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Navigating the Potential Impact of the Carbon Border Adjustment Mechanism on Pakistan's Exports: Sectoral Implications and Future Challenges

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Abstract

This study assesses the potential impact of the European Union (EU)'s Carbon Border Adjustment Mechanism (CBAM) on Pakistan's exports. Starting in 2026, CBAM's definitive phase will initially target high-emission sectors, so Pakistan's exports may not be immediately affected. However, the gradual expansion of CBAM's coverage to textiles and agricultural products could significantly decrease demand for Pakistani goods as EU importers seek lower-carbon alternatives. Using historical export growth rates, this study projects Pakistan's exports to the EU from 2024 to 2036 under scenarios with and without CBAM implementation in the agricultural, manufacturing, and industrial sectors. Sectoral emission intensities are estimated using greenhouse gas emissions data from Climate Watch and data from the Asian Development Bank's input-output tables. By incorporating carbon pricing and Pakistan's long-run price elasticity of demand for exports, we estimate that CBAM implementation in 2026 could result in a decline of USD 308 million in exports, reaching USD 479 million by 2036. This corresponds to reductions of 2.26 percent in manufacturing, 10.4 percent in agriculture, and 21.1 percent in industrial exports. Additionally, Pakistan's export share to the EU, currently 29 percent, may decline by 2 percent in 2026. Our analysis suggests that the actual impact could be more severe if demand elasticity increases, carbon pricing rises, or if more countries implement similar mechanisms. To mitigate these risks, policymakers must establish a domestic carbon pricing system and transition toward environmentally sustainable production practices.

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Introduction

What is the Carbon Border Adjustment Mechanism?

The Carbon Border Adjustment Mechanism (CBAM) is an environmental policy tool designed to impose carbon costs on imported goods equivalent to those faced by industries operating within the European Union (EU). The EU's carbon pricing mechanism, the European Union Emissions Trading System (EU ETS), is a market-based mechanism that sets a price on carbon dioxide (CO_2) to incentivize emission reductions in energy-intensive industries within the EU. It is the world's largest carbon trading system, influencing global climate policies (Appunn & Wettengel, 2024). There is, however, a risk of carbon leakage associated with the EU ETS, which indicates that companies within the EU may relocate production to other countries with weaker climate policies to avoid carbon costs, potentially leading to zero net emission reduction globally. CBAM's role is to address this risk by introducing a level playing field within the EU. It ensures that imported goods bear a carbon cost equivalent to that of domestically produced goods by verifying that a price has been paid for embedded carbon emissions. This helps maintain the integrity of the EU's climate goals as it creates an incentive for EU importers to purchase products from countries where carbon pricing mechanisms are in place or where the greenhouse gas (GHG) emissions per unit exported to the EU are minimized due to stringent environmental policies. Furthermore, CBAM encourages cleaner industrial production in non-EU countries as a fair carbon price is charged on emissions generated during the production of carbon-intensive goods imported into the EU (European Commission, 2025).

CBAM's transition phase began on October 1, 2023, and will last until December 31, 2025, during which it will be applied solely for data collection purposes without a financial obligation on importers (European Commission, 2024). Targeted sectors include cement, iron and steel, aluminum, fertilizer, electricity, and hydrogen, all of which are at high risk of carbon leakage. The policy's definitive phase will commence in 2026, when EU importers will be required to pay a carbon tax to the relevant authorities before importing certain products. CBAM will be phased in gradually across other sectors, allowing a careful, predictable, and proportionate transition for public authorities and EU and non-EU businesses.

How CBAM Works

The EU has eight-digit Combined Nomenclature (CN) product codes based on Harmonized System (HS) codes. EU importers must report embedded emissions in their imports to the relevant authorities using appropriate CN codes. This involves the following steps:

1. Based on CN codes, EU importers reaffirm that the products they are importing are covered by CBAM.

2. Importers identify all parameters and request them from exporters. These include direct GHG emissions from production in exporting countries and indirect emissions from electricity consumption per product multiplied by suitable emissions factors. Emissions factor options include the following:

    a. Default factors from the European Commission (International Energy Agency data).

    b. Other publicly available national grid factors.

    c. For self-produced electricity, emissions must be monitored at the power unit level.

    d. If electricity is sourced via a power purchase agreement, actual emission factors may be used if the supplying installation follows the same monitoring rules. Embedded emissions from precursors are included in CBAM goods data. If the precursor is produced within the same installation, embedded emissions are included. However, if the precursor is purchased externally, supplier data is requested, including installation details, direct/indirect emissions, production routes, reporting periods, and applicable carbon prices. Additional qualifying parameters need to be reported under CBAM as well, although they vary by product, e.g., clinker content is required for cement and nitrogen composition is required for fertilizer.

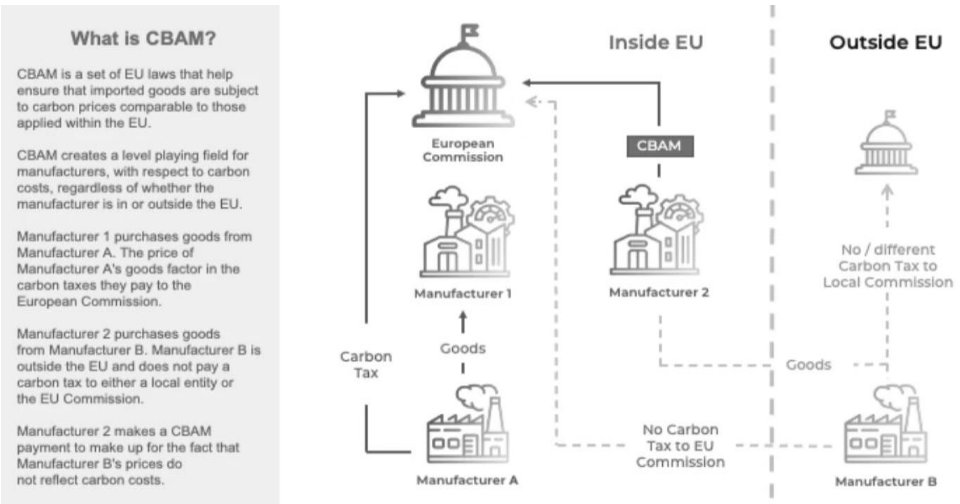
3. If a carbon price is paid in the jurisdiction where the CBAM good or precursor is produced, it reduces CBAM obligations from 2026 onwards. However, this information must still be reported during the transition period. The carbon price is assumed to be zero if no data is provided.

4. The EU importer ensures that the exporter/operator understands the reporting period, i.e., the European calendar year. Alternative periods are allowed if they cover at least three months, particularly if they align with local carbon pricing schemes, mandatory emissions monitoring schemes, and fiscal years with external audits for credibility.

5. Embedded emissions data from operators is communicated to EU importers, who then report to the relevant authorities. Operators compile monitored data for the entire reporting period, determine the attributed emissions of each production process, and divide them by the corresponding 'activity level' (total goods in a CBAM category produced during the reporting period) to obtain specific embedded emissions.[3]

Figure 1 illustrates the CBAM process. Implementation will be gradual—the proportion of embedded emissions covered will increase over time. Full coverage will not be achieved until 2034.

