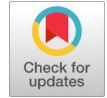


Beyond Borders: CBAM's Revolutionary Potential and Challenges in Achieving Carbon Neutrality



Taniya Choudhury Anupam Tiwari Rakshit Jakhar

Abstract: *The Carbon Border Adjustment Mechanism (CBAM) is a ground-breaking method for attaining carbon neutrality in international trade as the world community struggles with the pressing need to address climate change. This research examines how the CBAM may impact the dynamics of global trade and foster a shift toward low-carbon, sustainable economies. A critical analysis has been conducted to explore the CBAM's transformational potential in bringing trade practices into line with climate goals by examining its economic, environmental, and political components and its implication practice, covering issues with trade equity, enforcement protocols, and possible geopolitical conflicts. The information has been gathered from several reliable sources, including the WTO, the European Commission for trade input, the World Bank, and the EPA for emission information. It has been compiled into a tabular format for simplicity of reading. The graphs have been plotted using Python (3.11.6) to improve visual comprehension. Stakeholders can help CBAM implement successfully by adopting these suggestions, maximising its revolutionary potential, and overcoming the challenges in achieving carbon neutrality in international trade. By using an interdisciplinary approach, the study seeks to offer a thorough grasp of CBAM's function in becoming carbon neutral, revealing the complex obstacles that must be overcome for it to integrate into the world economy successfully.*

Keywords: CBAM, Carbon Neutrality, Climate Change, Sustainable Development.

I. INTRODUCTION

In the global effort to mitigate climate change, achieving carbon neutrality has become a key goal. An extraordinary instrument to address the carbon footprint connected to international trade is the Carbon Border Adjustment Mechanism (CBAM), which ensures that imported items are held to the same environmental standards as those produced domestically, which seeks to advance sustainability and fairness [1]. However, in its pursuit of achieving global carbon neutrality, it faces enormous obstacles and possible

rewards, just like any innovative project. The CBAM is intended to mitigate the potential problem of carbon leakage, which happens when businesses relocate their operations to areas with less stringent environmental laws to save money on reducing their emissions. This carbon leakage can be mitigated by placing a price on certain imports based on their embedded carbon emissions. This might encourage funding for initiatives that actively remove carbon from the atmosphere or find other ways to offset emissions, resulting in a more comprehensive and well-rounded plan for achieving carbon neutrality. In December 2019, the EU reached a consensus on the European Green Deal. By 2050, it seeks to establish Europe as the first carbon-neutral continent. The 'Fit for 55' is an updated version of the European Green Deal that preserves the original framework while adding implementation mechanisms [2]. It was initially introduced on July 14, 2021. The law claims to apply the CBAM to other nations and pledges to reduce carbon emissions by 50–55% [3]. In terms of politics, things evolved in the summer of 2019. CBAM will only cover imports of cement, iron and steel, aluminium, fertilizers, power, and hydrogen during its transitional period. EU importers of certain commodities will be required to submit reports detailing the amount of their imports and the greenhouse gas (GHG) emissions incurred during production; however, no financial adjustments will be made at this time. Importers will only need to submit their first report by January 31, 2024, even though they are required to gather data for the fourth quarter of 2023. Additionally, several flexibility features have been incorporated into the structure of the CBAM for the first year of usage [2]. Trade economists view this as a possible threat to the smooth operation of the global trading system, which may come as no surprise. Lower-income individuals in Eastern Europe (particularly Russia), South America, Africa, and Asia also view this policy as a threat to their well-being, as it will limit their access to markets by significantly disrupting trade. The issues remain whether border tax adjustments will be made, their impacts, and whether their justification is sound [4]. Furthermore, international negotiations have moved away from prescriptive targets that could lead to a global carbon price towards facilitating country-level efforts with the adoption of nationally determined contributions (NDCs) by parties to the United Nations Framework Convention on Climate Change (UNFCCC) and the 2016 Paris Agreement [5].

Manuscript received on 14 February 2024 | Revised Manuscript received on 22 February 2024 | Manuscript Accepted on 15 March 2024 | Manuscript published on 30 March 2024.

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The economic and environmental effectiveness of border compensation has been measured before; thus, the EU is not the first to do so. Ref. [6] conducted a quantitative analysis of scenarios involving compensating carbon taxes at the borders of Annex B countries before the US opted out used the same tool to quantify the effects and effectiveness of various CBA schemes (Voluntary Export Restraints, compensating tariffs,

free allowances, and export rebates) under the Kyoto Protocol following the US opt-out in a multi-region CGE model of the world economy, examine several designs for compensating tariffs and assess their effects on global welfare.

