

Carbon Border Adjustment Mechanism (CBAM) and Burden Sharing: A CGE Modelling Approach

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Abstract

The EU CBAM which proposes to impose carbon content related tariffs on the imports of energy-intensive goods to the EU could have significant implications for the exports of energy intensive goods from developing countries. In this study three different scenarios were constructed, using a CGE model, to assess the economic impacts of CBAM on India. The results indicate that in general CBAM could have negative impacts on GDP and EU exports. However, the imposition of a domestic carbon tax (cooperative burden sharing) could help to reduce the adverse effects.

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1. Introduction

The European Union's Carbon Border Adjustment Mechanism (EU-CBAM) aims at mitigating carbon leakage under its ambitious climate target of reducing 55% of GHG emissions by 2030 by seeking to equalise the cost of carbon between domestic producers and foreign exporters of energy-intensive goods. While carbon pricing has been used as a climate policy instrument in the EU for a long time this is not the case for many countries, especially developing countries. Developing country exports of energy intensive goods to the EU could lose competitiveness under CBAM due to additional taxes on account of the differences in carbon price levels between the EU and the exporting country in question. In this paper we study this issue by estimating the economic costs of carbon pricing under alternative burden sharing schemes, in the case of India.

India's exposure to EU-CBAM is relatively minor compared to many other countries. The CBAM sectors' exports to the EU in the past decade amounted to only 0.2% of India's GDP of which almost 90% were accounted by the Iron and Steel sector. The imposition of carbon tariffs on CBAM-exposed exports could erode India's competitiveness in the EU market, potentially leading to broader macro impacts. An assessment using a Computable General Equilibrium (CGE) model can shed light on such heterogeneous impacts. This study employs a single-country CGE model tailored to India's economic structure and trade patterns to assess the implications of EU-CBAM. CGE models are economy-wide, multi-sectoral models capable of capturing the interlinkages between production, consumption, trade, and income distribution. Simulating the CBAM using such a model can provide insights into the direct, indirect and induced effects on the economy, including the reallocation of resources, changes in sectoral competitiveness, and shifts in income/consumption among households. Additionally, CGE models enable the analysis of optimal policy responses to changes in the external environment.

The paper consists of six sections. Section Two outlines recent trends in carbon pricing. Section Three presents some key findings from the literature. Section Four discusses the methodology. Section Five is devoted to the presentation and discussion of results, and finally, Section Six provides the policy implications.

2. Carbon Pricing Trends

Carbon pricing is an important tool to achieve cost-effective carbon reductions. Carbon pricing has been one of the important drivers for the development and adoption of cleaner technologies in advanced economies. The adoption of cleaner technologies has put these economies on a declining emissions trajectory compared to an upward emissions trajectory for most of the developing economies. However, developing economies are increasingly making efforts to price carbon in recent years.

Currently, there are 75 carbon pricing schemes operating globally, which cover about 24% of global greenhouse gas (GHG) emissions. The carbon price level in most of the schemes is, however, not consistent with the 2°C goals of the Paris Agreement. In 2017, the High-Level Commission on Carbon Prices recommended carbon prices in the range of 40-80 USD/tCO_{2e} in 2020 and 50-100 USD/tCO_{2e} in 2030 to be on track to limit the rise in global temperature to well below 2°C (Paris Agreement Target). Based on current data only seven carbon pricing instruments covering less than 1% of global GHG emissions are consistent with the above carbon price levels.

As mentioned earlier one of the main reasons for CBAM is to prevent carbon leakage, that is, the relocation of production from the EU to other jurisdictions with less stringent carbon pricing policies. CBAM requires EU importers to purchase certificates representing embedded emissions in the goods. The cost of certificates is proposed to be linked to allowance prices in the EU Emissions Trading System (ETS). If the imported goods are subject to carbon pricing in the exporting country the compliance burden would be adjusted accordingly. The EU CBAM initially covers six energy-intensive sectors, namely, aluminium, cement, electricity, fertilisers, hydrogen, and iron and steel. The implementation of CBAM is likely to stimulate countries to pursue carbon pricing in order to remain competitive in the European market.

3. Literature Review

The effectiveness of CBAM depends on trade relationships, production emissions, and partner nations' carbon policies. Studies suggest CBAM is likely to reduce carbon leakage and level the playing field for Emissions-Intensive-Trade-Exposed (EITE) sectors, but it may also lead to reduced exports, an increase in regional inequalities, and pose legal challenges to WTO (Boehringer et al., 2010 and Monjon & Quirion, 2011). Recent studies underscore CBAM's

