WEP
Warwick Evans Publishing

Transactions on Economics, Business and Management Research
ISSN: 2960-1789, eISSN: 2960-2254 | Volume 16
EMFT 2025

The Impact of Carbon Tariff Policies on China's Steel Export Industry-A Perspective Based on the EU Carbon Border Adjustment Mechanism

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Abstract. As the world's first cross-border carbon tariff policy, the EU Carbon Border Adjustment Mechanism (CBAM) will profoundly impact international trade patterns and carbon reduction pathways upon implementation. Steel, among the first industries included, faces heightened scrutiny due to its high energy consumption and emissions. This study examines China's steel exports to identify practical challenges confronting the sector under carbon tariffs, analyzes specific policy impacts and potential risks, and proposes corresponding countermeasures. Research findings indicate that carbon tariffs will significantly increase export costs for Chinese steel enterprises in the short term, undermining their price competitiveness in the EU market—particularly for bulk products like plates and pipes with higher carbon intensity. In the medium to long term, however, this external pressure mechanism is expected to accelerate China's steel industry's green and low-carbon transformation. It will promote R&D and application of clean technologies such as hydrogen-based steelmaking, electric arc furnace processes, and carbon capture, while also compelling China's domestic carbon market mechanisms to align with international standards. This paper further proposes establishing a multi-dimensional response system encompassing technological innovation, policy coordination, and international cooperation to enhance the resilience and competitiveness of China's steel industry within the global low-carbon trade landscape.

Keywords: CBAM; carbon tariff; steel exports; international trade.

1. Introduction

Global climate change has become a critical challenge facing humanity and promoting green and low-carbon economic transformation has gained international consensus. Against this backdrop, climate policies and trade rules are increasingly converging, with traditional tariff barriers gradually being replaced by "green trade barriers" centered on carbon footprints, profoundly reshaping global industrial chains and trade patterns. As a pioneer in climate governance, the European Union launched the world's first CBAM transition period in October 2023, with full implementation planned for 2026. This mechanism covers high-emission industries such as steel, cement, and aluminum, requiring importers to declare product carbon emissions data and pay corresponding fees based on carbon intensity [1]. This initiative not only prevents "carbon leakage" and protects the competitiveness of EU enterprises but also aims to encourage global trading partners to adopt comparable carbon emission standards, marking the entry of international trade into the "carbon-constrained" era.

The steel industry forms the foundation of modern economies but also ranks as a primary industrial source of carbon dioxide emissions, accounting for approximately 7%-9% of global emissions [2]. China has maintained its position as the world's largest steel producer since 1996, with crude steel output reaching 1.018 billion tons in 2022—representing 54% of global production [3]. The EU represents a crucial export market for Chinese steel, accounting for approximately 12% of China's total steel exports. Products are primarily used in automotive manufacturing, mechanical engineering, and related sectors. However, China's steel industry predominantly employs the blast furnace-converter long-process route, relying heavily on coal in its energy mix. This results in average carbon emissions of about 2.1 tons of CO_2 per ton of steel produced—significantly higher than the EU's average of 1.3 tons—posing substantial challenges for Chinese steel in complying with the EU's CBAM [4,5].

The implementation of CBAM necessitates a new cost accounting system for China's steel exports to Europe. Exporters must now bear carbon emission costs in addition to production expenses. Studies indicate that after CBAM's full implementation, the export costs for Chinese steel enterprises to Europe could increase by 10%-25% [6]. This "green cost increment" will erode China's steel price competitiveness, narrow profit margins, and jeopardize market share. More profoundly, CBAM represents a new trade paradigm based on "carbon sovereignty," potentially prompting emulation by economies like the United States and the United Kingdom. This could establish new green trade barriers and even trigger international trade friction [7].

