International Journal of
Economic Policy
(IJECOP)

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International Journal of Economic Policy
ISSN: 2788-6352 (Online)
Vol. 5, Issue No. 4, pp 53 - 61, 2025
www.carijournals.org

Impact of Carbon Border Adjustment Mechanisms (CBAMS) on the Export Competitiveness of Developing Nations

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Abstract

Purpose: The purpose of this article was to analyze impact of carbon border adjustment mechanisms (CBAMs) on the export competitiveness of developing nations.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: Carbon border adjustment mechanisms (CBAMs) pose a significant risk to the export competitiveness of developing nations. Their carbon-intensive exports, such as steel, aluminum, and fertilizers, face higher costs and administrative burdens when entering markets like the EU, making them less competitive. This can lead to export revenue losses and hinder industrial development. Consequently, these nations face urgent pressure to decarbonize their industries to maintain market access, a transition that requires significant financial and technological investment.

Unique Contribution to Theory, Practice and Policy: Pollution haven hypothesis, theory of ecological unequal exchange & porter hypothesis may be used to anchor future studies on the impact of carbon border adjustment mechanisms (CBAMs) on the export competitiveness of developing nations. For practical implementation, it is recommended that industry associations in vulnerable sectors, such as steel, aluminum, and fertilizers, establish Sector-Wide Carbon Accounting Hubs. At the policy level, governments must pursue a dual-track strategy of negotiation and domestic transformation.

Keywords: *Carbon Border Adjustment Mechanisms (CBAMs) Export Competitiveness*

INTRODUCTION

The export competitiveness of carbon-intensive industries is largely insulated from Carbon Border Adjustment Mechanisms (CBAMs) due to their advanced decarbonization infrastructure and alignment with importer climate policies. These nations typically compete on quality and technological sophistication rather than price alone, and their production often occurs under carbon pricing regimes similar to the EU's, minimizing the CBAM's financial impact. For example, Japan's steel industry, a major exporter, has maintained relatively stable export volumes to the EU due to its leadership in developing advanced, lower-carbon blast furnace technologies and electric arc furnaces. Similarly, the United Kingdom's chemical sector has preserved its market share by leveraging a national emissions trading scheme that aligns with EU standards, preventing a significant cost penalty. This resilience underscores how advanced industrial bases with proactive climate policies can maintain competitiveness under carbon-neutral trade frameworks (Pavel & Taran, 2019).

In contrast, developing economies face severe threats to their export competitiveness from CBAMs, as their cost advantage is often tied to carbon-intensive energy and production processes. The mechanism directly erodes this price competitiveness by imposing a cost on embedded emissions, leading to projected declines in export volume and market share. For instance, India's aluminum sector, which accounts for a significant portion of its exports to the EU, is highly vulnerable; studies suggest that a full CBAM implementation could render a substantial portion of its current exports uncompetitive due to the sector's coal-dependent power sources. Likewise, Vietnam's growing steel exports to Europe are at risk despite rapid growth, as their high grid carbon intensity could lead to a significant CBAM levy. This creates a direct trade-off between industrial development and climate compliance for these nations (Branger & Quirion, 2018).

The situation for Sub-Saharan African economies is particularly acute, as their nascent carbon-intensive industries risk being stillborn under the pressure of CBAMs. These regions often lack the capital for rapid decarbonization and face the dual challenge of achieving industrial growth while navigating stringent new trade rules. For example, Nigeria's developing aluminum sector, which relies heavily on diesel and gas-powered electricity, faces production costs that would become prohibitive under the EU CBAM, threatening to strand assets and halt industrial development before it matures. Similarly, South Africa's well-established but coal-intensive steel and iron exports to the EU are projected to experience a significant decline in market share without a fundamental and costly energy transition. The mechanism thus poses a fundamental constraint on their industrial export-led development strategies (Alova, 2021).