potential in trade and carbon governance. By shifting trade patterns towards countries with lower carbon intensities, CBAM could incentivise cleaner production methods globally (Morsdorf, 2022; UNCTAD, 2021). Country-specific analyses reveal diverse outcomes. For Japan, Takeda and Arimura (2023) found that CBAM would impact the GDP and overall welfare positively, but the output of the EITE sectors witnessed small declines. Similarly, for Finland, CBAM would lead to a realignment of imports from non-EU to EU countries, enhancing Finnish exports within the EU while slightly reducing GDP (Kussi et al., 2020). In the Indian context, findings are mixed. Xiaobei et al. (2022) estimated a likely decline of 58.5% in India's iron and steel exports to the EU due to CBAM, while Majumder et al. (2024) projected minimal declines across sectors such as fertiliser, cement, aluminium, and iron and steel, with the cement sector experiencing the largest reduction at only 0.6%. Banerjee (2021) emphasised the potential for domestic carbon policies to complement border carbon adjustments, arguing that improvements in energy efficiency and fuel-switching technologies can further reduce carbon leakage. The study also recommended carbon revenue recycling schemes to counterbalance distortions arising from carbon taxation in India. The issue of carbon revenue recycling in India has been studied by Pradhan and Ghosh (2022) according to whom the coal cess (now called GST Compensation Cess) could facilitate the shift towards a low carbon economy by being a source of finance for supporting R&D in clean energy.

4. Methodology

This study develops and extends the CGE framework introduced by Pradhan and Ghosh (2012) to create a comprehensive model tailored to represent the core characteristics of India's economy. The model is designed to capture the interactions between the energy system and the broader economy. The static component of the model is based on Löfgren et al. (2022), while the energy system design is adapted from models such as DART 97, EPPA, and EMPAX-CGE. Further, a recursive dynamic version of the model was developed to capture the CBAM impacts over time. A description of the CGE model is presented below.

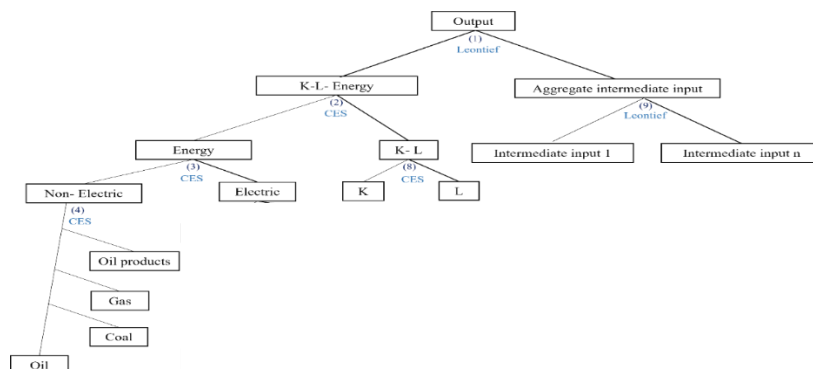
4.1 Production Structure

The production structure in CGE models breaks down the production process into detailed components to depict how inputs are used. Separate nesting structures are applied for non-fossil fuel and fossil fuel sectors (see Figures 1 and 2) to account for the distinct substitution possibilities in their production processes. For instance, Node 3 in Figure 1 highlights the distinction in non-fossil fuel production between electric (thermal and renewable electricity producing sectors) and non-electric (fossils sectors) sectors, a separation not reflected in the fossil fuel nesting structure in Figure 2. This detailed nesting approach also facilitates tracking physical flows of carbon-based resources throughout the economy (RTI International, 2008).

In Figure 1, Node 1 represents the aggregate output of the non-fossil fuel sector, nested using a Leontief functional form that combines the capital-labour-energy composite with intermediate inputs. Subsequent nodes further disaggregate this composite into energy and value-added components, with substitutability incorporated through a Constant Elasticity of Substitution (CES) functional form. This enables the simulation of technological adjustments, such as shifts driven by carbon pricing. For example, imposing a carbon price on an emissions-intensive sector might encourage producers to adopt fuel-efficient technologies, a change that the CES function can capture.

At Node 3, the energy composite is split into non-electric and electric aggregates. Non-electric energy is further divided into coal, oil, gas, and petroleum products, while electric energy is categorised into renewable and thermal sources. Renewables consist of hydro, nuclear, and wind/solar electricity. This differentiation captures the imperfect substitutability between renewable and non-renewable energy due to issues such as intermittency.

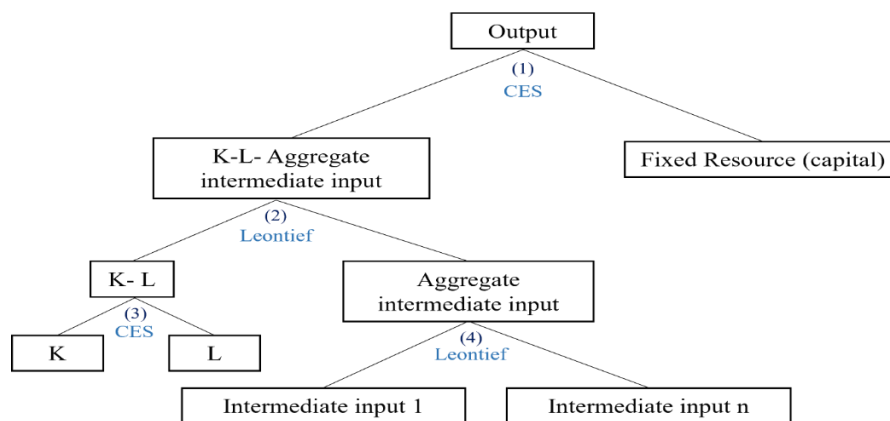
Figure 1: Production Structure of Non-Fossil Fuel Sectors



Source: Pradhan and Ghosh (2012)

For fossil fuel production (Figure 2), the nesting structure uses a CES function to combine macro goods (capital, labour, and intermediate inputs) with fixed capital resources. Subsequent nodes model the combination of value-added and intermediate inputs using a mix of CES and Leontief functions. The standard microeconomics assumption of producers maximising their profits in a perfectly competitive market holds. Further, factor demands are determined assuming the minimisation of factor and output costs given fixed prices.

