementation of CBAM, China's export costs of steel and aluminum to Europe will increase by about 4 %–6 % and 9 %, respectively.

In contrast, the pressure brought by carbon footprint regulation is more covert and harder to summarize with a single number. According to the evolution of international carbon footprint standards: in 2008, the British Standards Institution released PAS2050, pioneering the global evaluation of product carbon footprints; in 2018, the International

Organization for Standardization (ISO) provided a general accounting framework through ISO14067; and the GHG Protocol, jointly developed by the World Resources Institute and the World Business Council for Sustainable Development, has been widely applied at the corporate level. However, these standards are essentially voluntary tools, giving companies considerable discretion in defining accounting boundaries, selecting data, and determining the extent of disclosure. The EU Battery and Waste Batteries Regulation has completely rewritten the rules of the game — the regulation requires that electric vehicle batteries exported to the EU calculate carbon footprints according to EU rules and undergo certification by February 2025, be graded starting from August 2026, and have limits set starting from February 2028, with products exceeding the limits being banned from sale[55]. As a result, the carbon footprint has turned from an 'optional item' into a 'passing line,' and the regulatory logic has shifted from information disclosure to market access.

Therefore, based on the cost characteristics of the above three types of regulatory tools, the incremental compliance costs for companies can be broken down into three core dimensions: first, investment in green transformation on the production side, mainly including the introduction of clean production technologies, the replacement of high-energy-consuming equipment, and the substitution with renewable energy; second, certification and data monitoring expenses, covering full lifecycle carbon footprint accounting, third-party verifications, and the construction of supporting data systems --the new regulation requires companies to establish a refined data system covering the entire chain from 'raw material extraction- production and manufacturing - transportation and sales - recycling,' the complexity of which is far higher than that of previous voluntary standards [55]; third, supply chain restructuring costs, including switching to low-carbon transportation methods

and raising green entry standards for upstream suppliers.

What is particularly noteworthy is that the new EU regulations fundamentally change the requirements for data quality: traditional international standards allow companies to use industry-average secondary data for accounting, whereas the EU Battery and Waste Batteries Regulation explicitly requires that, after February 2025, power batteries exported to the EU must use the company's own primary production data, and the data across the entire supply chain must be independently verified by an EU-recognized third-party institution [55]. According to comprehensive industry estimates, for the first batch of companies covered by CBAM and the Battery Regulation, the comprehensive cost per unit of exported products will increase by 8 %–12 %; among them, small and medium-sized enterprises with annual revenues below 50 million yuan are in the most difficult position - they usually lack dedicated compliance teams and complete supply chain data management systems, and often struggle in the primary data collection phase.

The trend of changes in export scale is also worth examining in detail. Between 2018 and 2025, although China's total goods exports continued to grow, the growth rate fluctuated significantly (see table 3). In 2018, the export value was 16,417.7 billion yuan, an increase of 7.1 % year-on-year; in 2021, driven by the global demand recovery, the growth rate once rebounded to 21.2 %; thereafter, it gradually declined, reaching only 0.6 % in 2023 and rising again to 6.1 % in 2025. Of course, the fluctuations in export growth are influenced by multiple overlapping factors—global economic cycles, pandemic shocks, and geopolitical frictions all play a role. But an undeniable fact is that increasingly stringent green regulations form a structural backdrop that suppresses export momentum, particularly in the growth low of 2023, where their cumulative effect may not be negligible. Analysis based on a dynamic

general equilibrium framework shows that the combined green trade barriers formed by the linkage of CBAM and CRMA have a “nonlinear inhibitory effect” on China's exports. The interaction of the two policies causes the decline in exports to exceed the maximum decline caused by a single policy, showing an excess inhibitory characteristic of a 'compliance cost spiral.' In industries with high carbon intensity and high dependence on raw materials, the marginal effect rate of this linkage reaches as high as 22.54 % [57]. Table 3 shows the total goods export value and year-on-year growth rate of China from 2018 to 2025, as shown in the following data:

Table 3 -Total goods export value and growth rate of China from 2018 to 2025
[32;33;34;35;36;37;38;39]

Year	Export Value (100 Million Yuan)	Growth Rate (%)
2018	164177	7.1
2019	172342	5.0
2020	179326	4.0
2021	217348	21.2
2022	239654	10.5
2023	237726	0.6
2024	254545	7.1
2025	269890	6.1

If the observation period is extended, it can be seen that the effect of green barriers is

far more than a short-term squeeze on costs; it is reshaping the deep structure of China's foreign trade. According to the general experience of developing countries, green trade barriers often exhibit a “dual effect”: strict environmental standards and technical certifications certainly raise market entry thresholds, causing traditional labor-intensive products to shrink because they fail to meet environmental requirements; on the other hand, this external pressure also forces export enterprises to adjust certain structures of their products, guiding them toward high-tech, high value-added, and environmentally friendly directions [43].

China's recent years of export practice also provide empirical material for this judgment. Between 2018 and 2025, exports of the 'new trio'—electric vehicles, lithium batteries, and photovoltaic products—expanded rapidly: the production of new energy vehicles increased from 1.15 million units in 2018 to 16.524 million units in 2025; during the same period, automobile (including new energy vehicles) exports surged to 8.32 million units, with export value reaching 1,018.3 billion yuan (see Table 4). The rise in automobile export value was partly due to the higher unit price of new energy vehicles causing a structural increase, rather than expansion in quantity. A deeper change stems from the fact that green barriers force exported products to meet ecological standards in design, material selection, and manufacturing processes, promoting a shift in the export trade model from 'quantity-based' to 'quality-based' [43]. However, this transformation is not without cost: the export space for traditional labor-intensive industries is squeezed, and some small and medium-sized enterprises choose to withdraw from high-end markets like the EU due to compliance costs, instead seeking emerging markets with relatively relaxed standards. Therefore, the coexistence of 'passive transfer' and 'active upgrading' creates a complex

situation, forming a real picture of China's current foreign trade structural adjustment.

Table 4 presents the production of new energy vehicles and the overall vehicle export volume and value in China from 2018 to 2025, as shown in the following data:

Table 4-Production of new energy vehicles and vehicle export situation in China, 2018–2025[32;33;34;35;36;37;38;39]

Year	Car Export Volume (ten thousand units)	Car Export Value (100 million yuan)
2018	115	972
2019	112	1049
2020	108	1090
2021	212	2227
2022	332	4054
2023	522	7165
2024	641	8347
2025	832	10183

Empirical tests based on panel data of Chinese provinces and industries from 2002 to 2020 show that the long-term technological upgrading effect of green trade barriers is significant. For every 1 percentage point increase in their intensity, the average export technology complexity of China's manufacturing industry increases by 0.689 percentage points. This result remains robust after replacing core explanatory variables and conducting instrumental variable tests. Mechanism tests further indicate that green barriers, through

competition effects and innovation incentives, force manufacturing enterprises to increase technological innovation to improve export technology complexity. Moreover, in regions with higher marketization levels and stronger industrial agglomeration, this promotion effect is more pronounced [47]. However, this conclusion also reveals a fact that can easily be obscured by average effects: the impact of green barriers varies significantly across industries with different technology levels. The promotion effect is strongest for high-technology industries (coefficient 0.927), followed by medium-technology industries (0.790), and weakest for low-technology industries (0.171) [47]. This means that green barriers objectively accelerate the transformation of China's export product structure toward greenness and high-end development, but the benefits are not evenly distributed—the technology-intensive industries receive stronger upgrading incentives, while low-technology industries may face the dilemma of 'high compliance costs that are difficult to offset through technological upgrading'.

Adaptive adjustments in market layout represent another major structural change. From the export data to major trading partners between 2018 and 2025 (see table 5), China's export growth to markets with stringent green regulations such as Europe and the United States has relatively slowed, while exports to emerging markets such as ASEAN and countries along the Belt and Road have maintained rapid growth. In 2018, China's exports to the EU accounted for 16.4 % and to the US 19.2 %; by 2025, the share to the EU slightly decreased to 14.8 %, while the share to the US dropped significantly to 11.1 %. During the same period, exports to ASEAN increased from 12.8 % to 17.6 %, making ASEAN the largest export destination for China. This shift in market focus, although partly driven by institutional arrangements such as the Regional Comprehensive Economic Partnership (RCEP), also

reflects the 'push effect' created by the strengthening of green barriers in developed markets and should not be overlooked. Simulation analysis shows that under a high-intensity composite green trade barrier scenario, China's exports to Europe decline by 9.45 %, while exports to third-party markets such as the US, UK, and Japan experience structural growth, indicating significant trade diversion effects in the global trading pattern [57]. However, the sustainability of this shift is questionable: if emerging markets like ASEAN gradually tighten their green standards in the future, Chinese export enterprises may face a new round of regulatory adaptation pressure, and the 'dividend from the shift' could quickly dissipate. In fact, some ASEAN countries have already begun formulating their own carbon footprint standards, and it is expected that a mandatory carbon labeling system will be fully implemented before 2030, by which time Chinese exporters may face pressure from green regulations on a global scale. Table 5 compares the share of China's major export markets in 2018 and 2025 and their changes, as shown in the following data:

Table 5-Comparison of China's major export market shares in 2018 and 2025
(%)[32;33;34;35;36;37;38;39]

Export market	2018 Proportion	Proportion in 2025	Change
European Union	16.4	14.8	-1.6
United States	19.2	11.1	-8.1
ASEAN	12.8	17.6	+4.8

Export market	2018 Proportion	Proportion in 2025	Change
Hong Kong, China	12.2	8.9	-3.3
Japan	5.9	4.2	-1.7
South Korea	4.4	3.8	-0.6
Russia	1.9	2.7	+0.8
India	3.1	3.6	+0.5
Brazil	1.3	1.9	+0.6

We also need to pay more attention to the evolution of green barriers. The 'EU Battery and Waste Battery Regulation' has for the first time introduced the 'battery passport' system—industrial batteries, light vehicle batteries, and electric vehicle batteries placed on the EU market after January 1, 2026, must have online accessible electronic records covering comprehensive data such as carbon footprint, material composition, recycling content, and supply chain information[55]. This innovation signifies that green barriers have evolved from single carbon accounting to full lifecycle transparency governance, representing typical characteristics of 'Green Regulation 2.0.' For Chinese export enterprises, compliance requirements have expanded from 'calculating carbon well' to 'managing data well.' The integrity, traceability, and transparency of data are becoming a new dimension alongside traditional price competitiveness. It can be expected that the future competition over green barriers will largely turn into a contest of data governance capabilities and supply chain transparency.

The impact of green barriers does not stop at the customs declaration stage. Taking steel exports as an example, when the cost of exports to Europe rises by about 4 %-6 % due to CBAM, enterprises either compress profits or reduce production the latter directly affecting jobs in regions such as Hebei and Liaoning. Furthermore, this pressure is transmitted upstream along the supply chain to the iron ore and coking industries. From a macro perspective, composite green barriers (such as the linkage of CBAM and CRMA) not only lead to bidirectional GDP losses for both China and the EU (under high-intensity scenarios, Chinese GDP decreases by 0.20 % and the EU by 0.43 %), but also drive the regional reorganization of global value chains [57]. While green barriers cause a contraction in the market share of some enterprises, they also provide an external driving force for the macroeconomic green transition by promoting green technological innovation and industrial upgrading. This section intends to examine the macro transmission effects of green barriers from the dimensions of net export contributions to GDP growth, changes in foreign direct investment flows, energy consumption, and carbon intensity. At the same time, since macroeconomic indicators are influenced by multiple intertwined factors, the following analysis aims to reveal possible lines of influence of green barriers rather than establish strict causal attribution.

Changes in the contribution of net exports to economic growth provide a window for observation. Between 2018 and 2025, the pull of net exports of goods and services on GDP growth fluctuated significantly (see Table 6). In 2018, the contribution rate of net exports to GDP growth was -8.6 %, and in 2019, the contribution rate was 11.0 %; between 2020 and 2025, the pull of net exports on GDP growth fluctuated between -0.6 and 1.7 percentage points. This fluctuation feature corresponds in some way to the phased strengthening of

global green trade regulations: when major trading partners intensively introduced green barrier measures, China's exports of high-carbon products were hindered, and the contribution of net exports to growth correspondingly weakened. Analysis based on dynamic general equilibrium found that the inhibitory effect of green barriers shows a three-stage dynamic characteristic over time: 'short-term rigidity, medium-term elasticity release, and long-term lock-in [57].' This means that the fluctuations in the contribution of net exports are not short-term disturbances but the temporal manifestation of the long-term impact of green barriers. In 2023, the pull of net exports was -0.6 percentage points. Although it cannot be entirely attributed to green barriers, the cumulative effect of these barriers is very likely to be one of the background factors suppressing export momentum. Table 6 shows the driving effect of the three major demands (final consumption, capital formation and net exports) on China's GDP growth from 2018 to 2025, as shown in the following data:

Table 6- The driving effect of the three major demands on GDP growth from 2018 to 2025[32;33;34;35;36;37;38;39]

Year	GDP Growth Rate (%)	Final consumption contribution (percentage points)	Capital formation pull (percentage points)	Net export contribution (percentage points)
2018	6.6	—	—	—
2019	6.1	—	—	— ¹
2020	2.3	-0.5	2.2	0.7

¹ The 2018–2019 bulletins did not publish sub-item contribution data in the form of 'percentage point pull,' only the contribution rates were published. In 2018, the contribution rate of final consumption was 76.2%, the contribution rate of capital formation was 32.4%, and the contribution rate of net exports was -8.6%; in 2019, the contribution rates of the three were 57.8%, 31.2%, and 11.0%, respectively.

Year	GDP Growth Rate (%)	Final consumption contribution (percentage points)	Capital formation pull (percentage points)	Net export contribution (percentage points)
2021	8.1	5.3	1.1	1.7
2022	3.0	1.0	1.5	0.5
2023	5.2	4.3	1.5	-0.6
2024	5.0	2.2	1.3	1.5
2025	5.0	2.6	0.8	1.6

The 2018–2019 bulletins did not publish sub-item contribution data in the form of 'percentage point pull,' only the contribution rates were published. In 2018, the contribution rate of final consumption was 76.2%, the contribution rate of capital formation was 32.4%, and the contribution rate of net exports was -8.6%; in 2019, the contribution rates of the three were 57.8%, 31.2%, and 11.0%, respectively.

The changes in the sectoral flow of foreign direct investment (FDI) also reflect the transmission effect of green barriers. Between 2018 and 2025, the proportion of actual foreign investment used in high-tech industries (including high-tech manufacturing and high-tech services) continued to rise (see Table 7). In 2018, the actual use of foreign investment in high-tech manufacturing was 89.8 billion yuan, an increase of 35.1 %; starting in 2019, the bulletins published full-caliber data for high-tech industries, with actual foreign investment reaching 266 billion yuan that year, accounting for 28.3 % of total FDI; by 2025, actual foreign investment in high-tech industries reached 241.8 billion yuan, accounting for 32.3 % of total FDI. The concentration of FDI in green, low-carbon, and high-tech areas is not only the result of domestic industrial policy guidance but also related to multinational companies adjusting global supply chain layouts to avoid green barriers — foreign-invested enterprises tend to locate production in regions with relatively complete environmental

regulations and green supply chain support to reduce the carbon footprint of their products and meet the green market access requirements of target markets. New regulations, through mechanisms such as carbon footprint limits and digital passports, are indirectly promoting the transfer of global supply chains to low-carbon regions [55], a trend that is already reflected in the flow of FDI in high-tech industries.

However, the data in Table 7shows some uncertainty. Between 2023 and 2025, both the actual use of foreign investment in high-tech industries and its proportion of total FDI declined — from 444.9 billion yuan (36.1 %) in 2022 to 241.8 billion yuan (32.3 %) in 2025. Whether this reversal is due to a weakening green barrier effect or other factors such as the overall contraction of global FDI and rising geopolitical risks cannot be determined at present. But at least this phenomenon reminds us that the guiding effect of green barriers on FDI is not linearly increasing and exists within a more complex global investment environment.Table 7 lists the actual utilization of foreign investment in high-tech industries from 2018 to 2025, as presented below.

Table 7-Actual utilization of foreign investment in high-tech industries from 2018 to 2025[32;33;34;35;36;37;38;39]

Year	Actual Use of Foreign Capital in High-Tech Industries/Manufacturing (100 Million Yuan)	Proportion of total FDI (%)	Growth rate (%)
2018	898(High-tech manufacturing only)	—	35.1
2019	2660(All-caliber High-Tech Industry)	28.3	25.6
2020	2963	29.6	11.4

Year	Actual Use of Foreign Capital in High-Tech Industries/Manufacturing (100 Million Yuan)	Proportion of total FDI (%)	Growth rate (%)
2021	3469	30.2	17.1
2022	4449	36.1	28.3
2023	4233	37.3	-4.9
2024	2864	34.7	-32.3
2025	2418	32.3	-15.6

From the perspective of the macro effects of green development, the external pressure of green barriers and the endogenous motivation of China's green transformation have formed a certain resonance, promoting the continuous decline of energy intensity and carbon emission intensity (see table 8). Between 2018 and 2025, the energy consumption per 10,000 yuan of GDP decreased at an average annual rate of about 2.5 %, and carbon dioxide emissions per 10,000 yuan of GDP decreased at an average annual rate of about 3.0 %. The proportion of clean energy consumption increased from 22.1 % in 2018 to 30.4 % in 2025, with a cumulative increase of 8.3 percentage points. The improvement of these indicators has created a positive feedback with the greening transformation of export products and the low-carbon transformation of the manufacturing industry: enterprises' investments in energy saving and emission reduction to overcome green barriers objectively reduce energy consumption and carbon emission intensity at the macro level; meanwhile, national green transformation policies provide institutional support and technological reserves for export enterprises to cope with green barriers. Relevant studies show that China's green production

level has continued to improve during the study period, and the coupling coordination between green production and green life has evolved from being on the verge of imbalance to achieving barely coordination, indicating that green transformation has become an endogenous trend in economic development [45].

Table 8 presents the changes in energy consumption per ten thousand yuan of GDP and the proportion of clean energy consumption from 2018 to 2025, as shown below.

Table 8- Changes in energy consumption per ten thousand yuan of GDP and the proportion of clean energy consumption from 2018 to 2025[32;33;34;35;36;37;38;39]

Year	Energy consumption per 10,000 yuan of GDP decrease rate (%)	CO2 Emission Reduction Rate per 10,000 Yuan of GDP (%)
2018	3.1	4.0
2019	2.6	4.1
2020	0.1	1.0
2021	2.7	3.8
2022	0.1	0.8
2023	—	— ²
2024	3.8 ³	3.4
2025	5.1	5.0

² The original text of the 2023 bulletin was 'The CO₂ emissions per 10,000 yuan of national GDP remained flat compared with the previous year.'

³ The 2024 and 2025 decline rates of energy consumption per 10,000 yuan of GDP are data calculated 'after deducting the energy used for raw materials and the consumption of non-fossil energy.'

It should be pointed out that the impact of green barriers on China's foreign trade has extended from the initial level of product compliance to macro areas such as trade structure, market layout, industrial investment, and energy consumption, exhibiting characteristics of multi-dimensional penetration and deep interconnection. This impact is not a simple linear accumulation, but presents a complex transmission path through policy linkage, industry heterogeneity, and dynamic adjustment. From the common situation of developing countries, green barriers are both a challenge temporarily increasing export costs, suppressing the growth of certain product exports, and intensifying the risk of trade friction-and an opportunity-forcing industrial green upgrading, optimizing the structure of export products, and promoting the clean transformation of the energy structure [43]. Represented by the European Union's new Battery Regulation, “Green Regulation 2.0” is upgrading the carbon footprint from a voluntary management tool to a mandatory market access threshold, and is extending regulatory reach from single carbon accounting to transparent governance of the full lifecycle data, signaling a qualitative change in the institutional form of green barriers[55]. Faced with this trend, the high-quality development of China's foreign trade is likely unavoidable along the core path of green transformation; compared with low-carbon transformation at the production end, building data capability including collection, verification, traceability, and international mutual recognition of supply chain data may become a more urgent and long-term challenge.

2.2 Analysis of the Impact of Green Trade Barriers on China's Major Export Industries

As a new type of non-tariff trade protection measure, green trade barriers are changing

the international competitive landscape of China's major export industries. As the world's largest exporter of goods, China's key export sectors, including agricultural products, textiles and apparel, light industrial products, and new energy products, are all being impacted to varying degrees by green trade barriers. Between 2018 and 2025, the total value of China's imports and exports of goods increased from 30.5 trillion yuan to 45.5 trillion yuan, with an average annual growth rate of about 5.8 %. At the same time, the number of notifications of technical trade measures received by major export industries is also increasing, making the restrictive effects of green barriers increasingly evident. Due to differences in the production characteristics, technological levels, market structures, and capacities to comply with environmental standards among industries, the ways in which green trade barriers operate, their impact levels, and industry responses also vary significantly. This section will systematically analyze the current impact, mechanisms, and response strategies of green trade barriers on China's major export industries from the perspectives of the agricultural and food industry, the textiles, apparel and light industry, and the new energy industry.

As a traditional agricultural country, agricultural exports are an important part of China's foreign trade, and the European Union, the United States, Japan and the core RCEP member countries are the most complete markets in the global green trade barrier system with the most stringent implementation standards. Compared with industrial products, the production process of agricultural products is highly dependent on the natural environment, which involves multiple environmental aspects such as pesticide residue control, soil ecological protection, water resource utilization, and biodiversity maintenance, which also makes it easier for importing countries to implement trade restrictions in the name of “food

safety”and “ecological protection”[9].

From the perspective of export scale, China's agricultural product output has maintained a steady growth trend, but the export value and output growth have not formed a synchronous match, and the crowding out effect of green barriers has gradually emerged. According to statistics, China's total aquatic product output will reach 71 million tons in 2023, a year-on-year increase of 3.4 %; in 2024, it will increase to 73.66 million tons, with a growth rate of 3.5 %; In 2025, it will further break through the 76 million tons mark, reaching 76.57 million tons, a year-on-year increase of 4.1 %. In terms of livestock and poultry products, the total output of pigs, cattle, sheep and poultry in 2023 was 96.41 million tons, a year-on-year increase of 4.5 %; In 2025, it will break through the 100 million ton mark for the first time, reaching 100.72 million tons. However, the continuous growth of production did not lead to a simultaneous increase in export value. Taking the RCEP region as an example, from 2002 to 2022, the number of SPS measures notified by other member states to the WTO soared from 128 to 648, an increase of 4.06 times, of which Japan experienced the most rapid growth, from 22 to 354, accounting for half of the total RCEP notifications. In contrast, from 2018 to 2022, the batches of China's agricultural products detained and compulsorily recalled by the customs of developed countries have always remained high, reaching 755 batches in 2022, accounting for 55.27% of the detained batches of all export products in China, which is 2.3 times that of mechanical and electrical products and 1.8 times that of chemical products [16]. In terms of the reasons for notification, in 2022, 62.55% of the SPS notifications were made on the grounds of “animal disease prevention and control” and 28.28 % were reported on the grounds of “food safety standards”, accounting for more than 90 % of the two types of reasons combined [54]. This

data clearly shows that the trade barriers faced by China's agricultural exports have shifted from traditional tariff barriers to more hidden technical restrictions with inspection and quarantine, residue limits, and environmental protection certification as the core.

Figure 3 illustrates the changes in the output of major agricultural products in China from 2018 to 2025, as shown below.

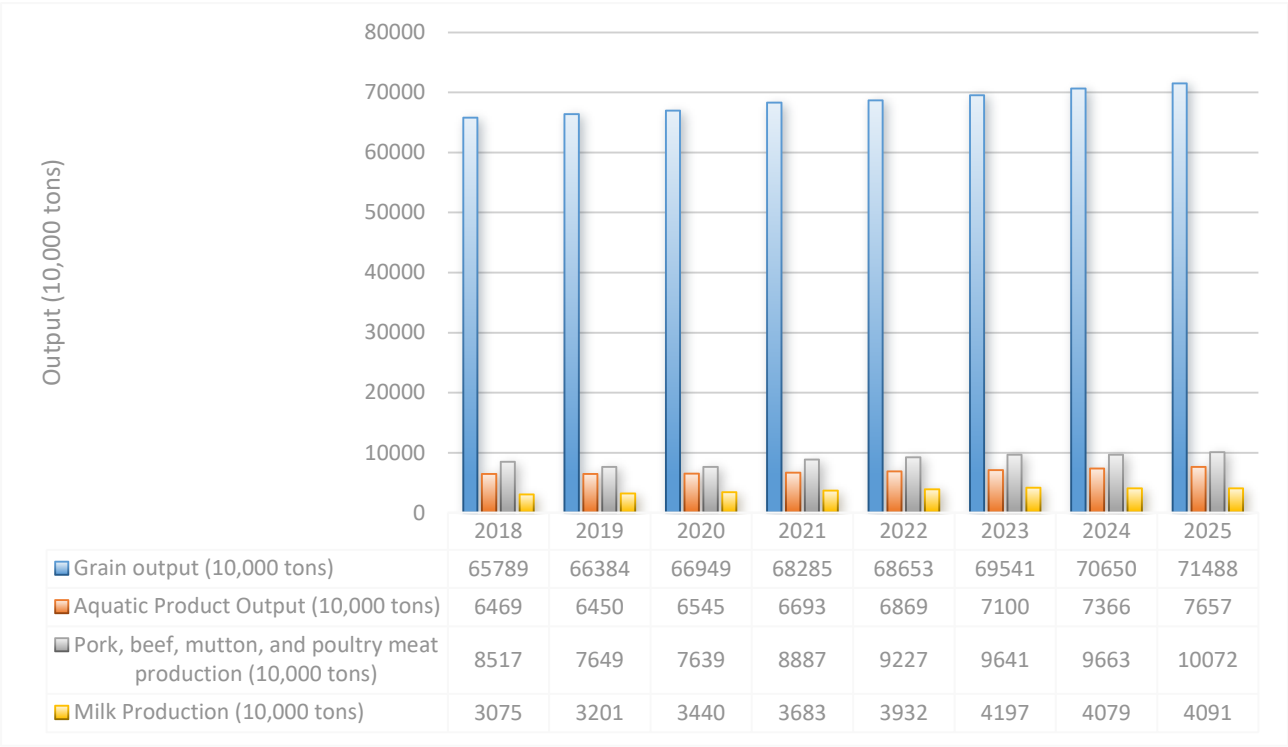


Figure 3-Changes in the output of major agricultural products in china from 2018 to 2025[32;33;34;35;36;37;38;39]

In terms of impact, green trade barriers have a dual effect on China's agricultural product exports. On one hand, the barriers do suppress the growth of export volumes. Empirical studies show that for every 1 % increase in SPS notifications from RCEP member

countries, China's agricultural exports to them decrease by approximately 0.026 %. The fixed-effects model regression results also show that the coefficient of the green trade barrier variable (LnDV) is -0.225 and is significant at the 1 % level, confirming the negative inhibitory effect of the barriers on total exports. This suppressive effect is mainly due to the increased compliance costs: in order to meet importing countries' requirements regarding pesticide residue limits, microbial indicators, environmentally friendly packaging, and so on, enterprises have to increase testing expenses, upgrade production processes, and apply for various certifications, all of which directly raise export costs and weaken the enterprises' price competitiveness [25;42].

On the other hand, green trade barriers also produce a positive forcing effect. Studies have found that the green trade barriers of RCEP member countries have a significant positive effect on the extensive margin (i.e., the diversity of export types) of China's agricultural product exports. For every additional unit of barrier, the extensive margin increases by about 0.04 units [54]. This finding also validates the applicability of the “Porter Hypothesis” in the agricultural sector: strict environmental regulations can stimulate technological innovation in enterprises and promote industrial upgrading. Specifically, in order to overcome these barriers, exporting enterprises increase investment in green planting technology research and development, introduce ecological farming models, and establish a full-process quality traceability system from field to table, thereby producing more high-value-added agricultural products that meet international environmental standards [25;42]. Structural effect theory also points out that the combination of trade liberalization and environmental requirements can guide resources from high-pollution, low-efficiency traditional agriculture to green, sustainable modern agriculture, achieving optimization and

upgrading of industrial structures.

One point that needs attention is that the impact of green trade barriers shows significant differences. From the perspective of national development levels, green trade barriers in developed countries have a clearer inhibitory effect on China's agricultural product exports, while their impact on developing countries is not significant. The main reason for this difference is that developed countries have higher technological levels, stricter environmental standards, and stronger enforcement capabilities, creating higher market entry thresholds. From the perspective of product categories, the extent and direction of the impact of barriers on animal, plant, and processed agricultural products also vary: SPS measures have a significant positive effect on the extensive margins of all three types of products, but have an inhibitory effect on the intensive margins of plant and processed products. This difference indicates that response strategies need to be formulated according to different countries and different products.

Overall, the agricultural and food industry has become the main battlefield for China in coping with green trade barriers. In the short term, these barriers have increased the cost pressures and market access difficulties for export enterprises; however, from a long-term development perspective, external pressure is being transformed into an endogenous driving force for industrial upgrading, promoting China's shift from a major agricultural product trading country to a trading power[25;42]. This transformation process requires coordination among the government, industry, and enterprises, and should be advanced through the improvement of early warning mechanisms, enhancement of quality standards, and deepening of international cooperation, in order to effectively address the challenges brought by green barriers.

The textile, apparel, and light industry sectors are among the pillar industries of China's foreign trade and are also areas that are severely impacted by green trade barriers. As the world's largest producer and exporter of textiles and apparel, China's textile industry holds an important position in the national economy. In 2023, the added value of the textile industry decreased by 0.6 % compared to the previous year, turned to a 5.1 % growth in 2024, and grew by 3.0 % in 2025. Retail sales of clothing, footwear, hats, and knitted and woven products grew by 12.9 % in 2023, only 0.3 % in 2024, and 3.2 % in 2025, showing significant fluctuations, reflecting the ongoing impact of green trade barriers on industry exports. In 2023, developed markets such as the European Union, the United States, and Japan accounted for a significant share of the total textile and apparel exports. However, with the increasing global emphasis on environmental protection and sustainable development, developed economies represented by the EU have continuously upgraded environmental regulations, Eco-label systems, and packaging waste management standards, forming systematic green trade barriers that pose considerable challenges to the export of Chinese textile, apparel, and light industry products. In 2023, developed markets such as the EU, the US, and Japan accounted for a considerable share of the total textile and apparel exports. In recent years, the international community has placed increasing importance on environmental protection and sustainable development. Developed economies represented by the EU have continuously upgraded environmental regulations, Eco-label systems, and packaging waste management standards, forming systematic green trade barriers that have brought significant challenges to the export of Chinese textile, apparel, and light industry products. Figure 4 shows the growth of China's textile and apparel retail from 2018 to 2025, as presented below.