Figure 1: What is CBAM?



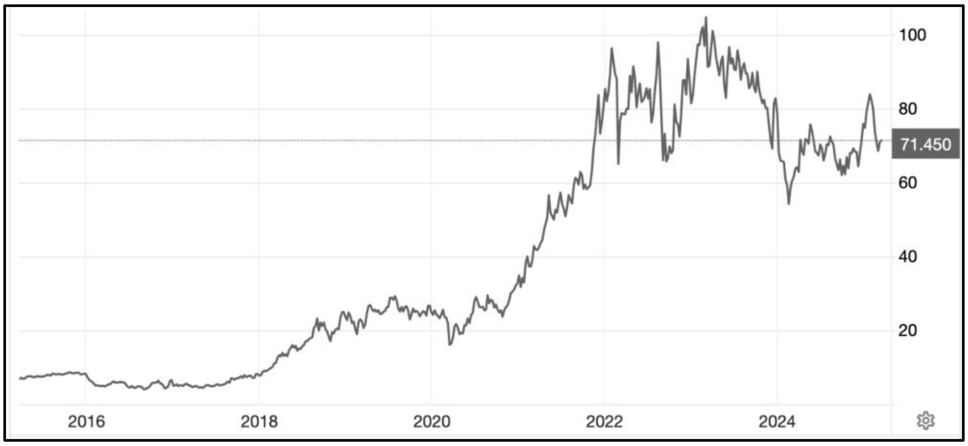
Source: Mavarick AI. (2025, December 18). *A comprehensive guide to the EU CBAM reporting.* https://mavarick.ai/blogs/eu-cbam-reporting-regulation-guide/.

As CBAM enters its definitive phase, importers will be required to fulfill a CBAM obligation by purchasing certificates for each CBAM good imported into the

[3] The European Commission is simplifying and updating CBAM packages. The latest developments are available at https://taxation-customs.ec.europa.eu/index_en.

EU, which will be expressed in EUR/tonne of carbon dioxide equivalent (CO_2eq) emitted. CBAM certificate prices will be based on the weekly average auction price of EU ETS allowances, expressed in EUR/tonne of CO_2eq emitted. The charge per tonne of GHGs emitted could vary from EUR 60 to EUR 100 (Figure 2).

Figure 2: Historical trend of the price of EU carbon permits (EUR)



Source: Trading Economics. (n.d.). *EU carbon permits.* https://tradingeconomics.com/commodity/carbon.

While CBAM aims to reduce carbon emissions in EU and non-EU countries alike, certain risks are associated with the policy's procedures and consequences. First, the accurate measurement and reporting of carbon emissions in imported products are challenging. Second, fairness is a key concern. International climate agreements like the Paris Agreement acknowledge that wealthy, industrialized nations bear the greatest responsibility for tackling climate change due to their historical contributions and greater financial resources. However, CBAM applies an equal burden to exporters from low-income countries and those from wealthier nations, possibly further widening the world's wealth gap (Wolfram & Krol, 2023).

CBAM's Potential Impact on Pakistan's Export Sector

CBAM's potential impact on various developing economies has been explored in recent literature. However, empirical studies highlighting the impact on Pakistan are missing. We fill this gap by estimating the effect of CBAM implementation on Pakistan's exports to the EU. While Pakistani exports may not be affected immediately, the gradual expansion of CBAM coverage to sectors like textiles and agricultural products in the next nine years could shift demand away from

Pakistani exports. EU importers may prefer suppliers from countries with lower carbon costs to minimize tax burden while also aligning with the EU's decarbonization goals. This could well affect Pakistan's export competitiveness. The EU is a major trading partner, so any loss in competitiveness could hinder the country's overall export growth. To address this challenge, it is essential to quantify and estimate the potential decline in Pakistan's exports to the EU resulting from CBAM so that policymakers can devise timely and appropriate mitigation strategies.

Using Pakistan's historical export growth rates (1996–2023), we project export trends from 2024 to 2036 under two scenarios: with and without CBAM. We calculate sectoral emission intensity (tonnes per dollar of production) for agriculture, manufacturing, and industry using GHG emissions data from Climate Watch and data from the Asian Development Bank (ADB)'s input-output tables. We then estimate embedded emissions in exports to the EU by multiplying emission intensity by projected bilateral export volumes.

The costs of exports rise as EU importers must purchase CBAM certificates based on carbon pricing before importing goods in the definitive phase. For example, if the carbon price is set at USD 100 per tonne in the absence of any domestic carbon tax, the cost of exports from Pakistan would rise in proportion to the emissions embedded in these exports. Applying the long-term price elasticity of demand for Pakistan's exports derived from the country's export demand function, we estimate that CBAM implementation in 2026 will lead to a decline in exports in the range of USD 308 million in 2026 to USD 479 million in 2036. This corresponds to a reduction of 2.26 percent in manufacturing exports, 10.4 percent in agricultural exports, and 21.1 percent in industrial exports. In 2023, Pakistan's export share to the EU stood at 29 percent, which could decrease by 2 percent in 2026. These estimates represent a simple baseline scenario with basic parameters. The actual impact is potentially more severe if indirect GHG emissions are incorporated in goods exported to the EU, if Pakistan's export demand elasticity increases, or if carbon pricing rises. Additionally, the adverse effects on Pakistan's exports could be exacerbated as more countries adopt similar carbon pricing policies.

Organization of the Paper

The next section is a review of the relevant literature. We then describe the methodology employed to estimate the potential decline in Pakistan's exports to the EU after CBAM implementation. This is followed by sections on results, limitations, and future research. The last section presents policy implications.

Literature Review

The EU's imposition of CBAM could potentially reshape the export landscape for developing economies. It is designed to internalize the cost of carbon emissions associated with the production of imported goods, aiming to level the playing field between domestic industries subject to stringent carbon regulations and foreign producers operating in regions with more relaxed environmental standards (Chepeliev, 2021; United Nations Economic and Social Commission for Asia and the Pacific [UNESCAP], United Nations Environment Programme [UNEP], & United Nations Conference on Trade and Development [UNCTAD], 2021; Berahab, 2022).

However, CBAM implementation raises concerns about the potential impact on the overall economic development of developing nations (Brandi, 2013; Magacho et al., 2023). Empirical studies using modeling techniques to quantify CBAM impacts on developing countries' exports can provide valuable insights into potential trade diversion effects, competitiveness losses, and economic consequences (Zhu et al., 2024).

The EU CBAM could inadvertently curtail exports from the EU's trading partners (Perdana & Vielle, 2022). It could significantly impact the exports of least developed countries to the EU, especially for countries like Mozambique (aluminum) and Uzbekistan, Egypt, Ukraine, Zimbabwe, and India (various products), potentially impacting their entire economies (Brandi, 2013). Increased production costs, both domestically and in the EU, could alter export firms' competitiveness (Acar et al., 2022). Countries with a high share of CBAM-applicable exports to the EU and high carbon intensity, such as Ukraine, Iran, Bahrain, and Belarus, may be significantly affected (Overland & Sabyrbekov, 2022). Moreover, evidence suggests that the Eastern European economies, especially in the Balkans, and several African nations, such as Mozambique, Zimbabwe, and Cameroon, face disproportionate exposure (Magacho et al., 2023).