Figure 2: Production Structure of Fossil Fuel Sectors



Source: Pradhan and Ghosh (2012)

The model incorporates four primary institutions: households, enterprises (private and public), the government, and the Rest of the World (ROW). The SAM integrates detailed household consumption patterns, categorised into five quintiles each for rural and urban regions in India. The Linear Expenditure System (LES) is used to model household demand for goods and services. ROW accounts for trade and financial flows, enabling policy simulations like CBAM to assess impacts on trade and government revenue. Moreover, the Net Indirect Taxes (NIT) and ROW accounts are disaggregated into EU and non-EU regions, bridging critical gaps in the existing literature on single-country CGE models that have examined policies like CBAM. This enables a comprehensive assessment of CBAM's impact on EU vs. non-EU trade and government revenue.

Additionally, the model provides a framework for simulating potential trade diversion strategies that Indian firms might adopt in response to the EU CBAM. Note that standard Armington and CET functions are used to model aggregate imports and exports, respectively. However, aggregate imports/exports are CES composites of EU and non-EU imports/exports.

The model closures are as follows: the model is investment-driven, i.e., the capital stock for each sector has been assumed to be fixed (exogenous). For the current account balance, foreign saving is assumed to be fixed, and the exchange rate is assumed to be variable. Note that there are two current account balance equations in the model as the ROW account has been disaggregated into EU and non-EU. Therefore, there are two types of foreign savings and exchange rates in the model. Further, aggregate labour supply has also been assumed to be fixed. However, there is intersectoral mobility of labour. Government savings have been assumed to be flexible while the direct/indirect tax rates have been kept constant.

The recursive dynamic version of the model was constructed based on assumptions about investment (capital stock), productivity, employment, government consumption and energy efficiency growth.

4.2 Data

The primary data source for CGE models is the Social Accounting Matrix (SAM), which details the economic interlinkages between producers, households, governments, and other institutions. This study uses the CSEP SAM 2019–20 for India (Chadha et al., 2023), which depicts interrelationships between production sectors, factors of production, households, institutions and environmental factors such as emissions. The SAM was aggregated into 21 production sectors (including three fossil fuel sectors—coal, oil, and natural gas—and 18 non-fossil fuel sectors), two factors of production (labour and capital), and 10 household categories divided equally between rural and urban groups. This aggregation allows for distinction between carbon-intensive sectors and less carbon-intensive sectors which facilitates a detailed analysis of carbon pricing policies on emissions-intensive CBAM exposed sectors like iron and steel, aluminium, cement and fertiliser.

4.3 Construction of Baseline and Policy (Burden Sharing) Scenarios

A baseline and three counterfactual (burden sharing) scenarios were constructed using the recursive dynamic CGE model described above to study the impacts of CBAM. An average growth rate of 7% has been assumed in the baseline scenario. In the first scenario (PCARBON), a domestic carbon tax equivalent to the carbon price in the EU ETS has been applied to the CBAM exposed sectors, namely, fertiliser, cement, iron and steel, and aluminium. By applying an equivalent domestic carbon tax rate compared to the EU ETS, this scenario assumes that the

CBAM tax burden is completely offset and that there are no additional tax obligations on the part of Indian exporters. In this scenario, the entire carbon tax revenue is collected by the Indian government. This is because the applicable EU-CBAM rate is equivalent to the difference between the weekly average auction price of the EU-ETS and the domestic carbon tax rate prevailing in the exporting country.

In the second scenario (CBAM), the carbon tax is applied only to the exports of the CBAM sectors in the form of an export tax. This scenario assumes that there is no domestic carbon pricing policy in India and that Indian exporters pay the entire CBAM tax obligation to the EU authorities. That is, there is an outflow of export tax revenue to the EU. In the third scenario (PCARBON+CBAM), a domestic carbon price and an export tax coexist. The Indian government collects the domestic carbon tax revenue. In contrast, the export tax revenue flows out of the country to the EU. The policy scenarios are run from 2026 when the EU-CBAM is likely to come into effect.

