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The EU-India Free Trade Agreement: Ex-Ante Trade, CO2 Emission, and Welfare Effects under the Carbon Border Adjustment Mechanism

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The EU-India Free Trade Agreement: Ex-Ante Trade, CO2 Emission, and Welfare Effects under the Carbon Border Adjustment Mechanism

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Abstract:

Gains from trade liberalization are accompanied by environmental externalities of increased greenhouse gas emissions. The EU is currently active on both trade and climate policy frontiers. By means of a new quantitative trade model, this study uncovers counterfactual changes in trade, CO_2 emissions, and welfare of an EU-India FTA, first as a standalone policy, and then, in conjunction with the Carbon Border Adjustment Mechanism (CBAM).

Trade data from the OECD Inter-Country Input-Output (ICIO) tables and CO_2 emission data from the OECD Trade in Embodied CO2 (TECO2) database are used. While the CBAM decreases trade volumes and CO_2 emissions, a hypothetical EU-India FTA results in significant increases in both trade and CO_2 emissions. When considering the Armington assumption of national product differentiation and no intermediate goods, the welfare effects of the EU-India FTA alone are found to be negative for India.

JEL-Codes: F140, F170, F180

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1 Introduction

Trade is a powerful tool to move goods, specialization, and economic welfare gains around the world. But not only. Alongside its well-known "gains", trade facilitates the rise of CO2 emissions around the globe. Almost a third of CO2 pollution throughout the world is embodied in goods that are traded (Copeland (2021)). CO2 emissions accelerate climate change, which decreases social welfare through a range of channels such as fewer agricultural yields, civil conflict and crime, less labor supply, and more extreme weather events (Larch & Wanner (2017)). Policy considerations linked to trade and CO2 emissions are gaining more and more in importance. Trade and sustainability (TSD) chapters and sustainability impact assessments are already part of nowadays' EU trade agreements. Yet, mostly, the EU is relying on policy solutions based on market mechanisms. Since 2005, the emission trading scheme (ETS), the world's first carbon market, has required EU producers of several industries to buy permits to emit CO2. In October 2023, the EU's Carbon Border Adjustment Mechanism (CBAM) has come into effect. Intended to level the playing field in terms of global CO2 mitigation efforts, the CBAM equals the carbon price between the EU and its competitors. Since the CBAM works via an import tariff, it can be considered a unilateral trade policy measure. Towards the long haul, the CBAM is perceived as a first stepping stone towards multilateral climate clubs. Such multilateral climate clubs could feature mutual carbon markets and punitive import tariffs towards outsiders. Due to the larger coalitions, they are seen as more efficient than unilateral tools in slowing climate change, the world's biggest market failure.

Voices from developing countries, such as India, criticize the CBAM. Perceived as a punitive trade measure, policymakers fear a reduction of trade flows and the associated gains from trade (Bergin et al. (2021)). At the same time, the EU's current trade policy agenda is targeted towards developing countries such as India. The EU's recent geopolitical 'strategic autonomy' aims at diversifying the EU economy to be more resilient in times of trade shocks (Covid-19), wars (Russian war in Ukraine) or critical dependencies from rising hegemons (China). In search for new geopolitical partners, India as the world's largest country (and democracy) is thus a natural choice. After a failed first free trade agreement (FTA) negotiation round (2007-2013), it is questionable whether the EU can afford a halt of negotiations on an FTA given the current geopolitical tensions. Negotiations have been re-launched in June 2022 and are in full swing.

The counter-directional effects of trade liberalisation on economic gains from trade and environmental damage from increased CO2 emissions open the possibility to evaluate the role of tools such as the CBAM and FTAs on economic considerations such as trade, and the welfare gains from trade against their negative side-effects on climate outcomes such as CO2 emissions. Will India face a substantial reduction of exports to the EU when CBAM is in place? Will the EU-India FTA reverse the potential losses of trade volume under CBAM? And, how will production-based CO2 emissions change? Of further interest is the question whether the tightening of CO2 emission regulation as proposed in CBAM reduces trade flows and associated CO2 emissions between the EU and India (scale effects) and how the aggregate effects are driven by changes in industry-level composition (composition effects). The paper intends to contribute towards the debate on the right policy mix to achieve both economic competitiveness, and environmental protection, under the assumption that competitiveness-related and climate change mitigation policies are in tension. Thereby, it could help decision-makers currently engaged in negotiating the EU-India FTA in making better-informed decisions towards a tariff policy which is in line with the European Green Deal.

The currently negotiated EU-India FTA and the CBAM are taken as a case-in-point to deliver ex-ante predictions on the interplay of both policy areas. To this aim, this paper assesses the prospects of the planned CBAM and the negotiated EU-India FTA to alter trade, CO2 emissions and welfare of India and the EU in a counterfactual general equilibrium trade model, frequently applied in international trade research. The rationale of changes in trade flows, CO2 emissions and welfare after the introduction of a change in trade costs is reflected in the mechanisms underlying the model: demand for goods and services depends on country-specific characteristics and bilateral trade costs between countries. While a CBAM increases trade costs between the EU member states and India, an EU-India FTA entails a reduction of bilateral trade costs, linked to lower prices of foreign goods and services for consumers. Given the assumption of perfectly competitive goods markets, an increase in production is assumed to be distributed to consumers in the form of higher wages. Higher wages correspond to higher real income, which consumers use to increase expenditures on goods and services from all the countries in the world. However, a reduction in tariff revenues, which are also part of the expenditures, dampens the impact of an increase in income on real expenditures. Because of the nature of CBAM as a trade measure that increases import tariff barriers, the mechanism underlying changes in trade is assumed to apply to both the EU-India FTA and the CBAM, in the same manner.

The data used for the counterfactual model simulation stem from the following sources: trade flows of bilateral country-sector pairs are taken from the OECD Inter-Country Input-Output Tables (OECD (2022a)). To infer changes in CO2 emissions from percentage changes of trade flows, sectoral CO2 emission estimates from the IEA's fuel combustion statistics are divided by each country's production, at current prices (OECD (2022b)). Most of the the bilateral tariff data for the baseline equilibrium is taken from Felbermayr et al. (2022a). Sector-level trade elasticities and the FTA tariff liberalisation scenarios stem from Gallina et al. (2020). The base year of the model simulations is 2014.

The study is outlined as follows. In section 2, the literature on trade and welfare effects of the EU-India FTA and the CBAM is reviewed. Section 3 motivates the trade-off between economic and environmental considerations linked to EU-India trade in a descriptive data analysis. In section 4, the policy scenarios of the CBAM and the FTA are presented, along with hypotheses. The counterfactual general equilibrium trade model used to obtain trade, CO2 emissions and welfare effects is elaborated on in section 5. The findings and their discussion can be found in section 6. Section 7 concludes.

2 Literature

The literature review sets out with the economics of trade liberalisation. A review of EU-India trade policy and studies on the ex-ante trade and welfare effects of an EU-India FTA follows. Finally, the political economy of the CBAM in India and welfare effects of a CBAM on the Indian economy are examined.

2.1 Economics of the Gains from Trade Liberalization

There are many mechanisms through which gains from trade might work. The most prominent are specialization across sectors, increased competition, and a wider variety available. The mechanisms at play with FTAs are by and large the same as with other forms of trade (dis)-integration, such as tariff policies.