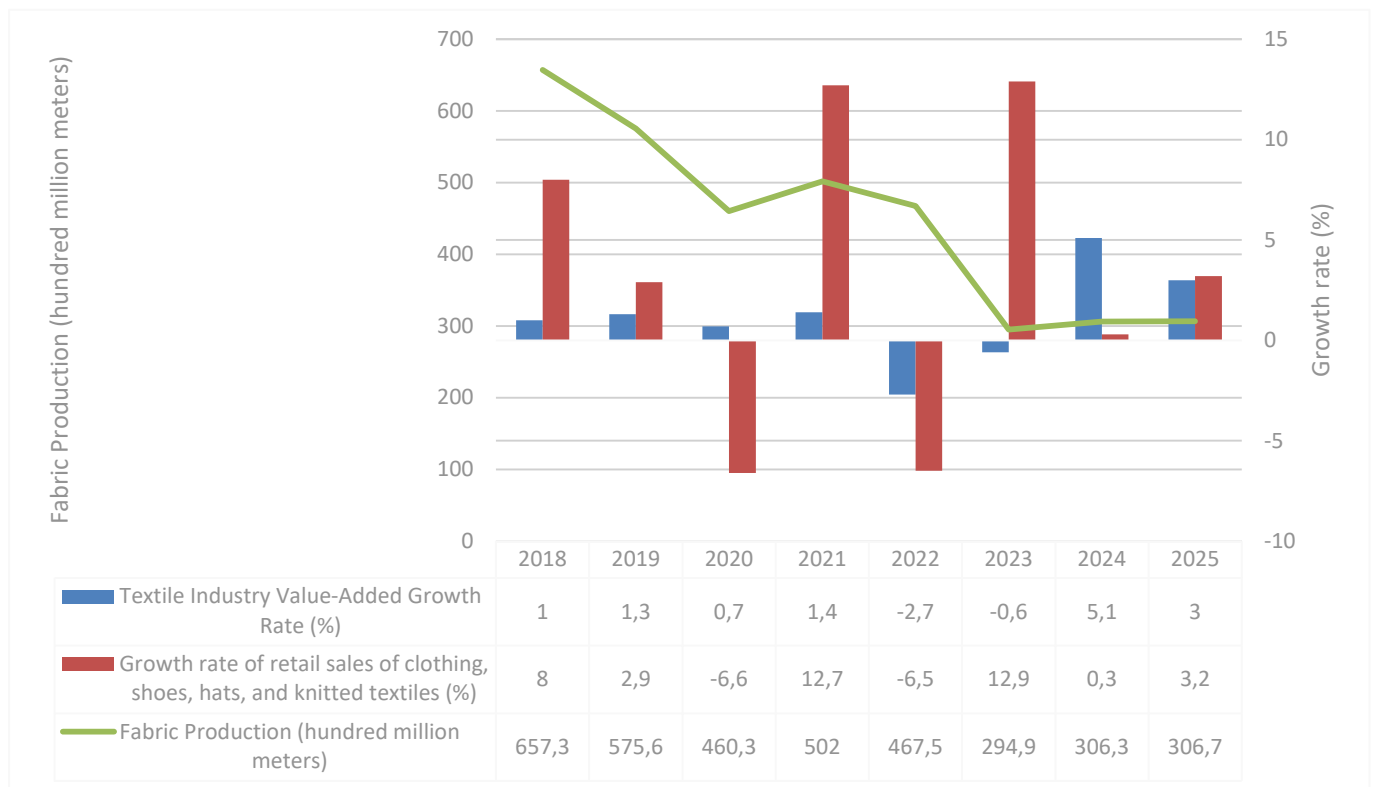


Figure 4- Growth of China's textile and apparel retail from 2018 to 2025[32;33;34;35;36;37;38;39]

At present, the green trade barriers faced by China's textile and apparel industry have shifted from single product standard restrictions to multi-level institutional constraints covering the entire industry chain. The EU REACH regulation implements unified management of registration, evaluation, authorization, and restriction for all chemicals and downstream products entering the EU market. As an important downstream industry of chemicals, textiles are directly and profoundly affected [15;24].The list of restricted chemical substances under this regulation continues to grow. Among the 12 high-concern

substances newly added in 2024, 7 are directly related to textile printing and dyeing auxiliaries, leading to nearly 30 % of domestic small and medium-sized dyeing enterprises having to suspend production for rectification[19]. At the same time, the EU Eco-label and the Oeko-Tex Standard 100 certification by the International Association for Research and Testing in the Field of Textile Ecology have become 'passes' to enter the EU market. The Eco-label covers all-dimensional indicators including textile fiber raw materials, production processes, chemical usage, and product applicability, with standards updated every 3-5 years, and its certification process is complex and costly. Oeko-Tex Standard 100 is revised annually based on the latest international regulations and scientific research results, with extremely strict limit requirements for formaldehyde, chlorophenols, harmful dyes, colorfastness, and other indicators in textiles. According to the 2025 survey data from the Guangdong Textile Association, only about 15 % of textile and apparel enterprises in the province have obtained Oeko-Tex Standard 100 certification, with large enterprises accounting for as much as 70 %, while the vast majority of small and medium-sized enterprises, restricted by funding and technical capabilities, have a certification pass rate of less than 5% [11].

The EU Packaging and Packaging Waste Regulation (PPWR), which will come into effect in 2025, further raises the export threshold for China's textile and apparel products. This regulation replaces the previous Directive 94/62/EC and imposes mandatory requirements on the sustainability of packaging materials, recyclable content, and limits on hazardous substances. For example, it stipulates that the total content of four heavy metals-lead, cadmium, mercury, and hexavalent chromium-in all packaging must not exceed 100 mg/kg, and the concentration of per- and polyfluoroalkyl substances (PFAS) in food-contact

packaging is strictly limited; it also requires that by 2030, the recyclable content in plastic packaging must reach between 10% and 35% [50]. These requirements directly increase the packaging compliance costs of Chinese export products, with estimates showing an average increase of 0.5 to 1 RMB per garment for packaging. Moreover, with the gradual implementation of the EU Carbon Border Adjustment Mechanism (CBAM) and the Ecodesign for Sustainable Products Regulation (ESPR), textile and apparel products will face new green barriers such as carbon intensity accounting and mandatory carbon labeling, requiring companies to provide environmental performance data for the product's entire lifecycle [24;30].

From the perspective of influence mechanism, green trade barriers have both short-term inhibition and long-term reversal effect on China's textile and garment exports. For now, barriers significantly inhibit export volume and market share. Empirical studies have shown that for every 1 % increase in the intensity of green trade barriers (measured by SPS/TBT circulars), Guangdong Province's textile and garment exports will decrease by about 0.325 % [11]. The impact of barriers set by developed countries is particularly significant, while that of developing countries is not, reflecting the advantages of developed countries in terms of technical standards and enforcement capabilities. From 2010 to 2020, China's textile exports only increased by 24.6 billion US dollars, and the growth rate slowed down significantly compared with the previous decade [19]. At the same time, the sharp rise in compliance costs has weakened the price competitiveness of products. In order to meet REACH regulations and obtain Eco-label or Oeko-Tex certification, enterprises need to invest a lot of money in the purchase of testing equipment, environmentally friendly material substitution, production process transformation and third-party certification, and the average

cost of each certification of small and medium-sized enterprises accounts for about 5 % to 10 % of their annual profits [11]. It is estimated that the loss of China's textile and garment industry due to non-compliance with EU green testing standards exceeds 18 % of the total exports [15].

From the perspective of long-term development, green trade barriers are forcing the industry to upgrade technology and optimize structure. Regression analysis showed that the coefficients of the first and second lag coefficients of green trade barriers were -0.210 and -0.016, respectively, and the inhibitory effect gradually weakened with time, indicating that enterprises could gradually adapt to the requirements of barriers through technical learning[11]. This effect is particularly evident in the textile printing and dyeing industry: the green barrier index is positively correlated with market concentration (correlation coefficient 0.38) and positively correlated with technological innovation investment (correlation coefficient 0.40), indicating that the improvement of environmental protection standards has prompted large enterprises to increase R&D investment and promote the innovation of cleaner production technology and alternative materials, thereby enhancing the green competitiveness of the industry to a certain extent. In addition, green trade barriers have also triggered significant industrial chain transmission effects [52;60]. By mastering the right to formulate standards for eco-labels, the EU has made downstream international brands the actual executors of compliance supervision, while upstream printing and dyeing auxiliaries and fabric suppliers bear the main cost of technological upgrading [24;52]. This change in the power structure of the value chain has accelerated the differentiation and integration of the textile and garment industry: leading enterprises have built a closed-loop green production system through vertical integration, while small and micro enterprises are

facing increasing market exit pressure [11;52].

From the perspective of industry differences, the impact of green trade barriers varies significantly across different product categories and enterprises of different scales. Among the three major product categories of apparel, home textiles, and functional textiles, functional textiles, with their high technological content and product added value, demonstrate stronger innovation capabilities and market adaptability during the green transformation process. In contrast, the apparel industry faces greater certification thresholds and cost pressures due to intense market competition and a high proportion of small and medium-sized enterprises (SMEs). In supporting industries such as dyeing auxiliaries, the negative impact of green trade barriers is even more pronounced. Studies show that for every 1 unit increase in the GTB index, the export volume of China's dyeing auxiliaries decreases by approximately 0.45 units. At the same time, large enterprises, with their financial and technological advantages, can more quickly obtain international green certifications and establish comprehensive green supply chain systems, while SMEs, due to limited resources, mostly can only respond passively and are at a clear disadvantage[18]. Overall, the green trade barriers faced by the textile, apparel, and light industry sectors have evolved from single product standard restrictions to multi-dimensional systemic constraints covering chemical management, Eco-labeling, packaging waste, carbon footprint, and more. These barriers increase the compliance costs and market entry difficulties for export enterprises in the short term, but in the long term, they also promote technological innovation and structural upgrades within the industry. To address this challenge, a coordinated effort by the government, industry associations, and enterprises is required: the government should accelerate the alignment of domestic environmental standards with

international ones and establish a green trade barrier early warning mechanism; industry associations should organize enterprises to carry out technological breakthroughs and certification guidance; and enterprises should increase investment in green technology R&D, actively apply for international eco-label certifications, and optimize their export market layout to reduce dependency risks on a single market.

The new energy industry is a core force driving the global green and low-carbon transition. China has established a relatively complete industrial chain and significant competitive advantages in areas such as new energy vehicles, power batteries, and photovoltaics. China's production of new energy vehicles grew from 1.15 million units in 2018 to 16.524 million units in 2025, with an average annual growth rate exceeding 50 %. In 2023, the production of new energy vehicles was 9.443 million units, an increase of 30.3 %; in 2024, production reached 13.168 million units, an increase of 38.7 %; and in 2025, production is projected to be 16.524 million units, an increase of 25.1 %. The production of solar cells (photovoltaic cells) is expected to grow from 340 million kilowatts in 2022 to 830 million kilowatts in 2025. Currently, the share of China's new energy vehicle production and sales in the global market has exceeded 60 % for consecutive years. However, as the international competitiveness of China's new energy products continues to improve, developed economies represented by the EU and the United States have begun to accelerate the establishment of new green trade barriers. Through measures such as anti-subsidy investigations, carbon footprint regulations, and carbon border adjustment mechanisms, they impose systematic restrictions on the export of China's new energy products.

Figures 5, 6, and 7 respectively depict the production of new energy vehicles, the production of solar cells, and the power generation installed capacity in China from 2018 to

2025, as shown below.

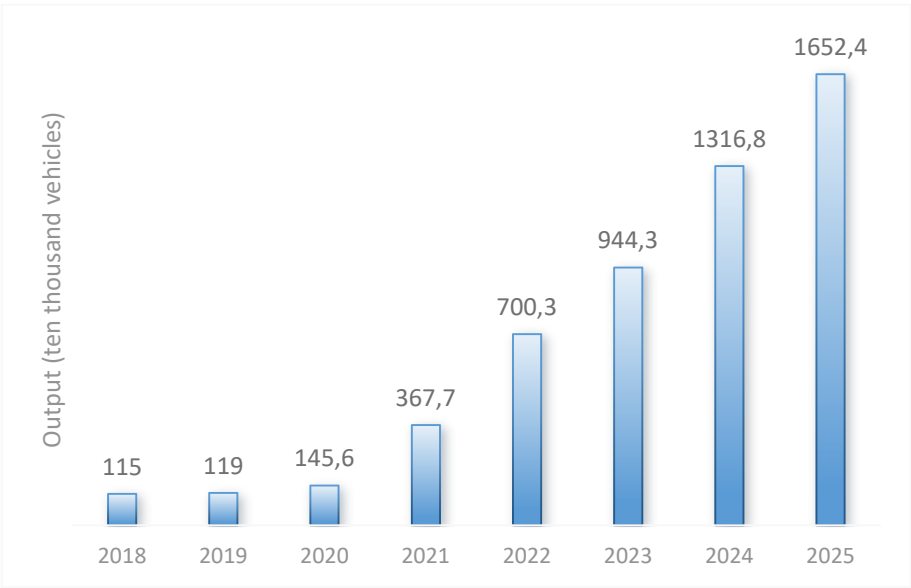


Figure 5-New energy vehicle production[32;33;34;35;36;37;38;39]

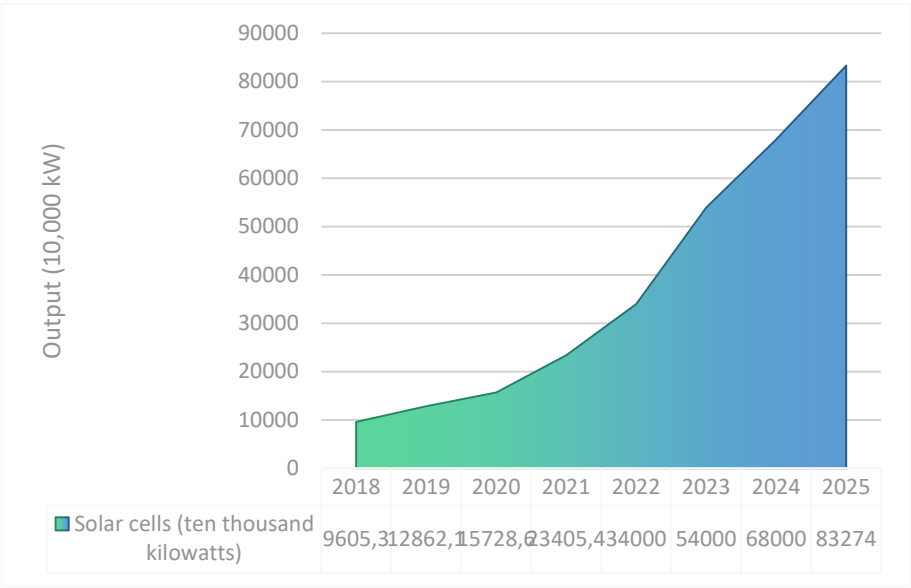


Figure 6-Solar cell production[32;33;34;35;36;37;38;39]

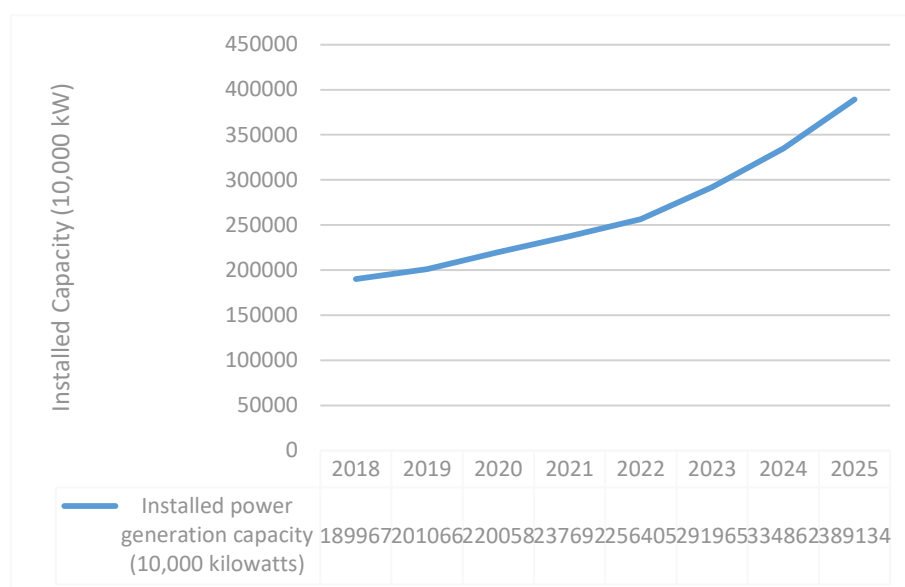


Figure 7-Power generation installed capacity[32;33;34;35;36;37;38;39]

Unlike the technical barriers in the agricultural and textile industries, the green barriers in the new energy sector carry more of a trade protectionist character. In October 2023, the European Commission officially launched an anti-subsidy investigation against China's pure electric vehicles based on the “Regulation on Foreign Subsidies that Distort the Internal Market of the EU”. In July 2024, the EU announced a four-month provisional anti-subsidy duty on electric vehicles imported from China, with BYD facing a rate of 17.4 %, Geely 20 %, SAIC up to 38.1%, and other manufacturers cooperating in the investigation but not sampled subject to a weighted average rate of 21% [20;46]. This measure directly increased the export cost of China's new energy vehicles significantly, severely weakening the price competitiveness of the products in the European market.

Meanwhile, the EU Carbon Border Adjustment Mechanism (CBAM) will be officially implemented on January 1, 2026, requiring imported products to pay corresponding carbon tariffs based on the carbon emissions in the production process. Currently, the first batch

covers six major categories: steel, aluminum, cement, fertilizer, electricity, and hydrogen, with plans to gradually expand to machinery, automobiles and auto parts, home appliances, and other sectors. CBAM uses the product's full lifecycle carbon emissions as the core accounting standard and will have a profound impact on all high-carbon-emission manufacturing industries, posing a serious challenge to the manufacturing sectors of developing countries that primarily use coal for their energy structure. In addition, the EU “Batteries and Waste Batteries Act” officially came into effect in August 2023, stipulating that from February 18, 2025, power batteries sold in the EU market must provide a complete carbon footprint declaration and a digital battery passport, imposing full-chain compliance requirements on the traceability of battery raw materials, carbon emission accounting, and recycling. The EU “Sustainable Product Ecodesign Regulation” (ESPR) has included tires in its first batch of controlled products, requiring the entire lifecycle of products from raw material procurement, manufacturing, and use to disposal and recycling to meet ecodesign standards. France has required that carbon emissions be included in the scoring system for photovoltaic project bids over 100 kW, and Italian power companies have introduced similar carbon emission scoring mechanisms in wind turbine product tenders [43]. These layered regulations form a full-lifecycle green trade barrier system covering traceable raw materials, low-carbon production, high product energy efficiency, and recyclable cycles.

From the perspective of impact mechanisms, green trade barriers have a significant inhibitory effect on the export of China's new energy products, and the effects are multidimensional and heterogeneous. Empirical research shows that the EU's green trade barriers have a significant negative impact on both the variety margin and quantity margin of China's new energy vehicle exports, while they have a positive promotion effect on the

price margin. Specifically, for each additional unit of EU green trade barriers, the variety of China's new energy vehicle exports decreases by about 0.12 units, the export quantity decreases by about 0.13 units, and export prices increase by about 0.06 units. This result confirms the quantity control mechanism and price control mechanism of green trade barriers: to meet the stringent green technology standards of importing countries, exporters need to increase R&D investment, improve production processes, and bear high testing and certification costs, leading to higher export costs, weakened price advantages, and some products being rejected for failing to meet standards. In terms of product heterogeneity, green trade barriers have a more significant inhibitory effect on the export quantity of pure electric vehicles, and a more pronounced inhibitory effect on the variety of hybrid electric vehicle exports. This may be related to the EU's policy subsidies favoring pure electric vehicles and the differences in market competition patterns faced by different types of products. In terms of country heterogeneity, the inhibitory effect on export quantity is more obvious in countries with larger EU economic scales, while countries that have announced plans to prohibit fuel vehicles have significantly restrained the variety of exports and promoted an increase in export prices [41].

In addition to directly affecting export costs and market access, green trade barriers also trigger deeper industrial chain transmission effects and data security risks. In the carbon emission accounting stage, in order to meet the EU's carbon footprint accounting requirements, enterprises must collect and disclose carbon emission data across the entire chain from raw material procurement, production and processing to transportation and sales. Due to the differences between China's carbon emission accounting boundaries and EU regulations, and the lack of a localized product carbon footprint database, most enterprises

can only rely on the EU database for accounting. The EU database assigns carbon emission factors for China's power grid (e.g., 1,155 grams per kilowatt-hour) which are much higher than the actual level in China (approximately 570 grams nationwide on average in 2022), leading to a systematic overestimation of product carbon emissions. At the data security level, enterprises are forced to disclose carbon emission information of the entire product production process, which may involve trade secrets such as production processes and supply chain layout, increasing the risk of technology leakage [43]. At the industrial chain level, the EU's Net Zero Industrial Act explicitly proposes promoting the localization of net-zero technology manufacturing to reduce dependence on imported products in fields such as solar photovoltaic, batteries, and wind power; the U.S. Inflation Reduction Act supports the development of the entire clean energy industrial chain through massive subsidies, aiming to reshape the competitive advantage of domestic industries. The cumulative effect of these policies may cause Chinese new energy enterprises to face the risk of forced industrial chain relocation, eroding their long-term competitiveness [46].

From a practical perspective, China's leading new energy companies have already begun actively exploring localized overseas layouts to avoid green trade barriers. BYD was the first to establish its full-process new energy vehicle production base overseas in Thailand. By using the CKD full-kit assembly model, it avoided about 30% of local vehicle import tariffs, and within just one year of production, it captured over 40 % of Thailand's electric vehicle market, becoming a typical case of using localized production to circumvent green barriers. Geely, on the other hand, leverages Volvo's existing production bases in Belgium and Sweden, adopting a 'China R&D + European manufacturing' model, effectively avoiding EU anti-subsidy taxes [20]. In terms of carbon footprint accounting,

some leading companies have started to establish carbon management systems and raw material traceability systems covering the entire supply chain. For example, Guangken Rubber has achieved 100 % traceability of natural rubber, enabling it to provide downstream companies with products that comply with the EU's Zero Deforestation law requirements[56]. Data shows that by 2025, China's new energy vehicle stock will reach 43.97 million, an increase of 12.57 million over the previous year-end, and the expansion of the domestic market also provides companies with a buffer. However, for many small and medium-sized enterprises developing new energy solutions, due to limited financial strength and insufficient technical reserves, it is difficult to bear the large investments required for compliance certification, technological transformation, and supply chain restructuring, facing the risk of being forced to exit the EU market [56].

Figure 8 Changes in the Share of Clean Energy Consumption and CO₂ Emission Intensity in China from 2018 to 2025

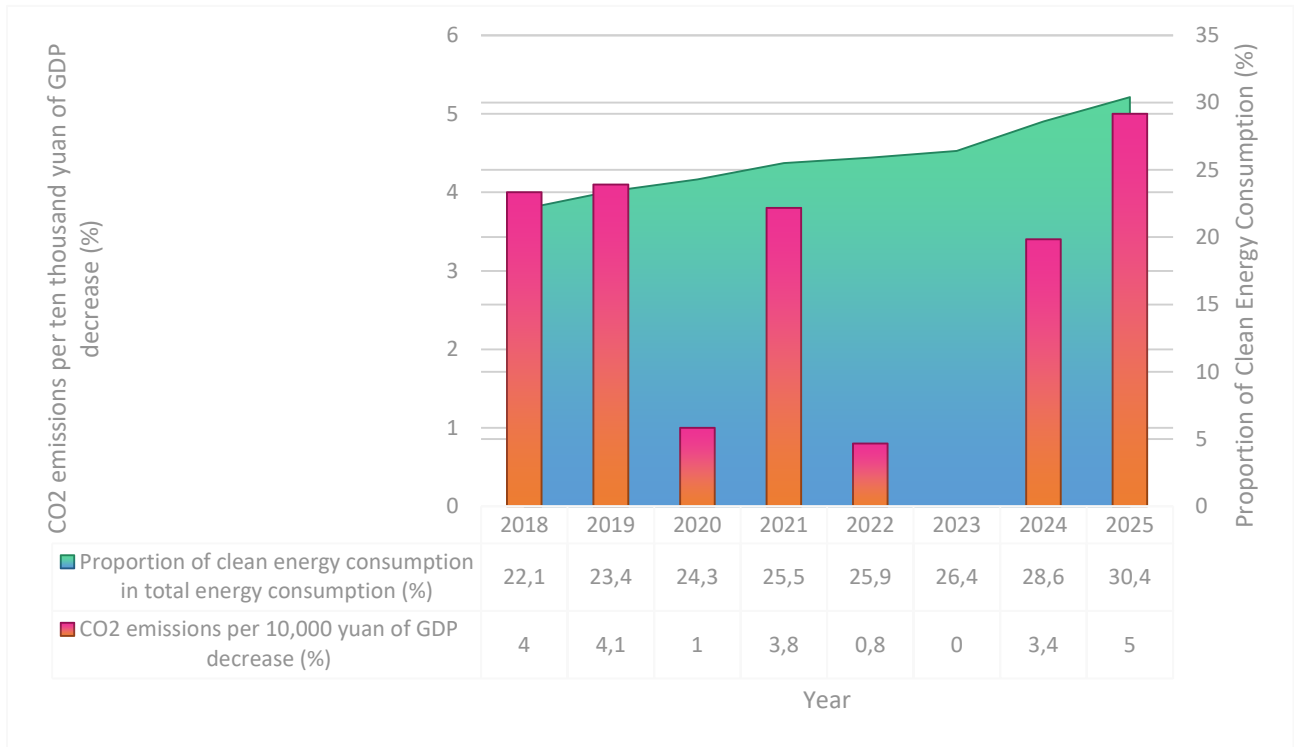


Figure 8-Changes in the share of clean energy consumption and carbon[32;33;34;35;36;37;38;39]

Therefore, the new energy industry has become one of the sectors in China most affected by new green trade barriers. Green barriers, represented by the EU Carbon Border Adjustment Mechanism, the Battery Act, and anti-subsidy investigations, are evolving from single end-product standard restrictions to a full life-cycle closed-loop control system covering raw material traceability, production carbon emissions, product energy efficiency, and recycling. In the short term, these barriers significantly increase compliance costs and market entry difficulties for exporting companies. In the long term, however, they drive technological upgrades and industrial chain restructuring, promoting the industry's transformation towards greenness and low carbon. The proportion of China's clean energy consumption in total energy consumption has increased from 22.1 % in 2018 to 30.4 % in 2025, and this green transition process provides intrinsic support for the new energy industry to respond to external barriers.

2.3 Core Challenges and Transformation Dilemmas of China's Foreign Trade in Responding to Green Barriers

The evolution of green trade barriers is much faster than many people anticipated. It is no longer simply an environmental label on products, but a network of rules covering the entire industrial chain and spanning the entire life cycle. For China's foreign trade, this is both a pressure test and a threshold that must be crossed.

Some leading export enterprises have indeed completed technological upgrades and

market adjustments under pressure, but if we widen the perspective to the whole industry, a less optimistic reality emerges: China's overall ability in foreign trade to cope with green barriers has several deep-seated structural contradictions. These contradictions are mainly concentrated in three aspects insufficient basic information capabilities, poor alignment of institutional systems, and a lack of motivation for industrial transformation. These three are not isolated; they are intertwined and reinforce each other, directly slowing down the cultivation of China's green competitiveness in foreign trade.

Figure 9 depicts the core structural contradictions and their interrelationships in China's foreign trade response to green barriers, as shown below:

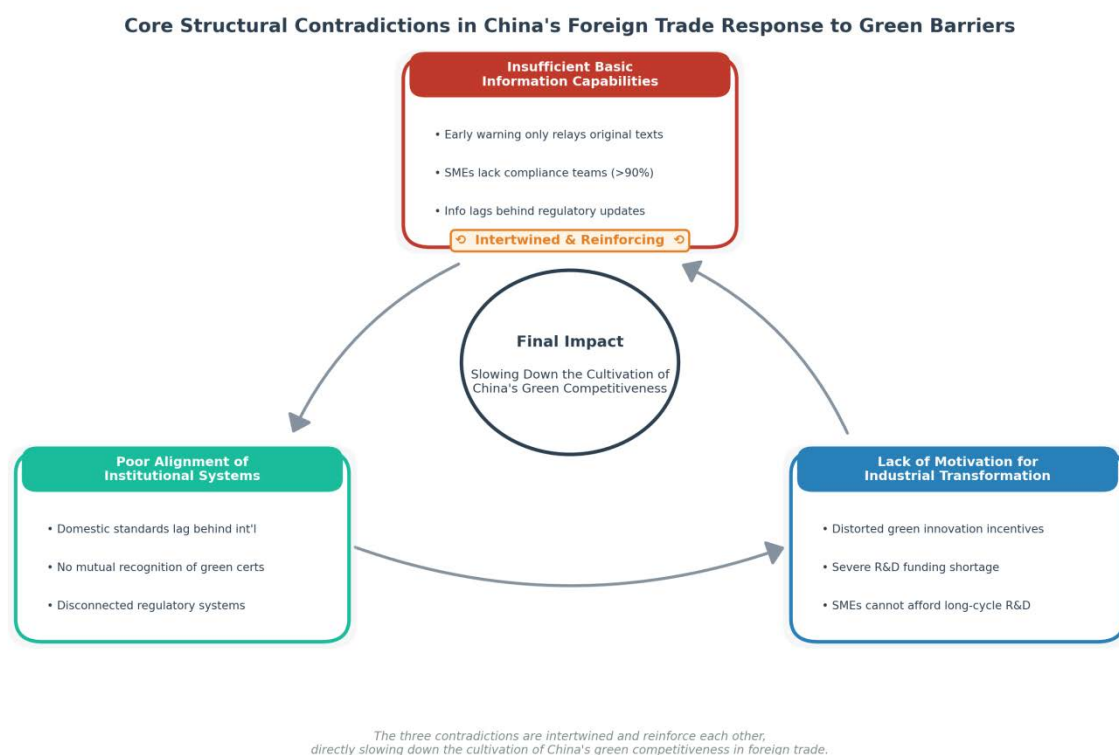


Figure 9-The core structural contradictions in China's foreign trade response to green barriers [14;47;49]

The core challenge of responding to green trade barriers stems from their inherent dynamism, technical complexity, and concealed nature. Unlike traditional tariff barriers, which operate with transparent, fixed pricing structures, the rules governing green barriers frequently change outside the regular visibility of exporting enterprises. Developed economies in Europe and the United States hold dominant control over the rule-making process: revisions to environmental regulations, updates to technical standards, and adjustments to certification processes are largely driven by domestic industry interest groups, resulting in severe gaps in information disclosure for developing countries [47]. This structural information imbalance frequently leaves Chinese export enterprises in a reactive, passive position of 'addressing losses after they have already occurred'. China does have formal early warning mechanisms in place. In fact, a national early warning framework covering green trade barriers from major trading partners has already been established, yet there remains a significant gap between its real-world operational effectiveness and the practical needs of exporting enterprises. The majority of existing early warning information stops at the level of 'translating and relaying' the original regulatory text, with little to no supplementary analysis of the policy background, detailed interpretation of technical parameters, assessment of the expected industry impact, and most critically step-by-step guidance on practical compliance operations [27]. When enterprises are confronted with a large volume of fragmented regulatory documents, it is extremely difficult for them to quickly identify content relevant to their specific business operations, let alone proactively identify and mitigate potential risks in advance. This challenge is exponentially amplified for small and medium-sized enterprises (SMEs). More than 90 % of China's foreign trade

entities are SMEs, the vast majority of which do not have dedicated in-house compliance departments, cannot afford to hire full-time specialized compliance personnel, and lack the financial resources to build independent international standards tracking systems. For these firms, information about regulatory changes comes almost exclusively from notifications from downstream buyers, or word-of-mouth updates from industry peers. In most cases, enterprises only learn that standards in their target market have changed after their products have been detained by customs, returned to the shipper, or even destroyed, by which point the financial losses have already been incurred [14].

Agricultural product exports are a major victim of information asymmetry. The data from the EU Rapid Alert System for Food and Feed (RASFF) speaks for itself: the number of Chinese agricultural product exports reported for excessive pesticide residues has consistently ranked among the top. In 2020, just in the category of tea, there were 8 batches rejected entry into the EU due to pesticide residue issues. In November 2023, Germany repeatedly reported that Chinese-exported black tea and green tea contained excessive residues of multiple pesticides such as imidacloprid and cyflumetofen, and all involved products were officially detained. By February 2024, the Netherlands reported that Chinese-exported pomelos contained residues of chlorpyrifos, propiconazole, and thiacloprid exceeding the EU limit of 0.01 mg/kg, requiring all recipients to immediately remove them from shelves and recall them. In October 2025, Denmark issued the highest-level 'alert notification' for Chinese-exported dried jasmine flowers, detecting excessive residues of 12 pesticides including lambda-cyhalothrin, bifenthrin, and chlorpyrifos, determining that there was a 'potential serious food safety risk'.

These repeatedly issued notifications are not only rooted in the strict European Union

standards—for example, for tebuconazole, the EU has set its maximum residue limit in tea as low as 0.01 mg/kg, while tea gardens in our country are mainly operated by small farmers in a dispersed manner, making unified control over pesticide use extremely difficult—but also in the serious delays in information transmission. Most export companies know almost nothing about the EU's latest revisions to pesticide residue standards before their products are seized.

The dilemma of the REACH regulation is similarly typical. This system is extremely complex. As of 2024, the List of Substances of Very High Concern (SVHC) has been updated to over 200 substances and continues to expand each year [51]. For a small or medium-sized textile company to confirm whether a certain dye meets the latest requirements, it often needs to spend tens of thousands of yuan hiring a third-party agency for testing and evaluation. This “information acquisition cost” has already become an invisible barrier for many small and medium-sized enterprises to enter the EU market. The consequences of information asymmetry are twofold: on one hand, it leads to huge trade losses; on the other hand, Chinese enterprises are in a long-term disadvantaged position of “passive following” in the international green rules competition.

If information asymmetry creates the obstacle of 'seeing the requirement but being unable to meet it', then the lack of coordination and equivalence at the institutional level forms a far deeper, structural bottleneck for Chinese exporters.

The first core issue is the clear gap between domestic and international green standards. The development of China's domestic green standard system has clearly lagged behind the advanced international level, creating a significant 'standard gap' with China's major trading partners. While China has accelerated the formulation and revision of green standards in

recent years, there remains a substantial gap in coverage scope, update frequency, and overall stringency when compared to developed economies including the European Union, the United States, and Japan [47].

The textile industry provides a clear example. Since the current “Technical Requirements for Ecological Textiles” (GB/T 18885-2009) in China was issued in 2009, it has not been comprehensively revised for 16 years. In contrast, the international mainstream Oeko-Tex Standard 100 for ecological textiles updates its list of restricted substances and limit values almost every year, and the EU REACH regulation's list of substances of very high concern is updated 2-3 times per year [49;55]. This creates an awkward situation: an ecological textile that fully complies with Chinese national standards may still be rejected when exported to the EU due to containing chemical substances newly restricted by the EU. The gap in standards is turning into a real export barrier. In 2024, Sweden reported that the DINP (Di(2-ethylhexyl) phthalate, DEHP) content in beach bags exported from China reached 13 %, far exceeding the 0.1 % limit set by REACH regulations, and required e-commerce platforms to immediately remove them from sales lists. In the same year, Hungary reported that plastic dolls exported from China tested positive for excessive amounts of both DEHP and dibutyl phthalate (DBP), classifying them as non-compliant products. Cyprus, Finland, and other countries have also repeatedly reported Chinese exports of toys, rain boots, stationery, and other products exceeding plasticizer limits in violation of REACH regulations. The disconnection between domestic standards and international regulations has become an important factor restricting the export of China's light industry products.