Table 1: A Summary of the Literature Survey

Sl. No.	Prime Research Objective	Findings	Impact Trajectory	Affected Region	Stand Point	Ref.
1	An investigation of environmental effectiveness	Alternate measures to compensate for its drawbacks	Not entirely positive	Globally	Neutral	[1]
2	An assessment of the variations in greenhouse gas emissions both within and across periods	Termed as 'a weak green paradox', it can lead to a detrimental acceleration of the exploitation of fossil fuels and an increase in the total amount of climate damage.	Disastrous	Globally	Supportive of the CBAM, the policy improves	[6]
3	We are unveiling the potential risks of the mechanism.	The scheme is too expensive, leading to global trade issues, and many countries are likely to oppose it.	Detrimental	Globally	Against the policy	[3]
4	How can the implementation of this policy affect other countries?	The Global South is underrepresented. Additionally, African countries are at a higher risk, and their GDP is likely to fall. A trade war between the US and China may be initiated.	Negative	Global view with more emphasis on emerging economies.	Against the policy	[7]
5	To measure the efficiency of the tool in carbon pricing.	The authors propose an "individual adjustment mechanism" to improve carbon pricing efficiently so that it will not violate the WTO agreements.	Harmful	Globally	Supportive of the CBAM, the policy improves	[8]
6	A rigorous literature survey about the potential impact of the policy.	It provides evidence-based guidelines to reframe the policy structure.	Detrimental	Globally	Neutral	[9]
7	Provide a preliminary assessment of the possible effects on various production sectors and develop a multi-sectoral AGE model to examine the macroeconomic impact on the Turkish economy.	By 2030, the Turkish economy is expected to have lost between 2.7% and 3.6% of its GDP.	Adverse	Turkey	Against the policy	[10]
8	How does this policy violate the rules of the WTO, and what should the WTO do to check global warming?	The Paris Climate Agreement's differentiated pledges and the WTO's "holy law" of non-discrimination are at odds. However, the WTO should reconsider its policies.	Beneficial	Globally	Supports the policy	[11]
9	This study examines various approaches designed to effectively reduce global emissions in a situation where not all nations cooperate.	None of these tactics lessens the issue of indirect leaks, and it's unclear if the Carbon Border Adjustments comply with WTO standards legally.	Detrimental	Globally	Against the policy	[12]
10	Exploration of border tax adjustments that would accompany the US, EU, and other OECD economies' pledges to cut carbon emissions.	Researchers contend that the effects of border tax modifications have to be evaluated independently of the reasons behind them.	Positive	Globally	Supportive	[13]
11	This article aims to assess the impact of various design decisions on the economy and the environment.	It demonstrates the effectiveness of CBAM in lowering carbon leakage. However, the European Emissions Trading Scheme's carbon price will be increased.	Both positive and negative	Globally	Neutral	[14]
12	Examine the CBAM proposal's key points and discuss how it would impact China, India, Russia, Turkey, and Ukraine economically—the EU's leading importers of goods covered by the CBAM.	The study indicates that the aggregate economic benefits of the CBAM would be low for most exporting countries, notwithstanding significant variance among countries and industries.	Beneficial	China, India, Russia, Turkey, and Ukraine	Supportive	[15]

13	This research assesses the environmental and economic effects of various design decisions in light of the conflict between WTO rule compliance and other considerations.	Carbon leaks can be effectively reduced via CBAM. However, the market for carbon quotas under the European Emission Trading System (ETS) is more expensive, and competitiveness in the export market needs to improve.	Both positive and negative	Globally	Neutral	[16]
14	The Impact of CBAM on the Chinese Economy and China's Response to It.	The country's domestic economy and international trade will be severely impacted. Consequently, China should prioritise safeguarding its interests.	Detrimental	China	Against the policy	[17]
15	An overview of this scheme	Its compatibility with the WTO needs to be revised. It will generate trade conflict and adversely affect poor nations. There is no intention to make up for the competitive losses incurred by EU exporters due to the progressive phase-out of free allocation. Therefore, the EU should reconsider this policy.	Detrimental	Globally	Against the policy	[18]

II. OPPORTUNITIES

The necessity for comprehensive and efficient carbon emission reduction policies is increasingly being acknowledged as the world faces more severe climate-related concerns. It provides countries with a powerful incentive to adopt proactive measures to reduce their carbon emissions. The mechanism connects the price of carbon to global trade, balancing economic interests with environmental objectives. Adopting cleaner technology and practices can give countries a competitive edge in the international market, leading to a worldwide race towards sustainable industrial processes.