Furthermore, many developing countries may face challenges with sector-specific emissions reporting, which may position CBAM as a pathway that limits the developing world's trade options rather than acting as an incentive to decarbonize (Eicke et al., 2021). A UN report suggests that CBAM could negatively affect real gross domestic product in South and Southwest Asia (UNESCAP et al., 2021). CBAM implementation could lead to a loss of jobs and tax revenues in developing countries if the specific characteristics of the EU's trading partners are not accounted for (Magacho et al., 2023). This is further substantiated by the fact that many middle- and low-income countries, particularly in North and Sub-Saharan Africa, exhibit limited diversification in their export portfolios and rely on exports to the EU (Beaufils et al., 2023). In addition, Chu et al. (2024) highlighted the potential for certain developing countries to experience significant welfare losses due to reduced exports and competitiveness.

Despite these adverse effects, CBAM also offers potential benefits. Even though exemptions or delayed implementation for developing countries could reduce administrative effort and allow more time to adjust to lower emission standards, they may limit the impact of CBAM's climate goals (Brandi, 2013) and cause significant increases in carbon leakage. CBAM could incentivize developing countries to reduce GHG emissions and provide fair competitive conditions to local firms developing low-carbon products (Berahab, 2022). Similarly, revenue generated from CBAM could be used to support green technology transfer and investments in developing countries, decrease carbon leakage, and lower welfare costs (Perdana & Vielle, 2022).

In addition, a study employing a multi-country, multi-sector general equilibrium model finds that CBAM implementation led to a marginal increase in the EU's gross national expenditure, accompanied by a shift in trade toward cleaner domestic production (Walczak et al., 2025). Adverse CBAM impacts could be mitigated if developing countries were to receive technical assistance and technology transfers to achieve climate objectives (UNESCAP et al., 2021).

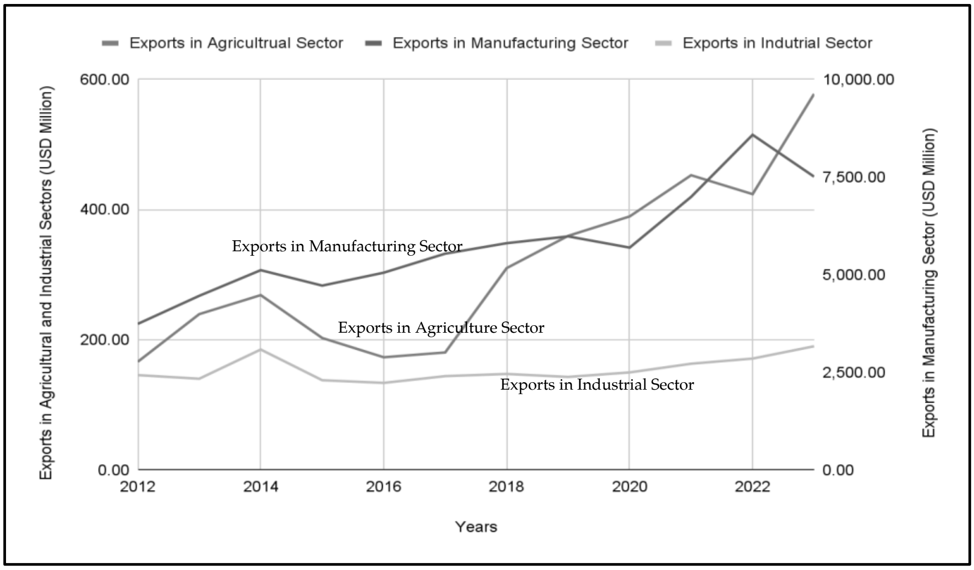
The structure of developing countries' economies, often characterized by limited diversification and heavy reliance on a few specific export commodities, exacerbates their vulnerability to the external shocks resulting from CBAM implementation. The magnitude of the impact will depend on factors like the carbon intensity of production processes in developing countries, the availability of cleaner technologies, and the capacity to adapt to new trade regulations (Magacho et al., 2023). Therefore, it is crucial to assess CBAM's potential implications on developing countries' exports by considering the carbon intensity of their industries, their economic development, and their trade relationships with developed nations that are implementing CBAM (Perdana & Vielle, 2022).

We build on the existing literature by focusing particularly on Pakistan, a country with a low share of exports to the EU but high carbon intensity (Overland & Sabyrbekov, 2022). Sectors important to Pakistan's economy, e.g., textiles and agriculture, could be affected depending on their carbon intensity and export volumes to the EU. Pakistan faces significant challenges in addressing the potential impacts of CBAM. Faruqui and Piracha (2023) express concerns about export barriers and the need for Pakistan's government and businesses to adapt to the evolving trade and environmental nexus. Pakistan was the world's seventh-largest textile exporter in 2021, with cotton-based textiles accounting for a significant portion of total exports (Jamil et al., 2024). This underscores the need to assess CBAM's potential implications for Pakistan's exports to the EU.

Methodology

Pakistan's exports to the EU increased from USD 2.6 billion in 2003 to USD 8.28 billion in 2023 (United Nations Statistics Division, 2025). For deeper insights, we analyze and explore bilateral export volumes within the agricultural, manufacturing, and industrial sectors. The Climate Watch GHG emissions dataset, also known as the Climate Analysis Indicators Tool dataset, is accompanied by an explanatory document that defines the agricultural sector and distinguishes between subsectors within the manufacturing and industrial sectors (World Resources Institute, 2022). Using these definitions, we explore Pakistani exports to the EU in these three broad economic sectors from 2012 to 2023 (Figure 3). Manufacturing holds the most significant share of exports, within which textiles dominate—bed linens, garments, yarn, and woven fabrics. Other significant export items include rice and cereals in the agricultural sector; non-alcoholic beverages, water, ethyl alcohol, raw hides, and skins in the manufacturing sector; and optical elements and base metal items like razors, knives, and blades in the industrial sector.

Figure 3: Pakistani exports to the EU in three broad economic sectors (2012 –2023)



Source: United Nations Comtrade Dataset.

As explained earlier, initial CBAM coverage may not immediately affect Pakistan. Later, however, CBAM implementation will have major implications for Pakistan's export growth as its exports become more expensive for EU importers. Therefore, it is important to estimate the potential decline of Pakistani exports to the EU using the steps below.

Step 1: The first step is to estimate emission intensity expressed in tonnes per US dollar of production in Pakistan. In Equation 1, *e* is the emission intensity in sector *i* over time period *t*. Data on GHG emissions in various sectors is taken from the Climate Watch GHG emissions dataset (Ritchie et al., 2020). The source shows GHG emissions in tonnes of CO_2eq, which includes emissions from CO_2, methane (CH_4), and nitrous oxide (N_2O) in 11 sectors from 1990 to 2021. The ADB's input-output tables show data for Pakistan's output in USD million from 2000 to 2022.

$$e_{it} = \frac{GHG\ emissions\ (tonnes)_{it}}{Output_{it}\ (USD)} \qquad (1)$$

We use Equation 1 for the same sectors (agriculture, manufacturing, and industry) shown in Figure 3. The definitions and scope of the sectors match those of the GHG emissions dataset explanatory note (methodology section). Appendix A lists the sectors in the GHG emissions dataset, the ADB's input-output tables, and the sectors considered in this analysis. Our analysis is limited to emission intensity data for the period 2012–2021. Therefore, in Equation 1, i = 3 and t = 10 (2012–2021).