The stringency and scope of a Carbon Border Adjustment Mechanism (CBAM) are its defining features, directly determining its economic impact. Stringency refers to the effective carbon price applied to imports, which can vary based on the aggressiveness of the domestic carbon price it mirrors and any adjustments for carbon costs already paid abroad. Scope defines the breadth of covered sectors and emissions, ranging from a narrow focus on direct emissions from a few basic materials to a wide net that includes indirect emissions from electricity and processed goods. We can conceptualize four likely CBAM scenarios: a Limited Pilot (low stringency/scope, covering only direct emissions from steel and cement), a Mirror Policy (moderate stringency/scope, matching the EU's current CBAM covering iron, steel, aluminum, fertilizers, electricity, and hydrogen), an Advanced Mechanism (high stringency/scope, incorporating indirect emissions and

expanding to chemicals and plastics), and a Comprehensive System (very high stringency/scope, including embodied carbon in complex manufactured goods and land-use emissions from imported agricultural products). The linkage to export competitiveness is direct: as we move from a Limited Pilot to a Comprehensive System, the compliance costs for producers in developing countries escalate non-linearly, severely eroding their price advantage in key export markets (Böhringer, 2022).

The impact of these scenarios on the export competitiveness of carbon-intensive industries in developing nations is profound and escalates with each expansion of stringency and scope. Under a Limited Pilot, the impact is contained, potentially causing only minor market share losses for a few sectors like steel, allowing nations time to adapt. The current EU CBAM, acting as a Mirror Policy, poses a significant threat, with studies projecting export declines of 5-10% for vulnerable sectors in countries like India and ASEAN nations, as the direct carbon cost makes their products less competitive (Eberbach & Lee, 2022; Kaushik & Malik, 2023). An Advanced Mechanism would dramatically intensify this pressure, as incorporating indirect emissions penalizes countries with carbon-intensive electricity grids, crippling the competitiveness of entire industrial ecosystems and leading to substantial drops in export volume. Finally, a Comprehensive System that includes agriculture would represent an existential threat to the export models of major commodity-driven developing economies, fundamentally restructuring global trade patterns by making it nearly impossible for high-carbon producers to compete in developed markets without a radical and rapid green transition.

Problem Statement

The European union's pioneering carbon border adjustment mechanism (CBAM), a cornerstone of its Fit for 55 policy package, represents a transformative shift in global climate and trade governance. Designed to prevent carbon leakage and uphold the integrity of its domestic climate ambitions, the mechanism imposes a carbon price on imports of specific carbon-intensive goods. While environmentally motivated, the implementation of CBAM creates a significant and urgent problem for developing nations, whose economic stability and development trajectories are heavily reliant on export-led growth. The core issue is that the mechanism risks functioning as a de facto tariff barrier that disproportionately penalizes these countries, not for a lack of environmental effort, but due to their carbon-intensive production structures and limited financial capacity to decarbonize rapidly (Van Asselt & Kulovesi, 2022). This threatens to severely erode the price competitiveness of key exports like steel, aluminum, and fertilizers from developing nations, potentially leading to substantial export revenue losses, deindustrialization in vulnerable sectors, and heightened economic distress (Kaushik & Malik, 2023).

Compounding this direct economic threat is the profound risk that CBAM may exacerbate existing global inequalities and undermine the principle of Common but Differentiated Responsibilities and Respective Capabilities (CBDR-RC), a cornerstone of international climate justice. The policy, if not carefully designed with equitable considerations, could effectively transfer financial resources from the Global South to the Global North, thereby restricting the fiscal space necessary for developing nations to invest in their own green transitions (Bao, 2023). Furthermore, the high administrative and technical burdens of compliance, including complex carbon accounting and verification, pose a significant obstacle, particularly for small and medium-sized enterprises in developing countries (Eberbach & Lee, 2022). Therefore, a critical problem exists: without a

comprehensive understanding of CBAM's multifaceted impacts and the development of effective, equitable mitigation strategies, the mechanism may inadvertently stall sustainable development, cement global economic disparities, and create new fault lines in international cooperation on climate change.

Theoretical Review

Pollution Haven Hypothesis

Originating from Walter and Ugelow (1979), this theory posits that industries with high pollution costs will relocate from countries with stringent environmental regulations to "pollution havens" with laxer rules. Its relevance is direct, as it provides the foundational fear driving CBAMs: that climate policies in developed nations could push carbon-intensive production to developing countries, increasing global emissions. Research can test if CBAMs effectively neutralize this effect or, conversely, if they simply penalize developing nations for their industrial structure (Branger & Quirion, 2018).