By distorting relative market prices vis-à-vis a world with zero MFN tariffs, tariffs imply that consumers pay more than it costs to trade under zero trade costs. By triggering efficient specialisation patterns in goods production between countries, trade liberalisation is considered to remove these distortions and increase trade and welfare by leading to lower overall cost allocations of factors and goods in models with perfect competition and no increasing returns to scale. Two prominent theories of specialisation stem from Ricardo and Heckscher-Ohlin. According to the Ricardian concept of comparative advantage, technology differences mirror factor productivity differences and induce sourcing from the least-cost supplier. Heckscher-Ohlin frameworks motivate trade by relative factor abundance that makes production of a good relatively cheaper in one country than another.

Models with imperfect competition and increasing returns to scale explain gains from trade, too. In oligopolistic or monopolistic competition models such as Markusen (1981), firms have price-setting power (market power), either due to a small number of firms in the market, due to product differentiation or both, set higher-than-efficient quantities, and earn positive profits by charging mark-ups. When the market size expands due to an FTA, a larger number of firms lowers the average mark-up level ("pro-competitive effect"). In the long-run equilibrium, firms make zero profits. At a given market size, a larger number of firms implies that a larger mark-up is required to break even. At a given number of firms, a larger market implies that a smaller mark-up is required for a given firm to break even. An FTA evokes an "industrial restructuring" process, which permits more productive firms within an industry to expand to export, and forces least efficient firms to exit the market ("productivity effect"). The more productive firms which stay in the market ("selection effect") can be characterized by larger output ("scale effect", Krugman (1980)), and, in case of goods heterogeneity, greater product variety ("variety effect", Melitz & Trefler (2012)). Consumers can meet their needs more precisely when a larger variety of products is available.

Both monopolistic competition models (Krugman (1979)) and oligopolistic competitions models (Brander & Krugman (1983)) motivate welfare-enhancing bilateral intra-industry trade due to scale effects. However, assuming completely symmetric firms, these so-called "New Trade theory" models do not explain which firms exit due to the "selection effect". In Melitz (2003)- type heterogeneous firms models ("New New Trade theory"), firms differ in terms of their productivity and only the most productive ones can cover the costs of exporting. Trade integration enables more firms to export, increasing competition in the domestic economy. The least productive firms exit ("selection effect") and the largest firms gain market shares ("reallocation effect").

There is also the question of trade diversion versus trade creation (Balassa (1967)}, Dai et al. (2014)). Trade creation occurs when there is a net increase in domestic imports, e.g., induced by a substitution of formerly more expensive imports from "outsiders" towards partners. Trade diversion occurs when there is a net decrease in domestic imports, e.g., when more expensive imports from the partner country overweigh less expensive imports from the rest of the world (ROW). As trade diversion implies a disadvantage for all "outsiders" that are discriminated against, the WTO and third countries generally object to bilateral FTA creation. According to Viner's ambiguity, FTAs are not necessarily good for national welfare (Viner (1951)). The liberalizing country might gain or lose from unilateral preferential trade liberalization. While FTAs might increase national welfare through trade creation, overall national welfare might decrease when existing trade from the outside world is diverted to trade with the FTA partner countries and tariff revenue is foregone. Linked to the gains from trade, the formation of an FTA could also lead to a terms-of-trade improvement for the group compared to the ROW.

Third countries that participate in the FTA countries' global value chains may also benefit through spillover effects of intermediate input trade. Last not least, trade deflection happens when in an FTA with different external tariffs all imports might enter FTA through the low-tariff country. This so-called transshipment will take place as long as the tariff difference is smaller than transport costs. The low-tariff country government receives all tariff revenue for imports into the entire FTA. To avoid such trade deflection, FTAs typically include rules of origin (ROO).

2.1.1 EU-India Trade Policy

The EU-India trade pattern is influenced by both driving and impeding forces. On the one hand, the EU-India trade pattern has been largely driven by the trade cost reductions following India's bold trade liberalisation agenda in the 1990s which marked the end of India's decade-long protectionist trade policy. After the WTO Uruguay Round (finalized in 1994) and in subsequent unilateral liberalization steps (Felbermayr et al. (2017)) between 1995 and 2010, India reduced its mean applied tariff rate from 54 to 7%, a trade cost equivalent of about 20 percentage points (Gaurav & Mathur (2016)). On the other hand, compared to the world average, India still maintains relatively high tariffs and non-tariff barriers that impair trade with the EU (Khorana & Garcia (2013), Felbermayr et al. (2017), Khorana & Narayanan (2017), Gallina et al. (2020)). In 2019, more Indian than EU sectors, including food, beverage and tobacco, fishing and agriculture, crops and animals and motor vehicles, were found to be protected with applied tariff averages of at least 15% (Gallina et al. (2020)). In the same year, while the EU applied 272 kinds of technical barriers to trade (TBT), and 97 sanitary and phytosanitary (SPS) measures, India reported a more significant number of NTMs (1,481 and 1,466, respectively) (Gallina et al. (2020)). Additionally, trade defense measures were used to a relatively large extent (Khorana & Garcia (2013)). Felbermayr et al. (2017) observe 19 anti-dumping, anti-subsidy, and safeguard measures of the EU against India at the end of 2015. Likewise, India was an important target for defensive EU trade policy measures including anti-dumping and anti-subsidy. Moreover, the standard Generalized System of Preferences (GSP) scheme is currently halted in products which the EU deems India to be competitive, such as mineral products, chemicals, textiles, base metals, and motor vehicles (Khorana & Narayanan (2017), Gallina et al. (2020)). Against this background, there is considerable scope for further tariff liberalisations.

2.1.2 Ex-Ante Trade and Welfare Effects of an EU-India FTA

Drawing upon trade flows of 2004 from the GTAP 7 database, Khorana & Narayanan (2017) examine the effects of the EU-India FTA on welfare in a computable general equilibrium (CGE) model. They consider two FTA scenarios: first, they model complete tariff elimination in all sectors. Second, they consider tariff reductions only for the textiles, wearing apparel and leather goods sectors in which they reckon India to have a relative comparative advantage. While the first scenario yields welfare gains for both the EU (positive terms-of-trade effect) and India (negative terms-of-trade but positive endowment effect), in the second scenario, only India gains (endowment effect). The scholars explain this with an increase in demand that induces the relocation of activities towards labour-intensive sectors.

Also, Felbermayr et al. (2017)'s ex-ante assessment of the EU-India FTA comes in between the halt of the first negotiation round (2007-2013) and the launch of the second series (2022). Using the GTAP 9 database to calibrate trade and tariff data from 140 countries and regions and 57 goods and services sectors for 2011 to the CGE "ifo Trade Model" (Aichele et al. (2016)), the authors quantify the effects of hypothetical EU-India FTA policy scenarios on sectoral trade flows, tariff revenues, and GDP. Focusing on the gains from trade and real income the EU and India can hope to unlock, also they abstract from CO2 emissions and potential competitive differences due to carbon pricing.

Felbermayr et al. (2017) model three scenarios. Their first scenario foresees a complete tariff elimination, first, for manufacturing only and then, for all goods. The second scenario models tariff elimination in all sectors, and a "shallow" reduction of NTMs (first, in manufacturing only, then, in manufacturing and services, third, in manufacturing and agriculture and last, in all sectors). The third scenario models tariff elimination in all sectors, and a "deep" reduction of NTMs with the same sector coverage as in scenario two. While for the first scenario, they do not need to quantify the exact tariff reduction, for the second and third scenario, Felbermayr et al. (2017) use data of existing FTAs to estimate their effect on sectoral trade flows in a gravity model. Once these parameters are known, they use estimated trade elasticities, and observed tariffs to back out how large the reduction in other costs than tariffs, such as non-tariff measures (NTMs) in terms of ad valorem tariff equivalents must be to achieve average FTA tariff reduction in the EU-India FTA.