A. Promoting Carbon Neutral Trade

The CBAM denotes a dedication to lowering the carbon footprint linked to international supply chains, promoting the shift to more ecologically friendly and sustainable trade practices. Research conducted by the European Roundtable on Climate Change and Sustainable Transition (ERCST, 2022) suggests that, depending on the carbon pricing scenario, the CBAM should cut exports of the five sectors it covers from 10 EU nations by 1.4% to 16.5% by 2030, which has the potential revenue for the European Union in 2030 ranging from 0.2 billion to 3.9 billion euros. By conducting research, planning events, and promoting discussions on climate change adaptation, mitigation, and sustainable development, ERCST aims to contribute to informed policymaking. These efforts include studies on climate policy, carbon markets, renewable energy, and other topics vital to addressing climate challenges and assisting stakeholders in comprehending and navigating the complexities of climate policy and sustainable development. According to a study by the Vienna University of Economics and Business (WU) and the International Institute for Applied System Analysis (IIASA), the CBAM can cut exports by 0.6% to 14.2% while increasing revenue generation from 0.1 billion to 2.8 billion euros by 2030 [19]. Lower carbon costs or exemptions may be available to businesses that implement eco-friendly practices, promoting the adoption of cleaner technologies and innovation in sustainable manufacturing methods.

B. Encouraging International Climate Action

The system signals trading partners to undertake aggressive climate measures by tying carbon prices to global commerce. This may help in a better-coordinated worldwide effort to combat climate change and cut carbon emissions [8].

Moreover, by extending carbon pricing policies to imported goods, the CBAM contributes to achieving more comprehensive emission reduction targets set by numerous nations and can improve the coherence of climate policies. Ref. [6] guarantees that the product's environmental impact is considered at every stage of the supply chain, encouraging a more thorough and integrated approach to reducing carbon emissions. The research, adaptation plans, and climate initiatives can all be funded with the proceeds from the CBAM, which can help support initiatives that facilitate the transition to a low-carbon economy and assist nations in achieving their climate goals. They can promote global climate action by,

- Encouraging clear emission reduction targets
- Setting targets for renewable energy
- Restoring the environment to absorb more carbon
- Enhance farming practices and promote vegan eating
- Spreading climate awareness

C. Maintaining Equitable Competition

By assigning a carbon price to imported goods according to their carbon footprint, the CBAM aims to maintain fair competition. This helps avoid a scenario in which local firms that follow stringent environmental regulations must pay more to produce goods than their international counterparts in places where carbon pricing is either non-existent or very cheap. As a result of being held responsible for their environmental impact, a carbon price on imports ensures a more level playing field for international business competition. If broadly implemented, this strategy can help reduce carbon emissions globally by incentivising businesses worldwide to switch to more environmentally friendly methods.

III. CHALLENGES

It can take time to develop a sophisticated and standardised methodology to implement a system that accurately measures and assigns carbon costs to imported goods. Fairness and economic growth are called into question by this. The primary concern is the adverse effect on global trade. The imports are subject to a price on carbon that is determined by their carbon footprint. This could result in higher costs for industries in nations with weaker environmental regulations, which could hinder those nations' ability to compete in the global market. Trade

conflicts and tensions may result from this. It is challenging to bring carbon pricing schemes into global harmony. Various strategies across nations may result in inefficiencies.

A. Trade Conflicts and Tensions

International trade agreements may give rise to disagreements regarding the fairness and legitimacy of CBAM in terms of the GATT and WTO.

In 2019, the WTO Appellate Body stopped operations. The multilateral trading system, which aims to preserve open and rules-based global commerce, may be at a crossroads if the CBAM is allowed to have a significant detrimental influence on trade. Moreover, nations with sizable export-oriented industries are concerned that the process may hurt their goods on the international market and perhaps spark trade disputes [3,11]. Adjustments for imports and exports are treated differently under the GATT regulations on the BTA. GATT Article II:2 (a) permits the imposition of an import charge "equivalent to an internal tax" as long as GATT Article III:2 regulations apply to it. GATT Article XVI on exports specifies that export refunds of taxes that aren't higher than those imposed domestically won't be considered subsidies. Verifying the Ad Note: GATT Article VI: 4 states that the rebate cannot result in countervailing or anti-dumping duties. The border tax adjustment of an indirect product tax does not result in any problems with GATT compatibility if specific regulations are followed [20]. Furthermore, this violates the WTO's special and differential treatment (SDT) provisions, which grant developing nations exceptional rights and include provisions for the least developed countries (LDCs). It demands that the Doha Agreement's requirements for WTO members to defend the trade interests of developing nations be followed and that the agreements be implemented for a longer period. A tariff designed to offset variations in carbon pricing is a prime candidate for challenge at the WTO. First, it must be administered in a discriminatory manner, which does not go against the GATT's MFN principle [11,12].