Table 1: Description of Policy (burden sharing) Scenarios

Scenario	Tax Rates				CBAM Revenue	Domestic Revenue
	Iron and Steel	Aluminium	Cement	Fertiliser		
Business As Usual (BAU)	Nil	Nil	Nil	Nil	Nil	Nil
PCARBON	5200	5200	5200	5200	Nil	Yes
CBAM	17.0%	2.9%	59.1%	11.7%	Yes	Nil
PCARBON+C BAM	2600 and 8.5%	2600 and 1.45%	2600 and 29.55%	2600 and 5.85%	Yes (half)	Yes (half)

Note: To incorporate the potential reduction in free allowances in the EU-ETS a 5% annual increase was assumed for the domestic carbon tax rate (PCARBON) and the CBAM tax rates

Source: Authors

We have assumed a carbon tax rate of Rs 5200 per tonne of CO₂ equivalent emissions in 2026, which is close to the annual average EU-ETS price (ICAP, n.d); thereafter, a 5% increase has been assumed until 2030 to account for the reduction in the number of free allowances in the EU-ETS. This tax rate has been simulated using the emissions factor of the relevant CBAM sectors obtained from the World Bank (2023). Data related to exports to the EU and non-EU have been extracted from the WITS database. The CBAM tax rates for different CBAM sectors (fertiliser, cement, iron and steel, and aluminium) have been computed as 11.7%, 59.1%, 17.0% and 2.9%, respectively.

Table 2: Computation of CBAM Tax Rates

CBAM Sectors	*Exports to EU (Rs billion)	*Exports to Non-EU (Rs billion)	**Export emissions to EU (tonne)	*EU Export Tax revenue (Rs billion)	CBAM Tax Rates (Tax Revenue/Total Exports in %)
Fertiliser	0.07	1.62	1468.41	.009	11.70
Cement	0.00	8.03	274.08	.002	59.09
Iron and Steel	204.50	747.85	5930408.97	34.69	16.97
Aluminium	11.10	162.46	55490.52	.33	2.93

Note: The exchange rate of Rs 90/Euro and the EU-ETS annual average auction price of Euro 65/permit were used to compute the CBAM tax rates.

Source: Authors' computations using the *WITS and **World Bank (2023)

In the following section, we present and discuss the findings from the CGE model.

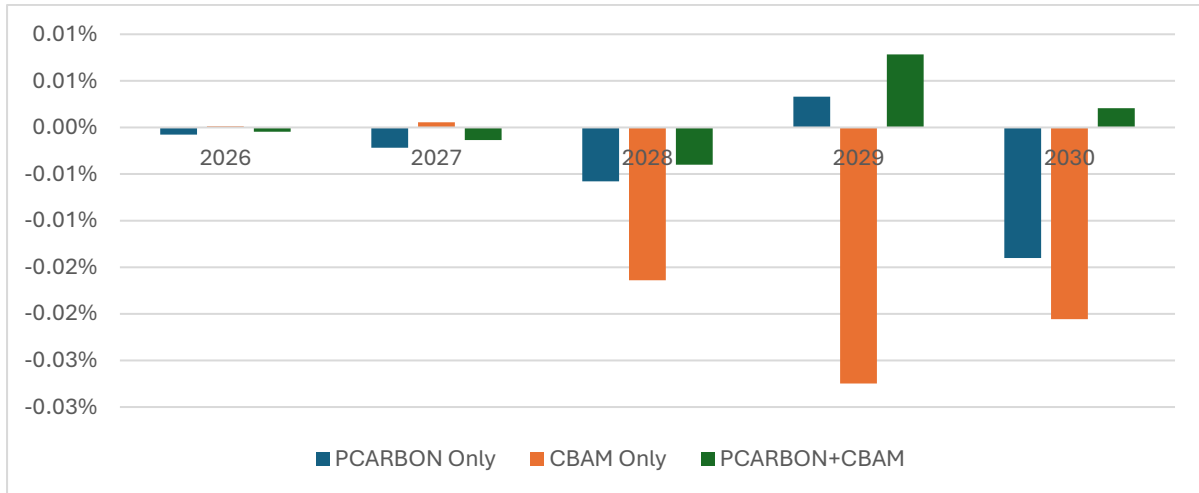
5.Results

5.1 Impact on GDP

The impact on GDP depends on the level of the carbon tax rate as well as burden sharing. A higher carbon tax rate has a relatively larger impact on GDP compared to a lower tax rate. A higher carbon tax rate on the CBAM sectors increases the prices of the goods produced by these sectors, which in turn affects demand throughout the economy. However, this effect is moderated if the carbon tax rate is lower, as seen in the third scenario (PCARBON+CBAM). In this scenario (PCARBON+CBAM), where there is both domestic carbon pricing and CBAM, there are positive impacts (0.01%) on GDP. Note that in this scenario, both the domestic carbon tax rate and the export tax rate are halved compared to the first two scenarios, respectively. In the scenario (CBAM) where there is no domestic carbon pricing, and the export tax revenue flows out of the country to meet CBAM obligations, there are relatively large negative impacts (-0.02% to -0.03%) on GDP. Thus, these results imply that the impact on GDP depends on the level of the carbon tax rate and burden sharing, that is, whether the carbon tax revenue is retained by India or is paid to the EU. A lower level of carbon tax rate and retaining the carbon tax revenue by India can improve the domestic fiscal position, which in turn could help to reduce the adverse effects on GDP. For some sectors, such as fertiliser and chemicals, there is a positive impact on output due to substitution effects which leads to a slight positive impact on the GDP. Although there is a decline in output due to higher tax rates, this is more than compensated by an increase in producer's price for the three CBAM sectors (iron and steel, aluminium and cement), which leads to a slight positive increase in the GDP for the PCARBON and combined taxation (PCARBON+CBAM) scenarios. The minor impacts of

CBAM on GDP are similar to studies by Majumder et al. (2024) and the African Climate Foundation and LSE (2023).