The gap in standards in the field of agricultural products is also prominent. China's

national standards for pesticide residues, heavy metal limits, and microbial indicators have not yet fully aligned with the standards of the Codex Alimentarius Commission (CAC) as well as major markets such as the EU and Japan [29]. In 2024, the EU revised the 'Maximum Residue Levels of Pesticides in Food', adding residue limits for multiple pesticides including flumetralin, setting the limit at 0.01 mg/kg, which is not yet covered by China's current standards. Japan's 'positive list system' increased the number of pesticide residue testing items to 799, and in 2024 added 37 new testing standards. In 2025, the EU further included tea in the official temporary intensified monitoring program, significantly increasing the random inspection rate of Chinese exported tea from the original 5 % to 20 %, which will undoubtedly further increase the compliance risk of China's tea exports.

Figure 10 presents the changes in the EU's sampling inspection ratio for China's tea exports, as shown in the following data:

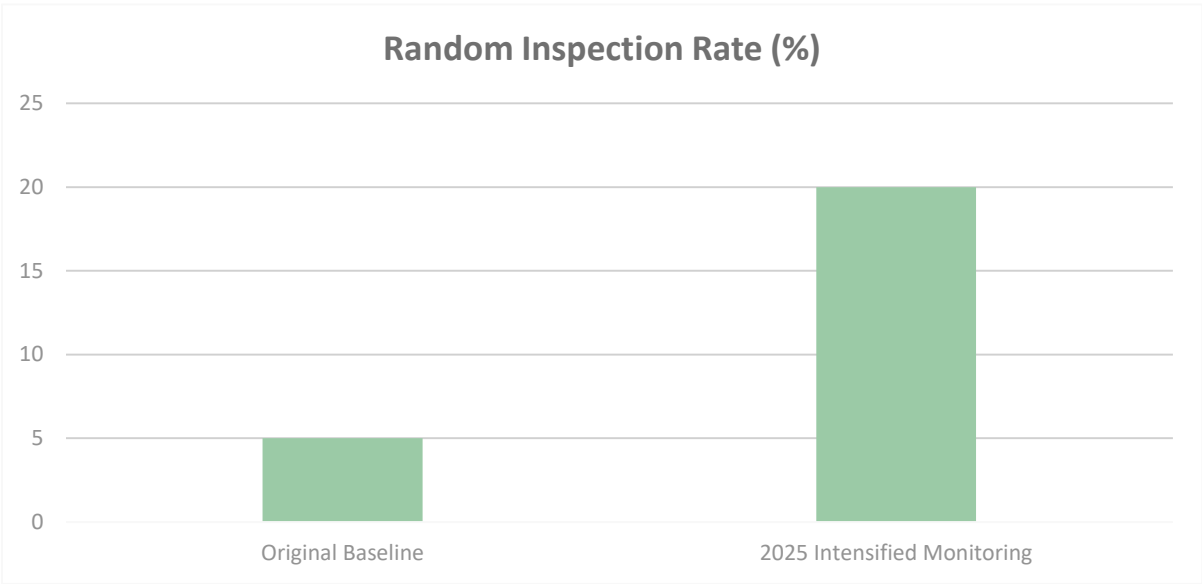


Figure 10-Changes in the EU's sampling inspection ratio for China's tea exports[29;55]

An even more pressing challenge than the standard gap itself is the absence of a broad international mutual recognition mechanism for green certification. China's domestic environmental label certification (the 'China Environmental Label'), carbon footprint accounting methodologies, and green product certification systems have not yet established wide-ranging bilateral or multilateral mutual recognition arrangements with mainstream international certification frameworks, including the EU Ecolabel ('EU Flower'), the US UL Environmental Declaration, and Japan's Eco Mark. This means that green certifications obtained by enterprises within China are largely unrecognized in international markets, forcing firms to undergo repeated testing and certification for each export market, and incurring massive institutional transaction costs in the process [55].

The EU Deforestation Regulation (EUDR), which officially came into effect in June 2023, has elevated this issue to a new level. The regulation stipulates that all 14 major commodities and their derivatives placed on the EU market, including natural rubber, wood, coffee, and cocoa, must prove that the raw materials come from land that has not been deforested or degraded after December 31, 2020, and that the sources are legal. For rubber tires, an important category of China's exports to the EU, the EUDR requires companies to establish a full-chain traceability system from upstream rubber plantations to end products, capable of providing precise geographic coordinate data to six decimal places for each batch of rubber, and to complete comprehensive deforestation due diligence [56].

However, the reality of China's natural rubber supply chain is that it is mainly composed of small and medium-sized rubber farmers and small processing factories. Most suppliers have not yet established standardized origin information recording systems and are unable to provide deforestation due diligence statements that meet EU requirements. The EUDR will

be mandatory for large companies from December 30, 2025, and will cover all small and medium-sized enterprises from June 30, 2026 [56]. At that time, a large number of small and medium-sized tire companies unable to meet traceability requirements may be forced to exit the EU market. This 'each-for-itself' certification pattern essentially amplifies the trade-restrictive effect of green barriers, placing Chinese companies in an unfair position in international competition [29].

The fundamental, long-term solution to addressing green trade barriers lies in advancing green technological innovation and value chain upgrading across export-oriented industries. For China's foreign trade sector, however, this transformation path has faced significant structural obstacles.

The first core structural contradiction is the distorted incentive mechanism for green innovation. In theory, green barriers, by raising market entry thresholds, can create a 'forcing effect' that pushes enterprises to increase investment in green technology research and development. For this forcing effect to deliver meaningful results, however, enterprises must first have strong existing technological accumulation and resource integration capabilities. For the vast majority of Chinese manufacturing firms positioned in the middle and lower ends of the global value chain, green transformation requires extremely high upfront investment, while the financial returns are long-term and highly uncertain. As a result, these enterprises generally lack the intrinsic motivation to pursue disruptive, long-term green technology innovation, and instead overwhelmingly opt for lower-cost, faster-return approaches such as basic 'end-of-pipe pollution management' or minimum-required compliance improvements [57].

The implementation of the European Union's Carbon Border Adjustment Mechanism

(CBAM) fully exposes this contradiction. CBAM will officially enter the substantial levy phase on January 1, 2026, initially covering six high energy-consuming sectors: steel, aluminum, cement, fertilizers, electricity, and hydrogen. According to estimates from authoritative institutions, after the full implementation of CBAM, China's steel and aluminum industries will need to pay 3.2 to 3.5 billion RMB in carbon tariffs to the EU annually. By 2034, when the EU carbon market's free allowances are entirely phased out, the CBAM cost per ton of steel exported from China to the EU will increase by 140 to 160 euros, which will significantly erode corporate profit margins. Some high-emission enterprises may even face a situation where 'exporting results in losses.'

Even more disadvantageous is that if companies cannot submit EU-recognized measured carbon emission data, they must use the 'default emission values' set by the EU to calculate carbon tariffs. These default values are usually significantly higher than the actual emission levels of Chinese products, potentially directly increasing companies' tariff costs by 30 % to 50 %. The EU also stipulates that in 2026, companies using default values will face an additional 10 % punitive tariff, rising to 20 % in 2027 and further to 30 % in 2028, which will undoubtedly further increase corporate compliance costs[53]. Figure 11 shows the trend of additional punitive tariff changes under the CBAM default value mechanism from 2026 to 2028, as shown in the following data:

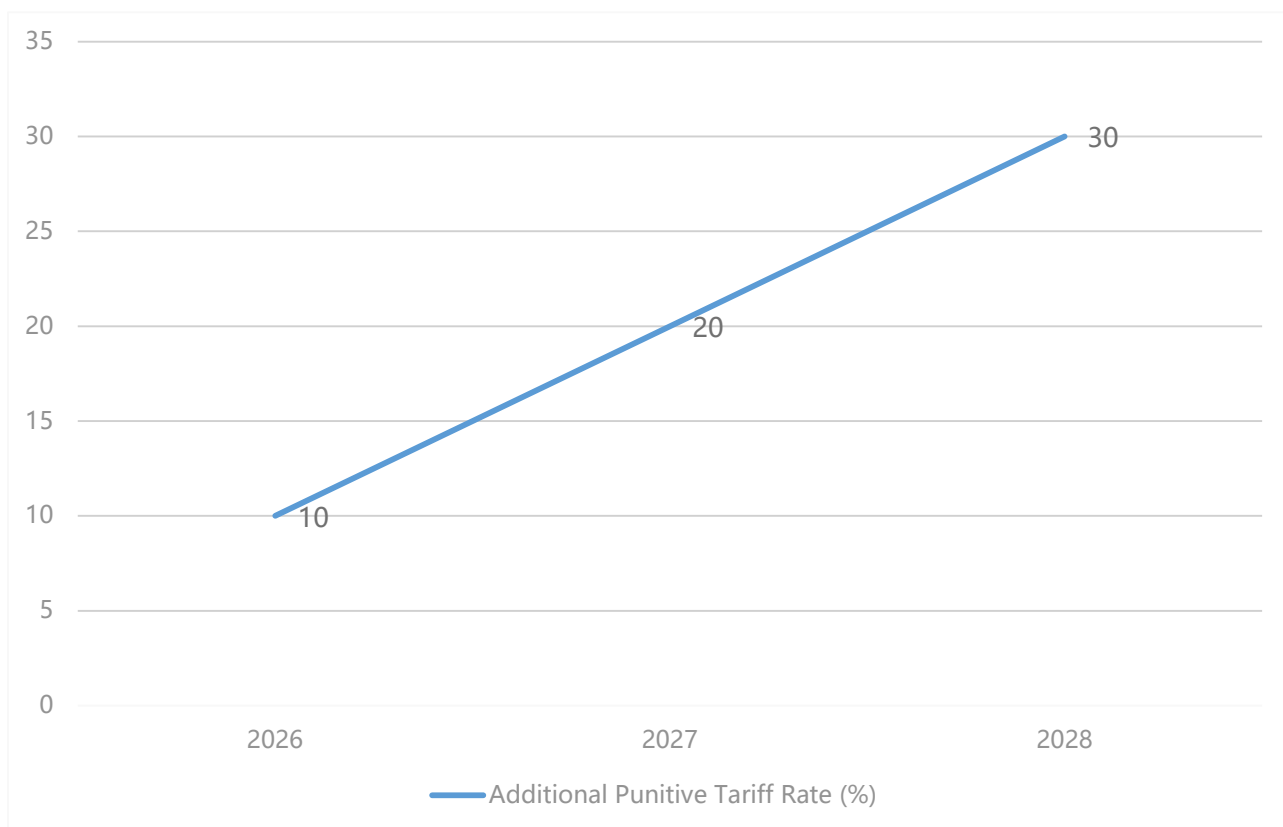


Figure 11 — Trend of additional tariff changes under the CBAM default value mechanism [31;57;53]

Faced with such immense pressure, a few large steel companies such as Baosteel and Hebei Steel have already started investing heavily in the research and development of cutting-edge low-carbon technologies like hydrogen-based smelting. However, for the numerous small and medium-sized steel enterprises, R&D investments that run into hundreds of millions of yuan and a technology verification cycle of 5-10 years are simply unaffordable. Therefore, these companies are more inclined to adopt short-term measures such as purchasing carbon allowances, optimizing existing production processes, and adjusting product structures to cope with the CBAM, rather than carrying out fundamental

technological innovations. According to the latest export data, in the first quarter of 2026, China's steel exports fell by nearly 10 % year-on-year, with exports to the European Union declining particularly significantly. This is closely related to the disputes over carbon emission accounting during the implementation of the CBAM. The EU's calculation method ignores the differences in energy structures among countries, which is extremely unfavorable to China's steel industry, which primarily relies on coal.

This phenomenon confirms a concern in academia: the green barrier may create a 'trap effect'—enterprises, in order to quickly gain market access, invest a large amount of capital into technological upgrades that meet the minimum compliance requirements, thereby crowding out resources for fundamental green technology innovation, ultimately falling into a vicious cycle of 'increasing compliance investment, but core technology always lagging behind.'

The second rigid constraint is the dual shortfall of dedicated funding and R&D investment. When compared to leading international multinational firms, the vast majority of Chinese export enterprises have significantly lower R&D intensity, with extremely limited financial resources available to invest in green process upgrades, clean production technologies, and low-carbon technology development. Data shows that in 2020, the proportion of green technology R&D expenditure of environmental protection companies in developed countries to their operating income was 14.58 %-19.57 %, while in my country it was only 2.98 %, a gap of more than 5 times [21]. This gap is even more stark among small and medium-sized enterprises, which routinely face significant financing difficulties and elevated borrowing costs. Ongoing survival pressure makes it nearly impossible for these firms to allocate their limited resources to green technology projects that come with

long development cycles and high operational risks.

Under the compliance pressure of the EUDR, China's rubber tire industry also faces dual constraints of funds and technology. Establishing a digital traceability system covering the entire supply chain requires substantial investment in hardware purchase, software development, and personnel training. A few leading enterprises, such as Guangken Rubber Taihua, have made early arrangements and had established a full traceability information loop from raw material procurement to finished product delivery by 2024, successfully passing the relevant EUDR certifications [56]. However, for a large number of small and medium-sized tire companies, this investment far exceeds their capacity. As the mandatory implementation deadline of December 2025 approaches, they will either be forced to withdraw from the EU market or depend on large enterprises as contract manufacturers. Additionally, in order to quickly meet compliance requirements, some enterprises choose to directly purchase mature foreign green technologies and equipment, which plunges China into a passive cycle of 'technology introduction — lagging behind — reintroduction,' severely suppressing the cultivation of independent innovation capabilities.

The structural contradiction between insufficient incentives for green innovation and the lack of funds and R&D capabilities intertwines and reinforces each other, making it arduous for China's foreign trade industry to overcome green barriers and achieve a truly meaningful green transformation and upgrading.

Chapter3. Strategies for Addressing Green Barriers to China's Foreign Trade

The global green trade rules system is currently undergoing a critical phase of profound

restructuring. New green trade barriers, exemplified by the EU's Carbon Border Adjustment Mechanism (CBAM) and the Corporate Sustainability Due Diligence Directive (CSDDD), have evolved from traditional, single-product end-of-life environmental standards into a systemic regulatory framework spanning the entire industrial chain and covering the entire product lifecycle. In January 2026, the CBAM officially entered the substantive collection phase, initially covering six energy-intensive industries including steel, aluminum, and cement. It is estimated that related Chinese enterprises will incur over €10 billion in additional compliance costs annually. Simultaneously, a series of new EU regulations, such as the Battery and Waste Battery Regulation and the Packaging and Packaging Waste Regulation, are being implemented intensively, creating a cumulative impact on my country's traditional advantageous export industries, such as new energy, textiles, and agricultural products. Faced with this severe situation, simply relying on passive corporate compliance is insufficient to address the systemic challenges. There is an urgent need to construct a comprehensive response framework integrating top-level government design, industry collaborative governance, and proactive corporate transformation to promote a strategic shift in my country's foreign trade development model from “passively adapting to international rules” to “actively participating in rule-making.”

3.1 Government Level:

As the maker of macroeconomic policies and the core player in international trade negotiations, the government's core function is to compensate for market failures and provide enterprises with a stable and predictable institutional environment and fair international competition conditions to cope with green barriers. In key areas such as

aligning standards systems, providing early warning services, and participating in international rules, the government needs to play a leading role.

My country's current green standards system still suffers from shortcomings such as incomplete coverage, slow updates, and relatively low indicator requirements, resulting in a significant “standard gap” compared to the standards systems of major trading partners like the EU and the US [47]. Taking the textile industry as an example, my country's current “Technical Requirements for Eco-textiles” (GB/T 18885-2009) has not undergone systematic revision since its promulgation in 2009, while the EU's REACH regulation's list of Substances of Very High Concern has expanded to over 200 substances, with new restricted substances added 2-3 times annually [55]. In the agricultural sector, the EU added residue limits for 37 pesticides, including flumetoquine, in 2024, uniformly setting a stringent standard of 0.01 mg/kg, while current Chinese standards do not yet cover these substances [47]. This standard gap directly leads to a large number of products that meet domestic standards being detained or returned by customs upon export.

To address the aforementioned issues, government departments should establish a dynamic updating mechanism for green standards, prioritizing the formulation and revision of standards in key areas such as carbon footprint accounting, chemical risk management, and supply chain sustainability. In the field of carbon footprint accounting, based on the characteristics of my country's energy structure and the realities of industrial development, a unified national standard for product lifecycle carbon footprint accounting should be formulated to correct the unreasonable overestimation of carbon emission factors in my country's power grid by relevant EU databases (the EU assigns a value of 1155 grams per kilowatt-hour, while my country's actual value in 2022 was approximately 570 grams). In

the field of chemical management, drawing on the advanced experience of the EU REACH regulation, my country should establish its own list of substances of very high concern and a risk assessment system [55]. In the field of supply chain management, a green standard system covering the entire chain from raw material extraction, production and processing to recycling should be developed. Simultaneously, the integration of a carbon tax system into the environmental protection tax system should be explored, establishing an independent carbon emission tax item and constructing a domestic carbon pricing system aligned with international carbon pricing mechanisms to prevent the outflow of tax revenue generated from domestic emission reduction investments [4].

Information asymmetry is one of the core pain points faced by Chinese export enterprises in dealing with green barriers. Currently, my country's WTO/TBT-SPS notification platform mainly provides translation services of the original regulations, lacking in-depth interpretations by industry, risk assessments, and practical compliance guidelines. This results in many SMEs only learning of changes in relevant standards after their products have been seized by customs. According to a special survey by the Guangdong WTO/TBT Center, over 70 % of SMEs exporting enterprises reported being unable to obtain timely and accurate updates to green regulations in their target markets [11].

To address this issue, the government should integrate resources from embassies and consulates abroad, industry associations, and research institutions to establish a national-level comprehensive early warning platform for green trade barriers. This platform should focus on strengthening three core functions: first, real-time monitoring, continuously tracking the legislative developments of green regulations in major trading partners such as the EU, the US, and Japan, and issuing tiered early warning information 6-12 months in

advance [59]; second, in-depth interpretation, organizing industry experts to break down regulatory clauses clause by clause, clarifying compliance requirements, implementation timelines, and penalties for violations; and third, precise service, compiling specialized compliance operation manuals for key affected industries such as steel, new energy, and textiles, and providing one-on-one professional consulting services [49]. Simultaneously, green compliance service windows should be established at key ports nationwide to provide enterprises with one-stop services such as on-site testing and certification consulting, effectively reducing compliance costs for businesses. Figure 12 presents the functional framework of China's green trade barrier early warning system, as shown in the following data:



Figure 12-Framework of China's green trade barrier early warning system [31]

Currently, the power to formulate global green trade rules is primarily held by

developed economies such as the EU and the US. These rules often ignore the development stages and technological levels of developing countries, exhibiting clear discriminatory and unilateralist characteristics. As the world's largest goods trading nation, my country should proactively participate in the international green rule-making process and promote a more equitable, just, and inclusive international green trade system.

At the multilateral level, my country should fully utilize multilateral platforms such as the United Nations Framework Convention on Climate Change (UNFCCC) and the World Trade Organization (WTO), uniting with developing countries like Brazil and India to jointly resist the abuse of green barriers by developed countries to promote trade protectionism. For example, in 2025, my country, together with Brazil and India, filed a consultation request with the WTO regarding the discriminatory clauses of the EU's CBAM, demanding that the EU fully consider the differences in energy structures among developing countries and adjust its unreasonable carbon emission accounting methods [22]. At the regional level, relying on regional cooperation mechanisms such as RCEP and the Belt and Road Initiative, China should promote the establishment of a unified regional green standard and certification mutual recognition system. For example, China should work with ASEAN countries to jointly develop regional carbon footprint accounting standards and promote mutual recognition of green product certifications between my country and ASEAN countries, reducing trade barriers within the region. In addition, we will actively promote the interconnection between the domestic carbon market and the international carbon market, explore cross-border carbon quota trading mechanisms, and gradually enhance my country's voice in the global carbon pricing system [55].

3.2 Industry Level:

Industry associations, serving as a bridge between the government and businesses, can effectively integrate industry resources and solve common problems that are difficult for individual enterprises to address. They are an indispensable force in combating green trade barriers. This is especially true for SMEs facing dual constraints of funding and technology, where industry-level collaboration is crucial.

Figure 13 illustrates the core service modules of the industry-level green public service platform for SMEs, as shown below:



Figure 13 - Industry-level green public service platform for SMEs [2;3]

Faced with the fragmented and dynamic development trend of international green standards, individual enterprises find it difficult to independently complete comprehensive standard research and alignment work. Industry associations should fully leverage their organizational and coordinating role, uniting leading enterprises, research institutes, and standardization experts to systematically study the technical regulations and standard systems of target markets, and formulate industry group standards that are stricter than national standards and aligned with advanced international levels. For example, in response to the requirements of the EU Zero Deforestation Act (EUDR), the China Rubber Industry Association spearheaded the development of the “Natural Rubber Sustainable Supply Chain Management Standard” in 2024, establishing a traceability system covering the entire chain of rubber plantation planting, processing, and transportation. More than 30 leading enterprises in the industry have participated in its implementation, effectively reducing their EUDR compliance costs by approximately 20 % [56].

Simultaneously, industry associations should actively promote mutual recognition of industry standards with international authoritative organizations. Through regular cooperation with organizations such as the European Committee for Standardization (CEN) and the American National Standards Institute (ANSI), they can promote international recognition of Chinese industry standards, reducing the costs of repeated testing and certification for enterprises. For example, the China National Textile and Apparel Council has carried out in-depth cooperation with Oeko-Tex to promote mutual recognition between my country's textile industry standards and Oeko-Tex Standard 100 certification, which has shortened the certification cycle for Chinese textile companies by 30 % and reduced

certification costs by 25 % [15].

Many small and medium-sized enterprises (SMEs) face significant challenges in areas such as carbon footprint accounting, supply chain traceability, and green certification due to limited financial resources and technological capabilities. Industry associations can leverage their resource integration advantages to build industry-level green public service platforms, providing SMEs with low-cost, high-efficiency technical support and professional services.

One key approach is to establish a unified industry-wide carbon emission factor database and carbon footprint accounting tools. This involves organizing industry experts to calculate the full-process carbon emission factors for key products and developing a user-friendly carbon footprint accounting system to provide free carbon footprint accounting services to SMEs. For example, the China Iron and Steel Association has established a carbon emission factor database covering the entire iron ore mining, smelting, and rolling process, providing crucial data support for SMEs in addressing CBAM (Carbon Footprint Assessment and Management).

Second, establish an industry technology exchange and sharing platform. Publish Best Feasibility Technologies (BAT) guidelines for key industries, organize leading enterprises to share green technologies and management experience with SMEs, conduct joint R&D, and jointly solve common technical challenges such as energy conservation, emission reduction, and cleaner production. For example, the China Photovoltaic Industry Association organized leading enterprises in the industry to conduct joint R&D on low-carbon technologies for photovoltaic cells, reducing the average carbon emission intensity of photovoltaic cells in my country by 15 %.

Third, establish an industry green certification service center. Establish strategic

partnerships with internationally authoritative certification bodies to provide SMEs with one-stop green certification services, lowering certification thresholds and costs. For example, the Guangdong Textile Association cooperated with the EU Eco-label agency to conduct special training sessions and centralized application services for SME certification, helping nearly 100 small and medium-sized textile enterprises successfully obtain EU Eco-label certification [11].

3.3 Enterprise Level:

Enterprises bear the ultimate responsibility for addressing green trade barriers. The fundamental solution for enterprises to overcome these barriers lies in transforming external compliance pressures into internal drivers for transformation, building sustainable green competitiveness through technological innovation, management upgrades, and strategic adjustments.

Technology innovation is the fundamental path for enterprises to overcome green trade barriers. Export enterprises should proactively increase investment in green technology research and development, integrating the concepts of environmental protection into product design, raw material procurement, manufacturing, packaging and transportation, and recycling, thereby reducing the environmental impact of products from the source [62]. Figure 14 summarizes the comprehensive green transformation path for export enterprises under green trade barriers, covering multiple dimensions from product design to brand building, as shown in the following data:



Figure 14-Green transformation path of export enterprises under green trade barriers[12;43;62]

In the production process, actively apply clean production technologies, energy-saving and carbon-reducing processes, and digital management systems. For example, Baosteel Co.Ltd. plans to establish China's first million-ton hydrogen-based vertical furnace production line by 2025, reducing carbon emissions per ton of steel by about 60 % compared with traditional blast furnace processes. The low-carbon steel it produces has received a 15 % product premium in the EU market, effectively offsetting the cost increases brought by the CBAM. CATL, by developing a low-energy production process for lithium iron phosphate, has reduced the energy consumption of power battery production by 20 % and lowered the product carbon footprint by 25 % compared with the industry average, successfully passing the strict certification of EU battery regulations [43].

In the product design phase, the company fully implements the concept of eco-design, prioritizing the selection of renewable and recyclable raw materials to improve the disassembly and recyclability of its products. For example, Midea Group adopts a modular design concept in its air conditioning products, enabling a recyclability rate of over 90%, which meets the relevant requirements of the EU's Sustainable Product Regulation (SPR)[12].

Under the new regulatory frameworks of the EU, such as CSDDD and EUDR, corporate compliance responsibilities have extended from their own production processes to the entire supply chain. Exporting companies must shift from traditional single-production management models and fully integrate green standards into the entire process of supplier access, performance evaluation, and capacity building.

First, establish a strict green supplier access mechanism. Develop clear environmental standards for suppliers, prioritize upstream suppliers with low-carbon production capabilities and high data transparency, and make environmental compliance a mandatory condition for supplier access. For example, Apple requires its global suppliers to use 100 % renewable energy by 2030, and suppliers that do not meet the requirements will be gradually removed from the supply chain [56].

Second, establish a supply chain carbon emission data sharing and traceability system. Utilize advanced technologies such as blockchain and the Internet of Things to achieve full-chain data traceability from raw material mining to finished product delivery. For example, Guangken Rubber Taihua Company has built a closed-loop information system for the entire traceability of natural rubber, providing geographic coordinate data for each batch of rubber accurate to six decimal places, and has successfully passed the relevant EUDR certification

[56].

Third, promote collaborative green transformation among upstream and downstream enterprises. By providing technical support and financial subsidies, Geely Automobile helps upstream suppliers upgrade their technologies to be more green, thereby improving the overall greenness of the supply chain. For example, Geely Automobile provides low-carbon technology training and financial support to its upstream parts suppliers, helping them reduce carbon emissions and lowering the carbon footprint of the entire supply chain by 18 % [51].

Against the backdrop of a growing global trend towards green consumption, green certifications recognized by international authorities have become a “green passport” for enterprises entering high-end international markets. Enterprises should proactively benchmark against advanced international standards and actively apply for international certifications such as ISO 14000 Environmental Management System, EU Eco-label, and EPD Environmental Product Declaration to demonstrate the environmental performance of their products and gain the trust of international consumers. By the end of 2025, more than 2,000 Chinese enterprises had obtained EU Eco-label certification, but over 90 % of these were large enterprises, with the certification rate for SMEs less than 5 %, indicating significant room for improvement [15].

Simultaneously, enterprises should deeply integrate green practices into their brand marketing strategies, proactively conveying their green concepts and achievements to the international market and consumers through various means such as publishing ESG reports, labeling products with carbon tags, and utilizing social media. For example, BYD labels its new energy vehicle products with detailed carbon footprint information and regularly

publishes annual ESG reports, comprehensively showcasing the company's efforts in energy conservation, emission reduction, and supply chain sustainability, successfully shaping a responsible green brand image. Its new energy vehicle sales in the European market have maintained rapid growth for three consecutive years [20].

Addressing green trade barriers is a long-term and complex systemic project that requires strong collaboration among the government, industry associations, and enterprises. The government should create a favorable policy environment and level playing field for enterprises by improving institutional support and enhancing its voice in international rules. Industry associations should help enterprises solve common challenges by strengthening collaborative governance and providing public service support. Enterprises should fundamentally enhance their ability to cope with green barriers by accelerating green transformation and reshaping their core competitiveness. Only through close cooperation and concerted efforts from all three parties can we effectively overcome the constraints of green trade barriers, promote high-quality development of my country's foreign trade, and secure a proactive position in the new global green trade landscape [26].

Conclusion

The pace of global carbon neutrality is accelerating, and international trade rules are undergoing earth-shaking changes accordingly, with 'green' becoming the most core keyword in the new rules. The old green barriers, which only looked at whether the product itself was environmentally friendly, are long outdated. Now, what is being used is a combination approach, centered on carbon control, covering the entire industrial chain from raw material extraction, production and processing, transportation and sales, all the way to final recycling. These rules are justified under the banner of environmental protection, which sounds legitimate, but in fact, they have become a means for developed countries in Europe and America to engage in trade protection and dictate the terms, causing considerable trouble for our country's foreign trade development and industrial upgrading. I have spent quite a bit of time studying what these green barriers really are, how they operate, how they will develop in the future, what impact they have on our foreign trade, the difficulties we face in responding to them, and finally, I have thought of a set of response measures from the national to the enterprise level. The following are my main research findings.

First, the most fundamental characteristic of green barriers is their dual nature: on one side, they are genuinely intended to protect the environment, while on the other side, they conceal a small intention of trade protection, and now they have formed a complete, constantly updated regulatory system. Based on the actual situation of international trade in recent years, I classify the commonly seen green barriers into six major categories: first, various environmental technical standards and inspection and quarantine requirements;

second, measures directly linked to carbon emissions, such as carbon border adjustment taxes; third, green certification and eco-labels; fourth, requirements for enterprises to be responsible for the sustainability of the entire supply chain; fifth, regulations on green packaging and waste recycling; and sixth, environmental impact assessments and market access restrictions. These rules can be implemented globally, relying on a four-layer coordinated mechanism: first, the importing country legislates domestically, creating binding legal constraints; then, through various regional trade agreements, these rules are promoted to other countries; the WTO multilateral framework also provides a certain legal basis for these rules; and finally, various industry standards set by multinational companies and industry associations serve as soft constraints. Looking at future development trends, two directions are particularly evident: one is that the European Union has linked rules such as CBAM, CSDDD, and CRMA to form a comprehensive regulatory network, no longer focusing solely on product entry but covering the entire life cycle of the product; the other is that the discourse power over global green rules is basically in the hands of Europe and the United States, and developing countries basically have to follow their lead on issues such as how standards are set, how carbon is calculated, and how certifications are mutually recognized, with very little say.

Secondly, the impact of green barriers on our country's foreign trade is not simply a bad thing; it is very complex. Different levels, industries, and companies feel the impact in completely different ways. From the perspective of the country as a whole, the most direct impact is that companies have to spend more money to comply with these rules, and export growth is bound to be somewhat limited. But in the long run, it also forces us to upgrade our industries, produce more technologically advanced, high-value-added, green, and low-

carbon products, and also prompts our companies to pay more attention to emerging markets like ASEAN, rather than focusing only on Europe and the United States. These impacts also propagate along the industrial chain to the entire economy, affecting macro indicators such as GDP growth, foreign investment flows, energy consumption, and carbon emissions. From the perspective of different industries, the most affected are the agricultural and food industries, where just pesticide residues and inspection and quarantine alone account for over 60 % of the losses in agricultural exports. The textile, apparel, and light industry sectors are mainly troubled by chemical controls, eco-labeling, and packaging recycling regulations, especially for small and medium-sized enterprises, where compliance costs are prohibitively high. The new energy industry, originally one of our advantageous sectors, now also faces issues such as carbon footprint accounting, supply chain due diligence, and anti-subsidy investigations, and even risks of industrial chain relocation. From the perspective of companies, large companies have money and technology, manage their supply chains well, and can quickly meet the requirements of new rules; some can even take advantage of green upgrading to sell their products at higher prices. However, over 90 % of our foreign trade companies are small and medium-sized enterprises, which lack timely information, funds, and technology for green transformation. Facing increasingly stringent rules, they simply cannot cope and many are at risk of being pushed out of the international market.

Furthermore, there are three fundamental problems in how we currently respond to green barriers. The first is information asymmetry. Although there are some early warning mechanisms in China, most only translate and forward foreign regulations without providing detailed interpretations for specific industries or telling companies what the impacts will be and what they should do. When companies face a pile of incomprehensible foreign

documents, they have no idea which ones are relevant to them and often only realize the standards have changed after their goods are detained or returned, constantly being in a passive, vulnerable state. The second problem is that our own systems are not compatible with international rules. Many domestic green standards are outdated, their coverage is insufficient, and their requirements are lower than those abroad, causing many products that meet domestic standards to be non-compliant once exported. Moreover, our green certification and carbon accounting systems are not widely recognized internationally, forcing companies to spend a lot of money obtaining foreign certifications, undergoing repeated testing and certification, which increases unnecessary costs. The third problem is the insufficient motivation for industrial transformation. Facing green barriers, many companies prefer to spend a little money on superficial measures just to barely pass, rather than investing significant funds and time in genuine technological innovation. Combined with the difficulty small and medium-sized enterprises have in financing and their inadequate R&D investment, the overall pace of green transformation in the industry is very slow.