Challenges coexist with opportunities. While presenting challenges, CBAM also provides a catalyst for transformation within China's steel industry. By intensifying R&D in low-carbon technologies, promoting energy-efficient equipment, optimizing energy structures, and refining carbon market mechanisms, China's steel sector can achieve green transformation and enhance sustainable development capabilities [8]. This represents not only a response to EU policy but also an intrinsic requirement for China to fulfill its "dual carbon" goals (carbon peak by 2030 and carbon neutrality by 2060).

This paper systematically analyzes the multidimensional impacts of the EU's CBAM mechanism on China's steel export industry, dissects its transmission pathways and potential risks, and proposes countermeasures. Its significance includes theoretically enriching research on green trade barriers and industrial competitiveness; practically, providing references for government industrial policy formulation and corporate responses to carbon costs; and internationally, supporting China's participation in global climate governance and trade rule negotiations to advance a more equitable global low-carbon economic order.

2. Analysis of the Current Status of China's Steel Export Industry

The EU CBAM entered its transition period in October 2023, requiring importers to declare the embedded carbon emissions of products in preparation for the formal imposition of taxes in 2026 [3]. The steel industry accounts for approximately 7% of global industrial emissions and is among the first sectors targeted for CBAM regulation [4]. As the world's largest steel producer, China generated 1.018 billion tons of crude steel in 2022, representing 54% of global output [5]. Exports to the EU constitute about 12% of China's total steel exports, exceeding $8 billion annually [6]. However, China's steel production primarily relies on the blast furnace-converter process, resulting in average carbon emissions of approximately 2.1 tons of CO_2 per ton of steel—significantly higher than the EU's electric arc furnace process (around 1.3 tons) [5-7]. Despite China's ongoing advancement of ultra-low emission retrofits and green technology R&D, gaps persist between its carbon accounting methods and carbon footprint certification standards and those of the EU [8]. This disparity creates short-term market pressures for Chinese steel exports but also presents medium-to-long-term opportunities for green transformation.

2.1. Export Scale and Trends

China's steel exports exhibit a fluctuating upward trend. In 2022, steel exports reached 67.32 million tons, a 0.9% year-on-year increase, with export value totaling $96.5 billion. During the first half of 2023, exports amounted to 43.5 million tons, marking a 31.6% year-on-year growth. Between 2018 and 2022, the compound annual growth rate reached 4.3%, demonstrating strong international competitiveness. This growth primarily stems from infrastructure demand in Belt and Road countries and the cost-effectiveness advantage of Chinese products. However, export volume growth has not been matched by profit growth, with profits per ton of steel trending downward, reflecting intensified international market competition and rising cost pressures [9].

2.2. Export Product Structure

China's steel exports predominantly feature "high volume, low price" products, with low-to-mid-range items like plates, pipes, and bars/wires accounting for over 75% of exports. These include hot-rolled coil, seamless steel pipes, and rebar, primarily used in construction and piping sectors. High-value-added specialty steels (such as premium automotive steel and electrical steel) constitute less than 25% of exports. This structural imbalance results in lower export unit prices. In 2022, China's average steel export price was $1,435 per ton, compared to over $2,000 per ton for countries like Germany and Japan. This disparity primarily stems from China's ongoing deficiencies in high R&D investment, brand development, and product consistency [10].

2.3. Distribution of Major Export Markets

The EU serves as a crucial high-end market for Chinese steel, accounting for 12% of total exports. Key destinations include Germany (28% of EU exports), the Netherlands (19%), Italy (15%), Belgium (12%), and Spain (9%), with products primarily used in automotive manufacturing and mechanical engineering. Southeast Asia represents the largest export market at 45%, mainly supplying infrastructure-hungry nations like Vietnam, the Philippines, and Thailand. Other Asian regions (South Korea, India, etc.) account for 15%, the Middle East for 10%, Africa for 8%, and Latin America for 5%. This market structure reflects both the competitive advantages of Chinese products and a high degree of reliance on emerging markets. The implementation of the EU's CBAM may prompt significant adjustments to China's steel export market landscape, requiring enterprises to reassess carbon costs and competitiveness across various markets.