Felbermayr et al. (2017)'s trade effects cement the status quo of the EU being India's most important export destination. They find that whilst today, about 24% of India's exports go to the EU, an FTA could increase this share by another 13 percentage points. In absolute terms, the agreement could boost India's overall exports, measured in free-on-board (FOB) values and constant 2011 USD, by 84 bn. USD. According to the "deep" FTA simulation, India's exports to the EU could rise by about 91%. While India's exports to the EU of metal products (+71%) would increase below the average over all sectors, exports in ferrous metals would increase above average (+144%). At the aggregate level, trade diversion is found to be minor. India's exports to the other BRICS countries would fall, but exports to other world regions would not change much; the only exception is Eastern Europe and

Türkiye which are strongly integrated into the European value chains, so that higher demand for European exports from India boost demand from Eastern Europe for Indian inputs. Under an EU-India FTA, total EU exports would rise by about 1%. The authors argue that the reason for this modest aggregate change lies in the fact that the Indian economy is still much smaller (measured in GDP) than the EU's, and that trade with India only accounts for about 1% of total EU trade. In absolute terms (measured in FOB values and constant 2011 USD, GTAP 9), the EU's exports to India are expected to more than double in a "deep" FTA. Also on the EU's export side, the model suggests some trade diversion. Most importantly, the EU-India FTA would reduce trade among EU members by about 6 bn. USD.; the rate of change however is very minor (-0.2% for both exports and imports). Felbermayr et al. (2017) motivate the trade effects of an EU-India FTA through the lens of the theory of comparative advantage à la Ricardo. Through the reduction or elimination of tariffs, and the lowering of costs of NTMs, an agreement between the EU and India would lower trade costs which would allow countries to specialize more strongly on those sectors in which they had a comparative advantage. The sectoral changes predicted by the model could lead India to specialize further in its sectors of comparative advantage, i.e., the textiles and wearing apparel and business services industries. In contrast, the importance of India's machinery and automotive export sector would shrink. For the EU, gains in sectoral value added in minerals and metals figure high on the list due to a comparably large relative demand increase. Growth in the metals sector is largely a by-product of growth in automotive and machinery, as metal inputs sourced in the EU would be increasingly needed (Felbermayr et al. (2017)).

An EU-India FTA could increase annual real income in India by 0.7 to 1.3% ("shallow" vs. "deep"). The underlying assumption is that the EU-India free trade agreement (FTA) lowers trade frictions between the two parties by as much as other modern ("deep") trade agreements have. For the EU, the proposed FTA is expected to increase per capita income between by about 0.1% per year (Felbermayr et al. (2017)).

Gallina et al. (2020) employ a new quantitative trade model (NQTM) to simulate the impact of the potential trade agreement between the EU and India. They study counterfactual changes in bilateral trade flows (exports from the EU to India and exports from India to the EU), and counterfactual changes in welfare (expenditure divided by the price level) associated to bilateral trade cost shocks. For their baseline equilibrium for 2014, the authors take bilateral trade flows from the World Input-Output Database (Timmer et al. (2015)) including 42 countries and 24 sectors (22 tradable goods and 2 tradable and non-tradable services) aggregated according to the ISIC Rev. 4 classification.

Gallina et al. (2020) use two models. Their first model distinguishes between the effect of tariffs and non-tariff measures (NTMs) to allow for three scenarios ranging from hypothetical sectoral average import tariff percentage reductions and NTM reductions (Scenarios 1a to 1c). It also accounts for government tariff revenue changes as a rent-creating tariff barrier. The depth of trade liberalisation ranges from a 90% tariff reduction to nearly all sectors (except sectors with high applied average import tariffs) and NTM reduction in goods and services of 3% in Scenario 1a to a tariff reduction scheme as in 1a but no reduction in NTMs in Scenario 1c. Like Felbermayr et al. (2017)}, their second model estimates the average partial trade impact of FTAs on bilateral trade flows in a gravity equation. Scenarios 2a to 2c assume either an average trade cost reduction from the EU-Korea FTA (2a), the average estimated effect of all existing FTAs (2b), or the additional assumption of CETA and the EU-Japan FTA in place (2c).

Gallina et al. (2020) show that the potential FTA increases trade between the EU and India. In the scenarios, exports from the EU to India increase by 52 to 56%, while exports from India to the EU increase by 31 to 33%. Almost doubling (3 to 6 bn. EUR), basic metals witness the largest increase in exports of all sectors from the EU in Scenario 1, followed by electrical equipment and electronics. Exports from India increase most in the textiles, apparel, and leather sector, followed by chemicals and basic metals. Concerning ex-ante welfare changes from the EU-FTA, Gallina et al. (2020) find that across all scenarios, an EU member state would gain between 0.02 and 0.03% (4 and 9 bn. EUR), on average. Welfare gains for India are similar in absolute value, but represent a larger share of aggregate welfare (0.1 to 0.3%) with respect to the baseline. Gallina et al. (2020) find that the EU-India FTA diverts trade from third country trading partners. Under an EU-India FTA, the rest of the world (ROW) would export less textiles and chemicals to the EU. The EU would export less textiles to the ROW. An EU-FTA would also impede trade flows within the EU. Again, trade declines more in such sectors where there is an expansion with India, such as textiles and chemicals.

2.2 Environmental and Trade Policy Nexus

Regarding the incorporation of environmental policy to the EU-India FTA, Gallina et al. (2020)} assert difficulties of quantifying the impact of an EU-India FTA in terms of its environmental dimensions. They however argue that a hypothetical FTA should consider the negative externalities from carbon emissions embodied in trade flows, claiming international collaboration on this matter to be particularly relevant.

The literature on the nexus of trade and the environment features a debate on the extent of GHG emissions as a negative externality linked to trade (Shapiro (2016), Copeland (2021)). Moreover, the effect of greenhouse gas (GHG) emission policies is assessed. One section of the literature is on pollution haven effects (PHE) and the pollution haven hypothesis (PHH) (Copeland & Taylor (1994)). PHE materialize wherever an increase in GHG emissions is found in a country with laxer environmental regulation, not necessarily but potentially induced by trade liberalisation. If the PHH was to be "true", emission increases or carbon leakage would be solely due to environmental policy, as opposed to all other potential drivers of trade. Some studies that measure scale, composition, and technique effects of GHG emissions also link them to trade liberalisation (Copeland & Taylor (1994), Larch & Wanner (2017)). While scale effects represent the absolute emission changes linked to gross output, composition effects decompose the absolute change into contributions from different goods sectors, which can be either cleaner or dirtier. Technique effects measure the change of emissions per unit of output in an industry or firm and intend to capture the firm-level effects of environmental regulation, for example via within-industry reallocation to cleaner plants, or innovative activities undertaken by firms (Copeland (2021)).

2.3 The Political Economy of the Carbon Border Adjustment Mechanism (CBAM)

The origins behind the EU's Carbon Border Adjustment Mechanism (CBAM) lie in the gradual phase-out of free allowances of the EU ETS. Since it is important to understand the CBAM in the context of the EU ETS, first, the CBAM is motivated from an EU ETS perspective. Then, the CBAM is introduced from a multilateral viewpoint. A review of ex-ante trade, CO2 emissions and welfare effects of CBAM in India follows.