Finally, in order to truly address the problems brought about by green barriers, relying solely on the efforts of enterprises is not enough. The government, industry associations, and enterprises must work together to form a complete response system. On the government side, the main task is to do a good job in top-level design, accelerate the updating of domestic green standards, and ensure our standards quickly align with international ones. At the same time, a more accurate and practical early warning platform should be established to promptly inform enterprises of changes in foreign regulations. It is also necessary to actively participate in the formulation of international rules, unite with other developing countries,

and strive for our legitimate rights. Industry associations should serve as a bridge between the government and enterprises, work with leading enterprises and research institutions to develop high-level industry standards, and promote the international recognition of these standards. They should also establish some public service platforms to provide SMEs with services such as carbon accounting, certification guidance, and technology sharing, helping them solve problems that individual enterprises cannot address on their own. Enterprises themselves must also change their mindset, no longer treating compliance as a burden, but as an opportunity for transformation and upgrading. They need to increase R&D investment, carry out green transformation across the entire product lifecycle, establish traceable green supply chains, and proactively apply for internationally recognized green certifications. At the same time, they should adjust their market layout, build their own green brands, and enhance product competitiveness

We must clearly recognize that the reconstruction of global green trade rules is a long-term process. In the future, green barriers will only become stricter, moving toward digital traceability, full lifecycle closed-loop supervision, and multi-domain rule coordination. If China's foreign trade wants to take the initiative in this transformation, it must unswervingly promote green low-carbon transformation across the entire industrial chain and address shortcomings in standards, technology, and data governance. We can no longer be satisfied with passively adapting to rules set by others; we must actively participate in and even lead rule-making. Only in this way can we turn external pressure into a driving force for industrial upgrading, establish a firm foothold in the new global green trade landscape, and achieve a win-win outcome of high-quality foreign trade development and global sustainable development

References

- 1 Apple Inc. Supplier responsibility progress report 2024.URL:
https://www.supplychainreports.apple/files/doc_downloads/2024/04/Apple-Supply-Chain-2024-Progress-Report.pdf (Accessed date: 26.06.2026).
- 2 China iron and steel association. low-carbon development report of China steel industry,2024.URL:<http://www.chinaisa.org.cn/gxportal/xfpt/portal/viewArticleById?params=%7B%22articleId%22:%22d8ac372e764aa60cfbca740836cdeefc2cf29fdb71fdf326f16ce0f76305e955%22,%22columnId%22:%2258af05dfb6b4300151760176d2aad0a04c275aaadbb1315039263f021f920dcd%22%7D> (Accessed date: 26.06.2026).
- 3 China photovoltaic industry association. annual development report [R], 2025.URL: https://www.chinapv.org.cn/Association/content_1621.html (Accessed date: 06.06.2026).
- 4 Dong Xiaojun, Tang Rui. Green trade barriers of "carbon border tax" in developed countries and china's response // Modern economic research. 2023. № 12. P. 1-8.
- 5 European commission. carbon border adjustment mechanism (CBAM)[EB/OL]. URL:<https://ec.europa.eu/> (Accessed date: 26.05.2026).
- 6 European commission. european green deal [EB/OL]. URL:<https://ec.europa.eu/> (Accessed date: 26.05.2026).
- 7 European Union. Corporate sustainability due diligence directive (CSDDD)[R], 2025.URL:<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52025SC0080> (Accessed date: 06.06.2026).

- 8 European Union. Packaging and packaging waste regulation (PPWR)[R], 2024.URL:<https://eur-lex.europa.eu/legal-content/EN-SL/TXT/?from=EN&uri=CELEX:32025R0040> (Accessed date: 06.06.2026).
- 9 Fang Mei, Jiang Yanni. Analysis of the impact of green trade barriers in RCEP member states on China's agricultural product export trade // Times Economic & Trade. 2025. № 5. P. 10-13.
- 10 Gao Jing, Cheng Xiaoxi. Analysis of the causes and countermeasures for export enterprises encountering green trade barriers // China Economic & Trade Herald. 2016. № 32. P. 9-10.
- 11 Geng Tingfei. Research on the impact of green trade barriers on the export of textile and apparel industry in Guangdong province // Foshan University. 2025. P. 23-25.
- 12 Guo Sijia. The impact of green trade barriers on Chinese export enterprises and their coping strategies // Business Economy. 2025. № 3. P. 95-97.
- 13 Guo Tingting, Li Shengyuan, Guo Junhua. Research on the construction of green transformation cooperation mechanism between China and ASEAN under the EU carbon border adjustment mechanism // New Economy Weekly. 2025. № 5. P. 32-38.
- 14 Guo Xuan. A brief analysis of the problems and suggestions for China's small and medium-sized enterprises' exports under green trade barriers // Economic & Trade Practice. 2018. № 14. P. 78-79.
- 15 Han Qi. Analysis of green certification requirements for textiles and clothing exported to the EU // Textile Testing and Standard. 2024.№ 10(4). P. 45-48.
- 16 Huang Minqing, You Qinlong. How to cope with US green trade barriers in agricultural product exports // Foreign Investment in China. 2024. № 4. P. 33-35.

- 17 Lai Yifan. Survival wisdom of export enterprises in coping with green barriers // China Businessman. 2025. № 14. P. 90-91.
- 18 Li H, Liu H. On the impact of green trade barriers on China's product export and the countermeasures // Proceedings of 3rd International Symposium on Economic Development and Management Innovation (EDMI 2021). 2021. P. 154-158.
- 19 Liang Li, Huang Ruxia, Li Yuanzhen. Research on the impact and countermeasures of green trade barriers on China's textile and apparel exports // China Circulation Economy. 2023. № 17. P. 58-61.
- 20 Lin Chen. Trade barriers and countermeasures for new energy vehicle exports // Auto Pictorial. 2026. № 1. P. 242-244.
- 21 Liu Changsong. Research on green trade strategies to break carbon barriers in international trade // World Environment. 2025. № 2. P. 50-54.
- 22 Liu Changsong. The impact of global green trade development and carbon neutrality process on China and coping strategies // Economy and Management. 2024. № 5. P. 77-84.
- 23 Liu H. The legal root and breakthrough of China's green trade barriers in the post-epidemic era // Proceedings of the 2023 International Conference on Management Research and Economic Development (Part 3). 2023. P. 328-338.
- 24 Liu Lu. The impact of the EU ecolabel system on China's exports of textile printing and dyeing products // Textile Auxiliaries. 2025. № 5. P. 1-5.
- 25 Liu Qinyan, Chang Jianjun. High green barriers put pressure on agricultural product exports to seek changes // China Reform Daily. 2025-06-23. № 3. P. 3-4.
- 26 Liu Shimeng. ESG turns green trade barriers into opportunities for Chinese

enterprises // Huaxia Times. 2025-03-17. № 2. P. 7-8.

27 Liu Xiaoquan. Research on green trade barriers in international trade // Investment and Entrepreneurship. 2021. № 32(19). P. 72-74.

28 Lu Xi. Research on the legal system related to green trade barriers faced by China's agricultural product trade // Shanghai Ocean University. 2024. P. 2-3.

29 Luo Biao. Research on the impact of green trade barriers on China's agricultural product exports and legal countermeasures // Northwest Minzu University. 2021. P. 4.

30 Ma Shiping, Man Hanyang, Cheng Yunlong. Current situation and improvement suggestions for Fujian province's textile, footwear and apparel industry to cope with international green trade barriers // Strait Science. 2025. № 9. P. 151-156.

31 Ministry of commerce of the PRC. report on technical trade measures[R], 2025.URL:http://tjs.customs.gov.cn/hangzhou_customs/575609/1708095/2068312/6777998/2025101517352132053.pdf (Accessed date: 06.06.2026).

32 National bureau of statistics. statistical communiqué of the people's republic of china on national economic and social development 2018 [EB/OL]. 2019-02-28. URL:https://www.stats.gov.cn/sj/zxfb/202302/t20230203_1900241.html(Accessed date: 26.05.2026).

33 National bureau of statistics. statistical communiqué of the people's republic of china on national economic and social development 2019 [EB/OL]. URL:https://www.stats.gov.cn/sj/zxfb/202302/t20230203_1900640.html(Accessed date: 26.05.2026).

34 National bureau of statistics. statistical communiqué of the people's republic of

china on national economic and social development 2020 [EB/OL].

URL:https://www.stats.gov.cn/sj/zxfb/202302/t20230203_1901004.html(Accessed date: 26.05.2026).

35 National bureau of statistics. statistical communiqué of the people's republic of china on national economic and social development 2021 [EB/OL].

URL:https://www.stats.gov.cn/sj/zxfb/202302/t20230203_1901393.html(Accessed date: 26.05.2026).

36 National bureau of statistics. statistical communiqué of the people's republic of china on national economic and social development 2022 [EB/OL].

URL:https://www.stats.gov.cn/sj/zxfb/202302/t20230228_1919011.html(Accessed date: 26.05.2026).

37 National bureau of statistics. statistical communiqué of the people's republic of china on national economic and social development 2023 [EB/OL].

URL:https://www.stats.gov.cn/sj/zxfb/202402/t20240228_1947915.html(Accessed date: 26.05.2026).

38 National bureau of statistics. statistical communiqué of the people's republic of china on national economic and social development 2024 [EB/OL].

URL:https://www.stats.gov.cn/sj/zxfb/202502/t20250228_1958817.html(Accessed date: 26.05.2026).

39 National bureau of statistics. statistical communiqué of the people's republic of china on national economic and social development 2025 [EB/OL].

URL:https://www.stats.gov.cn/sj/zxfb/202602/t20260228_1962662.html(Accessed date: 26.05.2026).

- 40 Qiao Yujiao. Research on ESG practices and international market access strategies of time-honored brand enterprises under green trade barriers // Time-Honored Brand Marketing. 2026. № 1. P. 1-3.
- 41 Qiu Rui. Research on the impact of green trade barriers on China's new energy vehicle exports to the European Union // Yunnan University of Finance and Economics. 2025. P. 5-6.
- 42 Qu Shicen. Research on the impact of green trade barriers on China's aquatic product exports // Lanzhou University of Technology. 2025.P. 2-4.
- 43 Su Nan. China's new energy industry faces green trade barriers head-on // China Energy News. 2024-05-13 .№ 8. P. 4-5.
- 44 Sun Jing'ao. Analysis of the impact of green trade barriers on the export trade of developing countries // Proceedings of the 2025 Experience Exchange Conference on Enterprise Development and Social Governance Innovation. 2025. P. 216-218.
- 45 Sun Xiaoxiao, Du Jianguo. Spatiotemporal evolution and driving factors of the coupling coordination between green production and green life in China // Statistics & Decision. 2026.№ 42(6). P. 66-71.
- 46 Tian Lei, Bai Yang. Global green trade barriers are rising, and the new energy industry needs fair, open and coordinated development // International Petroleum Economics. 2025. № 33(1). P. 35-36.
- 47 Tian Zhanghui. Research on legal issues of green trade barriers for agricultural products between China and RCEP partner countries // Northeast Agricultural University. 2023. P. 1-2.
- 48 Wang Jingyi. Research on the impact of green trade barriers on the

sophistication of export technology // Zhejiang University. 2024. P. 2-3.

49 Wang Kexin. Analysis of the impact of green trade barriers on China's textile exports to the EU // Beijing University of Posts and Telecommunications. 2019. P. 2.

50 Wang Manman. Interpretation of the EU's regulation on packaging and packaging waste // Green Packaging. 2025. № 7. P. 51-56.

51 Wei Guangjie. Research on low-carbon transformation strategies of export-oriented enterprises under green trade barriers // China Business Review. 2026. № 35(2). P. 60-63.

52 Wei Mei. The impact of global green trade barriers on the export of China's textile printing and dyeing auxiliaries industry // Textile Auxiliaries. 2025. № 42(2). P. 9-14.

53 WTO. Technical barriers to trade information management system[EB/OL]. URL:<http://tbttims.wto.org/>(Accessed date: 26.05.2026).

54 Wu Jingnan. Research on the dual margin impact of green trade barriers on China's agricultural product exports // Capital University of Economics and Business. 2024. P. 12.

55 XU Rong. Benchmarking international rules on carbon footprint and actively responding to green trade barriers // Science & Technology Vision. 2026. № 16(04). P. 5-10.

56 XU Yiming. EU green barriers: from terminal constraints to full-chain closed loop // China Rubber. 2026. № 42(03). P. 10-17.

57 YOU Pin, WANG Yudong, TIAN Jing. Non-Linear inhibitory effect of compound green trade barriers on China's exports: An investigation based on the linkage

of EU CBAM and CRMA // International Economics and Trade Research. 2026. № 42(02). P. 22-36.

58 ZHANG Bohang. Green barriers and sustainable development in international trade // Business Culture. 2025. № 24. P. 80-81.

59 ZHANG Jiao, LIU Yanan. Exploration on strategies for export enterprises to cope with green trade barriers // Financial Literary Circles. 2025. № 08. P. 19-21.

60 ZHANG Jing. Long-Term impact of green trade barriers on the market structure of China's Textile printing and dyeing industry // Textile Auxiliaries. 2024. № 41(11). P. 66-70.

61 ZHAO Zhujun. Research on green barriers and countermeasures for traditional Chinese medicine entering ASEAN under the background of the Belt and Road initiative // International Public Relations. 2024. № 07. P. 118-120.

62 ZHU Zhenhua. Research on the synergistic mechanism of environmental protection tax and enterprise green transformation under the “dual carbon” goal // Guangxi Cyberspace Security and Informatization Federation. Proceedings of the 9th Academic Exchange Conference on Digital Transformation and New Productivity Development in Engineering Fields 2025. Huayou New Energy Technology (Quzhou) Co., Ltd., 2025. P. 214-216.

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Introduction

The accelerated advancement of global carbon neutrality has deeply integrated sustainable development concepts into the international trade system, driving fundamental changes in global trade rules centered on greening. Since 2023, the European Union has successively introduced landmark regulations such as the Carbon Border Adjustment Mechanism (CBAM), Corporate Sustainability Due Diligence Directive (CSDDD), and Critical Raw Materials Act (CRMA), transforming green trade barriers from single product environmental standards into a complex regulatory network covering the entire product lifecycle and supply chain. As the world's largest goods trading nation, China has been the primary target of technical trade barriers for twelve consecutive years, with nearly all core export industries facing rising market access thresholds and exponentially increasing compliance costs. Existing academic research predominantly focuses on individual barrier tools and macro-level impacts, neglecting the composite effects of overlapping regulations, industry-specific heterogeneity, and the need for coordinated multi-stakeholder responses. Effectively addressing green trade barriers is not only crucial for China's foreign trade high-quality development and "dual carbon" goals but also contributes to building a fairer global trade governance system, making this research highly relevant in both theoretical and practical terms.

The research object of this paper is the impact patterns and mechanisms of green trade barriers on China's foreign trade, as well as the core dilemmas and strategic responses of China's foreign trade sector to these barriers.

The subject of this research is the three core types of actors involved in the development and response to green trade barriers in China's foreign trade context: government regulatory departments responsible for macro policy formulation and international rule negotiation, foreign trade industry associations serving as bridges between government and enterprises, and Chinese export enterprises directly undertaking compliance obligations and implementing green transformation.

The goal of the research is to systematically define the core connotations and evolutionary trends of contemporary green trade barriers, comprehensively reveal their

multidimensional impact mechanisms on China's foreign trade, identify key challenges in China's response capacity, and construct a coordinated response strategy system involving government, industry, and enterprises to support China's foreign trade green transformation and enhance its discourse power in global green trade rule-making.

Tasks of this paper are:

- define the narrow and broad connotations of green trade barriers, establish a scientific classification system, deconstruct their international implementation mechanisms, and forecast future evolutionary trends of global green trade regulations;
- quantitatively measure the direct and indirect impacts of green trade barriers on China's foreign trade scale, costs, structure, and market distribution, as well as their transmission paths to macroeconomic indicators;
- systematically examine the differentiated impacts of green trade barriers on China's three core export industries and reveal industry-specific mechanisms and enterprise-level response difficulties;
- explore the core challenges and deep structural contradictions restricting China's foreign trade response capacity from multiple dimensions;
- develop actionable response strategies at the government, industry, and enterprise levels, constructing a full-chain collaborative response system.

Novelty of this study lies in four key aspects. First, it adopts a timely and frontier perspective focusing on the composite green barrier system formed by multiple EU regulations implemented since 2022, analyzing the nonlinear superimposed effects of policy linkages and explaining the evolution from “end-product control” to “whole lifecycle + supply chain closed-loop regulation”. Second, it presents a highly systematic research framework covering theoretical connotation sorting, global trend judgment, macro impact analysis, industry heterogeneity examination, core dilemma identification, and strategy formulation, addressing deficiencies in existing research. Third, it constructs a synergistic strategy system based on the functional positioning and collaborative logic of government, industry, and enterprises, forming a closed-loop system of mutual support. Fourth, it employs cutting-edge data from 2018 to 2025 and practical cases from the EU green

regulation transition period, combined with advanced empirical methods to provide more robust and practically relevant conclusions.

The main research methods used in this paper are as follows: literature research method, quantitative analysis and empirical research method, comparative analysis method, and case study method. Through the literature research method, this study systematically reviews academic literature, industry reports, and international organization research to clarify the research context and existing gaps, laying a solid theoretical foundation. Based on authoritative statistical data from 2018 to 2025, the quantitative analysis and empirical research method uses panel data fixed effect models, the GTAP model, and dynamic general equilibrium analysis to quantitatively test the impacts of green trade barriers. The comparative analysis method horizontally compares green trade regulations in major developed economies and vertically compares the evolutionary stages of green barriers, while also examining heterogeneous effects across industries and enterprise scales. Finally, the case study method selects typical green trade barrier cases and corporate practices to analyze actual impact paths and successful response experiences, enhancing the practical relevance of the research conclusions.

The significance of this paper lies in both theoretical and practical aspects. Theoretically, it enriches and improves the theoretical research system of green trade barriers by expanding their connotation and classification based on the latest global developments, enhances the analytical framework for assessing impacts on developing countries by revealing nonlinear cumulative effects and heterogeneous paths, and constructs a multi-entity collaborative theoretical response system providing new directions for future research. Practically, it provides concrete operational guidance for Chinese export enterprises to reduce compliance costs and enhance green competitiveness, offers important decision-making references for government departments to improve relevant policies and participate in international rule-making, and clarifies implementation paths for industry associations to better fulfill their bridging role and promote industry-wide green transformation.

Chapter 1 Overview of green barriers

1.1 Definition and classification of green barriers

Green trade barriers, also referred to as environmental barriers to trade (ETB), describe tangible restrictions on cross-border trade activities enacted by the governments of importing nations or regional international bodies. These restrictive measures are put into practice via the development and enforcement of a range of regulatory documents and oversight mechanisms, with core priorities of safeguarding ecological environments, preserving natural resources, and upholding the health and safety of humans, animals, and plant life. Within international academic circles, the phrase “environment-related trade barriers” is widely adopted, highlighting the positive environmental protection focus of these rules; in Chinese academic research, combined with real-world foreign trade practices, these measures are widely acknowledged to hold dual characteristics of both environmental protection and trade restriction, and are classified as an innovative form of non-tariff barrier within the landscape of global sustainable development [18].

These measures span a wide range of regulatory dimensions, including formal laws and regulations, technical benchmarks, certification frameworks, inspection and quarantine protocols, and market access regimes. Their core purpose is to lift the environmental entry requirements for imported goods, drive up compliance costs for exporting enterprises across the full production-to-distribution chain, and in turn shape adjustments to overall trade volume and structural composition. The dual nature of these measures is especially notable: green trade barriers that are scientifically sound and aligned with the non-discrimination principle can effectively restrict the cross-border movement of high-pollution, high-emission goods. They push national production and trade systems toward green, low-carbon transformation, while delivering institutional support for global carbon neutrality targets and creating meaningful positive externalities. As early as 1992, Anderson K. noted in his work *Greening the World Trading System* that environmental safety and public health should serve as key evaluation metrics for trade policy, and that non-tariff trade control measures have inherent rationality. In real-world trade practices, however, developed economies

frequently use their first-mover technological advantages and international regulatory influence to set strict standards that far exceed the technical capabilities and economic capacity of developing nations. Some even enforce discriminatory dual standards, reframing green trade barriers as hidden tools for trade protection. A 2009 study by Copeland B.R. and Taylor M.S. further validated this pattern, confirming that many trade restrictive measures framed as environmental protection lack sufficient scientific grounding, and are essentially designed to shield domestic industries from external competitive pressures. This dual nature creates a unique dilemma for developing countries, which must balance environmental protection obligations with trade development needs.

From the perspective of conceptual boundaries, green trade barriers can be divided into narrow and broad categories.

Figure 1 illustrates the conceptual structure of green trade barriers, distinguishing between narrow and broad definitions and their core components, as shown below:

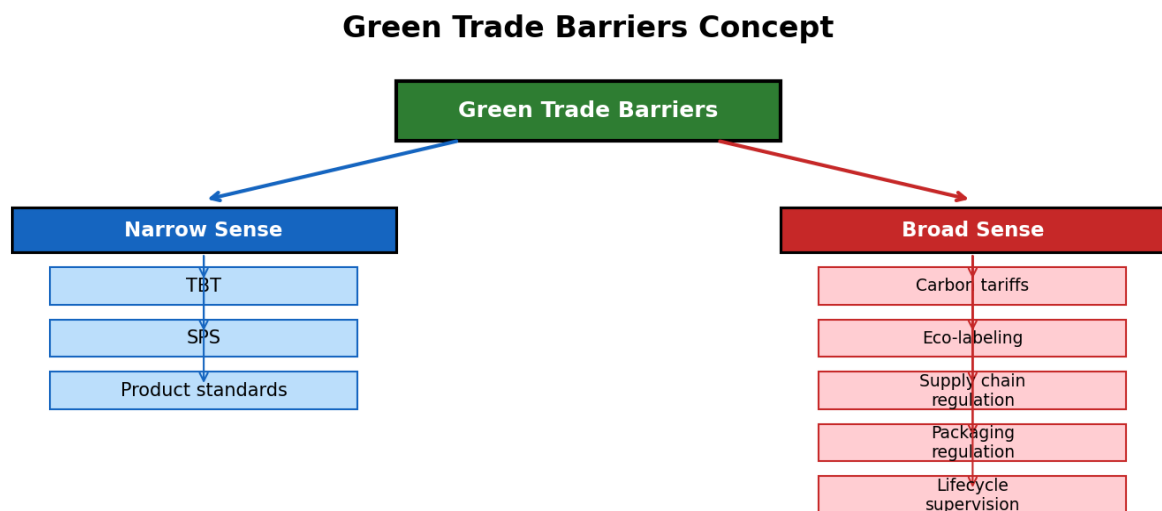


Figure 1 – Conceptual structure of green trade barriers [18; 44]

At the narrow level, they refer only to technical trade measures directly targeting the environmental attributes of products, corresponding to the core contents of the WTO's Agreement on Technical Barriers to Trade (TBT Agreement) and the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement), mainly focusing on the environmental performance and safety standards of the products themselves, such as

limits on pesticide residues in food and energy efficiency standards for electromechanical products. At the broad level, they encompass a comprehensive regulatory system covering all dimensions and the entire supply chain. In addition to traditional environmental technical standards, they also include carbon border adjustment measures, green certification and Eco-labeling systems, supply chain environmental sustainability regulations, green packaging and waste recycling requirements, and environmental impact assessment access systems [57]. Their regulatory scope has extended beyond the entry point of terminal products to upstream stages such as raw material extraction, production and processing, packaging, and storage and transportation, as well as downstream stages like consumer use and recycling and disposal, forming a complex trade barrier system that deeply integrates tariff and non-tariff measures with border control and domestic regulations. New regulations such as the EU Corporate Sustainability Due Diligence Directive (CSDDD) and the Critical Raw Materials Act (CRMA) clearly reflect this full-chain regulatory trend and place higher requirements on the compliance capabilities of Chinese export enterprises [56].

Table 1 summarizes the core mechanisms, representative regulations and main impacts of these six types of green trade barriers, as shown in the following data:

Table 1 – Classification of green trade barriers [5; 7; 8]

Type	Core Mechanism	Representative Regulation	Main Impact
Technical standards	Product compliance	REACH	Increase testing costs
Carbon tariffs	Embedded carbon pricing	CBAM	Raise export costs
Eco-labeling	Green certification	EU Ecolabel	Market exclusion
Supply chain regulation	Due diligence	CSDDD	Supply chain restructuring
Packaging regulation	Recycling obligation	PPWR	Packaging upgrade
Environmental access	Lifecycle assessment	SPR	Market prohibition

Based on the dynamics of international trade green regulations from 2022 to 2025 and actual cases of barriers encountered by Chinese export enterprises, and with reference to relevant domestic and international research findings, green trade barriers are classified into six core categories according to the implementation mechanisms of the measures, the scope

of supervision, and the trade impact pathways, comprehensively covering the mainstream forms of barriers faced by China's export trade.

Technical environmental standards and inspection-quarantine measures represent the most widely used foundational form of green barriers. At their core, these measures establish clear limits for product environmental performance, energy consumption, pollutant emissions, and food safety and hygiene via mandatory technical regulations, product benchmarks, and conformity assessment processes. Professional testing bodies are commissioned to carry out import inspections, and products that fail to meet requirements are either banned from entering the market or subject to mandatory return. Japan's Positive List System, the EU's REACH regulation, and U.S. energy efficiency access standards for mechanical and electrical products all sit within this category [28]. Official statistics show that annual export losses for China due to non-compliance with these measures exceed 30 billion USD, with agricultural products making up more than 60 % of these losses, making the sector the most heavily impacted.

Carbon border adjustment measures, commonly known as carbon tariffs, have emerged as one of the most rapidly expanding new trade barriers in recent years. Their core operating logic is to impose additional tariffs on imported goods based on the embedded carbon emissions across the full production chain, aligned with the carbon pricing benchmarks of the importing country. These measures are designed to address the risk of “carbon leakage”, while simultaneously mandating that companies submit comprehensive carbon footprint accounting reports.

The European Union's Carbon Border Adjustment Mechanism (CBAM) entered its transitional phase in 2023 and is set for full implementation in 2026. It will initially cover five high-energy-consuming industries including steel and aluminum, with plans to gradually expand to additional sectors in the coming years [4]. Industry estimates indicate that the annual compliance costs for Chinese exports of related goods to Europe will rise by more than 10 billion euros.

Green certification and eco label access systems operate on a voluntary basis, yet carry de facto market entry restrictions. Administered by independent third-party bodies, products that do not secure certification are not formally banned from entering a market, but

routinely face barriers to accessing mainstream retail channels and large supermarket chains, ultimately eroding their competitive edge in the market. The EU Eco label, PEF certification framework, and ISO14067 carbon footprint accounting standard all fall within this category [55]. These barriers have a disproportionate impact on small and medium-sized export enterprises: high certification costs and limited technical capacity mean these firms often struggle to meet strict certification requirements, leaving them at risk of being pushed out of the market entirely.

Supply chain environment and sustainability regulations have emerged as complex barriers since 2024. Their core is to impose mandatory requirements on the environmental sustainability and social responsibility of the entire product supply chain, extending the regulatory scope to upstream raw material extraction and production and processing stages, requiring enterprises to conduct supply chain environmental due diligence and disclose relevant information. The EU's Critical Raw Materials Act (CRMA) and Corporate Sustainability Due Diligence Directive (CSDDD) reflect this trend, forcing Chinese export companies to restructure their supply chain systems and strengthen environmental management of upstream suppliers.

Green packaging and waste recycling regulations mainly impose mandatory requirements on packaging materials, recyclability, recycled material content, and waste recycling responsibilities. They prohibit the use of highly polluting or non-degradable packaging materials, while also requiring companies to undertake obligations for packaging waste recycling.

The EU's Packaging and Packaging Waste Regulation (PPWR), WEEE Directive, and RoHS Directive all fall into this category [58]. As a result, influenced by these regulations, Chinese export companies have seen compliance costs increase by an average of 10 %-15 % due to packaging material upgrades and recycling system setup, with some small and medium-sized enterprises unable to bear the burden.

Environmental Impact Assessment and Market Access Ban: Through mandatory environmental impact assessments, the environmental impact of imported products during production, use, and disposal is comprehensively evaluated, directly prohibiting products that do not meet environmental requirements from entering the country. The EU's

Sustainable Products Regulation (SPR) and the U.S. import ban on raw logs and forest products fall into this category [56]. Some of China's high-pollution chemical products and primary forest products are banned from entering European and American markets for failing to pass environmental impact assessments, severely restricting export channels.

1.2 Characteristics and international implementation mechanisms of green barriers

Based on the international trade practices from 2022 to 2025 and the actual impact of green barriers on China's foreign trade, the core features of green trade barriers are concentrated in six aspects. These features are intertwined and mutually reinforcing, together forming a real obstacle to the high-quality development of China's foreign trade.

First, the dual attributes of green barriers are highly prominent, with the coexistence of legitimate environmental protection goals and hidden trade protectionism serving as their most fundamental characteristic. Green trade barriers draw their legitimacy from the global consensus on ecological and environmental protection, and when designed appropriately, can guide enterprises to optimize production processes, reduce environmental pollution, and support the delivery of global carbon neutrality targets. However, as rule-making authority has long been concentrated in the hands of developed economies, these barriers are frequently embedded with hidden trade protection functions. Leveraging their leading technological advantages, developed economies set standards that far exceed the technical and economic capacity of developing nations, creating what are effectively “trade barriers hidden behind a veneer of legal legitimacy.” The environmental standards set by the European Union, for example, are framed as measures to advance global environmental protection, yet in practice are designed to shield its domestic high-energy-consuming industries and restrict competitive exports from developing countries. This dual nature makes it extremely difficult for developing nations to clearly define the legitimacy of specific measures when formulating responses, often leaving them in a reactive, passive position.

Highly covert and not easily triggering international countermeasures, this is significantly different from traditional trade restriction measures such as tariffs and quotas. Green trade barriers are hidden under legitimate titles such as 'environmental protection' and 'public health,' and their trade-restricting effects are indirectly reflected through technical standards and certification requirements, making them difficult to detect and hard to classify as illegal trade protection measures. When developed countries revise product environmental standards, it may seem like normal policy adjustments, but in fact, it is aimed at raising market access thresholds. If developing countries attempt countermeasures, they are often accused of 'ignoring environmental protection,' putting them at a disadvantage in public opinion. Data from China's Ministry of Commerce show that China has been the country with the highest number of special trade concerns in the WTO regarding TBT/SPS for 12 consecutive years, fully highlighting the impact of this covert discrimination on China's foreign trade [47; 61].

The trend toward systematization and complexity is obvious, with prominent superimposed effects. Currently, green trade barriers are no longer merely a single technical standard or quarantine measure; instead, they have formed a complex system with multiple policy linkages and full-dimension coverage. Developed economies such as the European Union have established a green trade regulatory system covering the entire product life cycle through coordinated regulations, including carbon tariffs, supply chain management, product standards, and certification systems. This superimposed effect exponentially increases the compliance difficulty and costs for enterprises. When Chinese photovoltaic companies export to the EU, they must simultaneously meet technical standards, carbon footprint certification, supply chain sustainability requirements, and prohibitions on forced labor. The accumulation of multiple compliance requirements significantly raises export costs and market access difficulty.

The pace of dynamic upgrades is fast, and compliance costs continue to rise. With the global awareness of environmental protection increasing and technology continuously advancing, the green trade standards in developed economies are continuously tightening, and the frequency of revisions is accelerating. The European Union revises more than 300 environmental technical standards each year; Japan's "Positive List System" is constantly

increasing the types of pesticides and residue limits under control; the United States is also continuously updating energy efficiency standards for electromechanical products. This dynamic upgrading requires China's export enterprises to continuously invest resources, track, and adapt to new standards, which not only increases compliance costs but also faces export risks caused by untimely updates of standards. Some small and medium-sized enterprises are gradually being pushed out of the international market because they find it difficult to keep up with the pace. [8]

Country-specific heterogeneity and discrimination are significant, and the issue of imbalanced rule-making power is prominent. There are obvious country-specific differences in green trade barrier standards, and standards set by developed economies have not fully taken into account the development stages and technological levels of developing countries, with discriminatory characteristics being very pronounced. For example, the EU's carbon footprint requirements for our photovoltaic products are much higher than those for its domestic enterprises, and Japan's pesticide residue limits for our agricultural products are stricter than those of other developed countries. At the same time, the power to set global core rules for green trade is highly concentrated in developed economies such as the EU and the US, and developing countries like ours lack a voice and can only passively adapt to existing rules, which further exacerbates trade injustice.

