

The Economic Impacts of Carbon Border Adjustment Mechanism on International Trade and Developing Countries

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Abstract. Against the backdrop of intensifying global climate change and tightening carbon emission reduction policies worldwide, the Carbon Border Adjustment Mechanism (CBAM) represented by the EU has gradually become an institutional tool reshaping international trade rules and industrial division of labor. It integrates full life-cycle carbon emissions into trade costs and promotes global industrial decarbonization by internalizing carbon externalities. This paper investigates the effects of CBAM on international trade flows and developing economies by analyzing carbon cost transmission, shifts in global competition, and industrial restructuring based on policy documents and existing literature. The study finds that CBAM increases export costs for high-carbon products, reshapes global competition, promotes green industrial transformation, phases out high-carbon sectors, and helps reduce carbon leakage. Nevertheless, uneven levels of development and emission reduction capacities intensify the transition pressures and trade inequalities faced by developing countries. In response to CBAM-related challenges, developing countries need to enhance industrial upgrading, technological innovation, and international cooperation to achieve low-carbon transformation and sustainable development.

Keywords: Carbon Border Adjustment Mechanism, CBAM, International Trade, Industrial Structure, Low-carbon Transition

1. Introduction

With rising global climate risks and the pursuit of carbon peaking and carbon neutrality goals, the Carbon Border Adjustment Mechanism (CBAM), as a representative carbon tariff policy, has become an important instrument for international climate governance and the reshaping of trade rules [1]. Existing studies have primarily examined the rationale behind CBAM's institutional design, its compatibility with WTO rules, and its impacts on carbon-intensive industries such as steel and cement. Nevertheless, research on the broader and multi-dimensional effects of CBAM on international trade flows and the economies of developing countries remains limited in the context of global value chain restructuring. In particular, integrated analyses of the interactions among carbon cost transmission, industrial restructuring, and global distribution patterns are still lacking [2]. On this basis, this paper discusses the multi-faceted impacts and operating mechanisms of

CBAM on international trade flows and economic development in developing countries, with a particular focus on how carbon emission accounting and taxation reshape international competition patterns and drive industrial restructuring. Combining literature review with normative analysis, this paper systematically collates and compares relevant policy texts and existing studies, so as to further clarify the functional logic of CBAM and its transmission paths affecting international trade. It also provides targeted analytical evidence for developing countries to address CBAM shocks, offering references for optimizing industrial and trade strategies amid global lowcarbon transformation and adjustments to trade rules.

2. Basic concepts and operating mechanisms of the carbon border adjustment mechanism

2.1. Definition and evolution of CBAM

The Carbon Border Adjustment Mechanism (CBAM), commonly referred to as carbon tariffs, is an environmental trade tool formulated amid widening gaps in global carbon reduction policies. Its core operation is to levy corresponding fees on imported high-carbon goods based on full-life-cycle carbon emissions, integrating carbon costs into trade pricing systems to mitigate cost imbalances arising from uneven emission constraints across jurisdictions [1]. Due to varying stringency of carbon regulations worldwide, enterprises in regions with strict emission mandates bear higher abatement costs, while counterparts in loosely regulated areas gain price advantages that distort international competition. By calculating and charging importers for embodied carbon emissions, CBAM intends to narrow such cross-border cost gaps and push high-carbon industries toward decarbonization. From a rule-based perspective, the WTO framework emphasizes non-discrimination and trade liberalization while permitting members to adopt environmental measures under certain conditions. On this basis, the EU justifies CBAM as a WTO-consistent environmental policy. However, since the mechanism requires emissions to be tracked throughout production processes, it inevitably raises compliance costs for exporters. Besides, differences in industrial structures and decarbonization capacities across countries make uniform accounting standards a source of controversy regarding implementation fairness [3].

2.2. Implementation rules and response logic of CBAM

Under the CBAM framework, carbon emission accounting covers both direct and indirect emissions. Direct emissions arise from fuel combustion and raw material processing, whereas indirect emissions result from purchased electricity and thermal energy. Enterprises must submit actual emission data verified by third-party institutions. Where complete data cannot be provided, the EU applies default emission factors generally higher than enterprises' real emission levels, lifting the taxable benchmark [4]. In terms of coverage, CBAM initially targets six carbon-intensive sectors characterized by high emissions and intense cross-border competition: steel, cement, aluminum, fertilizers, electricity, and hydrogen. The mechanism affects market access through shifts in cost structures, with ripple effects extending to market competition and industrial adjustments. Goods exported to the EU incur extra carbon-related charges proportional to their emissions, pushing up export prices and squeezing profit margins of high-carbon products, whereas low-carbon goods with advanced abatement technologies gain an edge in price competition. Additionally, CBAM alters entry costs for overseas suppliers to the EU market, eroding the competitiveness of exporters from developing countries that previously relied on loose environmental regulations, and incentivizing the relocation of high-carbon production links to jurisdictions with lax oversight [5]. In the medium and

long run, carbon costs are embedded into global trade rules, making emission reduction capacity a core threshold for cross-border market participation. Enterprises must upgrade production techniques and optimize energy mixes to cut unit product emissions, otherwise they will face dual pressures of rising costs and restricted market access.