2.3.1 From the EU ETS to the CBAM

The European Green Deal sets the overall tune to make the EU carbon neutral by 2050. Under the "Fit for 55" strategy, the EU envisages a greenhouse gas (GHG) emission reduction by 55% (1990 vs. 2030). To make headway on this road, in 2005, the EU launched the Emissions Trading System (EU ETS), the world's first carbon market. The EU ETS works on the "cap and trade" principle. A cap is set on the total amount CO2 equivalents (CO2e) that can be emitted by participating firms – the so-called allowances. These allowances can either be auctioned or be granted to firms for free. Firms can trade allowances among each other on the EU ETS carbon market (Dröge (2021), Ambec (2022)).

The Carbon Border Adjustment Mechanism (CBAM) is linked to the free allowances' gradual phase-out. The implications of allowances for trade and the environment can be imagined as follows. Since a cap on allowed CO2e raises the price of production technologies, the concept of allowances can be transferred to the principle of a carbon price, with potential implications on competitiveness. The EU ETS allowances then have two potentially ambiguous effects: on the one hand, they might trigger a green transition toward less carbon-intensive production technologies, an intended "environmental steering effect." But on the other hand, through altering the relative prices between countries and sectors, carbon pricing in the form of allowances might impact relative competitiveness, resulting in a worse terms-of-trade vis-à-vis competitors (Dechezleprêtre & Sato (2017), Table 1, p. 186). One of the forms of the latter is often phrased as "carbon leakage", meaning the relocation of production to less strictly regulated jurisdictions abroad, and feared by EU producers, lobbies and policymakers (Lanzi et al. (2012), Cosbey et al. (2019), Simola (2021), Bellora & Fontagné (2022)). Nonetheless, the EU has been pushing forward environmental steering by tightening the ETS. This means that the ceiling of permitted CO2 equivalents is descending over time, thereby reducing free allowances, until they are projected to have been phased out entirely by 2030 (Dröge (2021), Bellora & Fontagné (2022), Overland & Sabyrbekov (2022)). A policy that reconciles the "Fit for 55" goal with competitiveness, the EU has created the CBAM as a tool to safeguard that the unilateral CO2 achievements by the EU are not counteracted by competitiveness losses accompanied by CO2 emission leakage elsewhere.

Indeed, the free-rider problem linked to emitting CO2 constitutes a fundamental challenge in global climate policy. Climate protection is considered a global public good and each country has a strong incentive to free-ride on the emissions abatement of other countries while contributing little itself (Böhringer et al. (2022)). The CBAM then can be seen as an answer to the negative externality resulting from a "tragedy of the commons" of unilateral climate policy efforts (Bellora & Fontagné (2022)). Advocated by Nordhaus (2015), Tagliapietra & Wolff (2021), Bierbrauer et al. (2021), the idea of a climate club is to gather like-minded countries as a club of co-operating parties who exempt each other from the application of a CO2 limit while sanctioning unwilling parties by means of CO2 border taxes or denied access to money and technology. As a club of EU countries jointly determined to tackle the global negative externality from CO2 emissions, the CBAM is intended to make the first move as a stepping stone towards larger climate clubs and, eventually, multilateral climate policy.

On the 16th of May 2023, the regulation of the Council of the European Union and European Parliament implementing the Carbon Border Adjustment Mechanism (CBAM) came into force (Li (2023)). The CBAM will impose the rules of the EU ETS to foreign importers, starting in the sectors of iron and steel, aluminium, fertilizers, electricity, and cement, from the 1st of October 2023 onwards. After a three-year phase-in period, the CBAM will become fully operational starting 2026. For each good whose tariff line pertains to the CBAM list, the exporting firm is to declare the total quantity and the total direct embedded CO2 emissions as well as the total number of CBAM certificates corresponding to the total embedded emissions.

A unilateral trade-distorting climate policy, WTO compatibility has always posed a challenge to the CBAM designers. The golden rule for EU policy makers is that imported products to the EU market face the same carbon price (Bergin et al. (2021)). In its CBAM proposal, the EU Commission chooses an ETS market with border compensation that addresses the competitiveness problems faced by the ETS sectors in the most WTO conform way (Bellora & Fontagné (2022)). Yet, the reference territory for the calculation of a product's CO2 emission intensity remains unclear. While importing firms or authorities might lack measures of CO2es, using EU CO2 data to determine direct emissions might not be fully WTO compatible (Hufbauer et al. (2022)).

But there are possible economic downsides to a WTO-conform CBAM. First, by establishing an equal carbon price between the EU and the world, a WTO conform CBAM safeguards a level playing field only on the EU market, while there is no guarantee for EU's firms' competitiveness on third markets (Cosbey et al. (2019), Ambec (2022)). To level the playing field also internationally, a CBAM would need to rebate the allowances paid by the exporters or provide refunds to exporters (i.e., by using CBAM revenues). The problem is that the WTO could consider them as subsidies.

Meanwhile, several extensions to the initial CBAM are discussed. The EU Parliament proposes to expand CBAM to include organic chemicals, hydrogen, and polymers. Concerning the CO2 emission scope, further CBAM policies include also indirect emissions deriving from electricity and other energy-intensive inputs used in the production of CBAM-covered goods (Hufbauer et al. (2022)). Finally, due to a high export coverage ratio of some least developed countries (LDCs), a potential exclusion to those is debated (Bellora & Fontagné (2022)).

2.3.2 The Political Economy of the CBAM in India

A similar mechanism as the EU CBAM has not been introduced before (Bergin et al. (2021)). For several years, policymakers have been worrying about the implications of using carbon tariffs because of ongoing international climate policy negotiations (Houser et al. (2008))) or trade relations: Böhringer et al. (2022) perceive the risk of trade conflicts as one explanation of the reluctance to implement border carbon adjustments to date. Bellora & Fontagné (2022) describe the CBAM as a target conflict between ambitious commitments to reduce global GHG emissions and the maintenance of the open multilateral trading system. The latter could be endangered as trading partners might impose protectionist countermeasures to carbon border taxes (Höslinger et al. (2022)). Hence, the reactions of the EU trading partners' reactions to the CBAM are critical for its success. Reactions to CBAM by the EU's trading partners range from being supportive to skeptical to opposed. In line with the climate club proposal, Canada, the United Kingdom, and the United States are considering own CO2 border adjustments, while Japan and South Korea are interested in working with the EU on the CBAM. China has meanwhile started its own emission trading system and might try to credit its own efforts when calculating CO2 emissions in exports. Russia's largest aluminum producer Rusal is planning reshuffling: only low-carbon aluminum from green hydro-powered facilities would be shipped to the EU. The large emerging countries, notably the BASIC group comprising Brazil, China and India are calling on the EU to dispense with the instrument entirely (Dröge (2021)). India prefers the idea of a climate club-like consensus-based solution in line with the principle of common but differentiated responsibilities (Payosova et al. (2022)).