Finally, these measures are backed by strong legal enforceability and full lifecycle supervision, creating highly tangible binding effects on exporters. Green trade barriers are underpinned by formal domestic legislation in importing countries, granting them significant legal enforceability. Enterprises that fail to comply with these regulations face severe penalties, including the return of goods, heavy fines, permanent market bans, and even permanent exclusion from the target market. The scope of regulatory oversight has expanded to cover the entire lifecycle of products, from raw material extraction, production and processing, packaging and transportation, through to end-of-life recycling and disposal, with clear environmental requirements set for every stage of the process. This places significantly higher demands on the end-to-end compliance management of China's manufacturing supply chains. The EU CSDDD, for example, explicitly requires enterprises to conduct full due diligence on the environmental performance of upstream raw material

suppliers. If suppliers are found to have committed environmental violations, downstream exporting enterprises can be held directly and jointly liable for those breaches.[7]

The implementation of green trade barriers relies on a multi-level, multi-entity linked institutional system, mainly composed of four core parts: national domestic legislation, regional trade agreements, multilateral international rules, and the behavior of market entities. This forms a comprehensive, multi-level implementation mechanism, where each mechanism works in coordination and support with others to ensure the effective implementation of green trade barriers.

Figure 2 depicts the hierarchical structure of this international implementation mechanism and its impact on Chinese export enterprises, as shown below:



Figure 2 – International implementation mechanism of green grade barriers [6]

“Domestic Law Enforcement Mechanisms at the National Level” is the core source of rigidity in the green trade barrier system and the key guarantee for the barrier's eventual implementation. Major developed economies have all incorporated green trade regulations into their domestic legal systems through formal legislative procedures, establishing a complete enforcement and regulatory closed loop. EU regulations such as CBAM, CRMA, and CSDDD are issued in the form of EU regulations and have direct legal effect in all member states without requiring separate national legislation; the United States, on the other

hand, has established a comprehensive green barrier legal system through a series of laws including the Clean Air Act, the Toxic Substances Control Act, and the Food, Drug, and Cosmetic Act, clearly defining the standards for implementing various measures and the rules for penalties. In the enforcement process, the customs, environmental protection authorities, and market regulation departments of the importing countries work together to form a closed loop of 'entry inspection – process supervision – violation punishment': customs are responsible for entry compliance review and sampling inspections, environmental protection authorities assess the environmental impact of products, and market regulatory authorities conduct follow-up supervision after the products enter the market. If Chinese exporting enterprises fail to meet the domestic legal requirements of the importing country, they will directly face consequences such as returned goods, heavy fines, and market bans, resulting in significant economic losses. [5;7]

As regional economic integration continues to deepen, regional trade agreements have emerged as a key vehicle for the global expansion of green barrier rules, and a primary channel for developed economies to export their domestic green regulatory frameworks. Today, every high-level regional trade agreement worldwide includes dedicated chapters on environment and sustainable development, cementing green trade rules as a core component of modern trade governance. Some agreements even go so far as to make the alignment of environmental standards a non-negotiable precondition for signing free trade agreements (FTAs). While the European Union constructs a unified internal green regulatory system, it also positions its domestic environmental standards and certification frameworks as a core prerequisite for signing FTAs with third countries, actively driving the global export of its green rule set. High-level FTAs including the United States-Mexico-Canada Agreement (USMCA) and the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) contain stringent environmental provisions, covering areas including carbon emission reduction, biodiversity protection, and waste recycling and management. For China, the TBT/SPS measures coordination mechanism established under the Regional Comprehensive Economic Partnership (RCEP) has delivered tangible facilitation for exports to ASEAN and other member states, reducing the obstacles created by green trade barriers within the region. At the same time, the high-level environmental provisions

embedded in the CPTPP and the EU's bilateral FTAs create elevated regulatory pressure on China's foreign trade, forcing China to accelerate the alignment of its domestic green rules with high-level international standards.

The WTO's TBT Agreement and SPS Agreement are the core multilateral legal bases for the implementation of global green trade barriers. They provide basic guidelines for countries to implement green trade measures and offer channels for developing countries to respond to illegal green barriers. The TBT Agreement specifies three main principles for members when formulating and implementing technical regulations and standards: non-discrimination, necessity, and transparency. It requires that technical measures should not impose unnecessary restrictions on international trade and must be notified in advance with a reserved period for comments. The SPS Agreement makes specific provisions for food safety and animal and plant health measures, allowing members to take necessary actions, but these must be based on scientific principles and must not restrict trade disguisedly. The core of this mechanism includes a notification system and a dispute settlement mechanism: the notification system requires members to notify drafts of TBT/SPS measures in advance through the WTO e ping system, reserving at least a 60-day period for comments, during which other members can raise objections; the dispute settlement mechanism provides a legal channel for members to respond to illegal barriers. If a member believes that another member's green trade measures violate WTO rules, it can bring a lawsuit to the WTO dispute settlement body [23]. However, since the WTO agreements are relatively vague in defining the legality of environmental measures, and developing countries lack professional technical support and funding in dispute settlements, this mechanism has very limited restraining effect on developed countries' abuse of green barriers. This is also one of the key reasons why China's foreign trade frequently encounters barrier shocks.

Beyond government-led mandatory regulations, soft implementation mechanisms driven by multinational corporations, global brand owners, and industry associations have become an increasingly influential component of the green barrier system. In some sectors, these market-led mechanisms create entry requirements that are even stricter than official government regulations. Large multinational enterprises including Walmart, Apple, and Volkswagen have established their own internal green procurement standards and

sustainable supply chain guidelines, which mandate that upstream suppliers meet stringent environmental, carbon emission, and social responsibility requirements. Suppliers that fail to meet these requirements face removal from the approved vendor list [26]. For instance, Apple requires all its global suppliers to power their production with 100 % renewable energy, while Walmart mandates that all suppliers submit detailed product carbon footprint reports, with non-compliant suppliers losing access to purchase orders. Industry associations also drive the implementation of green trade rules by developing industry self-regulatory standards. For example, the environmental standards for photovoltaic products set by the European Solar Industry Association are more rigorous than the official EU regulatory standards. This category of soft market mechanism has a disproportionately broad impact on China's small and medium-sized export enterprises. These firms must not only comply with the formal mandatory regulations of importing countries, but also adapt to the private voluntary standards set by downstream global brand owners. This dual compliance requirement further intensifies the pressure on these enterprises, while also accelerating the global spread and adoption of green trade barrier rules.

1.3 Global trends in environmental regulations affecting trade

Currently, developed economies have completely moved beyond the limitations of single environmental technical standards, centering on carbon regulations to build a composite green trade rule system with multi-regulatory interaction and full-chain coverage. The synergy and binding nature of the rules continue to strengthen, becoming the core development direction of global green trade barriers. As the leader of this system, the European Union, with the “European Green Deal” as its top-level design, has formed a complete policy matrix centered on the Carbon Border Adjustment Mechanism (CBAM), the Critical Raw Materials Act (CRMA), and the Corporate Sustainability Due Diligence Directive (CSDDD), showing a clear step-by-step implementation feature and gradually achieving green control over the entire industrial chain [4; 21].

In terms of implementation pace, the EU launched the CBAM transition period in October 2023, requiring six high-energy-consuming industries including steel, aluminum,

and cement to complete carbon emissions reporting, laying the foundation for subsequent carbon tariff collection; in 2026, CBAM will be formally implemented, collecting carbon tariffs on relevant imported products based on actual carbon emissions and EU carbon market prices, and will gradually expand to downstream manufactured products; from 2026 to 2030, the Digital Product Passport (DPP) will be promoted to achieve digital traceability of full-life-cycle environmental data of products, further improving the full-chain regulatory system. This step-by-step approach not only ensures the feasibility of policy implementation but also continuously raises market access thresholds, placing higher requirements on the compliance capabilities of exporting enterprises.

Although the United States has not established unified federal-level carbon barrier legislation, it has built a uniquely characteristic green trade barrier system through the coordinated linkage of legislative proposals and industrial policies. Its proposed Clean Competition Act (CCA) focuses on the carbon intensity of high-carbon products and plans to impose a carbon tax on imports and domestic products that exceed the U.S. industry average, gradually extending coverage from primary products to downstream manufactured goods. The Inflation Reduction Act (IRA), on the other hand, effectively forms protective measures for the green industry through massive subsidies for domestic clean energy and electric vehicle industries, indirectly constituting non-tariff trade barriers. In addition, the U.S. and Europe have promoted coordination of carbon rules through cooperative frameworks such as the U.S.-EU Green Steel and Aluminum Alliance, attempting to form a regional green trade rule alliance and further strengthen their dominance over global trade [6].

The construction of such a composite rule system has made the cumulative effect of green trade barriers increasingly prominent. Chinese export enterprises, especially those in high-energy-consuming industries, must simultaneously meet multiple compliance requirements such as carbon footprint accounting, supply chain due diligence, and green certification. This significantly increases compliance difficulty and costs, severely weakening traditional price competition advantages. It also compels enterprises to accelerate low-carbon technology upgrades and the construction of compliance systems in order to adapt to changes in global green trade rules. Table 2 presents the detailed implementation

timelines, issuing bodies, core contents and main affected Chinese industries of major global green trade regulations from 2023 to 2030, as shown in the following data:

Table 2 – Below presents the implementation timelines of major global green trade regulations from 2023 to 2030 [5; 6; 53]

Time	Regulation Measure /	Issuing Body	Core Content	Main Affected Industries in China	Data Source
Oct 2023	CBAM Transition Period	European Union	Carbon emission reporting for six high-energy-consumption industries	Iron and steel, aluminum, chemical industry	European Commission Official Website
Jan 2024	Critical Raw Materials Act (CRMA)	European Union	Requirements for local proportion and dependency reduction of critical raw materials	New energy, electronics, automotive	Official Journal of the EU
Jan 2025	Corporate Sustainability Due Diligence Directive (CSDDD)	European Union	Full supply chain environmental and human rights due diligence	All export manufacturing	Official Journal of the EU
Jan 2026	Full implementation of CBAM	European Union	Formal carbon tariff collection, certificate surrender system	Iron and steel, aluminum, cement, fertilizer	European Commission Official Website
2026–2030	Digital Product Passport (DPP)	European Union	Digital traceability of environmental data over product lifecycle	Electronics, textiles, automotive	European Commission Proposal
2028	CBAM expansion to downstream products	European Union	Coverage extended to auto parts, home appliances, etc.	Automotive, home appliances, machinery	European Commission Roadmap
2030	Full implementation of Packaging and Packaging Waste Regulation (PPWR)	European Union	50% recycled content in plastic packaging	Food, light industry, electronics	Official Journal of the EU

The regulatory boundaries of global environmental governance are continuously breaking through the limitations of traditional end-product control, gradually forming a closed-loop regulatory model of “full lifecycle + full supply chain”. At the same time, green trade rules are showing a global expansion trend, but the issue of polarized rule-making authority remains prominent, constituting the current dual pattern of global green trade governance.

In terms of regulatory boundary extension, traditional environmental regulations have mostly focused on the inspection and quarantine of end products and environmental performance review. However, current global environmental regulations have achieved coverage of the entire process and all entities, from raw material extraction, production and processing, packaging and transportation to recycling and disposal, with clear environmental requirements set for each link, while also transmitting regulatory responsibilities to upstream suppliers. The EU's CSDDD explicitly requires exporting companies to conduct environmental due diligence throughout the supply chain, thoroughly checking the environmental compliance of upstream raw material suppliers [55]. If suppliers have environmental violations, downstream exporters must bear joint responsibility. The PEF certification system forces companies to calculate the carbon footprint of products across their entire lifecycle, ensuring that environmental impacts of products are traceable and verifiable. China's manufacturing industry is deeply embedded in the global value chain, with long supply chains and a large number of small and micro upstream enterprises. Such a closed-loop regulatory model not only increases the compliance difficulty for individual companies but also raises the risk of supply chain disruptions, compelling Chinese exporters to strengthen environmental management of upstream suppliers and promoting a green transformation of the entire supply chain.

In terms of the global diffusion of rules, with the widespread popularization of the concept of sustainable development, green trade regulations have extended from developed economies such as the European Union and the United States to the global level. An increasing number of emerging economies and developing countries are beginning to actively participate in the construction of green trade rules. ASEAN is promoting the establishment of a regional carbon labeling system and creating a unified carbon footprint

accounting standard within the region; RCEP member countries, through the TBT/SPS measures coordination mechanism, are promoting the coordination of green rules within the region and reducing trade barriers; emerging economies such as Brazil and India are also gradually introducing their own green technology standards and certification systems, strengthening the environmental control of imported products, and actively integrating into the global green trade governance system [13].

At the same time, however, the authority for formulating global core rules for green trade remains highly concentrated in developed economies such as the European Union and the United States. Leveraging their technological advantages, financial strength, and international influence, they dominate the formulation of core rules such as carbon accounting methods, green certification standards, and product sustainability requirements, without fully considering the technological levels and development stages of developing countries. As a result, developing countries like China can only passively adapt to existing rules, and compliance costs continue to rise. In addition, developed economies, through regional trade agreements such as the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) and the United States-Mexico-Canada Agreement (USMCA), make their own green rules a central part of the agreements, promoting the regional spread of rules. This further reinforces the polarization of rule-making authority, exacerbates the unfairness of global trade, and poses a severe challenge to the long-term stable development of China's foreign trade.

It is worth noting that digitalization and intelligence have become important supports for the implementation of green regulations. Initiatives such as the EU CBAM digital declaration platform and digital product passports have significantly improved regulatory efficiency and accuracy, while also placing higher demands on the environmental data management capabilities of our export enterprises, promoting the deep integration of green transformation and digital transformation, and becoming an inevitable choice for our export enterprises to cope with changes in global green trade rules.

Chapter 2 The multidimensional impact and core challenges of green barriers on china's foreign trade

2.1 The macroeconomic overall impact of green barriers on china's foreign trade

The global trade rules system is rapidly being reconstructed in a greener direction. Climate change issues, through tools such as carbon tariffs, carbon footprint certifications, and green technology standards, have deeply embedded themselves into the international trade rules system. For China, the world's largest trader in goods, the tightening of external green regulations is no longer a distant background constraint, but a reality that must be faced.

The evolution of the European Union's Carbon Border Adjustment Mechanism (CBAM) is quite emblematic – its transition period began in 2023, and it officially enters the substantive levy phase in January 2026, marking the global first systematic carbon border adjustment tool's leap from institutional design to practical implementation. Almost simultaneously, the EU's Critical Raw Materials Act (CRMA) came into effect in 2024. CBAM constitutes an explicit tariff constraint, while CRMA creates implicit non-tariff barriers in the raw material acquisition stage; the two are not simply parallel but form a mutually reinforcing composite regulatory network, whose cumulative effect on Chinese exports far exceeds the linear addition of a single policy. More importantly, the nature of carbon footprint management is undergoing a leap. The EU Battery and Waste Battery Regulation, effective in 2023, is a watershed, transforming the carbon footprint from a previously voluntary label into a mandatory entry threshold for the EU market. This section intends to analyze from three dimensions: export scale and trade costs, trade structure and market layout, and macroeconomic related indicators [24].

The direct impact of green barriers on China's exports is first reflected in the rigid increase of enterprises' compliance costs. Existing studies mostly focus on measuring the total amount of compliance costs, but generally neglect the fact that the cost generation logic of different green regulatory instruments essentially differs. Among them, implicit

compliance costs not only last longer but are often underestimated by many enterprises due to their difficulty to quantify.

Regarding carbon tariffs, the CBAM requires importers to purchase certificates based on the embodied carbon emissions of products, and the certificate price is dynamically linked to the carbon price of the European Union Emissions Trading System (EU ETS) – settled at the quarterly average in 2026, and from 2027 onwards, changed to the weekly average. This means that Chinese enterprises face not a fixed tax rate but a fluctuating cost that varies with the European internal carbon market. Based on simulations using a global trade analysis model, when the EU carbon price difference reaches \$120/tCO₂, the export costs of China's basic metals industry to Europe increase by approximately 11.84%. Other studies estimate that during the initial implementation of CBAM, China's export costs of steel and aluminum to Europe will increase by about 4 %–6 % and 9 %, respectively.

In contrast, the pressure brought by carbon footprint regulation is more covert and harder to summarize with a single number. According to the evolution of international carbon footprint standards: in 2008, the British Standards Institution released PAS2050, pioneering the global evaluation of product carbon footprints; in 2018, the International Organization for Standardization (ISO) provided a general accounting framework through ISO14067; and the GHG Protocol, jointly developed by the World Resources Institute and the World Business Council for Sustainable Development, has been widely applied at the corporate level. However, these standards are essentially voluntary tools, giving companies considerable discretion in defining accounting boundaries, selecting data, and determining the extent of disclosure. The EU Battery and Waste Batteries Regulation has completely rewritten the rules of the game – the regulation requires that electric vehicle batteries exported to the EU calculate carbon footprints according to EU rules and undergo certification by February 2025, be graded starting from August 2026, and have limits set starting from February 2028, with products exceeding the limits being banned from sale [55]. As a result, the carbon footprint has turned from an 'optional item' into a 'passing line,' and the regulatory logic has shifted from information disclosure to market access.

Therefore, based on the cost characteristics of the above three types of regulatory tools, the incremental compliance costs for companies can be broken down into three core

dimensions: first, investment in green transformation on the production side, mainly including the introduction of clean production technologies, the replacement of high-energy-consuming equipment, and the substitution with renewable energy; second, certification and data monitoring expenses, covering full lifecycle carbon footprint accounting, third-party verifications, and the construction of supporting data systems --the new regulation requires companies to establish a refined data system covering the entire chain from 'raw material extraction- production and manufacturing - transportation and sales - recycling,' the complexity of which is far higher than that of previous voluntary standards [55]; third, supply chain restructuring costs, including switching to low-carbon transportation methods and raising green entry standards for upstream suppliers.

What is particularly noteworthy is that the new EU regulations fundamentally change the requirements for data quality: traditional international standards allow companies to use industry-average secondary data for accounting, whereas the EU Battery and Waste Batteries Regulation explicitly requires that, after February 2025, power batteries exported to the EU must use the company's own primary production data, and the data across the entire supply chain must be independently verified by an EU-recognized third-party institution [55]. According to comprehensive industry estimates, for the first batch of companies covered by CBAM and the Battery Regulation, the comprehensive cost per unit of exported products will increase by 8 %–12 %; among them, small and medium-sized enterprises with annual revenues below 50 million yuan are in the most difficult position - they usually lack dedicated compliance teams and complete supply chain data management systems, and often struggle in the primary data collection phase.

The trend of changes in export scale is also worth examining in detail. Between 2018 and 2025, although China's total goods exports continued to grow, the growth rate fluctuated significantly (see table 3). In 2018, the export value was 16,417.7 billion yuan, an increase of 7.1 % year-on-year; in 2021, driven by the global demand recovery, the growth rate once rebounded to 21.2 %; thereafter, it gradually declined, reaching only 0.6 % in 2023 and rising again to 6.1 % in 2025. Of course, the fluctuations in export growth are influenced by multiple overlapping factors – global economic cycles, pandemic shocks, and geopolitical frictions all play a role. But an undeniable fact is that increasingly stringent green regulations

form a structural backdrop that suppresses export momentum, particularly in the growth low of 2023, where their cumulative effect may not be negligible. Analysis based on a dynamic general equilibrium framework shows that the combined green trade barriers formed by the linkage of CBAM and CRMA have a “nonlinear inhibitory effect” on China's exports. The interaction of the two policies causes the decline in exports to exceed the maximum decline caused by a single policy, showing an excess inhibitory characteristic of a 'compliance cost spiral.' In industries with high carbon intensity and high dependence on raw materials, the marginal effect rate of this linkage reaches as high as 22.54 % [57]. Table 3 shows the total goods export value and year-on-year growth rate of China from 2018 to 2025, as shown in the following data:

Table 3 – Total goods export value and growth rate of China from 2018 to 2025 [32; 33; 34; 35; 36; 37; 38; 39]

Year	Export Value (100 Million Yuan)	Growth Rate (%)
2018	164177	7.1
2019	172342	5.0
2020	179326	4.0
2021	217348	21.2
2022	239654	10.5
2023	237726	0.6
2024	254545	7.1
2025	269890	6.1

If the observation period is extended, it can be seen that the effect of green barriers is far more than a short-term squeeze on costs; it is reshaping the deep structure of China's foreign trade. According to the general experience of developing countries, green trade barriers often exhibit a “dual effect”: strict environmental standards and technical certifications certainly raise market entry thresholds, causing traditional labor-intensive products to shrink because they fail to meet environmental requirements; on the other hand, this external pressure also forces export enterprises to adjust certain structures of their products, guiding them toward high-tech, high value-added, and environmentally friendly directions [43].

China's recent years of export practice also provide empirical material for this judgment. Between 2018 and 2025, exports of the 'new trio' – electric vehicles, lithium

batteries, and photovoltaic products – expanded rapidly: the production of new energy vehicles increased from 1.15 million units in 2018 to 16.524 million units in 2025; during the same period, automobile (including new energy vehicles) exports surged to 8.32 million units, with export value reaching 1,018.3 billion yuan (see Table 4). The rise in automobile export value was partly due to the higher unit price of new energy vehicles causing a structural increase, rather than expansion in quantity. A deeper change stems from the fact that green barriers force exported products to meet ecological standards in design, material selection, and manufacturing processes, promoting a shift in the export trade model from 'quantity-based' to 'quality-based' [43]. However, this transformation is not without cost: the export space for traditional labor-intensive industries is squeezed, and some small and medium-sized enterprises choose to withdraw from high-end markets like the EU due to compliance costs, instead seeking emerging markets with relatively relaxed standards. Therefore, the coexistence of 'passive transfer' and 'active upgrading' creates a complex situation, forming a real picture of China's current foreign trade structural adjustment.

Table 4 presents the production of new energy vehicles and the overall vehicle export volume and value in China from 2018 to 2025, as shown in the following data:

Table 4 – Production of new energy vehicles and vehicle export situation in China, 2018–2025 [32; 33; 34; 35; 36; 37; 38; 39]

Year	Car Export Volume (ten thousand units)	Car Export Value (100 million yuan)
2018	115	972
2019	112	1049
2020	108	1090
2021	212	2227
2022	332	4054
2023	522	7165
2024	641	8347
2025	832	10183

Empirical tests based on panel data of Chinese provinces and industries from 2002 to 2020 show that the long-term technological upgrading effect of green trade barriers is significant. For every 1 percentage point increase in their intensity, the average export technology complexity of China's manufacturing industry increases by 0.689 percentage

points. This result remains robust after replacing core explanatory variables and conducting instrumental variable tests. Mechanism tests further indicate that green barriers, through competition effects and innovation incentives, force manufacturing enterprises to increase technological innovation to improve export technology complexity. Moreover, in regions with higher marketization levels and stronger industrial agglomeration, this promotion effect is more pronounced [47]. However, this conclusion also reveals a fact that can easily be obscured by average effects: the impact of green barriers varies significantly across industries with different technology levels. The promotion effect is strongest for high-technology industries (coefficient 0.927), followed by medium-technology industries (0.790), and weakest for low-technology industries (0.171) [47]. This means that green barriers objectively accelerate the transformation of China's export product structure toward greenness and high-end development, but the benefits are not evenly distributed – the technology-intensive industries receive stronger upgrading incentives, while low-technology industries may face the dilemma of 'high compliance costs that are difficult to offset through technological upgrading'.

Adaptive adjustments in market layout represent another major structural change. From the export data to major trading partners between 2018 and 2025 (see table 5), China's export growth to markets with stringent green regulations such as Europe and the United States has relatively slowed, while exports to emerging markets such as ASEAN and countries along the Belt and Road have maintained rapid growth. In 2018, China's exports to the EU accounted for 16.4 % and to the US 19.2 %; by 2025, the share to the EU slightly decreased to 14.8 %, while the share to the US dropped significantly to 11.1 %. During the same period, exports to ASEAN increased from 12.8 % to 17.6 %, making ASEAN the largest export destination for China. This shift in market focus, although partly driven by institutional arrangements such as the Regional Comprehensive Economic Partnership (RCEP), also reflects the 'push effect' created by the strengthening of green barriers in developed markets and should not be overlooked. Simulation analysis shows that under a high-intensity composite green trade barrier scenario, China's exports to Europe decline by 9.45 %, while exports to third-party markets such as the US, UK, and Japan experience structural growth, indicating significant trade diversion effects in the global trading pattern

[57]. However, the sustainability of this shift is questionable: if emerging markets like ASEAN gradually tighten their green standards in the future, Chinese export enterprises may face a new round of regulatory adaptation pressure, and the 'dividend from the shift' could quickly dissipate. In fact, some ASEAN countries have already begun formulating their own carbon footprint standards, and it is expected that a mandatory carbon labeling system will be fully implemented before 2030, by which time Chinese exporters may face pressure from green regulations on a global scale. Table 5 compares the share of China's major export markets in 2018 and 2025 and their changes, as shown in the following data:

Table 5 – Comparison of China's major export market shares in 2018 and 2025 (%) [32; 33; 34; 35; 36; 37; 38; 39]

Export market	2018 Proportion	Proportion in 2025	Change
European Union	16.4	14.8	-1.6
United States	19.2	11.1	-8.1
ASEAN	12.8	17.6	+4.8
Hong Kong, China	12.2	8.9	-3.3
Japan	5.9	4.2	-1.7
South Korea	4.4	3.8	-0.6
Russia	1.9	2.7	+0.8
India	3.1	3.6	+0.5
Brazil	1.3	1.9	+0.6

We also need to pay more attention to the evolution of green barriers. The 'EU Battery and Waste Battery Regulation' has for the first time introduced the 'battery passport' system – industrial batteries, light vehicle batteries, and electric vehicle batteries placed on the EU market after January 1, 2026, must have online accessible electronic records covering comprehensive data such as carbon footprint, material composition, recycling content, and supply chain information[55]. This innovation signifies that green barriers have evolved from single carbon accounting to full lifecycle transparency governance, representing typical characteristics of 'Green Regulation 2.0.' For Chinese export enterprises, compliance requirements have expanded from 'calculating carbon well' to 'managing data well.' The integrity, traceability, and transparency of data are becoming a new dimension alongside traditional price competitiveness. It can be expected that the future competition over green

barriers will largely turn into a contest of data governance capabilities and supply chain transparency.

The impact of green barriers does not stop at the customs declaration stage. Taking steel exports as an example, when the cost of exports to Europe rises by about 4 %-6 % due to CBAM, enterprises either compress profits or reduce production the latter directly affecting jobs in regions such as Hebei and Liaoning. Furthermore, this pressure is transmitted upstream along the supply chain to the iron ore and coking industries. From a macro perspective, composite green barriers (such as the linkage of CBAM and CRMA) not only lead to bidirectional GDP losses for both China and the EU (under high-intensity scenarios, Chinese GDP decreases by 0.20 % and the EU by 0.43 %), but also drive the regional reorganization of global value chains [57]. While green barriers cause a contraction in the market share of some enterprises, they also provide an external driving force for the macroeconomic green transition by promoting green technological innovation and industrial upgrading. This section intends to examine the macro transmission effects of green barriers from the dimensions of net export contributions to GDP growth, changes in foreign direct investment flows, energy consumption, and carbon intensity. At the same time, since macroeconomic indicators are influenced by multiple intertwined factors, the following analysis aims to reveal possible lines of influence of green barriers rather than establish strict causal attribution.

Changes in the contribution of net exports to economic growth provide a window for observation. Between 2018 and 2025, the pull of net exports of goods and services on GDP growth fluctuated significantly (see table 6). In 2018, the contribution rate of net exports to GDP growth was -8.6 %, and in 2019, the contribution rate was 11.0 %; between 2020 and 2025, the pull of net exports on GDP growth fluctuated between -0.6 and 1.7 percentage points. This fluctuation feature corresponds in some way to the phased strengthening of global green trade regulations: when major trading partners intensively introduced green barrier measures, China's exports of high-carbon products were hindered, and the contribution of net exports to growth correspondingly weakened. Analysis based on dynamic general equilibrium found that the inhibitory effect of green barriers shows a three-stage dynamic characteristic over time: 'short-term rigidity, medium-term elasticity release,

and long-term lock-in [57]. This means that the fluctuations in the contribution of net exports are not short-term disturbances but the temporal manifestation of the long-term impact of green barriers. In 2023, the pull of net exports was -0.6 percentage points. Although it cannot be entirely attributed to green barriers, the cumulative effect of these barriers is very likely to be one of the background factors suppressing export momentum. Table 6 shows the driving effect of the three major demands (final consumption, capital formation and net exports) on China's GDP growth from 2018 to 2025, as shown in the following data:

Table 6 – The driving effect of the three major demands on GDP growth from 2018 to 2025 [32; 33; 34; 35; 36; 37; 38; 39]

Year	GDP Growth Rate (%)	Final consumption contribution (percentage points)	Capital formation pull (percentage points)	Net export contribution (percentage points)
2018	6.6	–	–	–
2019	6.1	–	–	– ¹
2020	2.3	-0.5	2.2	0.7
2021	8.1	5.3	1.1	1.7
2022	3.0	1.0	1.5	0.5
2023	5.2	4.3	1.5	-0.6
2024	5.0	2.2	1.3	1.5
2025	5.0	2.6	0.8	1.6

¹ The 2018–2019 bulletins did not publish sub-item contribution data in the form of 'percentage point pull,' only the contribution rates were published. In 2018, the contribution rate of final consumption was 76.2%, the contribution rate of capital formation was 32.4%, and the contribution rate of net exports was -8.6%; in 2019, the contribution rates of the three were 57.8%, 31.2%, and 11.0%, respectively.

The changes in the sectoral flow of foreign direct investment (FDI) also reflect the transmission effect of green barriers. Between 2018 and 2025, the proportion of actual foreign investment used in high-tech industries (including high-tech manufacturing and high-tech services) continued to rise (see table 7). In 2018, the actual use of foreign investment in high-tech manufacturing was 89.8 billion yuan, an increase of 35.1 %; starting in 2019, the bulletins published full-caliber data for high-tech industries, with actual foreign investment reaching 266 billion yuan that year, accounting for 28.3 % of total FDI; by 2025, actual foreign investment in high-tech industries reached 241.8 billion yuan, accounting for 32.3 % of total FDI. The concentration of FDI in green, low-carbon, and high-tech areas is

not only the result of domestic industrial policy guidance but also related to multinational companies adjusting global supply chain layouts to avoid green barriers – foreign-invested enterprises tend to locate production in regions with relatively complete environmental regulations and green supply chain support to reduce the carbon footprint of their products and meet the green market access requirements of target markets. New regulations, through mechanisms such as carbon footprint limits and digital passports, are indirectly promoting the transfer of global supply chains to low-carbon regions [55], a trend that is already reflected in the flow of FDI in high-tech industries.

However, the data in table 7 shows some uncertainty. Between 2023 and 2025, both the actual use of foreign investment in high-tech industries and its proportion of total FDI declined – from 444.9 billion yuan (36.1 %) in 2022 to 241.8 billion yuan (32.3 %) in 2025. Whether this reversal is due to a weakening green barrier effect or other factors such as the overall contraction of global FDI and rising geopolitical risks cannot be determined at present. But at least this phenomenon reminds us that the guiding effect of green barriers on FDI is not linearly increasing and exists within a more complex global investment environment. Table 7 lists the actual utilization of foreign investment in high-tech industries from 2018 to 2025, as presented below.

Table 7 – Actual utilization of foreign investment in high-tech industries from 2018 to 2025 [32; 33; 34; 35; 36; 37; 38; 39]

Year	Actual Use of Foreign Capital in High-Tech Industries/Manufacturing (100 Million Yuan)	Proportion of total FDI (%)	Growth rate (%)
2018	898(High-tech manufacturing only)	–	35.1
2019	2660(All-caliber High-Tech Industry)	28.3	25.6
2020	2963	29.6	11.4
2021	3469	30.2	17.1
2022	4449	36.1	28.3
2023	4233	37.3	-4.9
2024	2864	34.7	-32.3
2025	2418	32.3	-15.6

From the perspective of the macro effects of green development, the external pressure of green barriers and the endogenous motivation of China's green transformation have formed a certain resonance, promoting the continuous decline of energy intensity and carbon

emission intensity (see table 8). Between 2018 and 2025, the energy consumption per 10,000 yuan of GDP decreased at an average annual rate of about 2.5 %, and carbon dioxide emissions per 10,000 yuan of GDP decreased at an average annual rate of about 3.0 %. The proportion of clean energy consumption increased from 22.1 % in 2018 to 30.4 % in 2025, with a cumulative increase of 8.3 percentage points. The improvement of these indicators has created a positive feedback with the greening transformation of export products and the low-carbon transformation of the manufacturing industry: enterprises' investments in energy saving and emission reduction to overcome green barriers objectively reduce energy consumption and carbon emission intensity at the macro level; meanwhile, national green transformation policies provide institutional support and technological reserves for export enterprises to cope with green barriers. Relevant studies show that China's green production level has continued to improve during the study period, and the coupling coordination between green production and green life has evolved from being on the verge of imbalance to achieving barely coordination, indicating that green transformation has become an endogenous trend in economic development [45].

Table 8 presents the changes in energy consumption per ten thousand yuan of GDP and the proportion of clean energy consumption from 2018 to 2025, as shown below.

Table 8 – Changes in energy consumption per ten thousand yuan of GDP and the proportion of clean energy consumption from 2018 to 2025 [32; 33; 34; 35; 36; 37; 38; 39]

Year	Energy consumption per 10,000 yuan of GDP decrease rate (%)	CO2 Emission Reduction Rate per 10,000 Yuan of GDP (%)
2018	3.1	4.0
2019	2.6	4.1
2020	0.1	1.0
2021	2.7	3.8
2022	0.1	0.8
2023	—	— ¹
2024	3.8 ²	3.4
2025	5.1	5.0

1 The original text of the 2023 bulletin was 'The CO₂ emissions per 10,000 yuan of national GDP remained flat compared with the previous year.'