(Israel, Italy), oil-producing nations (Saudi Arabia, UAE), and emerging markets (India). The second and third groupings of nations may retaliate against these, which would be a blow to China's BRI debt-trap program. In 2022, developing countries exported US\$1,173 billion in goods to the EU, representing a 21.8% share of the EU's total imports. Imposing a carbon tax will suddenly be detrimental for exporting countries [Table 1]. The CBAM may cause a drop in African exports to the EU of up to 13.9% for aluminium, 8.2% for iron and steel, 3.9% for fertiliser, and 3.1% for cement [21].

B. Impacts on the Economy

The financial crisis relating to the CBAM may arise; these challenges will depend on several variables, such as design, execution, and cooperation across borders. It can be stated that the developing and underdeveloped economies will be at a disadvantage [15]. If industries in nations with strict climate policies incur increased costs due to CBAM, they can worry about the economic competitiveness of their products. Moreover, it is difficult to determine a reasonable carbon price for imported items [18]. It necessitates striking a balance between the need to stop carbon leaks and fairness, and avoiding placing undue financial strain on exporting nations. This is especially important for energy-intensive and trade-exposed companies. For instance, a report published on January 1, 2026, by the think tank Global Trade Research Initiative (GTRI) states that CBAM will result in a 20–35% tax on certain imports into the EU. India exports iron, steel, aluminium, and pelletised iron ore to the EU at a rate of 26.6%. The CBAM would target these products. In 2023, India sent the EU these items valued at USD 7.4 billion [22]. Industries in underdeveloped nations may be disproportionately affected by CBAM since they might need more infrastructure and resources to adhere to strict carbon pricing regulations. This raises concerns over the possible adverse effects on the economy and society in these areas. India and other developing nations have argued that CBAM could have a disproportionately large impact on their economies [Figure 2]. They say that wealthy countries should be more responsible for tackling climate change, emphasising historical responsibility and the concept of common but differentiated obligations adopted during the 1992 Rio Earth Summit [10]. Developing nations may still undergo industrialisation and frequently rely more on carbon-intensive industries. If a carbon tax is implemented without considering the unique conditions of these countries, it can result in an uneven distribution of the burden. It might impede their economic expansion, making it harder for them to achieve their development objectives. [Figure 2] demonstrates a lucid way of understanding how the economic growth of emerging regions might be adversely impacted. For instance, it is calculated that Mozambique's GDP will drop by 1.5% due to tariffs on aluminium imports alone [23]. African exports to the EU may decline by 5.72% and the GDP of the continent by 1.12% in a scenario in which all exports to the EU would be covered by CBAM and at a carbon price of €87 per tonne. Such expansion can also cause significant losses in Asia. Including plastic products

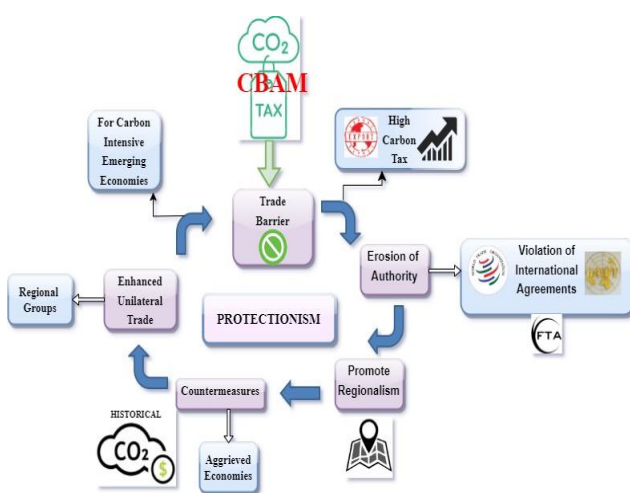


Fig. 1: The Vicious Circle of Protectionism in Trade

A. Impeding the advancement of IMEC

The competition with China's Belt & Road Initiative (BRI), the India-Middle East Economic Corridor (IMEC) is composed of three categories of states: developed nations

with high carbon intensity in the CBAM would result in a 0.6% and 0.2% decline in GDP for Vietnam and Thailand, two significant exporters [21].