To date, few studies examine the political economy of the CBAM in India. In 2020 and 2021, Bergin et al. (2021) conducted expert interviews with respondents from academia, firms, the government, and non-governmental organisations, asking them about India's average level of knowledge of the CBAM, India's perceptions and reactions to the mechanism, anticipated effects on India and how the EU should approach the CBAM. Although a tiny share of Indian population knows about the CBAM, those who have heard of it consider it a protectionist trade barrier. Experts foresee that if Indian products are not considered to have undergone carbon pricing equivalent to the EU ETS, increased costs of exporting goods to Europe could make India less competitive and thereby hurt the Indian export market (Bergin et al. (2021)). Such competitiveness-related view is also voiced in Payosova et al. (2022). Having scrutinized the literature and press statements, they argue that if the EU imposed punitive default CO2 emission benchmarks, India's exports could turn uncompetitive, with Indian exporters even struggling to regain the EU customer-base lost due to the CBAM. To a large share, these issues might affect India's steel industry, of which a large percentage of output is exported to the EU. While there are some large corporations that produce steel with techniques potentially less carbon-intensive than EU counterparts, many and smaller less technologically advanced enterprises could suffer from the CBAM. Indian policymakers wish for a "grand bargain" for climate goals, like trade deals, in which both sides make concessions. Having collected responses from further developing countries, Bergin et al. (2021)} conclude that all the WTO conform options proposed by the EU warrant a renegotiation of tariff arrangements in existing bilateral trade agreements. Payosova et al. (2022) suggest that India should take the ongoing EU-India FTA negotiations as an opportunity to discuss CBAM issues.

2.3.3 Ex-Ante Trade, CO2 Emissions and Welfare Effects of the CBAM on India

To uncover potential changes in trade flows and real output due to the CBAM, Bellora & Fontagné (2022) employ an ex-ante dynamic general equilibrium model of the world economy. They model the gradual phase-out of free allowances in parallel to the introduction of the CBAM by discounting the bilateral carbon price differentials with the share of free allowances and compare two different CBAM policy scenarios. The first two models reflect a CBAM in compliance with WTO rules. Differentiating between carbon intensities measured by the EU and the importer, the scholars compare results for first, the EU's CO2 emission intensity benchmarks, and second, the partner countries' own CO2 emission data. For Scenario 1 (EU sectoral emission intensity) Bellora & Fontagné (2022) find that both India's final and intermediate goods exports to the EU would decrease by 2%, in 2040. The effects of switching from CO2 emissions accounting from the EU to Indian sources (Scenario 2 vs. Scenario 1) on Indian exports are substantial: while final goods imports decrease by 17% w.r.t. Scenario 1, intermediate goods imports decrease by 26% w.r.t. Scenario 1, see Bellora & Fontagné (2022), Figure D2. It is important to note that Bellora & Fontagné (2022) model a CBAM which applies to all products under the EU ETS.

Using the multi-region, multi-sector structural gravity model of Larch & Wanner (2017), Korpar et al. (2023) estimate the effects of a CBAM on exports, real GDP, welfare, and emissions, for 43 countries and 14 sectors. They assume prevailing CO2 prices in each country, sector-specific average emission intensities of partner countries and by and large, the five sectors as in the EU Commission's CBAM proposal. The CBAM is modeled using by backing out the bilateral carbon price differential from the price of a ton of CO2 emissions in each country, while considering the gradual phase-out of free allowances granted within the EU ETS. At a 0.2% decrease of CO2 emissions, Indian exports, GDP, and welfare decrease of 0.3%, 0.03%, and 0.02%, respectively. While exports of the EU decrease by 0.04%, real GDP and welfare increase by 0.02% each, accompanied by a shift towards more emission intensive industries, which is reflected in a 0.3% increase of CO2 emissions relative to the baseline equilibrium.

Tracing the carbon content of final output through world supply chains, Ward et al. (2019) estimate how prices of the final output in each of 41 countries and 35 sectors (WIOD 2009) would react to the introduction of a global carbon price of 50 USD per ton of CO2. A short-term impact on industrial competitiveness is determined by the price increase and the associated demand-side reaction within each sector. For India, such carbon price would entail one of the highest cost increases. India's GDP would decline by 3%, possibly affecting 3% of medium-skilled and more than 3% of low-skilled workers. As the competitiveness of specific industries would impair economic activity. Finding a strong link between value added and price increase for the Indian metals sector, the authors hypothesize that this sector might be affected above average.

Zhong & Pei (2022) quantify changes in India's exports to the EU upon CBAM implementation. Using WIOD data for 43 countries and 23 aggregated sectors, CO2 emissions intensities for each country-sector pair and 2012 as the base year, they find that the EU CBAM would entail a redistribution of competitiveness among countries, with China, Russia and India losing the most sectoral output. India is projected to lose output of 647 mn. EUR in the basic metals sector. It is important to note that their CBAM covers Scope 1 and 2 emissions and all nine emissions-intensive and trade-exposed (EITE) industries, in line with the EU ETS.

Indian CBAM exports to the EU make up 1% of all Indian exports to all countries. Per year, the CBAM would cost India 220 mn. EUR, representing 9% of the total value of EU CBAM imports from India, and 0.6% of total EU imports from India. These costs are distributed over 192 mn. EUR in steel, 23 mn. EUR in aluminium, and 1 mio. EUR in fertilizers and cement, respectively (Simola (2021)). Estimating the CBAM costs to India at 190 mn. EUR, or 8% of the CBAM import value from India, Cosbey et al. (2021) provide a similar ex-ante estimate for India. Simola (2021) further relates the annual CBAM-costs of India to average product tariff coverage ratios. For aluminium, the CBAM costs comport with current baseline import tariffs for aluminium imports from non-EU countries of 5 to 8%. To compare, most steel products are not subject to baseline tariffs, but for certain individual products tariffs of 2 to 4% apply. For EU cement imports from extra-EU countries, the baseline tariff is 2% and 5.5 to 6.5% for fertilizers.

3 Descriptive Data Analysis

3.1 Data Sources

Trade data for 2014 stem from the OECD's inter-country input-output (ICIO) tables (OECD (2022a)), which cover domestic and foreign input-output linkages in 45 sectors of 67 countries plus the rest of world (ROW) in current prices in USD. Both for the sake of abstraction gain and due to computation issues, the rich country and sector depth of the original OECD ICIO table is broken down to 43 countries (+ROW) and 22 sectors, of which 21 are goods sector aggregates and one is a service sector aggregate including electricity. The CO2 emission intensity of each country-sector pair in million tons of CO2 per USD of gross output is obtained by dividing the CO2 emissions in million tonnes of CO2 by gross output at basic prices. Moreover, estimates for CO2 emissions embodied per unit traded from OECD (2022b) are used. OECD (2022b) is obtained by combining the OECD ICIO tables (OECD (2022a)) with estimations on sectoral CO2 emissions from the IEA CO2 emissions from fuel combustion database (Yamano & Guilhoto (2020)).