Figure 3: Impact on GDP for the different scenarios (% change relative to the Baseline)

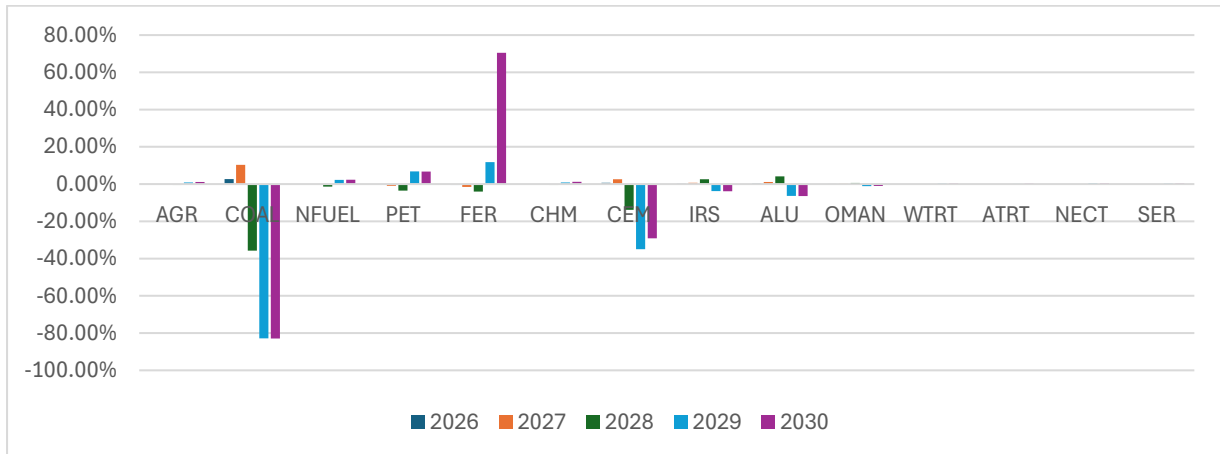


Source: Authors

5.2 Impact on EU Exports

The exports of most of the CBAM-exposed sectors (cement, iron and steel, and aluminium) to the EU declined in all the scenarios. This finding assumes significance, given the importance of these sectors in the Indian economy. These sectors already face several challenges, for instance, high logistics costs and cheap imports (steel), and the implementation of CBAM could lead to further loss of competitiveness for Indian exports of these goods to the EU. In the case of fertiliser, however, there is an increase in exports to the EU in the first two scenarios. This result is driven by the relatively small volume of fertiliser exports to the EU and the relatively lower carbon intensity of the fertiliser sector, which is due to the use of natural gas as an input. In other words, the fertiliser sector is relatively less impacted by CBAM compared to the other CBAM-exposed sectors under high carbon tax rates due to low export volumes and the use of low carbon inputs in the production process. Further, there is an increase in the exports of the agricultural sector to the EU which drives up the demand for fertiliser. Thus, the fertiliser sector becomes more competitive compared to the other CBAM exposed sectors leading to an increase in its exports to the EU.

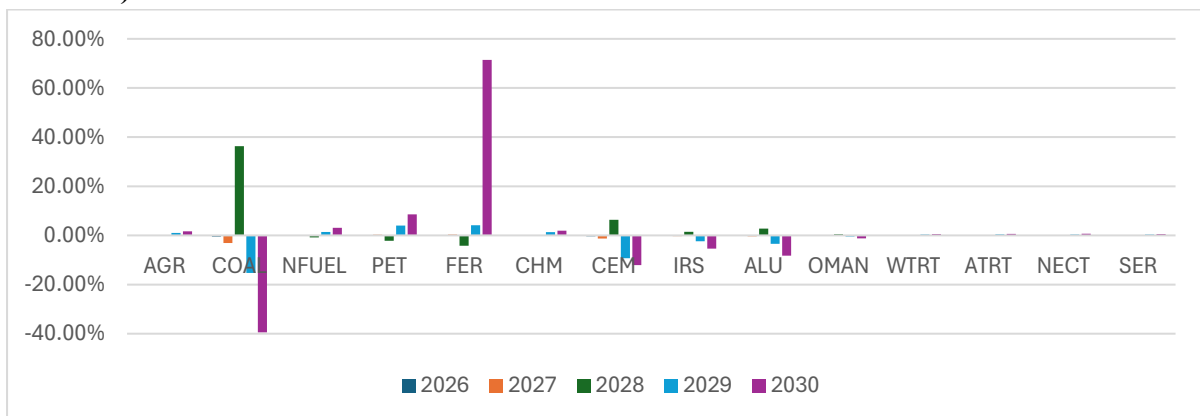
Figure 4: Impact on EU Exports in the PCARBON Scenario (% change relative to the Baseline)



Source: Authors

The impact on the cement sector is relatively less in the CBAM scenario compared to the PCARBON scenario because this sector has the highest carbon intensity among the CBAM-exposed sectors. Due to the higher carbon intensity, the cement sector is more impacted by domestic carbon pricing (PCARBON scenario) than carbon pricing on exports (CBAM scenario). It is important to note that exports to the EU constitute a very small share of domestic output for the CBAM-exposed sectors.