Step 2: After calculating emission intensity from 2012 to 2021 for the three sectors, we gather data on the exports within each sector. Using United Nations Comtrade data on Pakistan's exports to the EU from 2012 to 2023, we disaggregate the data at the HS 6-digit level, aggregate it at the HS 2-digit level, and sum it into three broad categories aligned with the emission intensity estimates. At the HS 2-digit level, the agricultural sector contains 15 subcategories, the manufacturing sector contains 77 subcategories, and the industrial sector contains 5 subcategories (Appendix B).

Step 3: Here, we estimate exports to the EU in the future. CBAM implementation begins in 2026, so we estimate the projected increase in exports to the EU over the 12-year period of 2024–2036. Pakistan's long-term annual export growth rate from 1996 to 2023 was 4.5 percent. Using the same growth rate for each sector, we estimate the potential increase in exports to the EU for the calendar years 2024–2036 and label the series as export growth without CBAM implementation.

Step 4: We estimate GHG emissions embedded in exports to the EU from 2024 to 2036 by multiplying emission intensity by the export growth series without CBAM implementation. Since emission intensity could only be calculated until 2021, we used the 2021 values to estimate embedded emissions for subsequent years (Equations 2 and 3).

$$Embedded\ emissions_{ijt} = e_{2021i} * exports_{ijt} \tag{2}$$

$$Embedded\ emissions_{it} = \sum_{j=1}^{n}(e_{2021i} * exports_{ijt}) \tag{3}$$

Here, i = sector, t = 13 years (2024–2036), and j = number of subcategories under the i^{th} sector. We sum the embedded emissions for all subcategories in the three sectors. Therefore, n = 15 for the agricultural sector, 77 for the manufacturing sector, and 5 for the industrial sector.

Step 5: Next, we multiply the embedded emission values by a hypothesized carbon pricing, which provides an estimate of CBAM certificates that EU importers will have to surrender to the EU authorities before Pakistan's goods can be imported. In general, the number of certificates to be purchased depends on: (a) whether there is any carbon tax in the non-EU country; (b) the weekly average auction price of EU

ETS allowances expressed in EUR/tonne of CO_2eq emitted; (c) the emissions embedded in the quantity of items imported by the EU trader. Given the historical trend in Figure 2, the price of EU carbon permits could vary between USD 75 and USD 110 per tonne of GHG emissions or CO_2eq. The new import cost for EU importers is shown in Equation 4. The addition of the second and third terms on the right side of the equation is an estimate of CBAM certificates to be purchased.

$$M_{ijt}{}^{CBAM} = (M_{ijt}{}^{WITHOUTCBAM} + Carbon\ price * embedded\ emissions_{ijt_0} - Carbon\ price\ paid\ to\ local\ authorities_{ijt}) \quad (4)$$

$$M_{it}{}^{CBAM} = \sum_{j=1}^{n}(M_{ijt}{}^{WITHOUTCBAM} + Carbon\ price * embedded\ emissions_{ijt} - Carbon\ price\ paid\ to\ local\ authorities_{ijt}) \quad (5)$$

Here, $M_{ijt}{}^{CBAM}$ = import costs with CBAM and $M_{ijt}{}^{WITHOUTCBAM}$ = import costs without CBAM (step 3); i = sector, t = 13 years (2024–2036), and j = number of subcategories under the i^{th} sector; n = 15 for the agricultural sector, 77 for the manufacturing sector, and 5 for the industrial sector.

If we set the carbon pricing at USD 100, in the absence of a carbon pricing mechanism in Pakistan, the new import cost will be:

$$M_{it}{}^{CBAM} = \sum_{j=1}^{n}(M_{ijt}{}^{WITHOUTCBAM} + 100 * embedded\ emissions_{ijt}) \quad (6)$$

Step 6: Finally, we estimate a series of export growth to the EU with CBAM implementation for the same period for the three sectors to estimate the potential decline in exports if CBAM is applied in 2026 and onwards. In other words, we estimate the decline in export revenues due to higher effective prices of exports from Pakistan. For this, we employ the price elasticity of demand (ε) of Pakistan's export demand function, which considers the dataset for 1994–2020 (Appendix C). If ε = 0.3, a 1-percent increase in export price (or a 1-percent increase in import cost for the EU importer) is estimated to reduce export revenues by 0.3 percent. We calculate the percentage increase in import costs for every sector (or percentage increase in export prices in our model) from Pakistan due to CBAM implementation in 2026 and onward, and then use ε to generate the percentage decline in export revenues from those projected in step 3 for the calendar years 2026–2036.

Sensitivity Analysis

We used the following parameters to keep our simple baseline scenario constant over the period being considered:

a. The long-term annual growth rate of Pakistan's exports

b. Emission intensity (tonnes/US dollar of production) in 2022 and onward

c. Carbon price (US dollars/tonne of embedded emissions in imports)

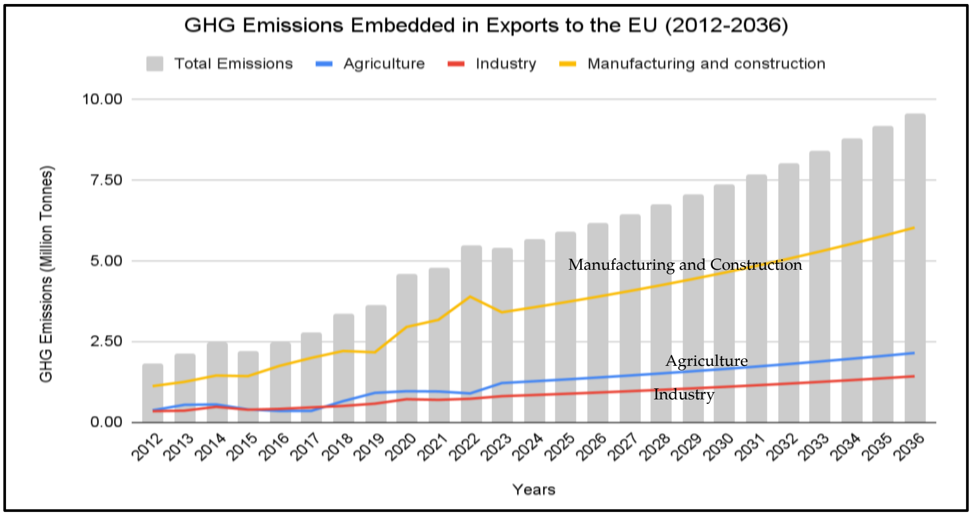
Keeping these factors constant, we vary the value of ε, which was originally derived from Pakistan's export demand function. This is because Pakistan's exports could become more elastic as EU importers shift demand toward low-carbon-intensive alternatives. Hence, we deviate from our baseline scenario by changing ε and analyzing the outcome.