3. Analysis of the Impact of Carbon Tariff Policies on China's Steel Export Industry

The implementation of the EU CBAM is expected to exert profound, multi-layered effects on China's steel exports. To systematically understand its operational mechanisms, this paper analyzes the policy through four dimensions: cost burden, competitive landscape, transformation drivers, and institutional responses.

First, cost burdens represent the most immediate impact. Under CBAM rules, imported steel must bear carbon costs proportional to its full lifecycle emissions. Given China's steel industry currently has relatively high carbon emissions, it will face significant additional financial pressure. Data indicates China's average carbon emissions per ton of steel are approximately 2.1 tons, exceeding the EU average (around 1.3 tons) by about 60% [1]. This gap implies that when exported to the EU market, the price competitiveness of Chinese steel products will be weakened, with particularly pronounced impacts on carbon-intensive bulk products like plates and long products.

Second, the international competitive landscape is expected to undergo structural shifts. The EU steel industry is actively pursuing low-carbon pathways, including the widespread adoption of electric arc furnace technology and the development of breakthrough processes like hydrogen-based direct reduced iron [2]. These initiatives not only secure domestic policy advantages but also bolster the EU's environmental reputation and market image. Should EU end-users and buyers persistently favor low-carbon steel, Chinese products risk market exclusion due to being labeled "high-carbon." This trend transcends traditional tariff frameworks, reflecting a fundamental shift in future market demand toward low-carbon solutions.

Third, low-carbon development requirements are rapidly being transmitted to domestic production. Although China's steel industry has achieved some success in energy conservation and emissions reduction—such as implementing ultra-low emission retrofits and moderately increasing the proportion of electric arc furnace steel—its overall greening level still lags behind the EU [3]. Bridging this gap necessitates large-scale technological upgrades, encompassing efforts to increase green electricity usage, advance hydrogen metallurgy technologies, and deploy carbon capture and storage (CCS) facilities. Such projects typically involve substantial investment, extended payback periods, and heavy reliance on coordinated development across upstream and downstream supporting industries.

Fourth, institutional and policy responses also face practical challenges. The Chinese government and industry organizations must actively engage in shaping international climate and trade rules to secure fair and reasonable treatment for Chinese products, preventing the emergence of disguised green barriers. Concurrently, it is imperative to advance the maturation of the national carbon market, broaden its sectoral coverage, and explore effective carbon pricing mechanisms to provide enterprises with more market-based tools for fulfilling their emission reduction responsibilities [4]. Currently, China's domestic carbon market remains in its early stages, with carbon prices failing to fully reflect marginal abatement costs. This lack of adequate internalization incentives and institutional support hinders enterprises' ability to adjust according to EU standards.

Overall, the EU carbon tariff poses systemic challenges to China's steel exports. In the short term, enterprises may be forced to sacrifice profits for market share, squeezing their profit margins. In the medium to long term, they must fundamentally reshape their core competitiveness through technological transformation and low-carbon transition. Against this backdrop, policymakers must coordinate international negotiations with domestic mechanism design to establish a multi-stakeholder response system involving government, industry, and enterprises. Otherwise, China's steel sector risks not only losing access to the EU market but also being marginalized from the global green supply chain system.

4. Strategic Recommendations for China's Steel Export Industry to Address Carbon Tariffs

The implementation of the EU CBAM poses systemic challenges to China's steel export industry, necessitating multi-dimensional countermeasures. Based on the preceding analysis of impact mechanisms and current issues, this paper proposes the following strategic recommendations across three dimensions: technological innovation, equipment promotion, and institutional development.

4.1. Strengthening Low-Carbon Technology R&D and Innovation

The key to addressing CBAM lies in fundamentally reducing carbon emissions intensity during steel production. It is recommended that the government establish a dedicated R&D fund for low-carbon metallurgical technologies, prioritizing support for disruptive technologies such as hydrogen metallurgy, Carbon Capture, Utilization, and Storage (CCUS), and high-proportion electric arc furnace short-process steelmaking. Steel enterprises should be encouraged to form innovation consortia with universities and research institutions to tackle common technological challenges, such as hydrogen-rich reduction in ironmaking, biomass energy substitution, and intelligent low-carbon scheduling. Concurrently, demonstration projects integrating industry, academia, research, and application should be promoted to accelerate the engineering validation and industrialization of green technologies. Systematic technological breakthroughs will not only effectively reduce the embedded carbon costs subject to CBAM accounting but also lay the foundation for cultivating internationally competitive green advantages within China's steel industry.