Theory of Ecological Unequal Exchange

This theory, advanced by contemporary political ecologists, argues that the global economic system is structured to facilitate a net transfer of resources and environmental burdens from peripheral, developing nations to core, developed ones. The main theme is that economic growth in the Global North is sustained by externalizing environmental costs to the South. This theory is crucial for framing CBAMs not just as a climate tool, but as a potential mechanism that reinforces historical inequalities by making developing nations pay for emissions embedded in the production of goods they export to the North (Dorninger, 2021).

Porter Hypothesis

Proposed by Michael Porter (1991), this hypothesis controversially argues that well-designed environmental regulations can spur innovation, leading to off-setting efficiency gains and improved competitiveness. Its relevance to CBAMs is in analyzing potential positive outcomes. The research can investigate whether the regulatory pressure of CBAMs acts as a "Porter-like" stimulus for developing nations, driving technological upgrading and a shift to higher-value, low-carbon exports, or if the costs simply overwhelm their capacity to adapt, leading to de-industrialization (Dechezleprêtre & Sato, 2019).

Empirical Review

Böhringer (2022) employed a sophisticated multi-sector, multi-region computable general equilibrium (CGE) model to simulate the global trade and emission impacts. Their key finding was that while the CBAM was effective in its primary environmental goal, reducing carbon leakage by approximately 19%, it imposed significant economic costs disproportionately on developing nations. The model projected notable decreases in GDP and economic welfare for regions like Sub-Saharan Africa and South Asia, primarily driven by reduced export demand for their carbon-intensive goods such as steel and fertilizers. Based on these findings, the study strongly recommended that the EU implement a robust revenue recycling mechanism, whereby a substantial portion of the income generated from the CBAM is directed towards compensating affected low-income countries and supporting their green energy transitions, thereby mitigating the regressive economic impacts of the policy.

Kaushik and Malik (2023) assessed the vulnerability of India's key export sectors to the EU's CBAM. Their methodology involved a detailed mapping of Indian export data to the EU against the carbon intensity of production for targeted sectors, notably iron, steel, and aluminum. The findings were stark, identifying nearly $8 billion worth of annual Indian exports as being at high risk due to the additional carbon costs imposed by the mechanism. The study concluded that this would severely erode the price competitiveness of these industries in the critical EU market. In response, the authors recommended a two-pronged national strategy: first, the government should urgently facilitate and subsidize industrial energy efficiency upgrades; and second, it should launch a major national initiative for green hydrogen production to decarbonize primary metal manufacturing, thereby future-proofing these strategically important export industries.

Eberbach and Lee (2022) aimed to project the impact of the EU CBAM on the manufacturing exports of ASEAN member nations. The researchers utilized a gravity model of trade, augmented with carbon emission data, to forecast changes in trade flows under different CBAM scenarios. Their central finding was a projected 5.7% decline in export volumes for the most carbon-intensive exporters within the ASEAN bloc, with Vietnam and Thailand identified as particularly vulnerable. The study highlighted that the administrative burden of compliance proving the carbon content of goods was a significant barrier for small and medium-sized enterprises in the region. Consequently, the primary recommendation was for ASEAN to pursue regional cooperation by developing and adopting a common carbon accounting and verification standard, which would reduce compliance costs for all member states and strengthen their collective bargaining position in international climate and trade forums.

Oguntuase (2024) assessed the potential impact of CBAM on Nigeria's developing aluminum sector. Their methodology combined surveys of local manufacturing firms with financial modeling to calculate the impact of the EU's carbon price on production costs. The findings revealed that the CBAM cost would completely erase the profit margins for most local aluminum producers, threatening to strand assets and halt the growth of the industry before it could mature. The study concluded that without intervention, the sector was not viable under the new trade rules. As a pragmatic solution, the authors recommended that the Nigerian government implement strategic subsidies and tax incentives for manufacturers to transition from diesel-generated power to natural gas as a lower-carbon bridging fuel, thereby reducing the embedded carbon in their products and mitigating the immediate financial threat of the CBAM.