3.2 EU-India Trade and CO2 Emissions

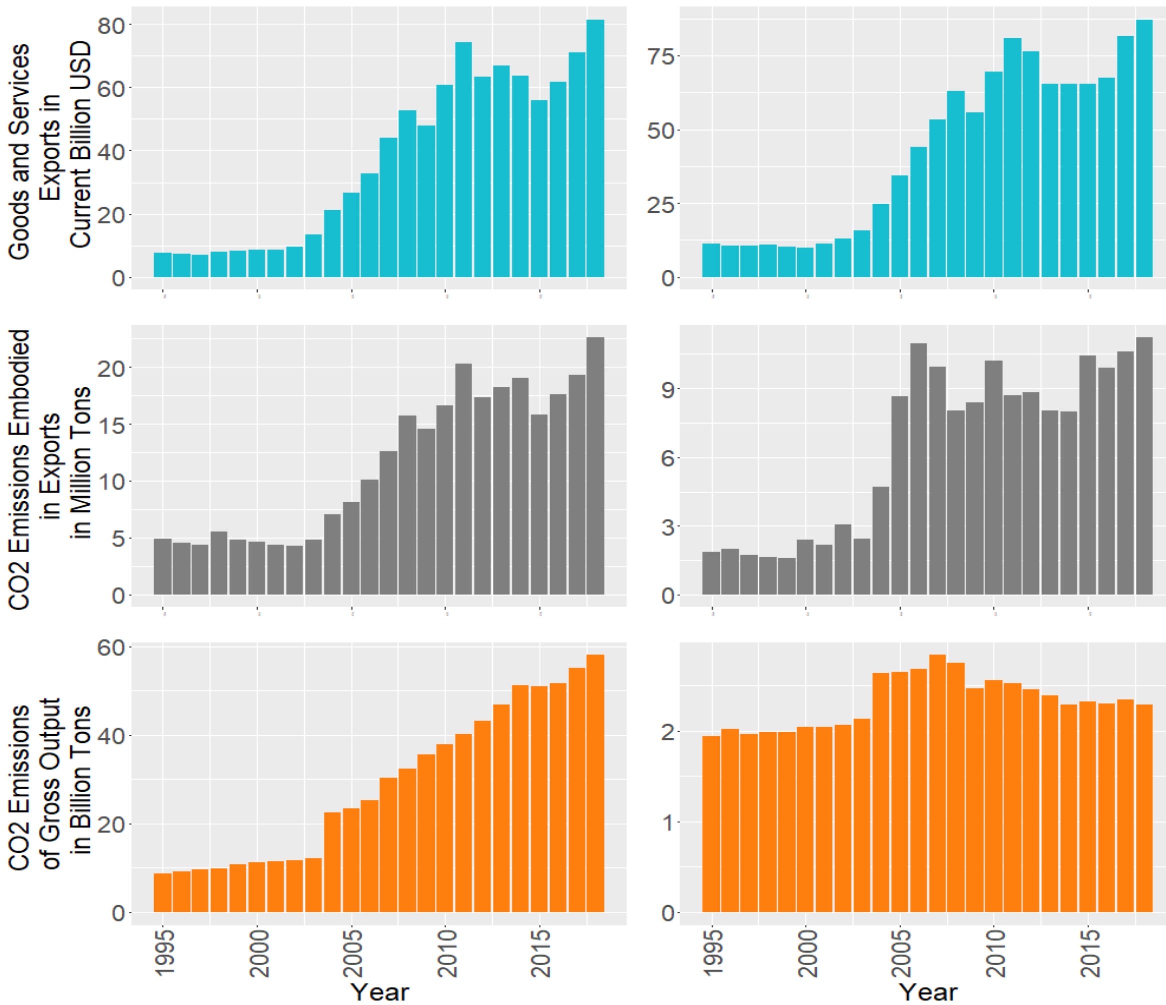

Figure 3.1. *Upper Panel: Goods and Services Exports from India to the EU (left) and from the EU to India (right). Middle Panel: CO2 Emissions Embodied in Goods and Services Exports from India to the EU (left) and from the EU to India (right). Lower Panel: CO2 Emissions of Production in India (left) and the EU (right). All 1995-2018. Sources: OECD (2022a) for Goods and Services Exports and OECD (2022b) for CO2 Emissions.*

The OECD (2022a) data plotted in the upper panel of Figure 3.1 confirm the sustained increase in goods and services trade between the EU and India from 1995 until 2018, with a plateau phase starting about 2011, documented and discussed in the literature (see Gallina et al. (2020), Felbermayr et al. (2017) and section 2.1.1). As a novel CO2 emissions mirror image to trade flows, the middle panel of Figure 3.1 depicts the evolution of CO2 emissions embodied in goods and services exports from India (the EU) to the EU (India). The increase in trade volume is accompanied by an escalation in CO2 emissions embodied in trade, almost similar in magnitude. The level of CO2 emissions embodied in exports from India to the EU being about three times as large as vice-versa, the EU is a net importer of carbon emissions from India. Interesting in this context is to note the overall CO2 emissions of India's production in country-sector pairs with positive EU-India trade in the lower panel of Figure 3.1. While production in India sees a sustained increase of production-based carbon emissions, reaching levels of up to 60 billion tons by 2018, CO2 emissions in EU country-sectors with exports to India are steadier at a rate of around 2 billion tons, on an annual basis.

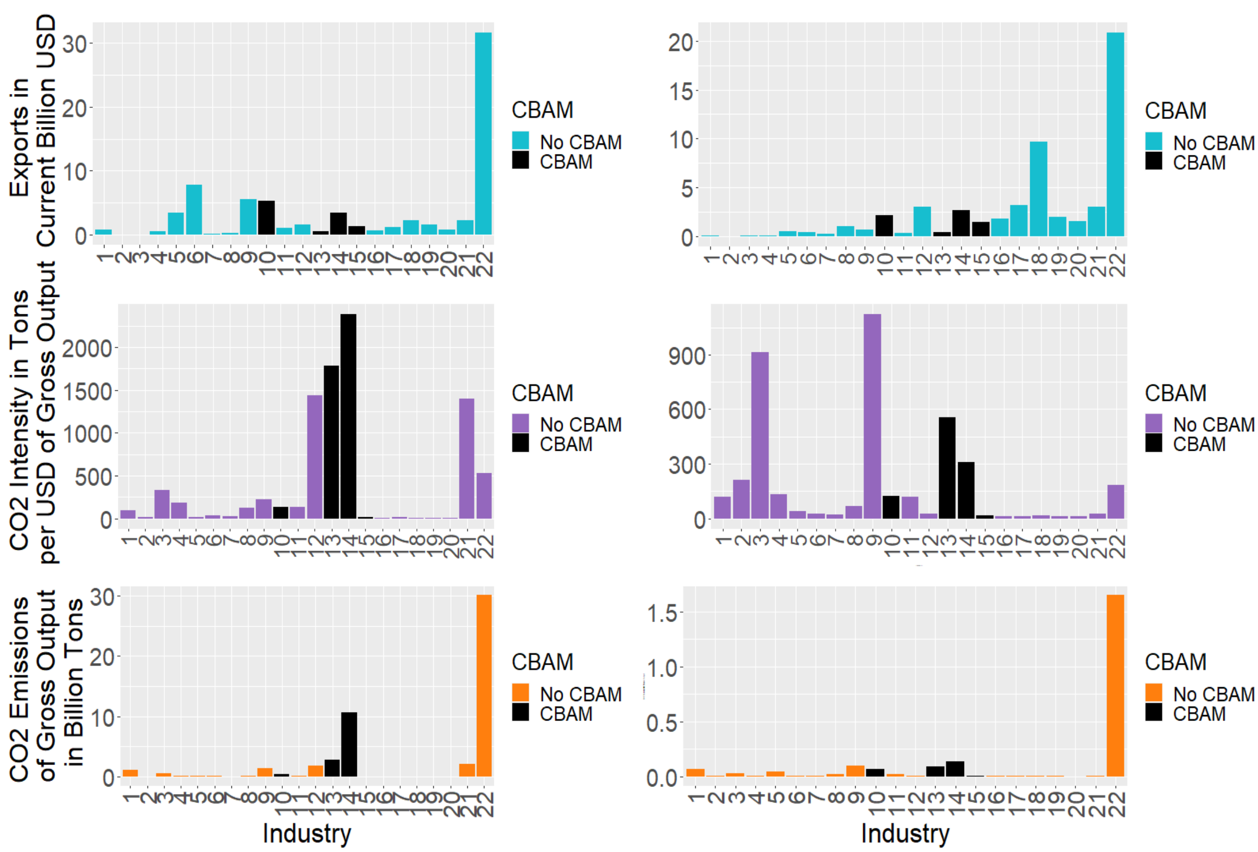

Figure 3.2. *Upper panel: Goods and Services Exports from India to the EU (left) and from the EU to India (right). Middle panel: CO2 Intensity per Current USD of Gross Output in India (left) and the EU (right). Lower panel: CO2 Emissions of Production in India (left) and the EU (right). At the Industry Aggregate Level, in 2014. Sources: OECD (2022a) for Goods and Services Exports and OECD (2022b) for CO2 Emissions.*

Figure 3.2 presents bilateral exports, CO2 intensities, and production-based CO2 emissions for each industry in India (left) and the EU (right), in 2014. A black bar indicates that an industry aggregate contains tariff lines (HS6 6-digits) which are included in the EU Commission's CBAM proposal. Although India's exports to the EU in basic metals (14) rank fourth in terms of goods export volume, the sector has the highest CO2 intensity and overall CO2 emissions compared to all other industries in India.