2 The 2024 and 2025 decline rates of energy consumption per 10,000 yuan of GDP are data calculated 'after deducting the energy used for raw materials and the consumption of non-fossil energy.'

It should be pointed out that the impact of green barriers on China's foreign trade has extended from the initial level of product compliance to macro areas such as trade structure, market layout, industrial investment, and energy consumption, exhibiting characteristics of multi-dimensional penetration and deep interconnection. This impact is not a simple linear accumulation, but presents a complex transmission path through policy linkage, industry heterogeneity, and dynamic adjustment. From the common situation of developing countries, green barriers are both a challenge temporarily increasing export costs, suppressing the growth of certain product exports, and intensifying the risk of trade friction-and an opportunity-forcing industrial green upgrading, optimizing the structure of export products, and promoting the clean transformation of the energy structure [43]. Represented by the European Union's new Battery Regulation, “Green Regulation 2.0” is upgrading the carbon footprint from a voluntary management tool to a mandatory market access threshold, and is extending regulatory reach from single carbon accounting to transparent governance of the full lifecycle data, signaling a qualitative change in the institutional form of green barriers [55]. Faced with this trend, the high-quality development of China's foreign trade is likely unavoidable along the core path of green transformation; compared with low-carbon transformation at the production end, building data capability including collection, verification, traceability, and international mutual recognition of supply chain data may become a more urgent and long-term challenge.

2.2 Analysis of the impact of green trade barriers on China's major export industries

As a new type of non-tariff trade protection measure, green trade barriers are changing the international competitive landscape of China's major export industries. As the world's largest exporter of goods, China's key export sectors, including agricultural products, textiles and apparel, light industrial products, and new energy products, are all being impacted to varying degrees by green trade barriers. Between 2018 and 2025, the total value of China's imports and exports of goods increased from 30.5 trillion yuan to 45.5 trillion yuan, with an average annual growth rate of about 5.8 %. At the same time, the number of

notifications of technical trade measures received by major export industries is also increasing, making the restrictive effects of green barriers increasingly evident. Due to differences in the production characteristics, technological levels, market structures, and capacities to comply with environmental standards among industries, the ways in which green trade barriers operate, their impact levels, and industry responses also vary significantly. This section will systematically analyze the current impact, mechanisms, and response strategies of green trade barriers on China's major export industries from the perspectives of the agricultural and food industry, the textiles, apparel and light industry, and the new energy industry.

As a traditional agricultural country, agricultural exports are an important part of China's foreign trade, and the European Union, the United States, Japan and the core RCEP member countries are the most complete markets in the global green trade barrier system with the most stringent implementation standards. Compared with industrial products, the production process of agricultural products is highly dependent on the natural environment, which involves multiple environmental aspects such as pesticide residue control, soil ecological protection, water resource utilization, and biodiversity maintenance, which also makes it easier for importing countries to implement trade restrictions in the name of “food safety” and “ecological protection” [9].

From the perspective of export scale, China's agricultural product output has maintained a steady growth trend, but the export value and output growth have not formed a synchronous match, and the crowding out effect of green barriers has gradually emerged. According to statistics, China's total aquatic product output will reach 71 million tons in 2023, a year-on-year increase of 3.4 %; in 2024, it will increase to 73.66 million tons, with a growth rate of 3.5 %; In 2025, it will further break through the 76 million tons mark, reaching 76.57 million tons, a year-on-year increase of 4.1 %. In terms of livestock and poultry products, the total output of pigs, cattle, sheep and poultry in 2023 was 96.41 million tons, a year-on-year increase of 4.5 %; In 2025, it will break through the 100 million ton mark for the first time, reaching 100.72 million tons. However, the continuous growth of production did not lead to a simultaneous increase in export value. Taking the RCEP region as an example, from 2002 to 2022, the number of SPS measures notified by other member

states to the WTO soared from 128 to 648, an increase of 4.06 times, of which Japan experienced the most rapid growth, from 22 to 354, accounting for half of the total RCEP notifications. In contrast, from 2018 to 2022, the batches of China's agricultural products detained and compulsorily recalled by the customs of developed countries have always remained high, reaching 755 batches in 2022, accounting for 55.27% of the detained batches of all export products in China, which is 2.3 times that of mechanical and electrical products and 1.8 times that of chemical products [16]. In terms of the reasons for notification, in 2022, 62.55% of the SPS notifications were made on the grounds of “animal disease prevention and control” and 28.28 % were reported on the grounds of “food safety standards”, accounting for more than 90 % of the two types of reasons combined [54]. This data clearly shows that the trade barriers faced by China's agricultural exports have shifted from traditional tariff barriers to more hidden technical restrictions with inspection and quarantine, residue limits, and environmental protection certification as the core.

Figure 3 illustrates the changes in the output of major agricultural products in China from 2018 to 2025, as shown below.

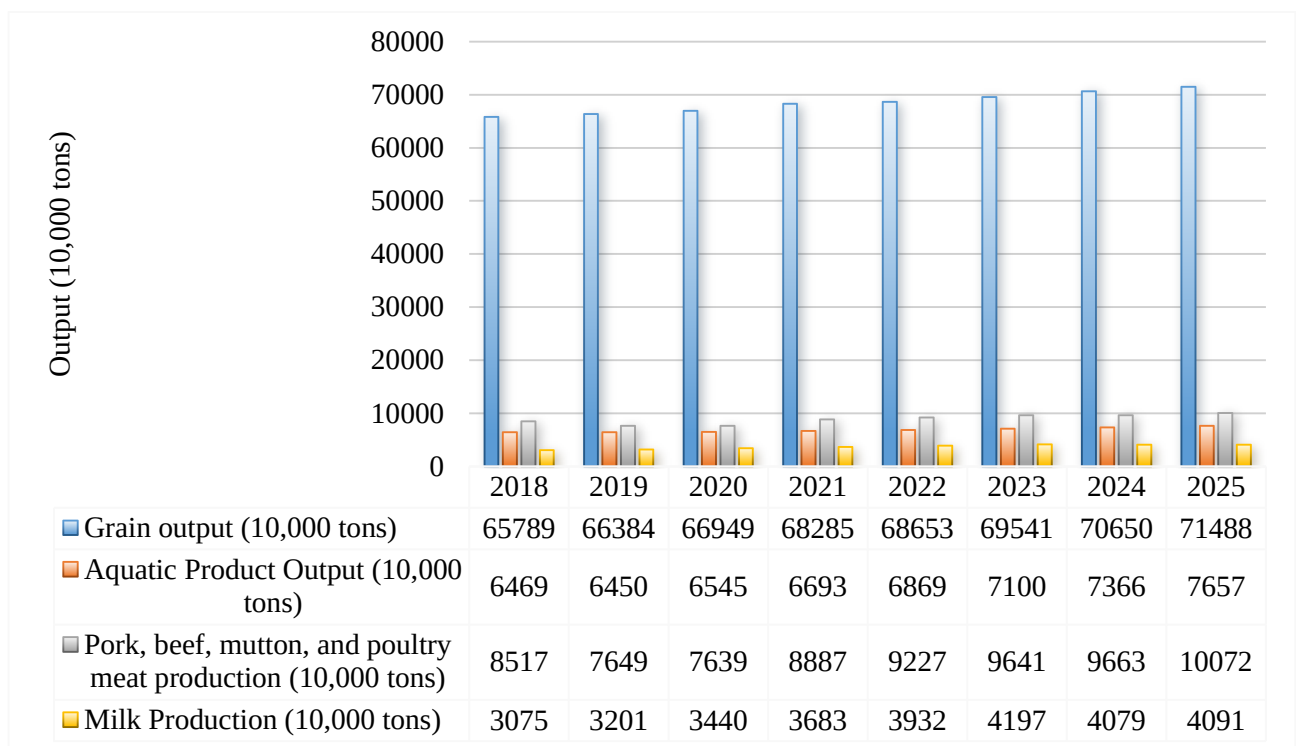


Figure 3 – Changes in the output of major agricultural products in china from 2018 to 2025 [32; 33; 34; 35; 36; 37; 38; 39]

In terms of impact, green trade barriers have a dual effect on China's agricultural product exports. On one hand, the barriers do suppress the growth of export volumes. Empirical studies show that for every 1 % increase in SPS notifications from RCEP member countries, China's agricultural exports to them decrease by approximately 0.026 %. The fixed-effects model regression results also show that the coefficient of the green trade barrier variable (LnDV) is -0.225 and is significant at the 1 % level, confirming the negative inhibitory effect of the barriers on total exports. This suppressive effect is mainly due to the increased compliance costs: in order to meet importing countries' requirements regarding pesticide residue limits, microbial indicators, environmentally friendly packaging, and so on, enterprises have to increase testing expenses, upgrade production processes, and apply for various certifications, all of which directly raise export costs and weaken the enterprises' price competitiveness [25;42].

On the other hand, green trade barriers also produce a positive forcing effect. Studies have found that the green trade barriers of RCEP member countries have a significant positive effect on the extensive margin (i.e., the diversity of export types) of China's agricultural product exports. For every additional unit of barrier, the extensive margin increases by about 0.04 units [54]. This finding also validates the applicability of the “Porter Hypothesis” in the agricultural sector: strict environmental regulations can stimulate technological innovation in enterprises and promote industrial upgrading. Specifically, in order to overcome these barriers, exporting enterprises increase investment in green planting technology research and development, introduce ecological farming models, and establish a full-process quality traceability system from field to table, thereby producing more high-value-added agricultural products that meet international environmental standards [25;42]. Structural effect theory also points out that the combination of trade liberalization and environmental requirements can guide resources from high-pollution, low-efficiency traditional agriculture to green, sustainable modern agriculture, achieving optimization and upgrading of industrial structures.

One point that needs attention is that the impact of green trade barriers shows significant differences. From the perspective of national development levels, green trade barriers in developed countries have a clearer inhibitory effect on China's agricultural

product exports, while their impact on developing countries is not significant. The main reason for this difference is that developed countries have higher technological levels, stricter environmental standards, and stronger enforcement capabilities, creating higher market entry thresholds. From the perspective of product categories, the extent and direction of the impact of barriers on animal, plant, and processed agricultural products also vary: SPS measures have a significant positive effect on the extensive margins of all three types of products, but have an inhibitory effect on the intensive margins of plant and processed products. This difference indicates that response strategies need to be formulated according to different countries and different products.

Overall, the agricultural and food industry has become the main battlefield for China in coping with green trade barriers. In the short term, these barriers have increased the cost pressures and market access difficulties for export enterprises; however, from a long-term development perspective, external pressure is being transformed into an endogenous driving force for industrial upgrading, promoting China's shift from a major agricultural product trading country to a trading power[25;42]. This transformation process requires coordination among the government, industry, and enterprises, and should be advanced through the improvement of early warning mechanisms, enhancement of quality standards, and deepening of international cooperation, in order to effectively address the challenges brought by green barriers.

The textile, apparel, and light industry sectors are among the pillar industries of China's foreign trade and are also areas that are severely impacted by green trade barriers. As the world's largest producer and exporter of textiles and apparel, China's textile industry holds an important position in the national economy. In 2023, the added value of the textile industry decreased by 0.6 % compared to the previous year, turned to a 5.1 % growth in 2024, and grew by 3.0 % in 2025. Retail sales of clothing, footwear, hats, and knitted and woven products grew by 12.9 % in 2023, only 0.3 % in 2024, and 3.2 % in 2025, showing significant fluctuations, reflecting the ongoing impact of green trade barriers on industry exports. In 2023, developed markets such as the European Union, the United States, and Japan accounted for a significant share of the total textile and apparel exports. However, with the increasing global emphasis on environmental protection and sustainable

development, developed economies represented by the EU have continuously upgraded environmental regulations, Eco-label systems, and packaging waste management standards, forming systematic green trade barriers that pose considerable challenges to the export of Chinese textile, apparel, and light industry products. In 2023, developed markets such as the EU, the US, and Japan accounted for a considerable share of the total textile and apparel exports. In recent years, the international community has placed increasing importance on environmental protection and sustainable development. Developed economies represented by the EU have continuously upgraded environmental regulations, Eco-label systems, and packaging waste management standards, forming systematic green trade barriers that have brought significant challenges to the export of Chinese textile, apparel, and light industry products. Figure 4 shows the growth of China's textile and apparel retail from 2018 to 2025, as presented below.

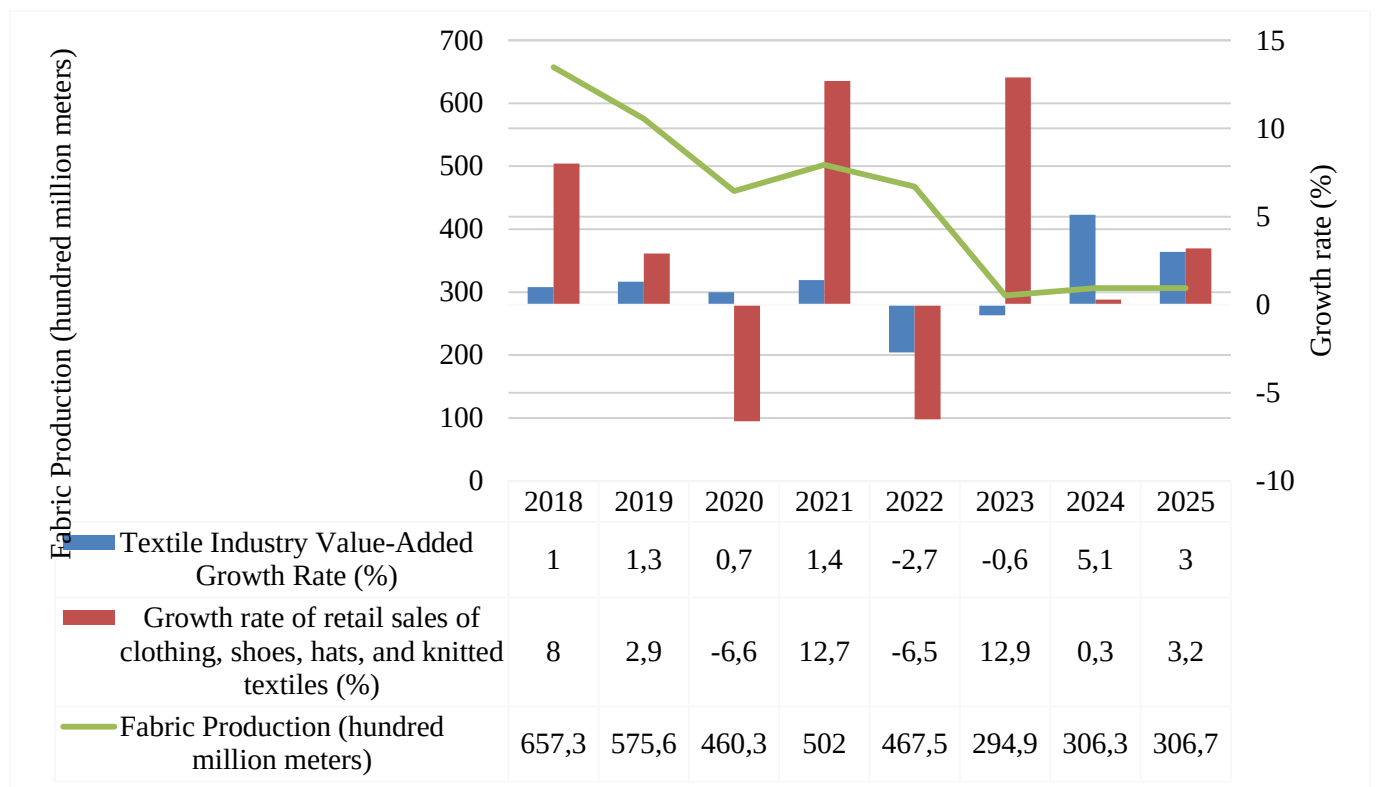


Figure 4 – Growth of China's textile and apparel retail from 2018 to 2025 [32; 33; 34; 35; 36; 37; 38; 39]

At present, the green trade barriers faced by China's textile and apparel industry have shifted from single product standard restrictions to multi-level institutional constraints

covering the entire industry chain. The EU REACH regulation implements unified management of registration, evaluation, authorization, and restriction for all chemicals and downstream products entering the EU market. As an important downstream industry of chemicals, textiles are directly and profoundly affected [15; 24]. The list of restricted chemical substances under this regulation continues to grow. Among the 12 high-concern substances newly added in 2024, 7 are directly related to textile printing and dyeing auxiliaries, leading to nearly 30 % of domestic small and medium-sized dyeing enterprises having to suspend production for rectification [19]. At the same time, the EU Eco-label and the Oeko-Tex Standard 100 certification by the International Association for Research and Testing in the Field of Textile Ecology have become 'passes' to enter the EU market. The Eco-label covers all-dimensional indicators including textile fiber raw materials, production processes, chemical usage, and product applicability, with standards updated every 3-5 years, and its certification process is complex and costly. Oeko-Tex Standard 100 is revised annually based on the latest international regulations and scientific research results, with extremely strict limit requirements for formaldehyde, chlorophenols, harmful dyes, colorfastness, and other indicators in textiles. According to the 2025 survey data from the Guangdong Textile Association, only about 15 % of textile and apparel enterprises in the province have obtained Oeko-Tex Standard 100 certification, with large enterprises accounting for as much as 70 %, while the vast majority of small and medium-sized enterprises, restricted by funding and technical capabilities, have a certification pass rate of less than 5% [11].

The EU Packaging and Packaging Waste Regulation (PPWR), which will come into effect in 2025, further raises the export threshold for China's textile and apparel products. This regulation replaces the previous Directive 94/62/EC and imposes mandatory requirements on the sustainability of packaging materials, recyclable content, and limits on hazardous substances. For example, it stipulates that the total content of four heavy metals—lead, cadmium, mercury, and hexavalent chromium—in all packaging must not exceed 100 mg/kg, and the concentration of per- and polyfluoroalkyl substances (PFAS) in food-contact packaging is strictly limited; it also requires that by 2030, the recyclable content in plastic packaging must reach between 10% and 35% [50]. These requirements directly increase the

packaging compliance costs of Chinese export products, with estimates showing an average increase of 0.5 to 1 RMB per garment for packaging. Moreover, with the gradual implementation of the EU Carbon Border Adjustment Mechanism (CBAM) and the Ecodesign for Sustainable Products Regulation (ESPR), textile and apparel products will face new green barriers such as carbon intensity accounting and mandatory carbon labeling, requiring companies to provide environmental performance data for the product's entire lifecycle [24; 30].

From the perspective of influence mechanism, green trade barriers have both short-term inhibition and long-term reversal effect on China's textile and garment exports. For now, barriers significantly inhibit export volume and market share. Empirical studies have shown that for every 1 % increase in the intensity of green trade barriers (measured by SPS/TBT circulars), Guangdong Province's textile and garment exports will decrease by about 0.325 % [11]. The impact of barriers set by developed countries is particularly significant, while that of developing countries is not, reflecting the advantages of developed countries in terms of technical standards and enforcement capabilities. From 2010 to 2020, China's textile exports only increased by 24.6 billion US dollars, and the growth rate slowed down significantly compared with the previous decade [19]. At the same time, the sharp rise in compliance costs has weakened the price competitiveness of products. In order to meet REACH regulations and obtain Eco-label or Oeko-Tex certification, enterprises need to invest a lot of money in the purchase of testing equipment, environmentally friendly material substitution, production process transformation and third-party certification, and the average cost of each certification of small and medium-sized enterprises accounts for about 5 % to 10 % of their annual profits [11]. It is estimated that the loss of China's textile and garment industry due to non-compliance with EU green testing standards exceeds 18 % of the total exports [15].

From the perspective of long-term development, green trade barriers are forcing the industry to upgrade technology and optimize structure. Regression analysis showed that the coefficients of the first and second lag coefficients of green trade barriers were -0.210 and -0.016, respectively, and the inhibitory effect gradually weakened with time, indicating that enterprises could gradually adapt to the requirements of barriers through technical

learning [11]. This effect is particularly evident in the textile printing and dyeing industry: the green barrier index is positively correlated with market concentration (correlation coefficient 0.38) and positively correlated with technological innovation investment (correlation coefficient 0.40), indicating that the improvement of environmental protection standards has prompted large enterprises to increase R&D investment and promote the innovation of cleaner production technology and alternative materials, thereby enhancing the green competitiveness of the industry to a certain extent. In addition, green trade barriers have also triggered significant industrial chain transmission effects [52; 60]. By mastering the right to formulate standards for eco-labels, the EU has made downstream international brands the actual executors of compliance supervision, while upstream printing and dyeing auxiliaries and fabric suppliers bear the main cost of technological upgrading [24; 52]. This change in the power structure of the value chain has accelerated the differentiation and integration of the textile and garment industry: leading enterprises have built a closed-loop green production system through vertical integration, while small and micro enterprises are facing increasing market exit pressure [11; 52].

From the perspective of industry differences, the impact of green trade barriers varies significantly across different product categories and enterprises of different scales. Among the three major product categories of apparel, home textiles, and functional textiles, functional textiles, with their high technological content and product added value, demonstrate stronger innovation capabilities and market adaptability during the green transformation process. In contrast, the apparel industry faces greater certification thresholds and cost pressures due to intense market competition and a high proportion of small and medium-sized enterprises (SMEs). In supporting industries such as dyeing auxiliaries, the negative impact of green trade barriers is even more pronounced. Studies show that for every 1 unit increase in the GTB index, the export volume of China's dyeing auxiliaries decreases by approximately 0.45 units. At the same time, large enterprises, with their financial and technological advantages, can more quickly obtain international green certifications and establish comprehensive green supply chain systems, while SMEs, due to limited resources, mostly can only respond passively and are at a clear disadvantage [18].

Overall, the green trade barriers faced by the textile, apparel, and light industry sectors have evolved from single product standard restrictions to multi-dimensional systemic constraints covering chemical management, Eco-labeling, packaging waste, carbon footprint, and more. These barriers increase the compliance costs and market entry difficulties for export enterprises in the short term, but in the long term, they also promote technological innovation and structural upgrades within the industry. To address this challenge, a coordinated effort by the government, industry associations, and enterprises is required: the government should accelerate the alignment of domestic environmental standards with international ones and establish a green trade barrier early warning mechanism; industry associations should organize enterprises to carry out technological breakthroughs and certification guidance; and enterprises should increase investment in green technology R&D, actively apply for international eco-label certifications, and optimize their export market layout to reduce dependency risks on a single market.

The new energy industry is a core force driving the global green and low-carbon transition. China has established a relatively complete industrial chain and significant competitive advantages in areas such as new energy vehicles, power batteries, and photovoltaics. China's production of new energy vehicles grew from 1.15 million units in 2018 to 16.524 million units in 2025, with an average annual growth rate exceeding 50 %. In 2023, the production of new energy vehicles was 9.443 million units, an increase of 30.3 %; in 2024, production reached 13.168 million units, an increase of 38.7 %; and in 2025, production is projected to be 16.524 million units, an increase of 25.1 %. The production of solar cells (photovoltaic cells) is expected to grow from 340 million kilowatts in 2022 to 830 million kilowatts in 2025. Currently, the share of China's new energy vehicle production and sales in the global market has exceeded 60 % for consecutive years. However, as the international competitiveness of China's new energy products continues to improve, developed economies represented by the EU and the United States have begun to accelerate the establishment of new green trade barriers. Through measures such as anti-subsidy investigations, carbon footprint regulations, and carbon border adjustment mechanisms, they impose systematic restrictions on the export of China's new energy products.

Figures 5, 6, and 7 respectively depict the production of new energy vehicles, the production of solar cells, and the power generation installed capacity in China from 2018 to 2025, as shown below.

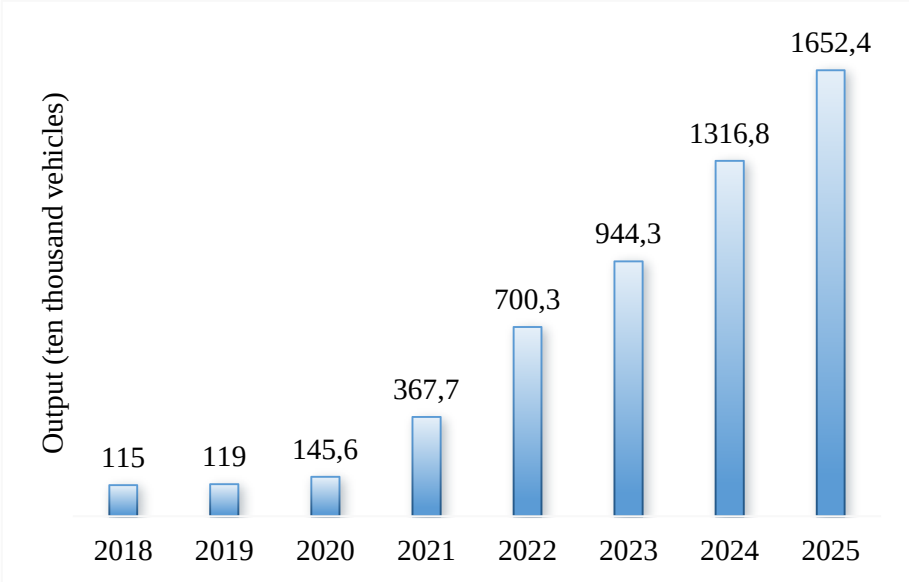


Figure 5 – New energy vehicle production [32; 33; 34; 35; 36; 37; 38; 39]

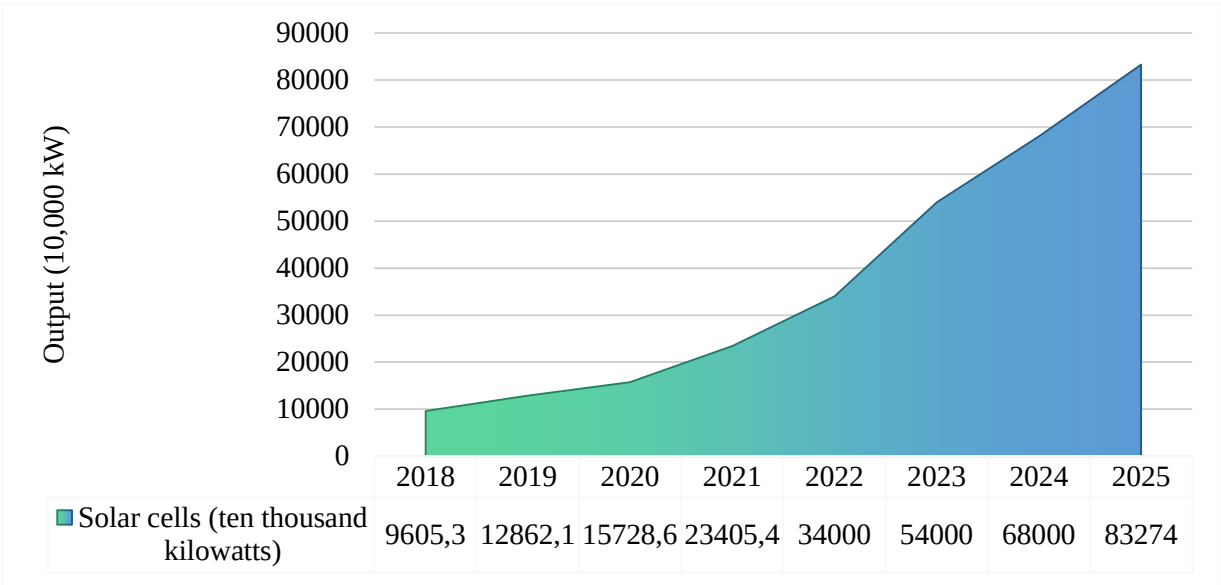


Figure 6 – Solar cell production [32; 33; 34; 35; 36; 37; 38; 39]

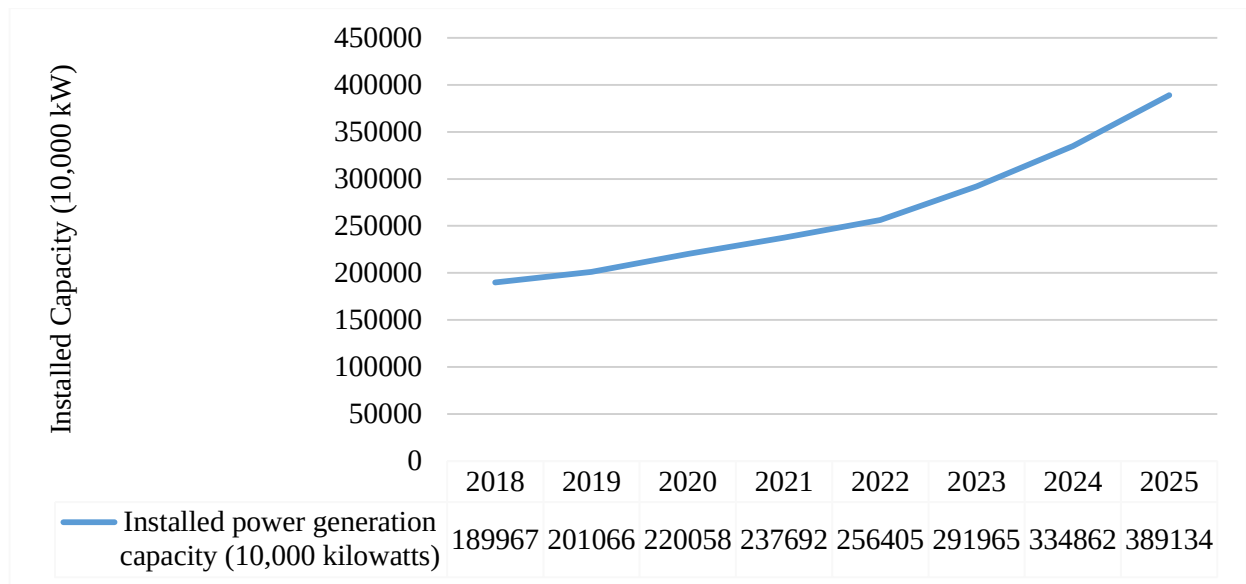


Figure 7 – Power generation installed capacity [32; 33; 34; 35; 36; 37; 38; 39]

Unlike the technical barriers in the agricultural and textile industries, the green barriers in the new energy sector carry more of a trade protectionist character. In October 2023, the European Commission officially launched an anti-subsidy investigation against China's pure electric vehicles based on the “Regulation on Foreign Subsidies that Distort the Internal Market of the EU”. In July 2024, the EU announced a four-month provisional anti-subsidy duty on electric vehicles imported from China, with BYD facing a rate of 17.4 %, Geely 20 %, SAIC up to 38.1%, and other manufacturers cooperating in the investigation but not sampled subject to a weighted average rate of 21% [20;46]. This measure directly increased the export cost of China's new energy vehicles significantly, severely weakening the price competitiveness of the products in the European market.

Meanwhile, the EU Carbon Border Adjustment Mechanism (CBAM) will be officially implemented on January 1, 2026, requiring imported products to pay corresponding carbon tariffs based on the carbon emissions in the production process. Currently, the first batch covers six major categories: steel, aluminum, cement, fertilizer, electricity, and hydrogen, with plans to gradually expand to machinery, automobiles and auto parts, home appliances, and other sectors. CBAM uses the product's full lifecycle carbon emissions as the core accounting standard and will have a profound impact on all high-carbon-emission manufacturing industries, posing a serious challenge to the manufacturing sectors of developing countries that primarily use coal for their energy

structure. In addition, the EU “Batteries and Waste Batteries Act” officially came into effect in August 2023, stipulating that from February 18, 2025, power batteries sold in the EU market must provide a complete carbon footprint declaration and a digital battery passport, imposing full-chain compliance requirements on the traceability of battery raw materials, carbon emission accounting, and recycling. The EU “Sustainable Product Ecodesign Regulation” (ESPR) has included tires in its first batch of controlled products, requiring the entire lifecycle of products from raw material procurement, manufacturing, and use to disposal and recycling to meet ecodesign standards. France has required that carbon emissions be included in the scoring system for photovoltaic project bids over 100 kW, and Italian power companies have introduced similar carbon emission scoring mechanisms in wind turbine product tenders [43]. These layered regulations form a full-lifecycle green trade barrier system covering traceable raw materials, low-carbon production, high product energy efficiency, and recyclable cycles.

From the perspective of impact mechanisms, green trade barriers have a significant inhibitory effect on the export of China's new energy products, and the effects are multidimensional and heterogeneous. Empirical research shows that the EU's green trade barriers have a significant negative impact on both the variety margin and quantity margin of China's new energy vehicle exports, while they have a positive promotion effect on the price margin. Specifically, for each additional unit of EU green trade barriers, the variety of China's new energy vehicle exports decreases by about 0.12 units, the export quantity decreases by about 0.13 units, and export prices increase by about 0.06 units. This result confirms the quantity control mechanism and price control mechanism of green trade barriers: to meet the stringent green technology standards of importing countries, exporters need to increase R&D investment, improve production processes, and bear high testing and certification costs, leading to higher export costs, weakened price advantages, and some products being rejected for failing to meet standards. In terms of product heterogeneity, green trade barriers have a more significant inhibitory effect on the export quantity of pure electric vehicles, and a more pronounced inhibitory effect on the variety of hybrid electric vehicle exports. This may be related to the EU's policy subsidies favoring pure electric vehicles and the differences in market competition patterns faced by different types of

products. In terms of country heterogeneity, the inhibitory effect on export quantity is more obvious in countries with larger EU economic scales, while countries that have announced plans to prohibit fuel vehicles have significantly restrained the variety of exports and promoted an increase in export prices [41].