3. Impacts of CBAM on international trade flows

3.1. Shifts in market competition patterns driven by CBAM

By incorporating carbon costs into trade pricing systems, CBAM rewrites competition logic in global markets via cost pass-through effects on commodity prices. For energy-intensive goods such as steel, cement, and aluminum, carbon emissions generated during production are translated into additional compliance costs, increasing export prices by around 10%-20% and weakening traditional low-cost competitive advantages [5].

Under such circumstances, low-carbon products maintain stable prices with minimal carbon-related surcharges, securing comparative advantages in market rivalry. Meanwhile, the landscape of market competition undergoes structural changes. This is mainly driven by rising costs for carbon-intensive imports, reducing competitive pressure on EU producers, shifting competition from price-based rivalry toward carbon-performance differentiation, and raising overall commodity prices. In response to these external cost pressures, exporters invest in energy-efficient equipment, optimize production processes, and increase clean energy use to reduce carbon intensity and offset additional carbon tariff costs. As low-carbon technologies are widely deployed, enterprises gradually ease carbon cost burdens and restore the competitiveness of their products [6]. In the long term, this mechanism drives persistent market differentiation: high-carbon and inefficient production capacity withdraws amid cost pressures, while market shares of low-carbon and energy-efficient manufacturers expand, shifting the competitive focus from price advantages to decarbonization capabilities.

3.2. Restructuring effects of CBAM on industrial layout

In terms of industrial impacts, CBAM imposes significant cost constraints on domestic high-carbon industries and increases operational burdens for relevant manufacturers. For instance, traditional energy-intensive sectors such as steel, cement and electrolytic aluminum face extra expenditure on carbon certificates when exporting to the EU, directly inflating export costs and weakening their long-standing low-price competitive edges [2].

Moreover, many small and medium-sized enterprises lack mature emission reduction technologies. They not only struggle to satisfy carbon audit requirements, but also need to invest extra funds in establishing carbon accounting systems and cooperating with third-party testing bodies, which further aggravates operational burdens. Given the high upfront investment and long payback cycles of emission reduction renovations, technologically backward production capacity gradually exits the EU market, leading to shrinking export volumes across related industries. Conversely, CBAM facilitates the development of green industries. Guided by policy signals, capital and production factors rapidly converge in energy conservation, clean energy and low-carbon new materials [7]. Products from these sectors bear minimal carbon charges when exported to the EU, granting them distinct cost advantages and steadily growing overseas orders. Market demand further stimulates corporate investment in green technology R&D, promoting upgrades in new energy equipment manufacturing and low-carbon production processes while strengthening upstream and

downstream industrial chains. Driven by both policy constraints and foreign trade demand, local authorities accelerate the phase-out of backward capacity and optimize industrial layouts. Green enterprises expand their market shares continuously, propelling the transformation of industrial structures from energy-intensive dependency to low-carbon sustainable development [8].

3.3. Environmental effects of CBAM and carbon leakage prevention

Carbon leakage refers to the phenomenon where high-carbon industries transfer production links or orders to regions with weak environmental constraints and absent carbon pricing mechanisms, as strict emission reduction policies in individual economies push up carbon costs and erode corporate competitiveness. Such transfers fail to deliver overall reductions in global carbon emissions, merely shifting emission liabilities across borders. As a spillover effect of regional decarbonization policies, carbon leakage impairs the achievement of global emission reduction targets. The core environmental function of CBAM is to internalize the external costs of carbon emissions by imposing charges on carbon-intensive imports, narrowing cost disparities between jurisdictions with different levels of carbon regulation, discouraging firms from avoiding carbon constraints through production relocation, preserving the effectiveness of emission reduction policies, and mitigating "emission transfer without overall abatement" [1].

To curb leakage, CBAM expands its taxable scope from basic high-carbon commodities such as steel and cement to downstream products including machinery and home appliances. It establishes unified carbon accounting standards mandating third-party verified emission data from importers, and applies elevated default emission factors to goods without complete compliance records. Additionally, a carbon cost deduction mechanism allows exporters to offset charges for carbon expenses already paid in their home countries. Nevertheless, implementation faces multiple obstacles: inconsistent national carbon pricing and environmental supervision frameworks hinder rule alignment; small and medium enterprises bear heavy costs for carbon accounting and technical renovations with limited adaptive capacity; certain nations regard CBAM as a disguised trade barrier triggering disputes over international rules; and complex global value chains create technical hurdles for carbon emission tracking and precise accounting [3].

4. Potential impacts of CBAM on developing countries

4.1. Economic pressures and industrial conflicts

Economic challenges and industrial conflicts manifest in three progressive dimensions: cost burdens, technological bottlenecks and structural industrial contradictions. In terms of cost pressure, global low-carbon policies impose substantial economic burdens on developing countries. And their growth models remain heavily dependent on resource exploitation, while substantial investments in equipment upgrades and energy-efficiency improvements directly increase marginal production costs. Meanwhile, compliance obligations such as carbon footprint accounting and thirdparty audits add institutional expenses for enterprises, disproportionately burdening small and medium-sized firms, some of which even suspend or partially halt production [2].