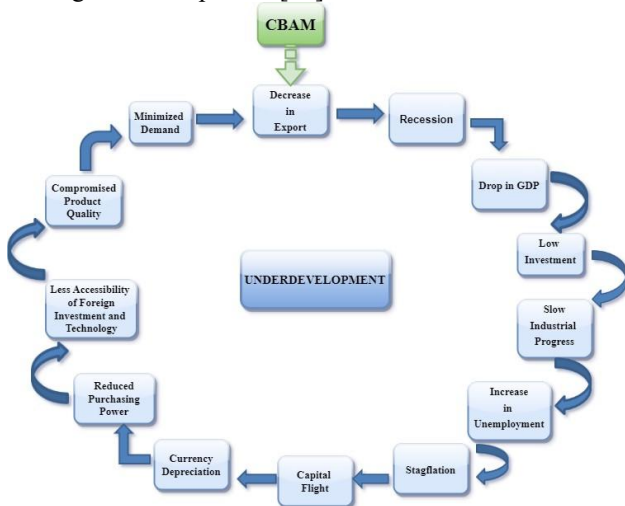


Fig. 2: The Circle of Underdevelopment

C.Impacts on Geopolitical Environment

The international collaboration is essential for CBAM to be effective. Significant economies risk carbon leakage if they do not implement comparable measures, whereby firms relocate to areas with less stringent environmental laws. This undercuts CBAM's goal of reaching global emission reduction targets. It may lead to trade tensions and retaliatory measures from countries [24] who regard it as a trade barrier. This might intensify into more significant trade disputes and obstruct international collaboration on climate-related matters.

The international cooperation and consensus on shared standards are essential to the success of CBAM. Reaching an agreement among nations with diverse economic and environmental policies can be a challenging task. Some detractors argue that CBAM could exacerbate international tensions, thereby undermining global collaboration on climate change. They emphasise that instead of taking unilateral action, it is crucial to forge international accords and promote cooperation. The global North-South partnership is required in areas such as long-term climate funding (LTF) and the transfer of green technologies. Due to the West's sanctions against Russia and its allies for their invasion of Ukraine [25], as well as their subsequent sabotage of the Nord Stream pipeline [26], which supplied the EU with over 40% of its natural gas imports in 2020, there is now a significant supply chain bottleneck for petroleum gases in the EU [27]. The events above caused cost-push and demand-pull inflation, which hit a record high of 8.6% since the creation of the euro area [28]. Consequently, the ability to attain carbon neutrality and effective CBAM has been further undermined by EU member countries' continued use of outdated coal plants and the rejection of replacing them with renewable energy sources [29]. It is feared that if one region introduces CBAM, trading partners may retaliate, creating a vicious cycle of trade [Figure. 1] disputes and protectionist policies. It's crucial to remember that discussions and positions on international climate policy, such as CBAM, might change over time. India and other developing nations actively participate in global climate

forums, and current negotiations and events may impact their positions. It is advised to review official statements from the Indian government and updates from international climate negotiations to get the most recent information on India's position on CBAM.

As per the latest statement by India's commerce minister, Piyush Goyal, "Bharat will address the problem of CBAM with confidence, and we will find solutions. If it comes in, we will see how to convert CBAM to our advantage. Of course, I will retaliate. You need not worry about it", for example [22]. India and other developing nations contend that, historically, developed countries have borne the bulk of the global carbon emissions; 79% of historical carbon emissions come from developed countries [Figures 4 and 5]. Consequently, there is a call for wealthy nations to take the lead in mitigating climate change, highlighting shared but distinct responsibilities and capacities. The coal-fired generation increased in the European Union by nearly 7% amid low hydropower and nuclear output, for instance [30].

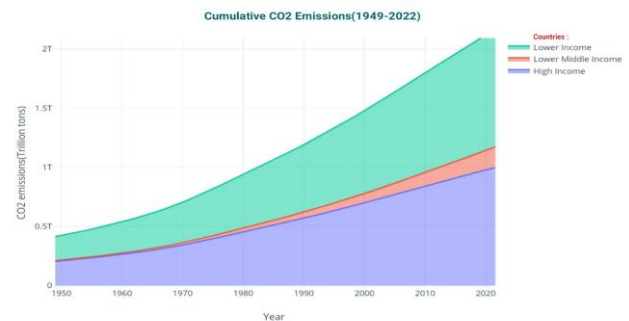


Fig. 3: The Global Carbon Emitters in History [31]