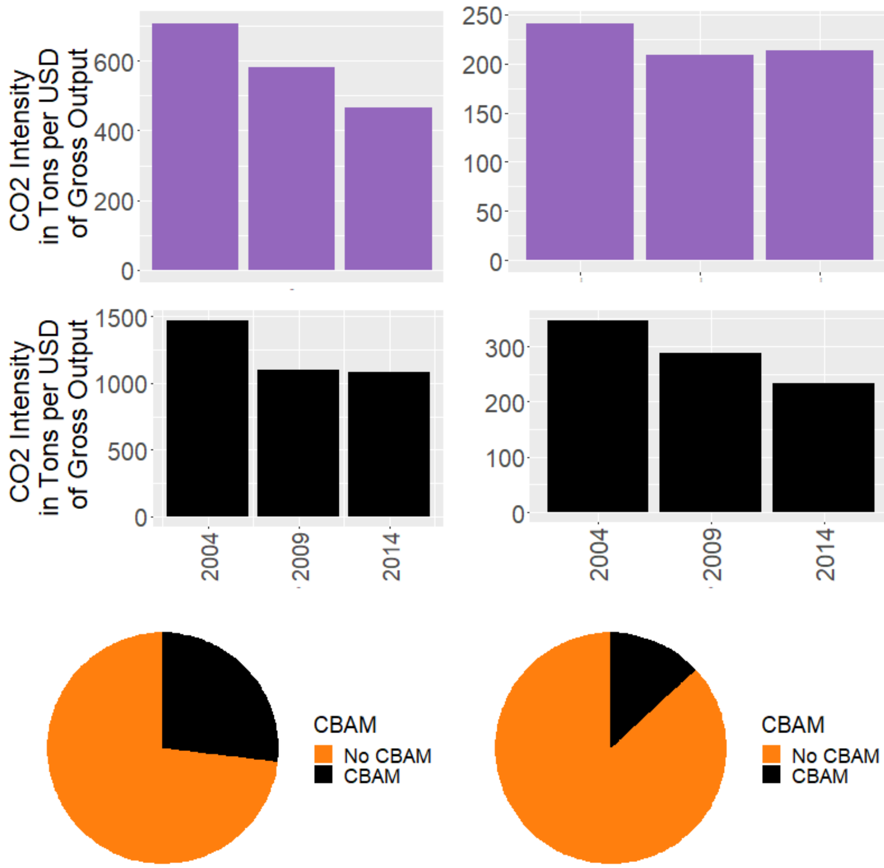

Figure 3.3. *Upper panel: Average Evolution of CO2 Emission Intensity in India (left) and the EU (right). Middle panel: Average Evolution of CO2 Emission Intensity in India (left) and the EU (right) in CBAM Industry Aggregates. Year-on-Year Comparison between 2004, 2009 and 2014. Lower panel: Share of CBAM Industry Aggregates in Total CO2 Emissions of Production in India (left) and the EU (right), in 2014. Source: OECD (2022b).*

While the scale of production-based CO2 emissions in India has been rising since 1995, the CO2 intensity in production, measured in current prices, has declined. The upper panel of Figure 3.3 documents a step-wise average decrease of CO2 emission intensity of each Indian (EU) industry per USD of gross output, measured in current prices, over a ten-year horizon. The absolute decline is higher in CBAM sectors (see Figure 3.3, middle). When comparing India's CO2 emission intensity of 2004 to 2014, it appears that India's production is up to 50% cleaner, on average, for both all goods and CBAM goods.[1] Across all goods industries, India's CO_2 emission input coefficient has decreased more than the EU's.

4. Policy Scenarios, Research Questions and Hypotheses

4.1 Policy Scenarios

The EU-India FTA and the EU CBAM as the two broad policies of current interest are modeled with three different bilateral tariff change scenarios between the EU and India to various sectors of the economy. The construction of the bilateral tariffs at the country-sector level is described in Appendix B.1. Exemplary for exports of basic metals (14) from India to the EU, Table B.1 shows the bilateral tariff structure assumed for BAU and all three policy scenarios.

Inspired by Gallina et al. (2020), Scenario 1c, this study assumes asymmetric tariff reductions across the EU's and India's sectors to infer static equilibrium changes in trade flows, CO_2 emissions, and welfare. Originating from a "business-as-usual" (BAU) baseline equilibrium, the following three different policy scenarios for changes in bilateral tariffs are fed into the model:

1. from BAU to the CBAM (BAU-CBAM)
2. from BAU to the EU-India FTA (BAU-FTA)
3. from CBAM to the EU-India FTA (CBAM-FTA)

Policy scenario 1, BAU-CBAM, models the phase-in of an EU CBAM, as currently implemented. The second scenario, BAU-FTA, models an EU-India FTA as a standalone policy, regardless of the CBAM. The BAU-FTA scenario can then be compared to scenario 3, CBAM-FTA, which models the trade, CO_2 emission and welfare effects of a hypothetical EU-India FTA if CBAM tariffs of the EU to its non-EU trading partners are already in place. Since the CBAM has been launched in October 2023 and the EU-India FTA negotiations are still ongoing, this latter scenario is the most likely one.

4.2 Research Questions

The research questions rest on the following thought experiment: how would trade, CO_2 emissions and real income look like in 2024, if the EU and India moved from the current observed equilibrium

[1] Again, output is measured in current prices.

(2014) to a hypothetical equilibrium with changes in trade costs? In concrete, the research questions concern the effects of changes in bilateral import tariff rates between the EU and India on

1. trade flows in current FOB USD
2. CO_2 emissions in million tons, and
3. welfare as a percentage change of real income

either in goods tackled by the CBAM and goods not tackled by the CBAM.