Figure 5: Impact on EU Exports in the CBAM Scenario (% change relative to the Baseline)

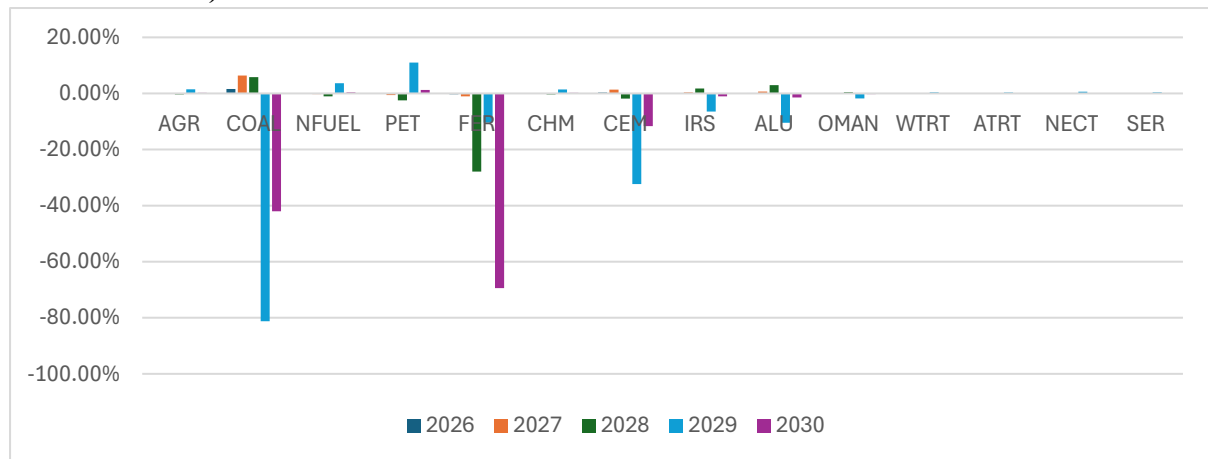


Source: Authors

The impact on exports to the EU in the third scenario, with lower carbon tax rates, is slightly different. In this scenario, all the CBAM-exposed sectors (fertiliser, cement, iron and steel, and aluminium) experience a decline in exports to the EU. The decline in Fertilizer exports is due

to a loss of competitiveness vis-a-vis the other CBAM-exposed sectors under low carbon tax rates. Note that the Fertilizer sector has the lowest carbon intensity among the CBAM-exposed sectors. Apart from the direct impacts of CBAM there are also repercussions across the value chain. The coal sector experiences a decline in exports to the EU in all the scenarios, which could be attributed to lower demand from sectors such as iron and steel. In general all the three scenarios depict similar patterns, except for the fertiliser sector. For the fertiliser sector there is an increase in exports to the EU in the first two scenarios. However, in the combined scenario (PCARBON+CBAM) this trend is reversed and there are lower exports to the EU and higher domestic sales.

Figure 6: Impact on EU Exports in the PCARBON + CBAM scenario (% change relative to the Baseline)

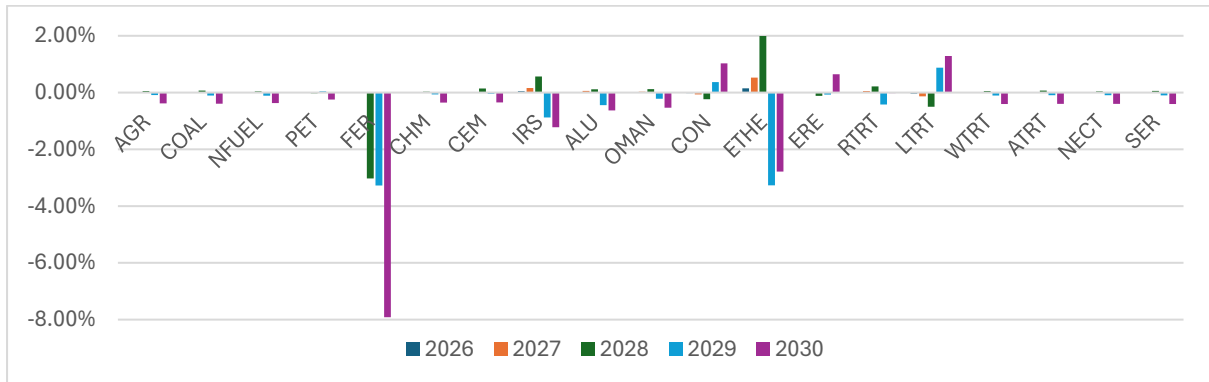


Source: Authors

5.3 Impact on non EU Exports

The results reveal that the impact on exports to the non-EU is broadly in line with the impact on exports to the EU. The CBAM exposed sectors, namely fertiliser, cement, iron and steel, and aluminium, experience a decline in exports to the non-EU in the high carbon tax rate scenarios, i.e. PCARBON and CBAM. However, exports of non CBAM goods to non-EU such as electricity (ETHE and ERE) are impacted indirectly.