From a technological perspective, key low-carbon technologies are concentrated in developed economies, thus resulting in high patent licensing costs for developing countries. Limited domestic innovation capacity and restricted access to advanced technologies hinder cost-effective emission reduction and slow the pace of low-carbon transition [4]. For industrial structural conflicts, most developing countries rely on energy-intensive and high-carbon sectors including steel, cement and

chemical manufacturing as economic pillars. These industries provide massive employment and export revenues yet face surging export costs and weakened competitiveness under CBAM rules [9]. Combined with fossil fuel-dependent energy systems and insufficient clean energy infrastructure, these pressures complicate industrial and energy transitions, forcing developing countries to balance transition costs with continued economic growth.

4.2. Trade inequality and market shocks

The rollout of CBAM amplifies structural disparities in international trade and widens development gaps between developed and developing economies. Equipped with mature low-carbon technologies and lightweight industrial structures, developed nations incur minor adjustment costs under carbon restrictions and suffer limited adverse impacts. By contrast, developing countries dependent on energy-intensive industries lack robust decarbonization capacity, and CBAM sharply raises their export costs, placing them in a disadvantaged position in global market competition [10].

Under these circumstances, many developing countries encounter dual challenges: export declines and growing technological dependence. The weakened competitiveness of carbon-intensive goods undermines foreign exchange revenues, while meeting carbon standards often necessitates costly imports of proprietary low-carbon technologies, placing further constraints on development resources and reinforcing a cycle of rising costs, industrial stagnation, and slower economic growth [11]. To address these issues, developing countries must pursue multidimensional adjustments. They can advocate for the implementation of "common but differentiated responsibilities" under multilateral frameworks to secure reasonable transition periods and technical support, scale up domestic R&D of low-carbon technologies to reduce reliance on foreign expertise, optimize industrial structures to expand new energy and energy conservation sectors, and strengthen regional cooperation and rule coordination to advance mutual recognition of carbon accounting standards and mitigate institutional trade frictions [12].

4.3. Transition strategies and international cooperation

To offset foreign trade losses induced by CBAM, developing countries can enhance international competitiveness through industrial green retrofits and export product upgrading.

In particular, governments and enterprises should upgrade energy-intensive production lines in sectors such as steel and construction materials, replace carbon-intensive equipment, and adopt clean energy solutions to reduce lifecycle carbon emissions and lower export-related carbon costs at the source. Meanwhile, export mixes should be adjusted by scaling down shipments of low-end crude high-carbon products and developing deepprocessed low-carbon goods, which create differentiated competitive edges based on decarbonization performance, ease cost pressures from EU CBAM and stabilize overseas order volumes. Independent national transformation alone cannot resolve structural imbalances in global climate governance, while multilateral cooperation can help reduce disparities between developed and developing economies [12]. Three key areas of cooperation include green finance, low-carbon technology transfer, and cross-border carbon trading. Among these, developed countries should honor financial commitments by providing concessional green loans to support technological upgrades in developing economies. They should also facilitate the transfer of low-carbon technologies by reducing barriers associated with patented energy-saving technologies and lowering technology adoption costs in less developed regions. In addition, improved international carbon markets could enable developing countries to trade surplus emission

allowances and offset part of the carbon costs imposed on their exports. These cooperative mechanisms can help alleviate trade inequalities associated with CBAM.

From a global governance perspective, all countries should uphold the principle of common but differentiated responsibilities and develop CBAM accounting frameworks that consider differences in development conditions and emission capabilities. For developing countries, differentiated carbon pricing benchmarks and transition arrangements are needed to support a fair adjustment process. Multilateral trade and climate negotiation platforms should coordinate carbon accounting standards and prevent unilateral rules from imposing excessive constraints on developing industries. With coordinated support in finance, technology, and carbon markets, carbon regulation can better balance climate objectives with national development needs, while reducing CBAM-related trade distortions.

5. Conclusion

This paper analyzes the operational framework of the EU CBAM and its multifaceted impacts on international trade, industrial structures, and the economies of developing countries. The research reveals that by integrating carbon emission costs into global trade systems, CBAM facilitates the internalization of carbon externalities, lowers carbon leakage risks, and drives green transformation of energy-intensive industries and the application of low-carbon technologies. Nevertheless, cross-country disparities in industrial foundations, energy mixes, technological proficiency and emission reduction capacities mean CBAM implementation triggers multiple adverse outcomes including climbing export costs, intensified industrial restructuring pressures and higher barriers to adapting to international trade rules. To mitigate these impacts, developing countries can strengthen adaptive capacity through industrial green upgrading, optimization of export mixes and expanded international green cooperation, while advancing the coordination of carbon accounting rules and the improvement of transition support mechanisms. This study contains certain limitations: it mainly explores the impact mechanisms of CBAM via normative analysis without quantitative evaluation based on sectoral and national trade data, and comparative analysis of carbon border policies across different regions remains insufficient. Future research may adopt trade data and econometric methods to quantify differentiated impacts of CBAM on various economies and industrial sectors, and design carbon border adjustment frameworks that better reconcile environmental goals and balanced economic development.

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