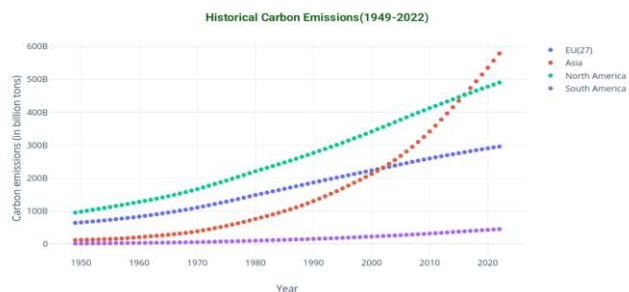


Fig. 4: The Global Carbon Emitters in History [31]

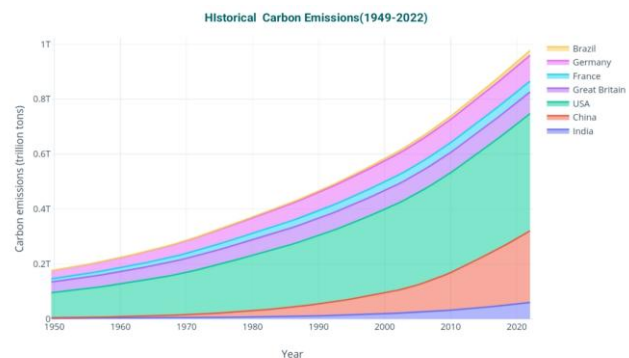


Fig. 5: The Major Historical Carbon Contributors [31]

Historically, wealthy nations have generally had higher per capita carbon emissions than emerging nations. Elements like increased industry frequently cause this, as more energy is used and higher living standards are achieved in developed countries [Figure 6]. Per capita and overall, China and the US have been the two countries most responsible for the world's carbon emissions.

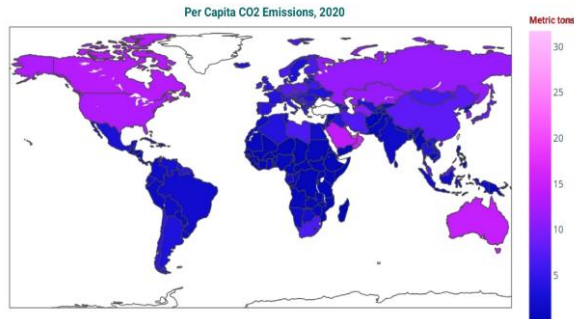


Fig. 6: The Worldwide Distribution of Per Capita CO₂ Emission [32]

Sr. No.	List of Developing Countries (based on Exports to the EU)	List of Carbon Intensive Articles (Exported to EU)	The Rank of the EU as an Export Destination	Export Value to EU (in US\$ Billion)	Percentage (%) of Total Export
1	Turkey	Iron & Steel, Cement, Aluminium, Fertilizers & Electricity	1	104.38	42.67%
2	Morocco	Fuels, Cement, Iron & Steel & Fertilizers	1	33.21	40.64%
3	Tunisia	Fuels, Cement, Iron & Steel & Fertilizers	1	13.86	37.93%
4	Algeria	Fuels, Cement, Iron & Steel & Fertilizers	1	15.54	32.63
5	Egypt	Fuels, Cement, Iron & Steel & Fertilizers	2	18.25	28.01%
6	India	Fuels, Iron & Steel, Cement & Fertilizers	2	49.76	14.90%
7	Angola	Fuels, Iron & Steel, Cement & Fertilizers	3	2.52	7.20%
8	Vietnam	Iron & Steel, Aluminium, Cement & Fertilizers	2	31.92	16.88%
9	Indonesia	Fuels, Palm oil, Cement & Fertilizers I	4	24.64	9.67%
10	Thailand	Fuels, Rubber, Cement & Fertilizers	4	23.86	10.44%

Extraction of raw materials, production, transportation, disposal at the end of their useful life, and direct manufacturing of items are necessary. The intricacy could lead to difficulties in execution and perhaps disagreements regarding the precision of carbon assessments [33]. The intricate value chain only evaluates high-emitting business imports covered by the European Union Emissions Trading System (ETS). Ref. [12] mentions that we consider the GHG content in every exercise, including all intermediate consumptions, and not just the one brought on by burning the fuel to create the embodied energy. Finally, in our scenario, all GHG emissions from all economic sectors are covered by the compensation at the border. The attempt to reduce GHG emissions cannot realistically be supported by particular sectors exclusively to be consistent with the degree of ambition declared by the European Commission in its Green New Deal. These are the ones exhibiting the most vigorous emissions. Consequently, we believe that every industry should reduce its greenhouse gas emissions. Crucially, in the first scenario, carbon permits are not traded outside the borders of the nation or group of countries that are reducing