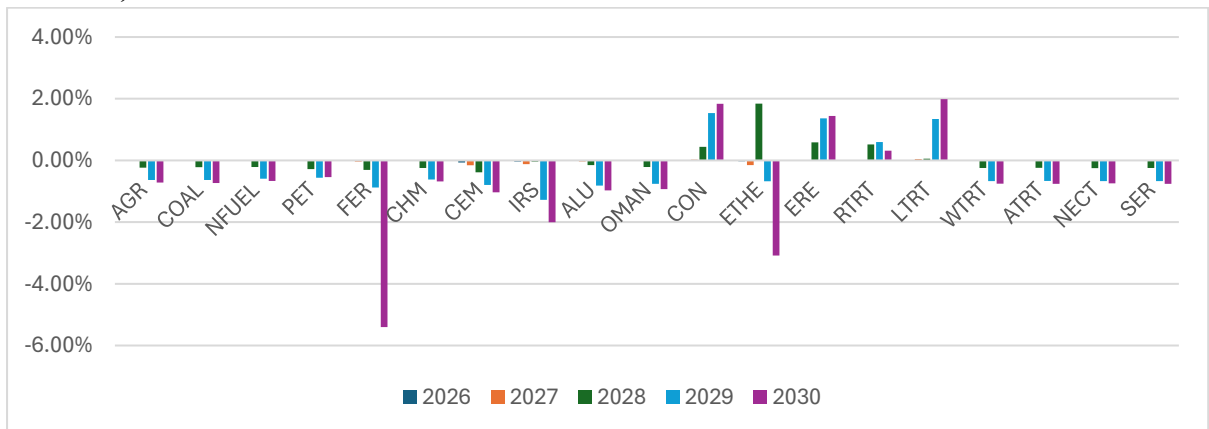
Figure 7: Impact on non EU Exports in the PCARBON scenario (% change relative to the Baseline)



Source: Authors

There is increase in renewable (ERE) exports and a decline in fossil-based electricity exports (ETHE) to non-EU countries. There is also a decline in the output of fossil-based electricity (ETHE). The implication is that while CBAM could negatively impact the energy-intensive industries it could also facilitate the growth of renewables.

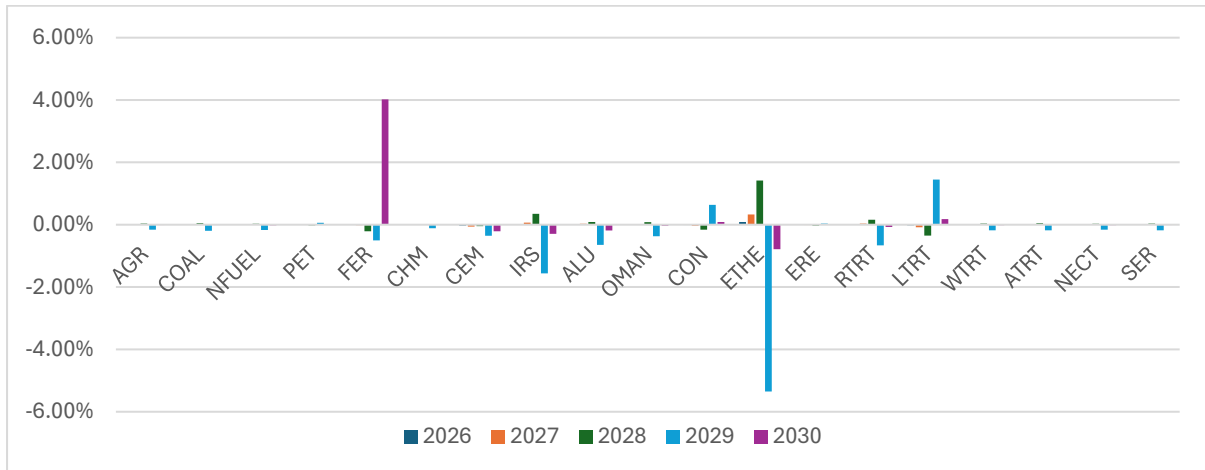
Figure 8: Impact on non EU Exports in the CBAM scenario (% change relative to the Baseline)



Source: Authors

In the third scenario, with lower carbon prices (equitable burden sharing), the Fertilizer sector experiences growth in non EU exports. The non EU exports of the other CBAM exposed sectors (cement, iron and steel, and aluminium) are likely to decline. The above results imply that trade diversion depends on several factors. A lower carbon price along with lower carbon intensity (as in the case of Fertiliser), leads to trade diversion from the EU to non-EU countries. In this context, it is important to note that our analysis is based on a single-country CGE model. Therefore, the structural and policy settings of other countries are not fully captured in this study.