Results

Emission Intensity

Emission intensity (tonnes/US dollar of output) increased steadily during the period 2012–2021. It was calculated to be in the range of 0.002–0.004 for the agricultural and industrial sectors, and 0.0003–0.0005 for the manufacturing sector. The trends of GHG emissions embedded in the exports of the three sectors are shown in Figure 4. Emissions from 2012 to 2021 are based on actual data from the sources mentioned in the methodology section. Following 2022, we employ 2021 emission intensity values and estimate the GHG emissions embedded in exports to the EU from 2022 to 2036. The export values from 2024 to 2036 are projections based on the long-term annual growth rate of exports (1996–2023), equivalent to 4.5 percent. With the assumed parameters in the baseline scenario, the aggregate GHG emissions increase from 5.48 million tonnes in 2022 to 9.57 million tonnes in 2036. The highest value is observed in the manufacturing sector, where emissions increase from 3.88 million tonnes to 6.02 million tonnes over the same period. This is followed by the agricultural sector, where the estimated increase is from 0.88 million tonnes to 2.14 million tonnes. The corresponding increase for the industrial sector is from 0.72 million tonnes to 1.42 million tonnes.

Figure 4: GHG emissions embedded in exports to the EU (2012–2036)



Source: Authors' calculations.

CBAM's Potential Impact on Pakistan's Exports to the EU

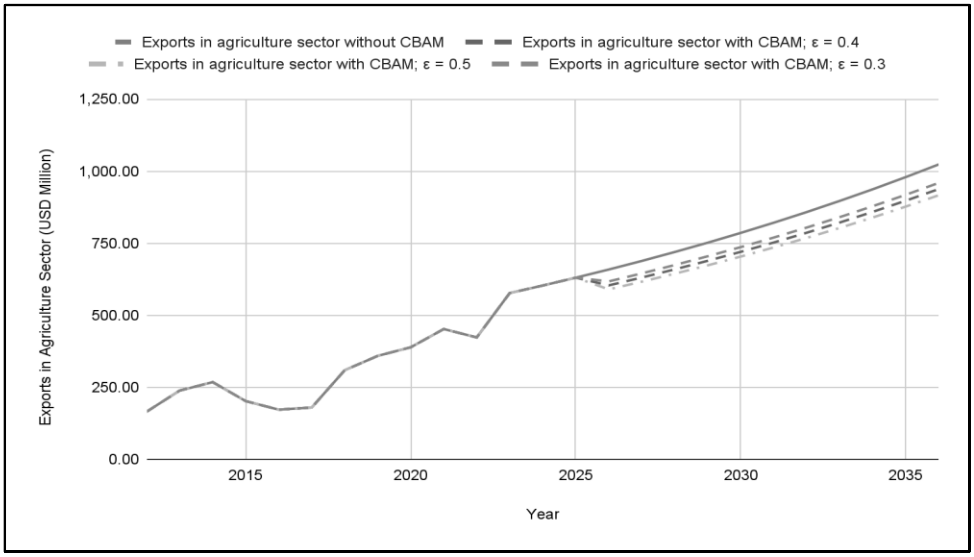
Using the annual growth rate of exports of 4.5 percent, we estimate the projected increase in exports to the EU from 2024 to 2036 in the absence of CBAM implementation. Then, as illustrated in the methodology section, we estimate the potential decline in exports using additional parameters like ε, equivalent to -0.3, and a carbon price of USD 100/tonne of GHG emissions. We apply these additional parameters from 2026, as that is when CBAM enters its definitive phase. The potential increase in the cost of Pakistan's exports to EU importers for each sector is shown in Appendix D (they also reflect the number of CBAM certificates that EU importers would have to surrender). The costs shown are added to projected exports in the non-CBAM scenario to estimate the new costs of imports for the EU. The percentage increase in import costs is calculated from the EU importer's perspective (equivalent to the percentage increase in export prices from the Pakistani exporter's perspective), and the corresponding percentage decline in export revenues (relative to the values estimated in step 3) is then generated for the three economic sectors using ε = -0.3.

Observing the aggregated values, our analysis shows that in the absence of CBAM, the projected increase in exports is from USD 9.45 billion in 2026 to USD 14.67 billion in 2036. If CBAM is applied in 2026, the estimated increase in exports could range from USD 9.14 billion in 2026 to USD 14.19 billion in 2036. This indicates that the share of exports to the EU could fall by almost two percent in 2026. Figures 5–7 show the estimated potential decrease in Pakistan's export revenues from 2026 to 2036 in each sector, incorporating the sensitivity analysis.

CBAM's Potential Impact on Pakistan's Exports to the EU in the Agricultural Sector

In the absence of CBAM implementation, agricultural exports are estimated to increase from USD 659.26 million in 2026 to USD 1.02 billion in 2036. If CBAM is applied in 2026, the estimated increase is from USD 617.96 million in 2026 to USD 959.67 million in 2036. This equals a decline of 6.26 percent annually. If we alter ε to -0.4 and -0.5, the fall in agricultural exports rises to 8.35 percent and 10.44 percent, respectively. The aggregate loss of exports over the ten-year period is estimated to be USD 571 million if ε = 0.3, USD 762 million if ε = 0.4, and USD 952 million if ε = 0.5 (Figure 5).

Figure 5: Potential decline in agricultural exports to the EU

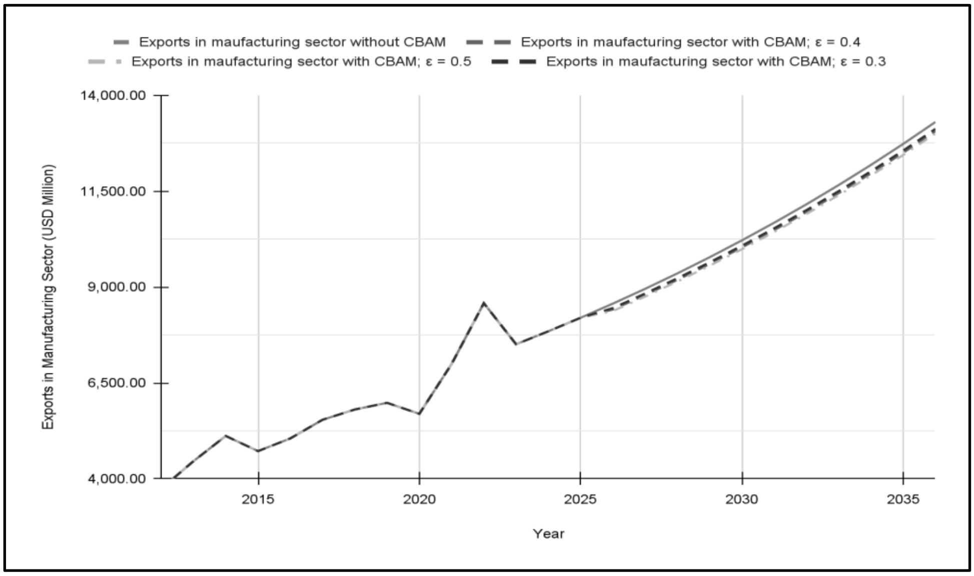


Source: Authors' calculations.