D. Unforeseen repercussions

The unintended effects, such as cascading taxes, complex implementation, and a shortage of resources, are concerns associated with CBAM, which could harm disadvantaged communities. Accurately calculating the carbon footprint of imported items can be challenging. Both upstream and downstream emissions in the supply chain would be considered. Robust procedures and data covering the complete life cycle of products, including

their emissions, except for the EU trading with the UK and EFTA nations in the ETS [34]. There are now administrative and technical difficulties in accurately, transparently, and fairly calculating the carbon content of items. Moreover, double taxation is possible if the same commodity is subject to carbon-related taxes in importing and exporting nations. This may result in higher expenses for companies and impede global trade. The carbon costs associated with imported intermediate items may be transferred to the subsequent manufacturing step. Consequently, the finished product may have an increased carbon cost, which might diminish its competitiveness. Each cross-border transaction in a complicated supply chain with numerous transactions may be subject to a cascading effect on the cumulative carbon tax [35]. India has often stressed how crucial it is for poor nations to have these resources to shift to low-carbon, more sustainable economies. Supporting initiatives for mitigation and adaptation is part of this. It is imperative to increase climate finance to assist developing countries with their efforts to

mitigate and adapt to climate change.

This encompasses both financial support and procedures to ensure accountability and transparency in the use of funding. For instance, India provides financial support to developing countries and transfers green technologies to help them achieve their climate goals. International Solar Alliance (ISA) and its Global Solar Facility aim to finance \$100 mn for solar energy in underdeveloped nations. Recently, ISA increased the range of grants from 10 % to 35% through its Viability Gap Funding (VGF) mechanism, which provides grants in the ratio of project cost per project per nation. Concerns exist over the economic effects on countries that can incur higher expenses due to CBAM [36]. The integration of developing countries into the Rare Earth Metals (REMs) supply chain and its processing through technology transfer (ToT) between producing and developing nations is essential to lowering the cost and increasing the accessibility of Battery Storage Systems (BSS) [37]. Only industrialised nations with solid research agendas can access emerging technology like electric boilers and mechanical vapour compressors, which purify ore and reduce carbon intensity in the mineral processing industries. Protectionist policies, like outlawing the ToT, might significantly reduce exports from developing nations by giving industrialised nations' green technology industries a one-way benefit. China produces 90% of the refined rare earth minerals (REMs) like lithium, which has prohibited the export of technology for extracting and separating the strategic metal needed to manufacture photovoltaic cells (PV), battery storage systems (BSS), and other critical parts required to install solar modules and other green energy sources [38]. Decentralized solar energy generation units are cheaper than conventional and centralised grid systems. It might have been a model for developing countries to adopt green energy, but it could now be in jeopardy [17]. The UK's version of the carbon tax will follow the EU's CBAM and go into effect in 2027, with many more countries to follow. It will cause a sharp increase in demand for resources used in manufacturing renewable energy, such as photovoltaic cells and rare earth minerals, which will drive up costs immediately and cause a significant supply chain bottleneck [10]. A method to support struggling businesses through reduced taxes and compensation is being implemented in developing nations like India; this could nullify the Agreement on Subsidies & Countervailing Measures (SCM). Countervailing Duties (CVD) could apply to certain products.

IV. RECOMMENDATIONS

Creating fair and efficient systems to address carbon leakage and promote international climate action is a challenging task. It is noteworthy that the impact of CBAM will be significantly influenced by how it is designed and implemented. A balanced strategy that fulfils environmental aims without unnecessarily hurting economic interests or aggravating global economic imbalances must be carefully considered by policymakers. Practical international cooperation is essential to guarantee that CBAM contributes to a just and sustainable shift to a low-carbon economy. CBAM is a potent tool for accomplishing the lofty climate goals set by countries worldwide because it prevents carbon leakage, fosters fair competition, encourages global emission reductions, stimulates investments in clean technologies, addresses economic inequality, and improves the efficacy of

climate policies. Some other methods and procedures can be considered, even if the CBAM is one suggested strategy. Here are some substitutes and supplemental actions [12].