Santos and Ferreira (2023) analyzed Brazil's unique position, with the purpose of evaluating both its resilience and vulnerability to carbon-adjusted trade. The methodology integrated detailed trade data with comprehensive land-use change and operational emissions figures, focusing on the agricultural sector. The findings presented a dual narrative: Brazil's relatively clean electricity grid provides a "green shield" for its manufacturing sectors, but its agricultural exports, particularly beef and soy, face a future "green sword" from potential future CBAM expansions that include land-use emissions. The study recommended that Brazil proactively future-proof its largest export sector by accelerating the development, certification, and marketing of low-carbon agricultural supply chains, leveraging its existing advantages to build a brand of sustainable production that could circumvent future trade barriers.

Chen and Li (2023) conducted a comparative empirical study with the purpose of understanding why CBAM impacts vary significantly even among developing Asian economies. Their

methodology used input-output analysis to calculate the embedded carbon in the export products of Bangladesh's textile industry and Vietnam's furniture industry. The key finding was a dramatic disparity in vulnerability: Bangladesh's high reliance on coal for its textile industry made it far more exposed to CBAM costs than Vietnam, which benefits from a grid heavily supplied by hydropower. This led the authors to recommend a fundamental change in the design of future border mechanisms, arguing that carbon tariffs should be based on the specific carbon intensity of the exporting region's energy grid rather than a global average, which would create a fairer and more accurate incentive structure for decarbonization.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low-cost advantage as compared to field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

FINDINGS

The results were analyzed into various research gap categories that is conceptual, contextual and methodological gaps

Conceptual Gaps: Conceptually, a significant gap exists in moving beyond macroeconomic and sector-level projections to understanding the micro-foundations of firm-level behavioral responses to CBAM. While studies like Böhringer (2022) model aggregate economic impacts and Kaushik & Malik (2023) assess sectoral exposure, they do not empirically investigate how individual firms in developing countries are adapting their production, investment, and innovation strategies in anticipation of or in response to the policy. There is a lack of a coherent theoretical framework that integrates the "compliance cost burden" a major concern in the ASEAN study (Eberbach & Lee, 2022) into models of export competitiveness, particularly for small and medium-sized enterprises (SMEs). Furthermore, the literature is silent on the potential for "Green Technological Leapfrogging"; while recommendations suggest decarbonization (e.g., green hydrogen in India), no study conceptualizes or tests the conditions under which CBAM pressure could actually accelerate a competitive advantage for developing nations that rapidly adopt state-of-the-art green technologies, rather than merely playing catch-up.

Contextual Gaps: Contextually, the research reveals a narrow focus on traditional, heavy industrial sectors like steel and aluminum, creating a blind spot regarding other critical economic pillars of the developing world. The study on Brazil (Santos & Ferreira, 2023) begins to address this by highlighting the future threat to agriculture, but a substantial gap remains in assessing the impact on other vulnerable contexts such as extractive industries (e.g., mining), chemical fertilizers, and refined petroleum products. Moreover, the studies fail to account for the critical role of domestic political economy. There is no analysis of how internal factors like state capacity, levels of corruption, the strength of industrial lobbies, and pre-existing subsidy regimes for fossil fuels influence a country's ability to formulate and implement an effective response strategy to CBAM, thereby mediating the ultimate impact on export competitiveness.

Geographical Gaps: Geographically, the evidence base is fragmented and leaves entire regions and country typologies unexamined. While there is focus on major emerging economies like India and

regional blocs like ASEAN, there is a pronounced lack of detailed, country-specific analysis for the world's least developed countries (LDCs), particularly in Sub-Saharan Africa beyond Nigeria, and for heavily fossil-fuel-dependent nations in the Middle East and North Africa (MENA) region. The case of Nigeria (Oguntuase, 2024) is a singular example, but its findings on nascent industries being stillborn due to CBAM cannot be generalized. Furthermore, a significant geographical-comparative gap exists: there are no studies that directly compare the differential impacts and response strategies of commodity-exporting nations (e.g., Nigeria, Mozambique) with more diversified manufacturing exporters (e.g., Vietnam, Malaysia) to derive typologies of vulnerability and resilience. This limits the ability to create tailored international support mechanisms.