CBAM's Potential Impact on Pakistan's Exports to the EU in the Manufacturing Sector

In the absence of CBAM implementation, the projected increase in manufacturing exports is from USD 8.57 billion in 2026 to USD 13.31 billion in 2036. In the case of CBAM implementation in 2026, the estimated increase in exports is from USD 8.45 billion in 2026 to USD 13.13 billion in 2036. This corresponds to a decline of 1.36 percent annually, assuming ε = 0.3. The sensitivity analysis related to the value of ε shows that the decline could amount to 1.81 percent if ε = 0.4 and 2.26 percent if ε = 0.5. The aggregate decline in manufacturing sector exports to the EU over the ten-year period is estimated to be USD 1.61 billion if ε is 0.3, USD 2.14 billion if ε is 0.4, and USD 2.68 billion if ε is 0.5 (Figure 6).

Figure 6: Potential decline in manufacturing exports to the EU

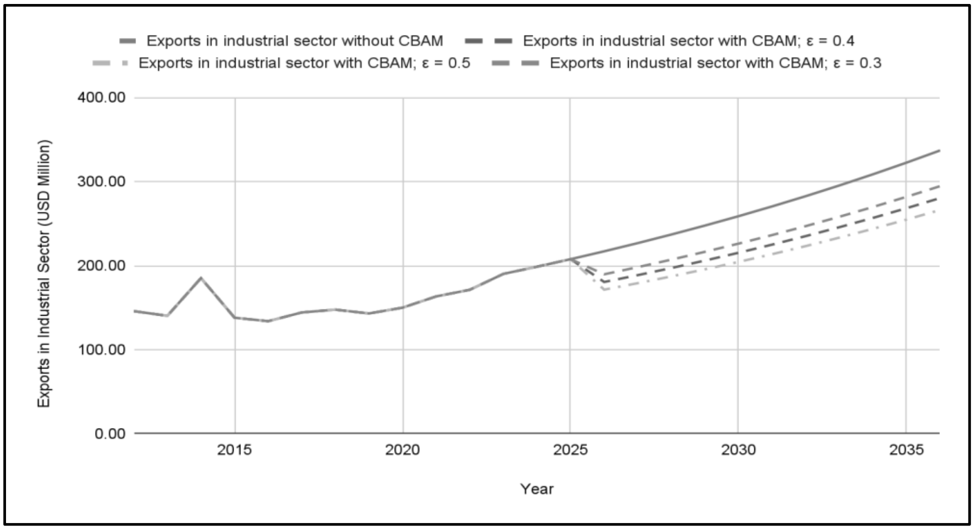


Source: Authors' calculations.

CBAM's Potential Impact on Pakistan's Exports to the EU in the Industrial Sector

In the absence of CBAM implementation, the projected increase in industrial exports is from USD 217 million in 2026 to USD 337 million in 2036. However, if CBAM is implemented in 2026, the estimated increase in exports is from USD 189.68 million in 2026 to USD 294.56 million in 2036. This corresponds to a fall of 12.6 percent annually, assuming ε = 0.3. If ε is increased to 0.4, the fall in exports could be as much as 16.81 percent, whereas if ε = 0.5, the value is estimated to be 21.01 percent. The aggregate fall in industrial sector exports to the EU over the ten-year period is estimated to be USD 378.61 million (ε = 0.3), USD 504.82 million (ε = 0.4), and USD 631.02 million (ε = 0.5) (Figure 7).

Figure 7: Potential decline in industrial exports to the EU



Source: Authors' calculations.

These estimates represent a baseline scenario with assumed parameters that may be different in reality. The numbers may not seem too drastic, but it is important to understand that the actual impact could be more severe. For instance, if Pakistan's export demand elasticity increases (which is likely in the future), if all the parameters used to calculate embedded emissions in imports are considered (they were not considered due to a lack of data), or if carbon pricing in the EU rises, the outcome could change significantly, not just undermining Pakistan's export goals but also altering trade dynamics with crucial export partners. In addition, adverse effects on Pakistan's exports could be exacerbated as more countries adopt similar carbon pricing policies. With these challenges in mind, policymakers should devise appropriate strategies to mitigate the risks posed by CBAM.

Limitations

Our analysis provides a general direction on how Pakistan's exports to the EU are likely to be affected when CBAM enters its definitive phase and is applied to Pakistan in 2026. However, there are several limitations to consider. First, we assume a fixed carbon price per tonne of GHG emissions, which is essentially an arbitrary figure. In reality, CBAM certificate prices will be continuously updated, leading to dynamic changes in export/import patterns.

Second, in our baseline scenario, the only source of variation in GHG emissions from 2022 to 2036 is the change in exports. Our model assumes that emission intensity remains constant over this period, which is unlikely. This assumption also impacts the calculation of embedded emissions, which would differ if the values of *e* in Equation 1 varied from 2022 to 2036.

Third, due to data unavailability, our measurement of embedded emissions in estimated EU imports from Pakistan is not fully accurate as it does not account for all parameters (as explained in the literature review). If data becomes available, or if Pakistan's production practices become more or less environmentally sustainable, both emission intensity and embedded emissions will change, directly affecting export revenues over time.

Fourth, we assume the price elasticity of demand for Pakistan's exports to be -0.3, -0.4, or -0.5. Although we conduct a basic sensitivity analysis for these values, EU importers may move toward less carbon-intensive suppliers outside Pakistan for products like rice, textiles, and optical instruments. This could make demand highly elastic, possibly exceeding -0.5, which would further exacerbate the negative impact on Pakistan's exports.

Fifth, we assume a uniform export growth rate across all sectors, whereas, in reality, agricultural exports may grow at a pace different from manufacturing exports, and growth rates may vary over time.

Sixth, we have not incorporated general equilibrium models or GTAP-E, an energy-environmental version of the Global Trade Analysis Project (GTAP) model that includes emissions trading.

Given these limitations, future research could refine the model by allowing key parameters to change over time. We could also integrate other approaches to estimate CBAM's impact on exports and compare the results with our baseline scenario for deeper insights.

Conclusions and Policy Implications

This study highlights the significant impact CBAM could have on Pakistan's exports to the EU in the manufacturing, agricultural, and industrial sectors. CBAM may not have an immediate impact on Pakistan's exports, as the current list of covered products does not include many of Pakistan's key exports to the EU. However, CBAM's scope will gradually expand over the next few years to include a wider range of imported goods. Its implementation poses substantial challenges for developing economies like Pakistan, where exporters may struggle with rising costs, trade barriers, and shifting demand patterns. Our estimate of a baseline scenario with simple parameters indicates that if CBAM is implemented in Pakistan in 2026, exports to the EU could decline by USD 308 million in 2026, reaching USD 479 million by 2036, with the manufacturing, agricultural, and industrial sectors experiencing reductions of as much as 2.26 percent, 10.4 percent, and 21.1 percent, respectively. The actual impact could be more severe if the parameters change or if more countries adopt similar mechanisms for their imports. To mitigate these potential risks, policymakers must take urgent action to align Pakistan's trade policies with global decarbonization efforts.