Figure 9: Impact on non EU Exports in the PCARBON + CBAM scenario (% change relative to the Baseline)

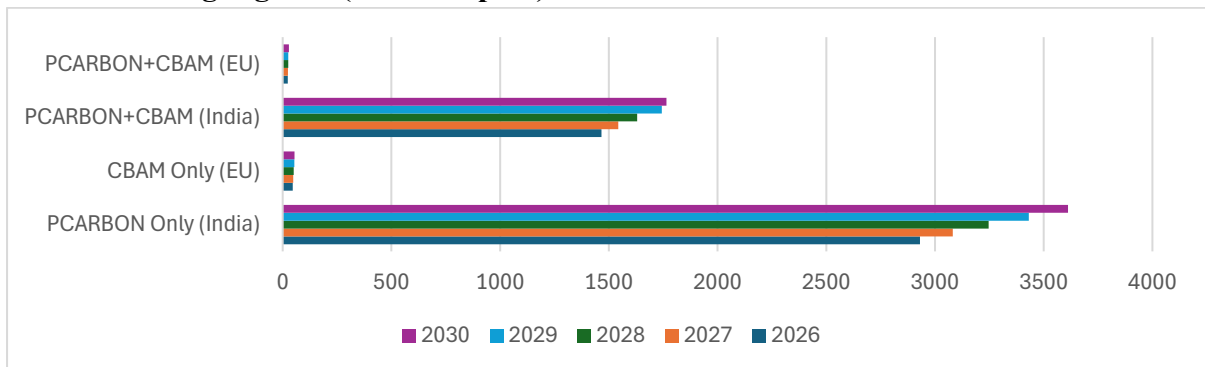


Source: Authors

5.4 Impact on Carbon Tax Revenue

The analysis suggests that CBAM related carbon pricing could be a significant source of government revenue. In the PCARBON scenario, India could generate carbon tax revenue worth 2930 billion rupees in 2026 and 3611 billion rupees in 2030, which is about 1% of GDP, respectively, while in the PCARBON + CBAM scenario, the carbon tax revenue is worth 1466 billion rupees in 2026 and 1765 billion rupees in 2030, which is about 0.5% of GDP, respectively. The EU share of carbon tax revenue in 2030 is much lower at 55 billion rupees in the CBAM scenario and 29 billion rupees in the PCARBON + CBAM scenario.

Figure 13: Allocation of Carbon Tax Revenue between India and the EU under different burden sharing regimes (billion rupees)



Source: Authors

6. Summary and Policy Implications

The main objective of this study was to conduct an ex-ante assessment of EU CBAM on the Indian economy. The EU CBAM, which proposes to impose tariffs on the EU imports of energy-intensive goods, could have implications for the exports of energy intensive goods from developing countries. In this study three different scenarios were constructed based on different assumptions about carbon pricing, in the context of CBAM. In the first scenario (PCARBON), the carbon tax is applied to the CBAM-exposed sectors and the carbon tax revenue is retained by India (full burden sharing); in the second scenario (CBAM), the carbon tax is applied only to the exports of the CBAM exposed sectors and the carbon tax revenue accrues to the EU (no burden sharing); and in the third scenario (PCARBON + CBAM), which is a combination of the above two scenarios the carbon tax rate on both domestic production and exports is halved and the carbon tax revenue is recycled to both India and the EU proportionately (cooperative burden sharing).

The results indicate that there are negative impacts on GDP in all the above scenarios. However, a lower level of carbon tax rate and proportionate distribution of the CBAM tax revenue between India and the EU (cooperative burden sharing) could help to reduce the adverse effects on GDP. Regarding trade the exports of most of the CBAM-exposed sectors (cement, iron and steel, and aluminium) to the EU declined in all the scenarios. This finding assumes significance, given the importance of these sectors in the Indian economy. In terms of exports to non-EU, the CBAM exposed sectors, namely fertiliser, cement, iron and steel, and aluminium, experience a decline in the high carbon tax rate scenarios. However, there are indirect effects on the energy sectors. There is an increase in renewable (ERE) exports and a decline in fossil-based electricity exports (ETHE) to non-EU countries. The implication is that while CBAM could negatively impact energy-intensive industries, it could also facilitate the growth of renewables. Finally, CBAM-related carbon pricing could be a significant source of government revenue. The estimated carbon tax revenue is 0.5% and 1% of GDP in the PCARBON+CBAM (cooperative burden sharing) and PCARBON (full burden sharing) scenarios, respectively. The main policy recommendation based on this study is that the optimal response to CBAM would be to impose a domestic carbon tax, starting with a lower tax rate (cooperative burden sharing). This finding in general could be applicable for countries that export energy intensive goods to the EU.

In conclusion, the impact of EU-CBAM could depend on several factors, and this study has highlighted that differences in carbon price levels between the EU and the exporting country

is one of them. It is important to consider this aspect while designing appropriate policy responses to the EU-CBAM.

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