In addition to directly affecting export costs and market access, green trade barriers also trigger deeper industrial chain transmission effects and data security risks. In the carbon emission accounting stage, in order to meet the EU's carbon footprint accounting requirements, enterprises must collect and disclose carbon emission data across the entire chain from raw material procurement, production and processing to transportation and sales. Due to the differences between China's carbon emission accounting boundaries and EU regulations, and the lack of a localized product carbon footprint database, most enterprises can only rely on the EU database for accounting. The EU database assigns carbon emission factors for China's power grid (e.g., 1,155 grams per kilowatt-hour) which are much higher than the actual level in China (approximately 570 grams nationwide on average in 2022), leading to a systematic overestimation of product carbon emissions. At the data security level, enterprises are forced to disclose carbon emission information of the entire product production process, which may involve trade secrets such as production processes and supply chain layout, increasing the risk of technology leakage [43]. At the industrial chain level, the EU's Net Zero Industrial Act explicitly proposes promoting the localization of net-zero technology manufacturing to reduce dependence on imported products in fields such as solar photovoltaic, batteries, and wind power; the U.S. Inflation Reduction Act supports the development of the entire clean energy industrial chain through massive subsidies, aiming to reshape the competitive advantage of domestic industries. The cumulative effect of these policies may cause Chinese new energy enterprises to face the risk of forced industrial chain relocation, eroding their long-term competitiveness [46].

From a practical perspective, China's leading new energy companies have already begun actively exploring localized overseas layouts to avoid green trade barriers. BYD was the first to establish its full-process new energy vehicle production base overseas in Thailand. By using the CKD full-kit assembly model, it avoided about 30% of local vehicle import tariffs, and within just one year of production, it captured over 40 % of Thailand's

electric vehicle market, becoming a typical case of using localized production to circumvent green barriers. Geely, on the other hand, leverages Volvo's existing production bases in Belgium and Sweden, adopting a 'China R&D + European manufacturing' model, effectively avoiding EU anti-subsidy taxes [20]. In terms of carbon footprint accounting, some leading companies have started to establish carbon management systems and raw material traceability systems covering the entire supply chain. For example, Guangken Rubber has achieved 100 % traceability of natural rubber, enabling it to provide downstream companies with products that comply with the EU's Zero Deforestation law requirements[56]. Data shows that by 2025, China's new energy vehicle stock will reach 43.97 million, an increase of 12.57 million over the previous year-end, and the expansion of the domestic market also provides companies with a buffer. However, for many small and medium-sized enterprises developing new energy solutions, due to limited financial strength and insufficient technical reserves, it is difficult to bear the large investments required for compliance certification, technological transformation, and supply chain restructuring, facing the risk of being forced to exit the EU market [56].

Figure 8 Changes in the Share of Clean Energy Consumption and CO₂ Emission Intensity in China from 2018 to 2025

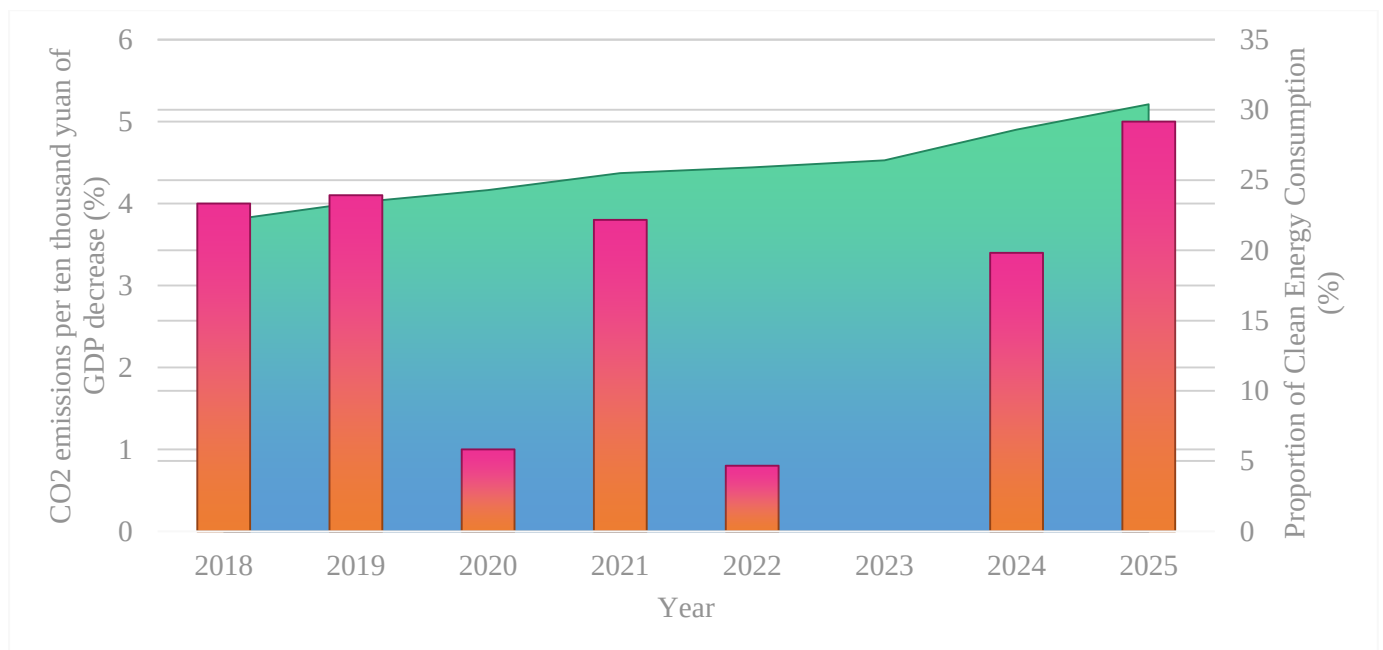


Figure 8 – Changes in the share of clean energy consumption and carbon [32; 33; 34; 35; 36; 37; 38; 39]

Therefore, the new energy industry has become one of the sectors in China most affected by new green trade barriers. Green barriers, represented by the EU Carbon Border Adjustment Mechanism, the Battery Act, and anti-subsidy investigations, are evolving from single end-product standard restrictions to a full life-cycle closed-loop control system covering raw material traceability, production carbon emissions, product energy efficiency, and recycling. In the short term, these barriers significantly increase compliance costs and market entry difficulties for exporting companies. In the long term, however, they drive technological upgrades and industrial chain restructuring, promoting the industry's transformation towards greenness and low carbon. The proportion of China's clean energy consumption in total energy consumption has increased from 22.1 % in 2018 to 30.4 % in 2025, and this green transition process provides intrinsic support for the new energy industry to respond to external barriers.

2.3 Core challenges and transformation dilemmas of China's foreign trade in responding to green barriers

The evolution of green trade barriers is much faster than many people anticipated. It is no longer simply an environmental label on products, but a network of rules covering the entire industrial chain and spanning the entire life cycle. For China's foreign trade, this is both a pressure test and a threshold that must be crossed.

Some leading export enterprises have indeed completed technological upgrades and market adjustments under pressure, but if we widen the perspective to the whole industry, a less optimistic reality emerges: China's overall ability in foreign trade to cope with green barriers has several deep-seated structural contradictions. These contradictions are mainly concentrated in three aspects insufficient basic information capabilities, poor alignment of institutional systems, and a lack of motivation for industrial transformation. These three are not isolated; they are intertwined and reinforce each other, directly slowing down the cultivation of China's green competitiveness in foreign trade.

Figure 9 depicts the core structural contradictions and their interrelationships in China's foreign trade response to green barriers, as shown below:

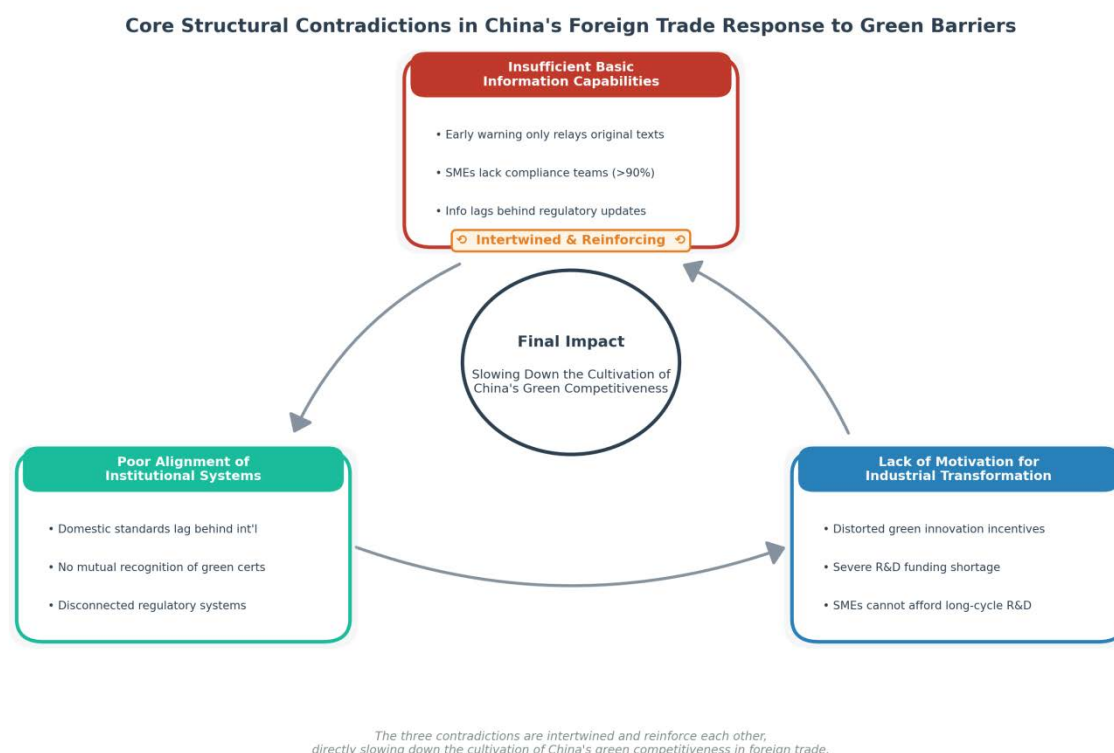


Figure 9 – The core structural contradictions in China's foreign trade response to green barriers [14; 47; 49]

The core challenge of responding to green trade barriers stems from their inherent dynamism, technical complexity, and concealed nature. Unlike traditional tariff barriers, which operate with transparent, fixed pricing structures, the rules governing green barriers frequently change outside the regular visibility of exporting enterprises. Developed economies in Europe and the United States hold dominant control over the rule-making process: revisions to environmental regulations, updates to technical standards, and adjustments to certification processes are largely driven by domestic industry interest groups, resulting in severe gaps in information disclosure for developing countries [47]. This structural information imbalance frequently leaves Chinese export enterprises in a reactive, passive position of 'addressing losses after they have already occurred'. China does have formal early warning mechanisms in place. In fact, a national early warning framework covering green trade barriers from major trading partners has already been established, yet there remains a significant gap between its real-world operational effectiveness and the practical needs of exporting enterprises. The majority of existing early warning information

stops at the level of 'translating and relaying' the original regulatory text, with little to no supplementary analysis of the policy background, detailed interpretation of technical parameters, assessment of the expected industry impact, and most critically step-by-step guidance on practical compliance operations [27].

Agricultural product exports are a major victim of information asymmetry. The data from the EU Rapid Alert System for Food and Feed (RASFF) speaks for itself: the number of Chinese agricultural product exports reported for excessive pesticide residues has consistently ranked among the top. In 2020, just in the category of tea, there were 8 batches rejected entry into the EU due to pesticide residue issues. In November 2023, Germany repeatedly reported that Chinese-exported black tea and green tea contained excessive residues of multiple pesticides such as imidacloprid and cyflumetofen, and all involved products were officially detained. By February 2024, the Netherlands reported that Chinese-exported pomelos contained residues of chlorpyrifos, propiconazole, and thiacloprid exceeding the EU limit of 0.01 mg/kg, requiring all recipients to immediately remove them from shelves and recall them. In October 2025, Denmark issued the highest-level 'alert notification' for Chinese-exported dried jasmine flowers, detecting excessive residues of 12 pesticides including lambda-cyhalothrin, bifenthrin, and chlorpyrifos, determining that there was a 'potential serious food safety risk'.

These repeatedly issued notifications are not only rooted in the strict European Union standards – for example, for tebuconazole, the EU has set its maximum residue limit in tea as low as 0.01 mg/kg, while tea gardens in our country are mainly operated by small farmers in a dispersed manner, making unified control over pesticide use extremely difficult – but also in the serious delays in information transmission. Most export companies know almost nothing about the EU's latest revisions to pesticide residue standards before their products are seized.

The dilemma of the REACH regulation is similarly typical. This system is extremely complex. As of 2024, the List of Substances of Very High Concern (SVHC) has been updated to over 200 substances and continues to expand each year [51]. For a small or medium-sized textile company to confirm whether a certain dye meets the latest requirements, it often needs to spend tens of thousands of yuan hiring a third-party agency

for testing and evaluation. This “information acquisition cost” has already become an invisible barrier for many small and medium-sized enterprises to enter the EU market. The consequences of information asymmetry are twofold: on one hand, it leads to huge trade losses; on the other hand, Chinese enterprises are in a long-term disadvantaged position of “passive following” in the international green rules competition.

If information asymmetry creates the obstacle of 'seeing the requirement but being unable to meet it', then the lack of coordination and equivalence at the institutional level forms a far deeper, structural bottleneck for Chinese exporters.

The first core issue is the clear gap between domestic and international green standards. The development of China's domestic green standard system has clearly lagged behind the advanced international level, creating a significant 'standard gap' with China's major trading partners. While China has accelerated the formulation and revision of green standards in recent years, there remains a substantial gap in coverage scope, update frequency, and overall stringency when compared to developed economies including the European Union, the United States, and Japan [47].

The textile industry provides a clear example. Since the current “Technical Requirements for Ecological Textiles” (GB/T 18885-2009) in China was issued in 2009, it has not been comprehensively revised for 16 years. In contrast, the international mainstream Oeko-Tex Standard 100 for ecological textiles updates its list of restricted substances and limit values almost every year, and the EU REACH regulation's list of substances of very high concern is updated 2-3 times per year [49;55]. This creates an awkward situation: an ecological textile that fully complies with Chinese national standards may still be rejected when exported to the EU due to containing chemical substances newly restricted by the EU.

The gap in standards is turning into a real export barrier. In 2024, Sweden reported that the DINP (Di(2-ethylhexyl) phthalate, DEHP) content in beach bags exported from China reached 13 %, far exceeding the 0.1 % limit set by REACH regulations, and required e-commerce platforms to immediately remove them from sales lists. In the same year, Hungary reported that plastic dolls exported from China tested positive for excessive amounts of both DEHP and dibutyl phthalate (DBP), classifying them as non-compliant products. Cyprus, Finland, and other countries have also repeatedly reported Chinese

exports of toys, rain boots, stationery, and other products exceeding plasticizer limits in violation of REACH regulations. The disconnection between domestic standards and international regulations has become an important factor restricting the export of China's light industry products.

The gap in standards in the field of agricultural products is also prominent. China's national standards for pesticide residues, heavy metal limits, and microbial indicators have not yet fully aligned with the standards of the Codex Alimentarius Commission (CAC) as well as major markets such as the EU and Japan [29]. In 2024, the EU revised the 'Maximum Residue Levels of Pesticides in Food', adding residue limits for multiple pesticides including flumetralin, setting the limit at 0.01 mg/kg, which is not yet covered by China's current standards. Japan's 'positive list system' increased the number of pesticide residue testing items to 799, and in 2024 added 37 new testing standards. In 2025, the EU further included tea in the official temporary intensified monitoring program, significantly increasing the random inspection rate of Chinese exported tea from the original 5 % to 20 %, which will undoubtedly further increase the compliance risk of China's tea exports.

Figure 10 presents the changes in the EU's sampling inspection ratio for China's tea exports, as shown in the following data:

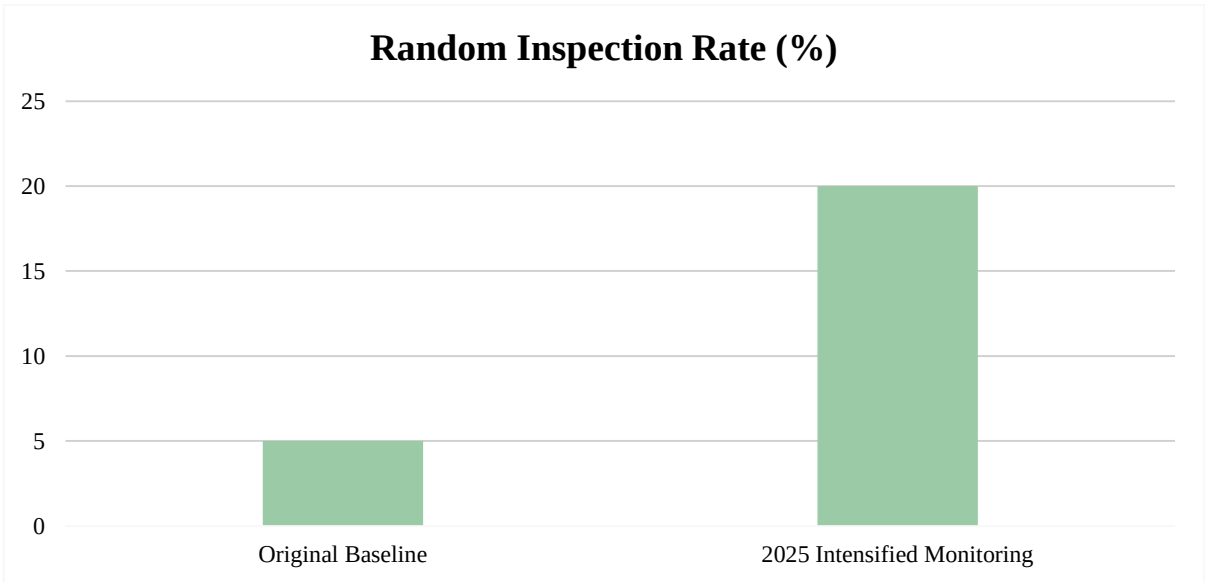


Figure 10 – Changes in the EU's sampling inspection ratio for China's tea exports
[29; 55]

An even more pressing challenge than the standard gap itself is the absence of a broad international mutual recognition mechanism for green certification. China's domestic environmental label certification (the 'China Environmental Label'), carbon footprint accounting methodologies, and green product certification systems have not yet established wide-ranging bilateral or multilateral mutual recognition arrangements with mainstream international certification frameworks, including the EU Ecolabel ('EU Flower'), the US UL Environmental Declaration, and Japan's Eco Mark. This means that green certifications obtained by enterprises within China are largely unrecognized in international markets, forcing firms to undergo repeated testing and certification for each export market, and incurring massive institutional transaction costs in the process [55].

The EU Deforestation Regulation (EUDR), which officially came into effect in June 2023, has elevated this issue to a new level. The regulation stipulates that all 14 major commodities and their derivatives placed on the EU market, including natural rubber, wood, coffee, and cocoa, must prove that the raw materials come from land that has not been deforested or degraded after December 31, 2020, and that the sources are legal. For rubber tires, an important category of China's exports to the EU, the EUDR requires companies to establish a full-chain traceability system from upstream rubber plantations to end products, capable of providing precise geographic coordinate data to six decimal places for each batch of rubber, and to complete comprehensive deforestation due diligence [56].

However, the reality of China's natural rubber supply chain is that it is mainly composed of small and medium-sized rubber farmers and small processing factories. Most suppliers have not yet established standardized origin information recording systems and are unable to provide deforestation due diligence statements that meet EU requirements. The EUDR will be mandatory for large companies from December 30, 2025, and will cover all small and medium-sized enterprises from June 30, 2026 [56]. At that time, a large number of small and medium-sized tire companies unable to meet traceability requirements may be forced to exit the EU market. This 'each-for-itself' certification pattern essentially amplifies the trade-restrictive effect of green barriers, placing Chinese companies in an unfair position in international competition [29].

The fundamental, long-term solution to addressing green trade barriers lies in advancing green technological innovation and value chain upgrading across export-oriented industries. For China's foreign trade sector, however, this transformation path has faced significant structural obstacles.

The first core structural contradiction is the distorted incentive mechanism for green innovation. In theory, green barriers, by raising market entry thresholds, can create a 'forcing effect' that pushes enterprises to increase investment in green technology research and development. For this forcing effect to deliver meaningful results, however, enterprises must first have strong existing technological accumulation and resource integration capabilities. For the vast majority of Chinese manufacturing firms positioned in the middle and lower ends of the global value chain, green transformation requires extremely high upfront investment, while the financial returns are long-term and highly uncertain. As a result, these enterprises generally lack the intrinsic motivation to pursue disruptive, long-term green technology innovation, and instead overwhelmingly opt for lower-cost, faster-return approaches such as basic 'end-of-pipe pollution management' or minimum-required compliance improvements [57].

The implementation of the European Union's Carbon Border Adjustment Mechanism (CBAM) fully exposes this contradiction. CBAM will officially enter the substantial levy phase on January 1, 2026, initially covering six high energy-consuming sectors: steel, aluminum, cement, fertilizers, electricity, and hydrogen. According to estimates from authoritative institutions, after the full implementation of CBAM, China's steel and aluminum industries will need to pay 3.2 to 3.5 billion RMB in carbon tariffs to the EU annually. By 2034, when the EU carbon market's free allowances are entirely phased out, the CBAM cost per ton of steel exported from China to the EU will increase by 140 to 160 euros, which will significantly erode corporate profit margins. Some high-emission enterprises may even face a situation where 'exporting results in losses.'

Even more disadvantageous is that if companies cannot submit EU-recognized measured carbon emission data, they must use the 'default emission values' set by the EU to calculate carbon tariffs. These default values are usually significantly higher than the actual emission levels of Chinese products, potentially directly increasing companies' tariff costs

by 30 % to 50 %. The EU also stipulates that in 2026, companies using default values will face an additional 10 % punitive tariff, rising to 20 % in 2027 and further to 30 % in 2028, which will undoubtedly further increase corporate compliance costs[53].Figure 11 shows the trend of additional punitive tariff changes under the CBAM default value mechanism from 2026 to 2028, as shown in the following data:

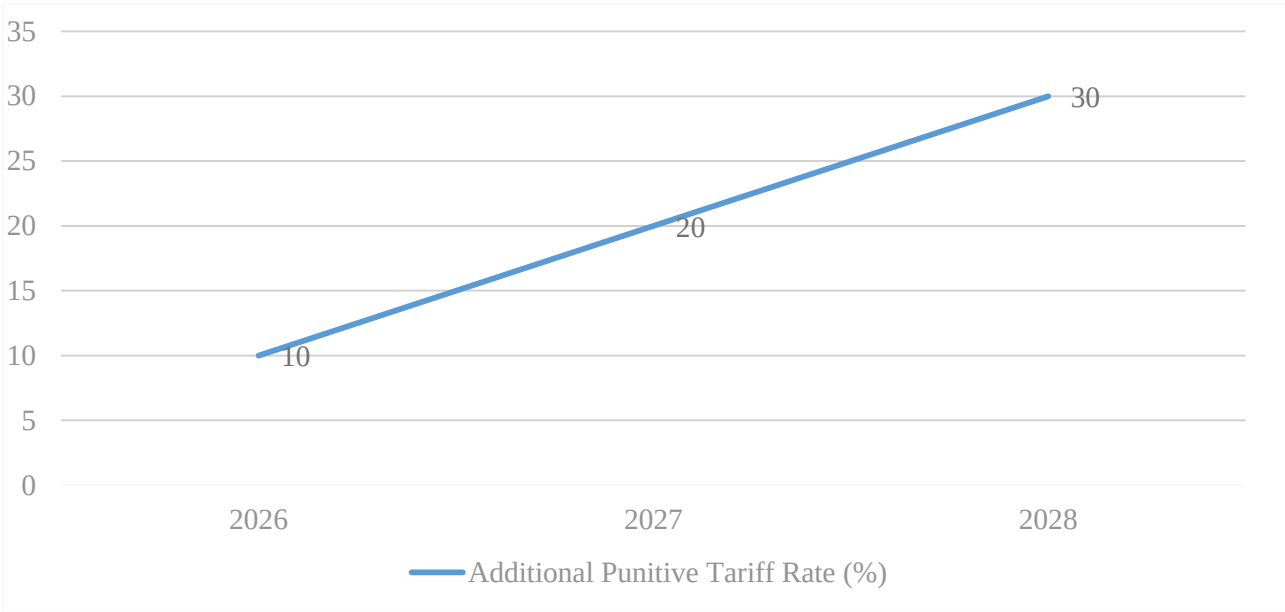


Figure 11 – Trend of additional tariff changes under the CBAM default value mechanism [31; 57; 53]

Faced with such immense pressure, a few large steel companies such as Baosteel and Hebei Steel have already started investing heavily in the research and development of cutting-edge low-carbon technologies like hydrogen-based smelting. However, for the numerous small and medium-sized steel enterprises, R&D investments that run into hundreds of millions of yuan and a technology verification cycle of 5-10 years are simply unaffordable. Therefore, these companies are more inclined to adopt short-term measures such as purchasing carbon allowances, optimizing existing production processes, and adjusting product structures to cope with the CBAM, rather than carrying out fundamental technological innovations. According to the latest export data, in the first quarter of 2026, China's steel exports fell by nearly 10 % year-on-year, with exports to the European Union declining particularly significantly. This is closely related to the disputes over carbon emission accounting during the implementation of the CBAM. The EU's calculation method

ignores the differences in energy structures among countries, which is extremely unfavorable to China's steel industry, which primarily relies on coal.

This phenomenon confirms a concern in academia: the green barrier may create a 'trap effect' – enterprises, in order to quickly gain market access, invest a large amount of capital into technological upgrades that meet the minimum compliance requirements, thereby crowding out resources for fundamental green technology innovation, ultimately falling into a vicious cycle of 'increasing compliance investment, but core technology always lagging behind.'

The second rigid constraint is the dual shortfall of dedicated funding and R&D investment. When compared to leading international multinational firms, the vast majority of Chinese export enterprises have significantly lower R&D intensity, with extremely limited financial resources available to invest in green process upgrades, clean production technologies, and low-carbon technology development. Data shows that in 2020, the proportion of green technology R&D expenditure of environmental protection companies in developed countries to their operating income was 14.58 %-19.57 %, while in my country it was only 2.98 %, a gap of more than 5 times [21]. This gap is even more stark among small and medium-sized enterprises, which routinely face significant financing difficulties and elevated borrowing costs. Ongoing survival pressure makes it nearly impossible for these firms to allocate their limited resources to green technology projects that come with long development cycles and high operational risks.

Under the compliance pressure of the EUDR, China's rubber tire industry also faces dual constraints of funds and technology. Establishing a digital traceability system covering the entire supply chain requires substantial investment in hardware purchase, software development, and personnel training. A few leading enterprises, such as Guangken Rubber Taihua, have made early arrangements and had established a full traceability information loop from raw material procurement to finished product delivery by 2024, successfully passing the relevant EUDR certifications [56]. However, for a large number of small and medium-sized tire companies, this investment far exceeds their capacity. As the mandatory implementation deadline of December 2025 approaches, they will either be forced to withdraw from the EU market or depend on large enterprises as contract manufacturers.

Additionally, in order to quickly meet compliance requirements, some enterprises choose to directly purchase mature foreign green technologies and equipment, which plunges China into a passive cycle of 'technology introduction – lagging behind – reintroduction,' severely suppressing the cultivation of independent innovation capabilities.

The structural contradiction between insufficient incentives for green innovation and the lack of funds and R&D capabilities intertwines and reinforces each other, making it arduous for China's foreign trade industry to overcome green barriers and achieve a truly meaningful green transformation and upgrading.

Chapter 3 Strategies for addressing green barriers to China's foreign trade

3.1 Government regulation of green barriers

As the maker of macroeconomic policies and the core player in international trade negotiations, the government's core function is to compensate for market failures and provide enterprises with a stable and predictable institutional environment and fair international competition conditions to cope with green barriers. In key areas such as aligning standards systems, providing early warning services, and participating in international rules, the government needs to play a leading role.

My country's current green standards system still suffers from shortcomings such as incomplete coverage, slow updates, and relatively low indicator requirements, resulting in a significant “standard gap” compared to the standards systems of major trading partners like the EU and the US [47]. Taking the textile industry as an example, my country's current “Technical Requirements for Eco-textiles” (GB/T 18885-2009) has not undergone systematic revision since its promulgation in 2009, while the EU's REACH regulation's list of Substances of Very High Concern has expanded to over 200 substances, with new restricted substances added 2-3 times annually [55]. In the agricultural sector, the EU added residue limits for 37 pesticides, including flumetoquine, in 2024, uniformly setting a stringent standard of 0.01 mg/kg, while current Chinese standards do not yet cover these substances [47]. This standard gap directly leads to a large number of products that meet domestic standards being detained or returned by customs upon export.

To address the aforementioned issues, government departments should establish a dynamic updating mechanism for green standards, prioritizing the formulation and revision of standards in key areas such as carbon footprint accounting, chemical risk management, and supply chain sustainability. In the field of carbon footprint accounting, based on the characteristics of my country's energy structure and the realities of industrial development, a unified national standard for product lifecycle carbon footprint accounting should be formulated to correct the unreasonable overestimation of carbon emission factors in my country's power grid by relevant EU databases (the EU assigns a value of 1155 grams per

kilowatt-hour, while my country's actual value in 2022 was approximately 570 grams). In the field of chemical management, drawing on the advanced experience of the EU REACH regulation, my country should establish its own list of substances of very high concern and a risk assessment system [55]. In the field of supply chain management, a green standard system covering the entire chain from raw material extraction, production and processing to recycling should be developed. Simultaneously, the integration of a carbon tax system into the environmental protection tax system should be explored, establishing an independent carbon emission tax item and constructing a domestic carbon pricing system aligned with international carbon pricing mechanisms to prevent the outflow of tax revenue generated from domestic emission reduction investments [4].

Information asymmetry is one of the core pain points faced by Chinese export enterprises in dealing with green barriers. Currently, my country's WTO/TBT-SPS notification platform mainly provides translation services of the original regulations, lacking in-depth interpretations by industry, risk assessments, and practical compliance guidelines. This results in many SMEs only learning of changes in relevant standards after their products have been seized by customs. According to a special survey by the Guangdong WTO/TBT Center, over 70 % of SMEs exporting enterprises reported being unable to obtain timely and accurate updates to green regulations in their target markets [11].

To address this issue, the government should integrate resources from embassies and consulates abroad, industry associations, and research institutions to establish a national-level comprehensive early warning platform for green trade barriers. This platform should focus on strengthening three core functions: first, real-time monitoring, continuously tracking the legislative developments of green regulations in major trading partners such as the EU, the US, and Japan, and issuing tiered early warning information 6-12 months in advance [59]; second, in-depth interpretation, organizing industry experts to break down regulatory clauses clause by clause, clarifying compliance requirements, implementation timelines, and penalties for violations; and third, precise service, compiling specialized compliance operation manuals for key affected industries such as steel, new energy, and textiles, and providing one-on-one professional consulting services [49]. Simultaneously, green compliance service windows should be established at key ports nationwide to provide

enterprises with one-stop services such as on-site testing and certification consulting, effectively reducing compliance costs for businesses. Figure 12 presents the functional framework of China's green trade barrier early warning system, as shown in the following data:

Currently, the power to formulate global green trade rules is primarily held by developed economies such as the EU and the US. These rules often ignore the development stages and technological levels of developing countries, exhibiting clear discriminatory and unilateralist characteristics. As the world's largest goods trading nation, my country should proactively participate in the international green rule-making process and promote a more equitable, just, and inclusive international green trade system.

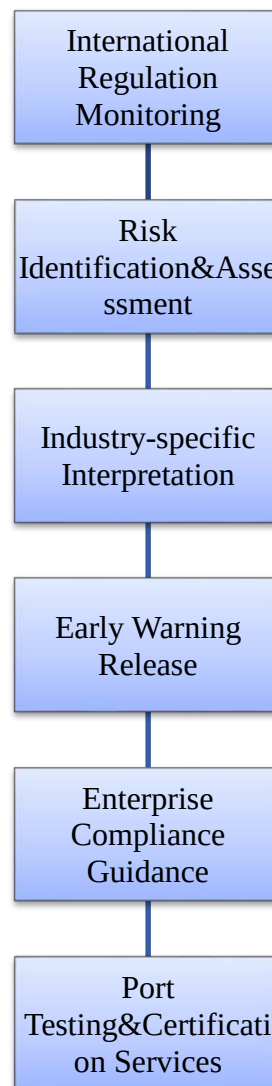


Figure 12 – Framework of China's green trade barrier early warning system [31]

At the multilateral level, my country should fully utilize multilateral platforms such as the United Nations Framework Convention on Climate Change (UNFCCC) and the World Trade Organization (WTO), uniting with developing countries like Brazil and India to jointly resist the abuse of green barriers by developed countries to promote trade protectionism. For example, in 2025, my country, together with Brazil and India, filed a consultation request with the WTO regarding the discriminatory clauses of the EU's CBAM, demanding that the EU fully consider the differences in energy structures among developing countries and adjust its unreasonable carbon emission accounting methods [22].