A crucial policy implication is that Pakistan must transition toward low-carbon production processes. Since CBAM taxes imports based on GHG emissions per unit, reducing emission intensity is essential. The government should provide incentives to firms to adopt renewable energy sources over fossil fuels and encourage resource-efficient production techniques to minimize waste and emissions. In this regard, policymakers may subsidize energy-efficient technologies in manufacturing, particularly in textile production. A sustainable textile roadmap with incentives for eco-friendly dyeing, energy-efficient machinery, and renewable power use could be developed. In the agricultural sector, policymakers could promote climate-smart farming and lower-emission fertilizers. For industrial exports, they could facilitate low-carbon industrial parks with cleaner production standards and relevant incentives.

In the long run, Pakistan's transition to low-carbon production will require significant investment. Financial resources will have to be mobilized so that appropriate funds can be established. For instance, a National Green Investment Fund to finance renewable energy projects and low-carbon manufacturing could be developed. Revenues raised from domestic carbon pricing mechanisms could be reinvested in this fund for the initiation of clean energy projects, energy efficiency improvements, and emission reduction technologies. Policymakers could also seek technical and financial support from global climate funds to help Pakistani businesses adapt to CBAM. A challenging but rewarding policy action could be setting up green certification programs for exporters to demonstrate compliance with EU sustainability standards.

Another policy suggestion is the introduction of a domestic carbon pricing system in Pakistan. If Pakistan imposed its own carbon pricing, the EU would deduct this from CBAM obligations, lowering the overall cost burden on exporters. A local carbon tax or cap-and-trade system would make Pakistani exports more competitive by signaling to the world that Pakistan is taking steps toward decarbonization. However, if a domestic emissions trading system were to be established, it would have to be phased in gradually for the ease of exporters, and emission monitoring and reporting would have to be transparent.

Pakistan must also diversify its export market to reduce reliance on the EU. Expanding trade with regions like China, the Middle East, and the Association of Southeast Asian Nations could offset potential losses from CBAM-related trade barriers. Strengthening economic ties with low-carbon trading partners where CBAM regulations do not apply could also be useful.

These policies may take time to implement, but certain short-term policy actions could be taken to mitigate the risks CBAM poses. As EU importers may shift to suppliers from other countries with lower carbon costs, reducing demand for Pakistani exports, a possible policy action could include Pakistan engaging in trade negotiations with the EU to ensure a fair transition toward carbon tax adjustment. Trade investment officers could negotiate exemptions or lower CBAM rates for Pakistani exports under existing Generalized Scheme of Preferences Plus status, or the relevant public authorities could form alliances with other developing nations to push for fairer terms at the WTO and advocate for lower compliance costs. Such proactive engagement with the EU, international trade bodies, and climate finance institutions could help reduce CBAM's impact on Pakistan's economy.

Lastly, accurate carbon emission reporting is crucial for complying with CBAM requirements. Pakistani exporters may lack standardized emission monitoring systems, which could result in higher CBAM costs due to default values being applied. Without proper verification mechanisms, exporters could struggle to prove lower emissions, making their products less attractive to EU buyers. Therefore, emission tracking must be efficient and transparent. Policymakers could support businesses, especially those exporting products to the EU, by providing relevant, timely, and appropriate technical assistance.

It is important to stress that policymakers must take early action to align Pakistan's trade policies with global decarbonization efforts. Implementing a domestic carbon pricing mechanism, investing in energy-efficient technologies, and diversifying export markets will be crucial for maintaining competitiveness. In addition, negotiating fairer trade terms with the EU and improving emission monitoring could help ease the transition for exporters. If Pakistan takes proactive steps to reduce its carbon footprint and integrates sustainable production practices, it could minimize CBAM-related trade losses while strengthening its position in an increasingly carbon-conscious global economy.

References

Acar, S., Aşıcı, A. A., & Yeldan, A. E. (2022). Potential effects of the EU's Carbon Border Adjustment Mechanism on the Turkish economy. *Environment Development and Sustainability*, *24,* 8162–8194.

Appunn, K. A., & Wettengel, J. W. (2024, May 23). Understanding the European Union's emissions trading systems (EU ETS). *Clean Energy Wire*. https://www.cleanenergywire.org/factsheets/understanding-european-unions-emissions-trading-system#one

Beaufils, T., Ward, H., Jakob, M., & Wenz, L. (2023). Assessing different European Carbon Border Adjustment Mechanism implementations and their impact on trade partners. *Communications Earth & Environment*, *4*(131).

Berahab, R. (2022). *Is the EU's Carbon Border Adjustment Mechanism a threat for developing countries?* Policy Center for the New South.

Brandi, C. (2013). Trade and climate change: Environmental, economic and ethical perspectives on border carbon adjustments. *Ethics Policy & Environment*, *16*(1), 79–93.

Chepeliev, M. (2021). Possible implications of the European Carbon Border Adjustment Mechanism for Ukraine and other EU trading partners. *Energy Research Letters, 2*(1).

Chu, L., Do, T. N., Le, T. H. L., Ho, Q. A., & Dang, K. (2024). Carbon Border Adjustment Mechanism, carbon pricing, and within-sector shifts: A partial equilibrium approach to Vietnam's steel sector. *Energy Policy*, *193*, 114293.

Eicke, L., Weko, S., Apergi, M., & Marian, A. (2021). Pulling up the carbon ladder? Decarbonization, dependence, and third-country risks from the European Carbon Border Adjustment Mechanism. *Energy Research & Social Science*, *80*, 102240.

European Commission. (2024). *Guidance document on CBAM implementation for importers of goods into the EU*.

European Commission. (2025). *Carbon Border Adjustment Mechanism*. https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

Faruqui, M. S., & Piracha, M. (2023). *Concept paper on carbon pricing, CBAMs and Pakistan's readiness*.

Jamil, N., Chaudhry, T. T., & Chaudhry, A. A. (2024). *Trade liberalization and carbon emissions: Firm-level evidence from Pakistan* (Innovation and Technology Centre Working Paper No. 19). Lahore School of Economics.

Magacho, G., Espagne, E., & Godin, A. (2023). Impacts of the CBAM on EU trade partners: Consequences for developing countries. *Climate Policy*, *24*(2), 243–259.

Mavarick AI. (2025, December 18). *A comprehensive guide to the EU CBAM reporting.* https://www.mavarick.ai/blogs/eu-cbam-reporting-regulation-guide

Overland, I., & Sabyrbekov, R. (2022). Know your opponent: Which countries might fight the European Carbon Border Adjustment Mechanism? *Energy Policy*, *169*, 113175.

Perdana, S., & Vielle, M. (2022). Making the EU Carbon Border Adjustment Mechanism acceptable and climate friendly for least developed countries. *Energy Policy*, *170*, 113245.