4.2. Promoting Advanced Energy-Saving and Emission-Reduction Technologies and Equipment

China's steel industry still holds significant untapped potential for energy conservation and emission reduction, urgently requiring technological promotion to unlock efficiency dividends. The industry should accelerate the adoption of mature technologies and equipment such as high-efficiency waste heat recovery systems, Energy Management Systems (EMS), ultra-high-temperature and ultra-high-pressure gas power generation, and deep utilization of low-temperature flue gas waste heat. The government can develop and dynamically update the "Steel Industry Energy Conservation and Emission Reduction Technology Promotion Catalog," offering policy incentives like tax breaks and green credit subsidies to enterprises adopting technologies and equipment listed therein.

Simultaneously, promote cross-sectoral collaborative carbon reduction, such as encouraging multi-industry coupling between steel, chemicals, and power to achieve circular utilization of carbon and energy flows, thereby enhancing carbon productivity across the entire industrial chain. Additionally, strengthen energy conservation and emission reduction capacity building for small and medium-sized enterprises through specialized technical assistance and energy audits to prevent widening disparities among enterprises during the low-carbon transition.

4.3. Improving Market Mechanisms and Deepening International Cooperation

Institutional development and multi-stakeholder collaboration form the long-term mechanism for effectively addressing CBAM. On the one hand, accelerate the refinement of the national carbon emissions trading market, systematically expand coverage to sectors like steel, and gradually introduce allocation methods such as auctions to generate effective carbon price signals, thereby internalizing carbon costs into corporate decision-making. Simultaneously, establish a product carbon footprint accounting, reporting, and verification system aligned with international standards, promote mutual recognition of carbon accounting methodologies between China and Europe, and reduce compliance costs. On the other hand, governments and industry associations should actively engage in external consultations and dialogues, participate in global rule-making on carbon pricing and green trade, and advocate for fair transition mechanisms based on the principles of common but differentiated responsibilities and respective capabilities. Leading enterprises should be encouraged to proactively integrate into global green supply chains, pursue low-carbon product labeling and international certifications, and leverage overseas investment and cooperation to drive the export of low-carbon technologies and the implementation of standards, thereby enhancing China's voice in global green trade governance.

5. Conclusion

This paper systematically analyzes the multidimensional impacts of the EU CBAM on China's steel export industry within its policy framework. The study indicates that CBAM implementation will significantly increase export costs for Chinese steel enterprises in the short term, weakening their price competitiveness—particularly for high-carbon bulk products. However, in the long run, this mechanism also presents a critical opportunity for the industry's green transition, compelling enterprises to accelerate R&D and application of low-carbon technologies.

Specifically, the core challenges facing China's steel industry include high carbon intensity, insufficient reserves of low-carbon technologies, and an immature domestic carbon market mechanism. To address these challenges, three key approaches are recommended: First, establish a carbon accounting and certification system aligned with international standards to enhance data transparency and international mutual recognition. Second, focus on breakthroughs in key technologies such as hydrogen metallurgy and electric arc furnace short-process production to effectively reduce carbon intensity in the production phase. Third, actively participate in international rulemaking to secure a fair and reasonable transition window and policy space.

Looking ahead, China's steel industry must transform carbon constraints into innovation drivers. Through the coordinated advancement of technology, standards, and policies, it should achieve a strategic shift from cost competitiveness to green competitiveness. This transition is not only crucial for the industry's sustainable development but also holds profound significance for China's pursuit of its dual carbon goals and its deep engagement in global climate governance.

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