At the regional level, relying on regional cooperation mechanisms such as RCEP and the Belt and Road Initiative, China should promote the establishment of a unified regional green standard and certification mutual recognition system. For example, China should work with ASEAN countries to jointly develop regional carbon footprint accounting standards and promote mutual recognition of green product certifications between my country and ASEAN countries, reducing trade barriers within the region. In addition, we will actively promote the interconnection between the domestic carbon market and the international carbon market, explore cross-border carbon quota trading mechanisms, and gradually enhance my country's voice in the global carbon pricing system [55].

3.2 Industry level in reaction on green barriers in China

The global green trade rules system is currently undergoing a critical phase of profound restructuring. New green trade barriers, exemplified by the EU's Carbon Border Adjustment Mechanism (CBAM) and the Corporate Sustainability Due Diligence Directive (CSDDD), have evolved from traditional, single-product end-of-life environmental standards into a systemic regulatory framework spanning the entire industrial chain and covering the entire product lifecycle. In January 2026, the CBAM officially entered the substantive collection phase, initially covering six energy-intensive industries including steel, aluminum, and cement. It is estimated that related Chinese enterprises will incur over €10 billion in additional compliance costs annually. Simultaneously, a series of new EU regulations, such as the Battery and Waste Battery Regulation and the Packaging and

Packaging Waste Regulation, are being implemented intensively, creating a cumulative impact on my country's traditional advantageous export industries, such as new energy, textiles, and agricultural products. Faced with this severe situation, simply relying on passive corporate compliance is insufficient to address the systemic challenges. There is an urgent need to construct a comprehensive response framework integrating top-level government design, industry collaborative governance, and proactive corporate transformation to promote a strategic shift in my country's foreign trade development model from “passively adapting to international rules” to “actively participating in rule-making”. Industry associations, serving as a bridge between the government and businesses, can effectively integrate industry resources and solve common problems that are difficult for individual enterprises to address. They are an indispensable force in combating green trade barriers. This is especially true for SMEs facing dual constraints of funding and technology, where industry-level collaboration is crucial.

Figure 13 illustrates the core service modules of the industry-level green public service platform for SMEs, as shown below. Faced with the fragmented and dynamic development trend of international green standards, individual enterprises find it difficult to independently complete comprehensive standard research and alignment work. Industry associations should fully leverage their organizational and coordinating role, uniting leading enterprises, research institutes, and standardization experts to systematically study the technical regulations and standard systems of target markets, and formulate industry group standards that are stricter than national standards and aligned with advanced international levels. For example, in response to the requirements of the EU Zero Deforestation Act (EUDR), the China Rubber Industry Association spearheaded the development of the “Natural Rubber Sustainable Supply Chain Management Standard” in 2024, establishing a traceability system covering the entire chain of rubber plantation planting, processing, and transportation.

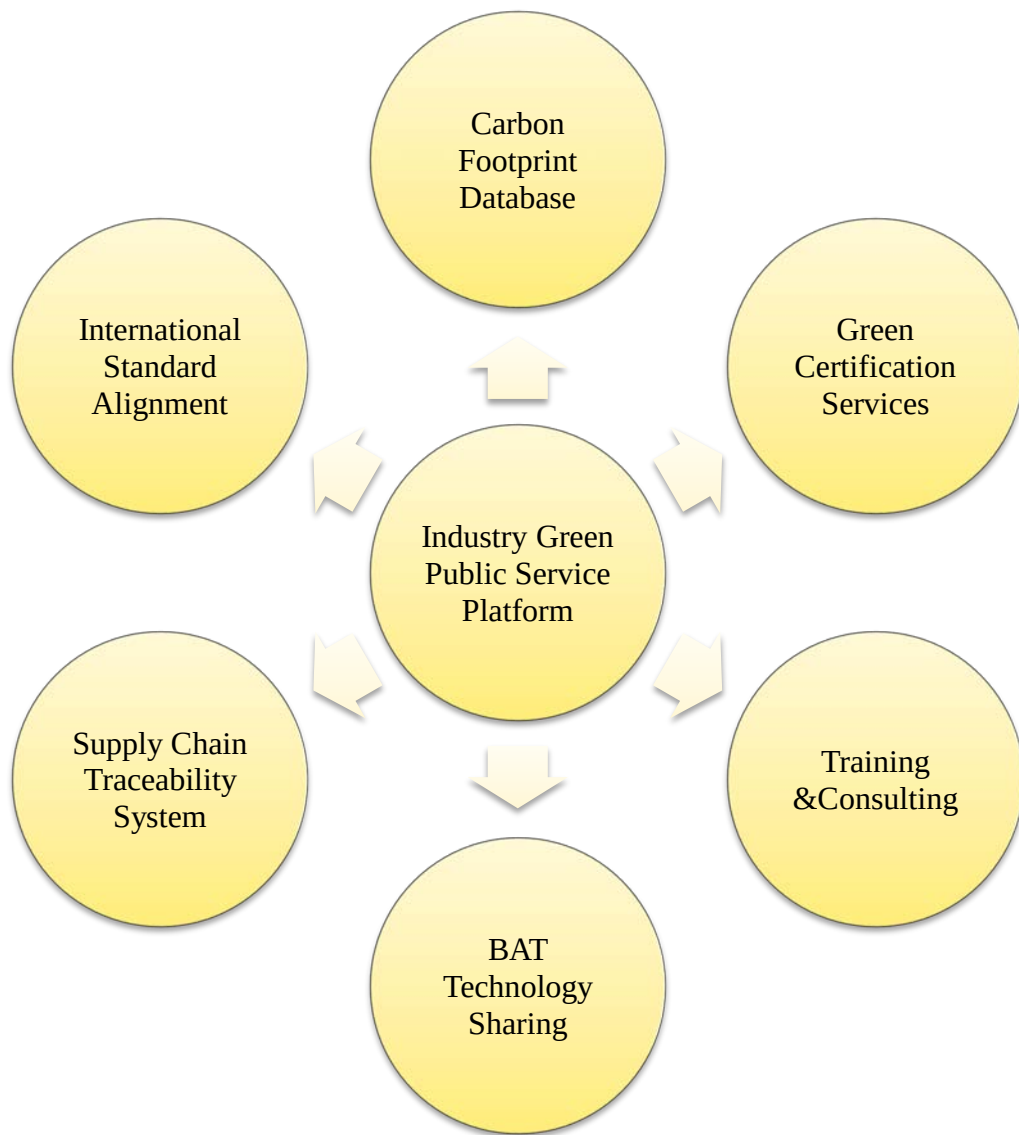


Figure 13 – Industry-level green public service platform for SMEs [2; 3]

More than 30 leading enterprises in the industry have participated in its implementation, effectively reducing their EUDR compliance costs by approximately 20 % [56].

Simultaneously, industry associations should actively promote mutual recognition of industry standards with international authoritative organizations. Through regular cooperation with organizations such as the European Committee for Standardization (CEN) and the American National Standards Institute (ANSI), they can promote international recognition of Chinese industry standards, reducing the costs of repeated testing and certification for enterprises.

For example, the China National Textile and Apparel Council has carried out in-depth cooperation with Oeko-Tex to promote mutual recognition between my country's textile industry standards and Oeko-Tex Standard 100 certification, which has shortened the certification cycle for Chinese textile companies by 30 % and reduced certification costs by 25 % [15].

Many small and medium-sized enterprises (SMEs) face significant challenges in areas such as carbon footprint accounting, supply chain traceability, and green certification due to limited financial resources and technological capabilities. Industry associations can leverage their resource integration advantages to build industry-level green public service platforms, providing SMEs with low-cost, high-efficiency technical support and professional services.

One key approach is to establish a unified industry-wide carbon emission factor database and carbon footprint accounting tools. This involves organizing industry experts to calculate the full-process carbon emission factors for key products and developing a user-friendly carbon footprint accounting system to provide free carbon footprint accounting services to SMEs. For example, the China Iron and Steel Association has established a carbon emission factor database covering the entire iron ore mining, smelting, and rolling process, providing crucial data support for SMEs in addressing CBAM (Carbon Footprint Assessment and Management).

Second, establish an industry technology exchange and sharing platform. Publish Best Feasibility Technologies (BAT) guidelines for key industries, organize leading enterprises to share green technologies and management experience with SMEs, conduct joint R&D, and jointly solve common technical challenges such as energy conservation, emission reduction, and cleaner production. For example, the China Photovoltaic Industry Association organized leading enterprises in the industry to conduct joint R&D on low-carbon technologies for photovoltaic cells, reducing the average carbon emission intensity of photovoltaic cells in my country by 15 %.

Third, establish an industry green certification service center. Establish strategic partnerships with internationally authoritative certification bodies to provide SMEs with one-stop green certification services, lowering certification thresholds and costs. For

example, the Guangdong Textile Association cooperated with the EU Eco-label agency to conduct special training sessions and centralized application services for SME certification, helping nearly 100 small and medium-sized textile enterprises successfully obtain EU Eco-label certification [11].

3.3 Enterprise strategies for addressing green barriers

Enterprises bear the ultimate responsibility for addressing green trade barriers. The fundamental solution for enterprises to overcome these barriers lies in transforming external compliance pressures into internal drivers for transformation, building sustainable green competitiveness through technological innovation, management upgrades, and strategic adjustments.

Technology innovation is the fundamental path for enterprises to overcome green trade barriers. Export enterprises should proactively increase investment in green technology research and development, integrating the concepts of environmental protection into product design, raw material procurement, manufacturing, packaging and transportation, and recycling, thereby reducing the environmental impact of products from the source [62]. Figure 14 summarizes the comprehensive green transformation path for export enterprises under green trade barriers, covering multiple dimensions from product design to brand building, as shown in the following data:



Figure 14 – Green transformation path of export enterprises under green trade barriers [12; 43; 62]

In the production process, actively apply clean production technologies, energy-saving and carbon-reducing processes, and digital management systems. For example, Baosteel Co.Ltd. plans to establish China's first million-ton hydrogen-based vertical furnace production line by 2025, reducing carbon emissions per ton of steel by about 60 % compared with traditional blast furnace processes. The low-carbon steel it produces has received a 15 % product premium in the EU market, effectively offsetting the cost increases brought by the CBAM. CATL, by developing a low-energy production process for lithium iron phosphate, has reduced the energy consumption of power battery production by 20 % and lowered the product carbon footprint by 25 % compared with the industry average, successfully passing the strict certification of EU battery regulations [43].

In the product design phase, the company fully implements the concept of eco-design, prioritizing the selection of renewable and recyclable raw materials to improve the disassembly and recyclability of its products. For example, Midea Group adopts a modular design concept in its air conditioning products, enabling a recyclability rate of over 90%, which meets the relevant requirements of the EU's Sustainable Product Regulation (SPR) [12].

Under the new regulatory frameworks of the EU, such as CSDDD and EUDR, corporate compliance responsibilities have extended from their own production processes to the entire supply chain. Exporting companies must shift from traditional single-production management models and fully integrate green standards into the entire process of supplier access, performance evaluation, and capacity building.

First, establish a strict green supplier access mechanism. Develop clear environmental standards for suppliers, prioritize upstream suppliers with low-carbon production capabilities and high data transparency, and make environmental compliance a mandatory condition for supplier access. For example, Apple requires its global suppliers to use 100 % renewable energy by 2030, and suppliers that do not meet the requirements will be gradually removed from the supply chain [56].

Second, establish a supply chain carbon emission data sharing and traceability system. Utilize advanced technologies such as blockchain and the Internet of Things to achieve full-chain data traceability from raw material mining to finished product delivery. For example,

Guangken Rubber Taihua Company has built a closed-loop information system for the entire traceability of natural rubber, providing geographic coordinate data for each batch of rubber accurate to six decimal places, and has successfully passed the relevant EUDR certification [56].

Third, promote collaborative green transformation among upstream and downstream enterprises. By providing technical support and financial subsidies, Geely Automobile helps upstream suppliers upgrade their technologies to be more green, thereby improving the overall greenness of the supply chain. For example, Geely Automobile provides low-carbon technology training and financial support to its upstream parts suppliers, helping them reduce carbon emissions and lowering the carbon footprint of the entire supply chain by 18 % [51].

When enterprises are confronted with a large volume of fragmented regulatory documents, it is extremely difficult for them to quickly identify content relevant to their specific business operations, let alone proactively identify and mitigate potential risks in advance. This challenge is exponentially amplified for small and medium-sized enterprises (SMEs). More than 90 % of China's foreign trade entities are SMEs, the vast majority of which do not have dedicated in-house compliance departments, cannot afford to hire full-time specialized compliance personnel, and lack the financial resources to build independent international standards tracking systems. For these firms, information about regulatory changes comes almost exclusively from notifications from downstream buyers, or word-of-mouth updates from industry peers. In most cases, enterprises only learn that standards in their target market have changed after their products have been detained by customs, returned to the shipper, or even destroyed, by which point the financial losses have already been incurred [14].

Against the backdrop of a growing global trend towards green consumption, green certifications recognized by international authorities have become a “green passport” for enterprises entering high-end international markets. Enterprises should proactively benchmark against advanced international standards and actively apply for international certifications such as ISO 14000 Environmental Management System, EU Eco-label, and EPD Environmental Product Declaration to demonstrate the environmental performance of

their products and gain the trust of international consumers. By the end of 2025, more than 2,000 Chinese enterprises had obtained EU Eco-label certification, but over 90 % of these were large enterprises, with the certification rate for SMEs less than 5 %, indicating significant room for improvement [15].

Simultaneously, enterprises should deeply integrate green practices into their brand marketing strategies, proactively conveying their green concepts and achievements to the international market and consumers through various means such as publishing ESG reports, labeling products with carbon tags, and utilizing social media. For example, BYD labels its new energy vehicle products with detailed carbon footprint information and regularly publishes annual ESG reports, comprehensively showcasing the company's efforts in energy conservation, emission reduction, and supply chain sustainability, successfully shaping a responsible green brand image. Its new energy vehicle sales in the European market have maintained rapid growth for three consecutive years [20].

Addressing green trade barriers is a long-term and complex systemic project that requires strong collaboration among the government, industry associations, and enterprises. The government should create a favorable policy environment and level playing field for enterprises by improving institutional support and enhancing its voice in international rules. Industry associations should help enterprises solve common challenges by strengthening collaborative governance and providing public service support. Enterprises should fundamentally enhance their ability to cope with green barriers by accelerating green transformation and reshaping their core competitiveness. Only through close cooperation and concerted efforts from all three parties can we effectively overcome the constraints of green trade barriers, promote high-quality development of my country's foreign trade, and secure a proactive position in the new global green trade landscape [26].

Conclusion

The pace of global carbon neutrality is accelerating, and international trade rules are undergoing earth-shaking changes accordingly, with 'green' becoming the most core keyword in the new rules. The old green barriers, which only looked at whether the product itself was environmentally friendly, are long outdated. Now, what is being used is a combination approach, centered on carbon control, covering the entire industrial chain from raw material extraction, production and processing, transportation and sales, all the way to final recycling. These rules are justified under the banner of environmental protection, which sounds legitimate, but in fact, they have become a means for developed countries in Europe and America to engage in trade protection and dictate the terms, causing considerable trouble for our country's foreign trade development and industrial upgrading. I have spent quite a bit of time studying what these green barriers really are, how they operate, how they will develop in the future, what impact they have on our foreign trade, the difficulties we face in responding to them, and finally, I have thought of a set of response measures from the national to the enterprise level. The following are my main research findings.

First, the most fundamental characteristic of green barriers is their dual nature: on one side, they are genuinely intended to protect the environment, while on the other side, they conceal a small intention of trade protection, and now they have formed a complete, constantly updated regulatory system. Based on the actual situation of international trade in recent years, I classify the commonly seen green barriers into six major categories: first, various environmental technical standards and inspection and quarantine requirements; second, measures directly linked to carbon emissions, such as carbon border adjustment taxes; third, green certification and eco-labels; fourth, requirements for enterprises to be responsible for the sustainability of the entire supply chain; fifth, regulations on green packaging and waste recycling; and sixth, environmental impact assessments and market access restrictions. These rules can be implemented globally, relying on a four-layer coordinated mechanism: first, the importing country legislates domestically, creating binding legal constraints; then, through various regional trade agreements, these rules are

promoted to other countries; the WTO multilateral framework also provides a certain legal basis for these rules; and finally, various industry standards set by multinational companies and industry associations serve as soft constraints. Looking at future development trends, two directions are particularly evident: one is that the European Union has linked rules such as CBAM, CSDDD, and CRMA to form a comprehensive regulatory network, no longer focusing solely on product entry but covering the entire life cycle of the product; the other is that the discourse power over global green rules is basically in the hands of Europe and the United States, and developing countries basically have to follow their lead on issues such as how standards are set, how carbon is calculated, and how certifications are mutually recognized, with very little say.

Secondly, the impact of green barriers on our country's foreign trade is not simply a bad thing; it is very complex. Different levels, industries, and companies feel the impact in completely different ways. From the perspective of the country as a whole, the most direct impact is that companies have to spend more money to comply with these rules, and export growth is bound to be somewhat limited. But in the long run, it also forces us to upgrade our industries, produce more technologically advanced, high-value-added, green, and low-carbon products, and also prompts our companies to pay more attention to emerging markets like ASEAN, rather than focusing only on Europe and the United States. These impacts also propagate along the industrial chain to the entire economy, affecting macro indicators such as GDP growth, foreign investment flows, energy consumption, and carbon emissions. From the perspective of different industries, the most affected are the agricultural and food industries, where just pesticide residues and inspection and quarantine alone account for over 60 % of the losses in agricultural exports. The textile, apparel, and light industry sectors are mainly troubled by chemical controls, eco-labeling, and packaging recycling regulations, especially for small and medium-sized enterprises, where compliance costs are prohibitively high. The new energy industry, originally one of our advantageous sectors, now also faces issues such as carbon footprint accounting, supply chain due diligence, and anti-subsidy investigations, and even risks of industrial chain relocation. From the perspective of companies, large companies have money and technology, manage their supply chains well, and can quickly meet the requirements of new rules; some can even take advantage of green

upgrading to sell their products at higher prices. However, over 90 % of our foreign trade companies are small and medium-sized enterprises, which lack timely information, funds, and technology for green transformation. Facing increasingly stringent rules, they simply cannot cope and many are at risk of being pushed out of the international market.

Furthermore, there are three fundamental problems in how we currently respond to green barriers. The first is information asymmetry. Although there are some early warning mechanisms in China, most only translate and forward foreign regulations without providing detailed interpretations for specific industries or telling companies what the impacts will be and what they should do. When companies face a pile of incomprehensible foreign documents, they have no idea which ones are relevant to them and often only realize the standards have changed after their goods are detained or returned, constantly being in a passive, vulnerable state. The second problem is that our own systems are not compatible with international rules. Many domestic green standards are outdated, their coverage is insufficient, and their requirements are lower than those abroad, causing many products that meet domestic standards to be non-compliant once exported. Moreover, our green certification and carbon accounting systems are not widely recognized internationally, forcing companies to spend a lot of money obtaining foreign certifications, undergoing repeated testing and certification, which increases unnecessary costs. The third problem is the insufficient motivation for industrial transformation. Facing green barriers, many companies prefer to spend a little money on superficial measures just to barely pass, rather than investing significant funds and time in genuine technological innovation. Combined with the difficulty small and medium-sized enterprises have in financing and their inadequate R&D investment, the overall pace of green transformation in the industry is very slow.

Finally, in order to truly address the problems brought about by green barriers, relying solely on the efforts of enterprises is not enough. The government, industry associations, and enterprises must work together to form a complete response system. On the government side, the main task is to do a good job in top-level design, accelerate the updating of domestic green standards, and ensure our standards quickly align with international ones. At the same time, a more accurate and practical early warning platform should be established to promptly

inform enterprises of changes in foreign regulations. It is also necessary to actively participate in the formulation of international rules, unite with other developing countries, and strive for our legitimate rights. Industry associations should serve as a bridge between the government and enterprises, work with leading enterprises and research institutions to develop high-level industry standards, and promote the international recognition of these standards. They should also establish some public service platforms to provide SMEs with services such as carbon accounting, certification guidance, and technology sharing, helping them solve problems that individual enterprises cannot address on their own. Enterprises themselves must also change their mindset, no longer treating compliance as a burden, but as an opportunity for transformation and upgrading. They need to increase R&D investment, carry out green transformation across the entire product lifecycle, establish traceable green supply chains, and proactively apply for internationally recognized green certifications. At the same time, they should adjust their market layout, build their own green brands, and enhance product competitiveness

We must clearly recognize that the reconstruction of global green trade rules is a long-term process. In the future, green barriers will only become stricter, moving toward digital traceability, full lifecycle closed-loop supervision, and multi-domain rule coordination. If China's foreign trade wants to take the initiative in this transformation, it must unswervingly promote green low-carbon transformation across the entire industrial chain and address shortcomings in standards, technology, and data governance. We can no longer be satisfied with passively adapting to rules set by others; we must actively participate in and even lead rule-making. Only in this way can we turn external pressure into a driving force for industrial upgrading, establish a firm foothold in the new global green trade landscape, and achieve a win-win outcome of high-quality foreign trade development and global sustainable development.

References

- 1 Apple Inc. Supplier responsibility progress report 2024. URL: https://www.supplychainreports.apple/files/doc_downloads/2024/04/Apple-Supply-Chain-2024-Progress-Report.pdf (Accessed date: 26.06.2026).
- 2 China iron and steel association. low-carbon development report of China steel industry, 2024. URL: <http://www.chinaisa.org.cn/gxportal/xfpt/portal/viewArticleById?params=%7B%22articleId%22:%22d8ac372e764aa60cfbca740836cdeefc2cf29fdb71fdf326f16ce0f76305e955%22,%22columnId%22:%2258af05dfb6b4300151760176d2aad0a04c275aaadbb1315039263f021f920dcd%22%7D> (Accessed date: 26.06.2026).
- 3 China photovoltaic industry association. annual development report [R], 2025. URL: https://www.chinapv.org.cn/Association/content_1621.html (Accessed date: 06.06.2026).
- 4 Dong X., Tang R. Green trade barriers of "carbon border tax" in developed countries and china's response // Modern economic research. 2023. № 12. P. 1–8.
- 5 European commission. carbon border adjustment mechanism (CBAM)[EB/OL]. URL: <https://ec.europa.eu/> (Accessed date: 26.05.2026).
- 6 European commission. European green deal [EB/OL]. URL: <https://ec.europa.eu/> (Accessed date: 26.05.2026).
- 7 European Union. Corporate sustainability due diligence directive (CSDDD), 2025. URL: <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52025SC0080> (Accessed date: 06.06.2026).
- 8 European Union. Packaging and packaging waste regulation (PPWR), 2024. URL: <https://eur-lex.europa.eu/legal-content/EN-SL/TXT/?from=EN&uri=CELEX:32025R0040> (Accessed date: 06.06.2026).
- 9 Fang M., Jiang Y. Analysis of the impact of green trade barriers in RCEP member states on China's agricultural product export trade // Times Economic & Trade. 2025. № 5. P. 10–13.

- 10 Gao J., Cheng Xi. Analysis of the causes and countermeasures for export enterprises encountering green trade barriers // China Economic & Trade Herald. 2016. № 32. P. 9–10.
- 11 Geng T. Research on the impact of green trade barriers on the export of textile and apparel industry in Guangdong province // Foshan University. 2025. № 6. P. 23–25.
- 12 Guo S. The impact of green trade barriers on Chinese export enterprises and their coping strategies // Business Economy. 2025. № 3. P. 95–97.
- 13 Guo T., Li Sh., Guo J. Research on the construction of green transformation cooperation mechanism between China and ASEAN under the EU carbon border adjustment mechanism // New Economy Weekly. 2025. № 5. P. 32–38.
- 14 Guo X. A brief analysis of the problems and suggestions for China's small and medium-sized enterprises' exports under green trade barriers // Economic & Trade Practice. 2018. № 14. P. 78–79.
- 15 Han Q. Analysis of green certification requirements for textiles and clothing exported to the EU // Textile Testing and Standard. 2024. № 10(4). P. 45–48.
- 16 Huang M., You Q. How to cope with US green trade barriers in agricultural product exports // Foreign Investment in China. 2024. № 4. P. 33–35.
- 17 Lai Y. Survival wisdom of export enterprises in coping with green barriers // China Businessman. 2025. № 14. P. 90–91.
- 18 Li H., Liu H. On the impact of green trade barriers on China's product export and the countermeasures // Proceedings of 3rd International Symposium on Economic Development and Management Innovation (EDMI 2021). 2021. P. 154–158.
- 19 Liang L., Huang R., Li Y. Research on the impact and countermeasures of green trade barriers on China's textile and apparel exports // China Circulation Economy. 2023. № 17. P. 58–61.
- 20 Lin Ch. Trade barriers and countermeasures for new energy vehicle exports // Auto Pictorial. 2026. № 1. P. 242–244.
- 21 Liu Ch. Research on green trade strategies to break carbon barriers in international trade // World Environment. 2025. № 2. P. 50–54.

- 22 Liu Ch. The impact of global green trade development and carbon neutrality process on China and coping strategies // *Economy and Management*. 2024. № 5. P. 77–84.
- 23 Liu H. The legal root and breakthrough of China's green trade barriers in the post-epidemic era // *Proceedings of the 2023 International Conference on Management Research and Economic Development (Part 3)*. 2023. P. 328–338.
- 24 Liu L. The impact of the EU ecolabel system on China's exports of textile printing and dyeing products // *Textile Auxiliaries*. 2025. № 5. P. 1–5.
- 25 Liu Q., Chang J. High green barriers put pressure on agricultural product exports to seek changes // *China Reform Daily*. 2025-06-23. № 3. P. 3–4.
- 26 Liu Sh. ESG turns green trade barriers into opportunities for Chinese enterprises // *Huaxia Times*. 2025-03-17. № 2. P. 7–8.
- 27 Liu X. Research on green trade barriers in international trade // *Investment and Entrepreneurship*. 2021. № 32(19). P. 72–74.
- 28 Lu X. Research on the legal system related to green trade barriers faced by China's agricultural product trade // *Shanghai Ocean University*. 2024. № 3. P. 2–3.
- 29 Luo B. Research on the impact of green trade barriers on China's agricultural product exports and legal countermeasures // *Northwest Minzu University*. 2021. № 2. P. 4.
- 30 Ma Sh., Man H., Cheng Y. Current situation and improvement suggestions for Fujian province's textile, footwear and apparel industry to cope with international green trade barriers // *Strait Science*. 2025. № 9. P. 151–156.
- 31 Ministry of commerce of the PRC. report on technical trade measures, 2025. URL: http://tjs.customs.gov.cn/hangzhou_customs/575609/1708095/2068312/6777998/2025101517352132053.pdf (Accessed date: 06.06.2026).
- 32 National bureau of statistics. Statistical communiqué of the people's republic of china on national economic and social development 2018. URL: https://www.stats.gov.cn/sj/zxfb/202302/t20230203_1900241.html (Accessed date: 26.05.2026).
- 33 National bureau of statistics. Statistical communiqué of the people's republic of china on national economic and social development 2019. URL:

https://www.stats.gov.cn/sj/zxfb/202302/t20230203_1900640.html (Accessed date: 26.05.2026).

34 National bureau of statistics. Statistical communiqué of the people's republic of china on national economic and social development 2020. URL: https://www.stats.gov.cn/sj/zxfb/202302/t20230203_1901004.html (Accessed date: 26.05.2026).

35 National bureau of statistics. Statistical communiqué of the people's republic of china on national economic and social development 2021. URL: https://www.stats.gov.cn/sj/zxfb/202302/t20230203_1901393.html (Accessed date: 26.05.2026).

36 National bureau of statistics. Statistical communiqué of the people's republic of china on national economic and social development 2022. URL: https://www.stats.gov.cn/sj/zxfb/202302/t20230228_1919011.html (Accessed date: 26.05.2026).

37 National bureau of statistics. Statistical communiqué of the people's republic of china on national economic and social development 2023. URL: https://www.stats.gov.cn/sj/zxfb/202402/t20240228_1947915.html (Accessed date: 26.05.2026).

38 National bureau of statistics. Statistical communiqué of the people's republic of china on national economic and social development 2024. URL: https://www.stats.gov.cn/sj/zxfb/202502/t20250228_1958817.html (Accessed date: 26.05.2026).

39 National bureau of statistics. Statistical communiqué of the people's republic of china on national economic and social development 2025. URL: https://www.stats.gov.cn/sj/zxfb/202602/t20260228_1962662.html (Accessed date: 26.05.2026).

40 Qiao Y. Research on ESG practices and international market access strategies of time-honored brand enterprises under green trade barriers // Time-Honored Brand Marketing. 2026. № 1. P. 1–3.

- 41 Qiu R. Research on the impact of green trade barriers on China's new energy vehicle exports to the European Union // Yunnan University of Finance and Economics. 2025. № 7. P. 5–6.
- 42 Qu Sh. Research on the impact of green trade barriers on China's aquatic product exports // Lanzhou University of Technology. 2025. № 12. P. 2–4.
- 43 Su N. China's new energy industry faces green trade barriers head-on // China Energy News. 2024-05-13. № 8. P. 4–5.
- 44 Sun J. Analysis of the impact of green trade barriers on the export trade of developing countries // Proceedings of the 2025 Experience Exchange Conference on Enterprise Development and Social Governance Innovation. 2025. P. 216-218.
- 45 Sun X., Du J. Spatiotemporal evolution and driving factors of the coupling coordination between green production and green life in China // Statistics & Decision. 2026. № 42(6). P. 66–71.
- 46 Tian L., Bai Y. Global green trade barriers are rising, and the new energy industry needs fair, open and coordinated development // International Petroleum Economics. 2025. № 33(1). P. 35–36.
- 47 Tian Zh. Research on legal issues of green trade barriers for agricultural products between China and RCEP partner countries // Northeast Agricultural University. 2023. № 5. P. 1–2.
- 48 Wang J. Research on the impact of green trade barriers on the sophistication of export technology // Zhejiang University. 2024. № 2. P. 2–3.
- 49 Wang K. Analysis of the impact of green trade barriers on China's textile exports to the EU // Beijing University of Posts and Telecommunications. 2019. № 1. P. 2.
- 50 Wang M. Interpretation of the EU's regulation on packaging and packaging waste // Green Packaging. 2025. № 7. P. 51–56.
- 51 Wei G. Research on low-carbon transformation strategies of export-oriented enterprises under green trade barriers // China Business Review. 2026. № 35(2). P. 60–63.
- 52 Wei Mei. The impact of global green trade barriers on the export of China's textile printing and dyeing auxiliaries industry // Textile Auxiliaries. 2025. № 42. P. 9–14.

- 53 WTO. Technical barriers to trade information management system. URL: <http://tbttims.wto.org/> (Accessed date: 26.05.2026).
- 54 Wu Jingnan. Research on the dual margin impact of green trade barriers on China's agricultural product exports // Capital University of Economics and Business. 2024. № 8. P. 12.
- 55 Xu R. Benchmarking international rules on carbon footprint and actively responding to green trade barriers // Science & Technology Vision. 2026. № 16(04). P. 5–10.
- 56 Xu Yiming. EU green barriers: from terminal constraints to full-chain closed loop // China Rubber. 2026. № 42(03). P. 10–17.
- 57 You P., Wang Y., Tian J. Non-Linear inhibitory effect of compound green trade barriers on China's exports: An investigation based on the linkage of EU CBAM and CRMA // International Economics and Trade Research. 2026. № 42(02). P. 22–36.
- 58 Zhang B. Green barriers and sustainable development in international trade // Business Culture. 2025. № 24. P. 80–81.
- 59 Zhang J., Liu Y. Exploration on strategies for export enterprises to cope with green trade barriers // Financial Literary Circles. 2025. № 08. P. 19–21.
- 60 Zhang J. Long-Term impact of green trade barriers on the market structure of China's Textile printing and dyeing industry // Textile Auxiliaries. 2024. № 41(11). P. 66–70.
- 61 Zhao Zh. Research on green barriers and countermeasures for traditional Chinese medicine entering ASEAN under the background of the Belt and Road initiative // International Public Relations. 2024. № 07. P. 118–120.
- 62 Zhu Zh. Research on the synergistic mechanism of environmental protection tax and enterprise green transformation under the “dual carbon” goal // Guangxi Cyberspace Security and Informatization Federation. Proceedings of the 9th Academic Exchange Conference on Digital Transformation and New Productivity Development in Engineering Fields 2025. Huayou New Energy Technology (Quzhou) Co., Ltd., 2025. P. 214–216.