Ritchie, H., Rosado, P., & Roser, M. (2020). *Breakdown of carbon dioxide, methane, and nitrous oxide emissions by sector.* Our World in Data. https://ourworldindata.org/emissions-by-sector

Trading Economics. (n.d). *EU carbon permits.* https://tradingeconomics.com/commodity/carbon

United Nations Economic and Social Commission for Asia and the Pacific, United Nations Environment Programme, & United Nations Conference on Trade and Development. (2021). *Asia-Pacific trade and investment report 2021: Accelerating climate-smart trade and investment for sustainable development.* United Nations. https://unctad.org/publication/asia-pacific-trade-and-investment-report-2021

United Nations Statistics Division. (2025). *United Nations Comtrade database UN* [Data set]. Retrieved July 24, 2025, from https://comtrade.un.org

Walczak, N., Huremović, K., & Rungi, A. (2025). Evaluating the EU Carbon Border Adjustment Mechanism with a quantitative trade model. *arXiv, 2506.23341v3.*

Wolfram, C., & Krol, A. (2023, December 11). *Carbon border adjustments.* The MIT Climate Portal. https://climate.mit.edu/explainers/carbon-border-adjustments.

World Resources Institute. (2022). *Climate watch country greenhouse gas emissions data method note.* https://wri-sites.s3.us-east-1.amazonaws.com/climatewatch.org/www.climatewatch.org/climate-watch/wri_metadata/CW_GHG_Method_Note.pdf

Zhu, J., Zhao, Y., & Zheng, L. (2024). The impact of the EU Carbon Border Adjustment Mechanism on China's exports to the EU. *Energies*, *17*(2), 509.

Appendix A: Sectors Considered

Output sectors	**Tonnes of GHG emissions**
Agricultural sector	
Agriculture, hunting, forestry, and fishing	GHG emissions from agriculture
Manufacturing sector	
Mining and quarrying	GHG emissions from manufacturing and construction
Food, beverages, and tobacco	
Textiles and textile products	
Leather, leather products, and footwear	
Wood and products of wood and cork	
Pulp, paper, paper products, printing, and publishing	
Coke, refined petroleum, and nuclear fuel	
Chemicals and chemical products	
Rubber and plastics	
Basic metals and fabricated metal	
Machinery, nec	
Transport equipment	
Manufacturing, nec; recycling	
Construction	
Industrial sector	
Other nonmetallic minerals	GHG emissions from industry
Electrical and optical equipment	

Other sectors not considered	
Electricity, gas, and water supply	GHG emissions from land use change and forestry
Sale, maintenance, and repair of motor vehicles and motorcycles; retail sale of fuel	GHG emissions from waste
Wholesale trade and commission trade, except of motor vehicles and motorcycles	GHG emissions from buildings
Retail trade, except of motor vehicles and motorcycles; repair of household goods	GHG emissions from transport
Hotels and restaurants	GHG emissions from electricity and heat
Inland transport	Fugitive GHG emissions from energy production
Water transport	GHG emissions from other fuel combustion
Air transport	GHG emissions from bunker fuels
Other supporting and auxiliary transport activities; activities of travel agencies	
Post and telecommunications	
Financial intermediation	
Real estate activities	
Renting of M&Eq and other business activities	
Public administration and defense; compulsory social security	
Education	
Health and social work	
Other community, social, and personal services	
Private households with employed persons	

Appendix B: Subcategories Within Each Sector

Agriculture	HS 2-digit codes
01	Animal products
02	Animal products
03	Animal products
04	Animal products
05	Animal products
06	Vegetable products
07	Vegetable products
08	Vegetable products
09	Vegetable products
10	Vegetable products
11	Vegetable products
12	Vegetable products
13	Vegetable products
14	Vegetable products
15	Animal or vegetable oils

Manufacturing	HS 2-digit codes
16	Food, beverages, and tobacco
17	Food, beverages, and tobacco
18	Food, beverages, and tobacco
19	Food, beverages, and tobacco
20	Food, beverages, and tobacco
21	Food, beverages, and tobacco
22	Food, beverages, and tobacco
23	Food, beverages, and tobacco
24	Food, beverages, and tobacco
28	Chemical products
29	Chemical products
30	Chemical products
31	Chemical products
32	Chemical products
33	Chemical products
34	Chemical products
35	Chemical products
36	Chemical products
37	Chemical products
38	Chemical products
39	Plastics and rubber
40	Plastics and rubber

Manufacturing	HS 2-digit codes
41	Raw hides and skins
42	Raw hides and skins
43	Raw hides and skins
44	Wood
45	Wood
46	Wood
47	Wood
48	Wood
49	Wood
50	Textiles
51	Textiles
52	Textiles
53	Textiles
54	Textiles
55	Textiles
56	Textiles
57	Textiles
58	Textiles
59	Textiles
60	Textiles
61	Textiles
62	Textiles
63	Textiles
64	Textiles
65	Textiles
66	Textiles
67	Textiles
68	Stones and glass
69	Stones and glass
70	Stones and glass
71	Pearls and precious metals
72	Base metal
73	Base metal
74	Base metal
75	Base metal
76	Base metal
78	Base metal
79	Base metal
80	Base metal
81	Base metal
82	Base metal

Manufacturing	HS 2-digit codes
83	Base metal
84	Nuclear
86	Transport equipment
87	Transport equipment
88	Transport equipment
89	Transport equipment
91	Clocks/musical instruments
92	Clocks/musical instruments
93	Arms
94	Misc. manufactured
95	Misc. manufactured
96	Misc. manufactured
97	Arts and antiques
98	Arts and antiques

Industry	HS 2-digit codes
85	Electrical
90	Optical
25	Minerals
26	Minerals
27	Minerals

Appendix C: Export Demand Function (1994–2020)

Johansen normalization restriction imposed:

Beta	Coefficient	Std. error	z-stat.	P > |z|	95% confidence interval
Ln-exports	1				
Ln-foreign-GDP (weighted by export share)	-1.234263	0.1921181	-6.42	0	-1.610808, -0.8577187
Ln-PPP	0.3724517	0.2622682	1.42	0.156	-0.1415844, 0.8864879
Constant	5.402005				

GDP = gross domestic product, PPP = purchasing power parity.

Appendix D: GHG Emissions (MT)

	Agriculture	Manufacturing	Industry	Total emissions
2012	36.21	111.14	33.45	180.8
2013	53.15	124.29	35.15	212.59
2014	54.35	143.89	46.99	245.24
2015	39.00	142.05	38.08	219.13
2016	34.05	173.97	40.50	248.53
2017	34.39	198.56	45.20	278.15
2018	64.58	219.96	49.72	334.26
2019	90.19	215.94	56.83	362.95
2020	95.29	294.4	70.59	460.28
2021	94.55	316.46	68.65	479.66
2022	88.49	388.30	71.96	548.75
2023	120.64	339.83	79.90	540.37
2024	126.07	355.13	83.50	564.69
2025	131.74	371.11	87.25	590.10
2026	137.67	387.81	91.18	616.65
2027	143.86	405.26	95.28	644.40
2028	150.34	423.49	99.57	673.40
2029	157.10	442.55	104.05	703.71
2030	164.17	462.47	108.73	735.37
2031	171.56	483.28	113.63	768.46
2032	179.28	505.02	118.74	803.05
2033	187.35	527.75	124.08	839.18
2034	195.78	551.50	129.67	876.95
2035	204.59	576.32	135.50	916.41
2036	213.80	602.25	141.60	957.65