CONCLUSION AND RECOMMENDATIONS

Conclusions

In conclusion, the assessment of carbon border adjustment mechanisms (CBAMs) reveals a complex and challenging landscape for developing nations, where environmental objectives and economic equity appear to be in direct tension. The analysis demonstrates that CBAMs pose a significant threat to the export competitiveness of carbon-intensive industries in developing economies, potentially eroding their hard-won market access and economic growth. This occurs not merely through the direct financial burden of carbon costs but through more fundamental structural pressures: the risk of technological dependency, the high compliance costs of emissions verification, and the potential diversion of scarce resources from broader development goals. The evidence suggests that without proactive intervention, CBAMs could inadvertently reinforce global economic inequalities, punishing nations that are historically least responsible for climate change and often lack the financial and technical capacity for a rapid green transition.

However, this assessment also illuminates a potential pathway for transformation. The immense pressure exerted by CBAMs can serve as a catalyst, compelling a strategic re-evaluation of industrial and energy policies in the developing world. The ultimate impact of these mechanisms whether they become a regressive barrier or a progressive catalyst for global green industrialization is not predetermined. It hinges critically on the responses of both developed and developing nations. For developed economies, it demands a commitment to equitable implementation, including substantial financial and technological support. For developing nations, it necessitates a decisive shift towards low-carbon production, leveraging international climate finance and domestic policy innovation. Therefore, the future of developing nations' competitiveness in a CBAM-world will be determined less by the mechanism itself and more by the global community's willingness to ensure a just transition and by their own agility in navigating the imperatives of a decarbonizing global economy.

Recommendations

Theory

To advance theoretical understanding, researchers should develop a "CBAM Vulnerability and Resilience Index" specific to developing economies. This model must move beyond simplistic export volume analysis by integrating multi-dimensional variables, including the carbon intensity of key export sectors, the economic dependency on those sectors, and the nation's adaptive capacity, which encompasses financial resources, technological access, and institutional strength. Furthermore, economic theory should be expanded to formally model CBAM not just as a trade

barrier but as a potential catalyst for a "green technological dependency," where developing countries become reliant on patented, high-cost decarbonization technologies from CBAM-imposing blocs, thereby creating a new form of economic subordination. The unique contribution to theory is the formalization of a nuanced, multi-parameter framework that shifts the scholarly conversation from assessing mere export losses to modeling complex, long-term structural shifts in global value chains and technological sovereignty, providing a more robust basis for empirical analysis.

Practice

For practical implementation, it is recommended that industry associations in vulnerable sectors, such as steel, aluminum, and fertilizers, establish Sector-Wide Carbon Accounting Hubs. These hubs would provide standardized, verifiable carbon footprint data for member companies, which is the critical first step for engaging with CBAM compliance. Additionally, individual exporting firms must conduct strategic carbon cost internalization audits to model the financial impact of CBAM on their production costs and to identify the break-even point for investing in specific decarbonization technologies versus paying the CBAM levy. The unique contribution to practice is the move from passive vulnerability to proactive data management and strategic financial planning. It provides businesses with a clear, actionable roadmap to navigate the new regulatory landscape, transforming a compliance burden into a calculable business decision and fostering a competitive edge through verified low-carbon production.

Policy

At the policy level, governments must pursue a dual-track strategy of negotiation and domestic transformation. Internationally, they should champion the argument that CBAM revenues be legally earmarked as "climate reparative finance," formally recycled to support green transitions in affected developing nations, thereby aligning the mechanism with the principles of Common but differentiated responsibilities (CBDR). Domestically, governments should implement "green industrial corridors," offering targeted incentives, streamlined regulations, and co-investment in renewable energy infrastructure within specific export-oriented zones to systematically lower the carbon footprint of key industries. The unique contribution to policy is the formulation of a legally-grounded and morally-consistent negotiating position that reframes CBAM from a unilateral penalty into a potential source of climate finance, coupled with a concrete domestic policy tool that directly targets the root cause of the penalty high carbon intensity thereby safeguarding both export competitiveness and sustainable development goals.

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