Suggestions	Rationale
Gradual Introduction of CBAM	1. The gradual implementation allows industries to adjust and may lessen unwanted interruptions. It will enable stakeholders to invest in environmentally conscious devices and adapt their activities to meet the latest regulations [39]. 2. More time should be allotted for the transition phase, particularly for developing market economies with little impact on "past carbon emission"[40]. Developing economies should initially be spared drastic measures and stringent policies.
Omitting Cascading Tax Effect	1. Provide precise instructions on how CBAM should be applied to various production and transaction stage,s and continuously monitor the dynamic supply chain to spot any possible cascading tax problems. 2. Introducing a rebate mechanism can be a great assistance.
International Collaboration	1. Work collaboratively with trading partners to align CBAM policies and avoid trade tensions [41]. 2. Engage in international discussions and negotiations to develop a unified approach to carbon pricing [42].
Providing Financial and Technological Assistance to Emerging Nations	1. Provide financial assistance to sectors of the economy that might have difficulties due to the shift. Implement programs such as grants, subsidies, and tax breaks to promote the use of low-carbon technologies. 2. Investing in research and development can foster innovation in low-carbon technologies. Incentivise firms to innovate and implement cutting-edge strategies that lower carbon emissions. 3. Sophisticated technology, such as Small Modular Reactors (SMRs) Engines based on Green Hydrogen and Mapping of White Hydrogen in underdeveloped countries, can be considered in collaboration with developed nations. [43].
Climate Resilient Architecture	1. Coalition to Disaster Resilient Infrastructure is an initiative to provide knowledge and best practices among nations vulnerable to climate change [44]. Infrastructure that can endure severe weather conditions and provide long-term sustainability falls under this category.
Worldwide Equal Carbon Pricing	1. Adopting a circular economic strategy can be beneficial because it encourages recycling and reuse while reducing waste production. Considering how the sustainability approaches encourage behaviour change through involvement and enhanced education is essential. [45].
Alternatives to Address Carbon Leakage Concern	1. Implement measures to address concerns about carbon leakage, where industries relocate to regions with lower environmental standards. Consider exemptions or adjustments for sectors particularly vulnerable to leakage [46]. 2. The EU should also work on internal issues to reduce carbon emissions, such as the electrification of railways, which is currently at 60% [47]. 3. The current trend is toward greener energy sources, including hydrogen, driven by the push for a net-zero energy transition. However, renewable energy sources like wind power are needed for hydrogen generation to achieve its environmental goals fully. In coastal and island environments, offshore wind energy infrastructure can be helpful. 4. The reference [48] indicates that the EU derives 68.4% of its energy from coal, crude oil, and natural gas, posing a significant challenge to achieving carbon neutrality. For instance, India's initiatives, such as the National Green Hydrogen Mission [49], the International Biofuel Alliance, and the Mission Life-Style for Environment [50], aim to reduce carbon leakage. The Mangrove Alliance for Climate (MAC) initiative in Indonesia [51] aims to scale up, accelerate, and expand plantation initiatives for mangrove habitats, which can assist in carbon sequestration [52].

V. CONCLUSION

The CBAM is crucial to achieving a more sustainable and just global economy. The CBAM is a multidimensional approach that balances commercial and environmental interests since it levels the playing field, prevents carbon leakage, incentivises emission reductions, encourages technical innovation, increases money for climate programmes, and ensures ecological justice. CBAM is a valuable and transformative tool in developing a greener and more resilient future as countries work to fulfil their climate commitments. Remembering that a mix of these actions could work better than a single strategy is crucial. There is no one-size-fits-all technique that can check carbon leakage. Each nation has a distinct socio-cultural and economic background, and policies should be implemented after a thorough grounding in the domestic scenario. Carbon leakage is not an individual problem to tackle but rather a collaborative action. Furthermore, governments have forums to explore and negotiate comprehensive and equitable solutions to climate change through continuous international climate discussions, such as the United Nations Framework Convention on Climate Change (UNFCCC). The willingness of nations to collaborate and implement these steps together will determine the effectiveness of any alternative. The application of CBAM may have unforeseen repercussions, including modifications to global supply networks, changes in manufacturing patterns, or effects on the environment in other areas. To ensure its effectiveness and minimal detrimental influence on international trade and economic development, policymakers must consider all relevant issues when drafting and implementing the program. Developing a robust monitoring and assessment system to gauge the CBAM's effects on trade, industry, and emissions using data-driven insights to support the necessary modifications to the mechanism should be done. Interacting with stakeholders, NGOs, companies, and industry associations is essential to get their opinions on the practical ramifications. This input can help refine the mechanism and mitigate unintended consequences. The Carbon Border Adjustment Mechanism is vital to the international plan to combat climate change. With the global community still struggling to address the pressing need for climate action, CBAM is a beacon of hope for a more just and sustainable future.

DECLARATION STATEMENT

Funding	No, I did not receive.
Conflicts of Interest	No conflicts of interest to the best of our knowledge.
Ethical Approval and Consent to Participate	No, the article does not require ethical approval or consent to participate, as it presents evidence.
Availability of Data and Material/ Data Access Statement	Not relevant.
Authors Contributions	All authors have equal participation in this article.

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