4.3 Hypotheses

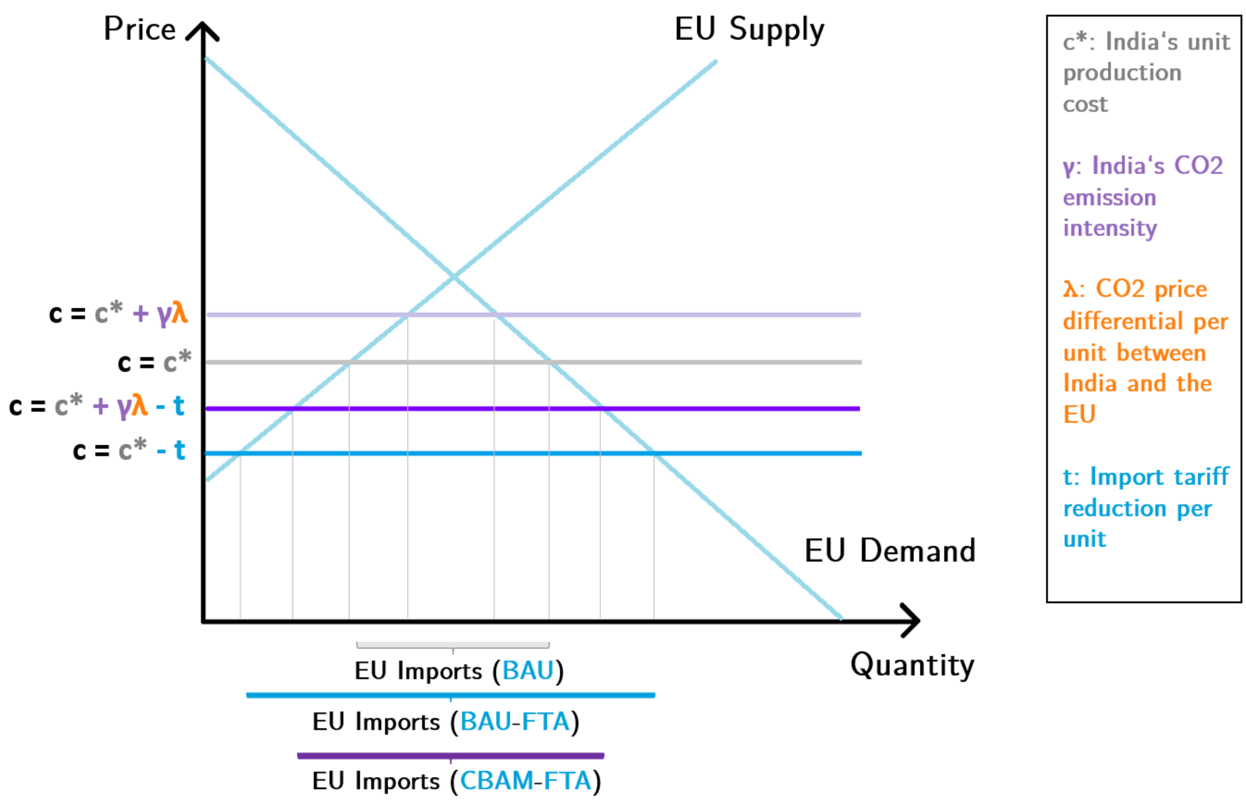

Figure 4. *EU-India FTA and CBAM: Stylized Potential Changes of Trade Flows Between the Business-as-Usual (BAU) Equilibrium and Two Counterfactual Equilibria (BAU-FTA and CBAM-FTA).*

By plotting supply and demand of a CBAM industry good in an EU country, Figure 4.1 intends to illustrate the comparative statics of potential trade effects linked to the policy scenarios. The import value in the BAU equilibrium hinges upon the relative production costs c/c^* of the EU and India, marked by an asterisk. While a reduction of the EU's import tariff by $-t$ might have a positive influence on exports from India, a CBAM tariff, modeled as the product of India's emission intensity γ and the carbon price differential between India and the EU λ, might lead to a contraction in exports vis-à-vis the baseline equilibrium or offset the gains from an FTA, to some extent.

4.3.1 Trade

The hypotheses regarding changes in trade flows and CO2 emissions adopted in this study are the following. Due to higher import tariffs to several CBAM goods industries, in the first CBAM standalone scenario, exports from India to the EU are expected to fall with respect to the business-as-usual (BAU) case. This would be in line with ex-ante evidence from Bellora & Fontagné (2022). Under a hypothetical EU-India FTA, exports from India to the EU are expected to rise above BAU-level exports, due to lower import tariffs. The trade effects of an EU-India FTA are expected to be in line with Felbermayr et al. (2017) and Gallina et al. (2020). Third, as to the interplay of the CBAM and the FTA, it is assumed that while the FTA might boost India's exports to the EU, the CBAM could have a dampening effect. The crucial question of interest is whether the CBAM's effect will be strong enough to reverse a potential positive change in trade flows.

4.3.2 CO2 Emissions

CO2 emissions are assumed to change in proportion with trade effects, just with the opposite sign. Like ex-ante evidence by Korpar et al. (2023), CO2 emissions are expected to decrease, in the CBAM standalone scenario. While a CBAM is expected to induce lower CO2 emissions in India, an FTA between the EU and India is expected to lead to higher CO2 emissions. Similarly to trade flows, the combination of a CBAM and the EU-India FTA might cause a level of CO2 emissions higher than under a standalone CBAM, but potentially lower than under a pure FTA.

4.3.3 Welfare

When two regions reduce trade barriers in a multilateral world, the overall impact on aggregate welfare is uncertain beforehand. A first reason for this uncertainty lies in the ambiguous interplay between the shift of trade towards the cheapest suppliers and the linked changes in tariff revenues. In their model with intermediate input-output linkages, Gallina et al. (2020) find an absolute decrease in India's tariff revenue. Under the tariff elimination scenario, Felbermayr et al. (2017) find Indian tariff revenue to decrease by 0.36 pp. Second, there is the possibility that lower tariffs encourage a country to redirect imports away from a more efficient trading partner to a less efficient one. This redirection occurs because the less efficient partner's disadvantage is offset by the preferential elimination of the tariff (trade diversion). Furthermore, welfare effects might hinge on the model structure. A difference to the framework applied here and the model used in Gallina et al. (2020) is the lack of accounting for intermediates. Costinot & Rodríguez-Clare (2014) find increasing welfare gains when using more complex models that include intermediate input structures. The reason is that models with intermediate input patterns produce more realistic results since the change in prices is magnified through tradable intermediates used in production, which increase welfare via a rise in expenditure. A fourth driver of welfare effects is related to the idea of positive optimal tariff levels (Gros (1987), Helpman & Krugman (1989)). Using a fictitious example of an import tariff for a group of countries, Costinot & Rodríguez-Clare (2014) demonstrates that welfare is highest when maintaining a tariff level of around 20% (see Costinot & Rodríguez-Clare (2014), Figure 4.1, p. 228). Moreover, the optimal tariff size is found to differ depending on the model structure. In the BCA scenario of Balistreri & Rutherford (2012), the Armington structure indicates small coalition gains and large non-coalition losses compared to a Melitz (2003) -type monopolistic competition framework. Given the difficulties, this paper argues for negative welfare effects linked to an EU-India FTA, on average. CBAM is not assumed to influence welfare, neither for the EU, nor for India.

5 Methodology

To analyze the research questions, the empirical analysis employs a counterfactual general equilibrium new quantitative trade model (NQTM). The model quantifies the ex-ante effects of both the CBAM and the EU-India FTA on trade, CO2 emissions and welfare. In the following, the most important concepts behind the model are presented.

The Counterfactual General Equilibrium Trade Model

Based upon the class of counterfactual general equilibrium trade models presented in Costinot & Rodríguez-Clare (2014), NQTMs feature sectors of the economy which are connected nationally and internationally through input-output linkages. The model's micro-theoretical foundation for trade is the assumption that each country produces a different good and consumers would like to consume at least some of each country's goods (Armington (1969)).

The model is characterized by the following assumptions. First, demand of each country-sector is generated by a representative agent who maximises utility in a constant elasticity of substitution (CES) utility function. The elasticity of substitution indicates the agent's propensity to exchange a good from one country to a good from another country. CES means that the agent's preferences are constant over all levels of quantity. Because the model rests on the assumptions of perfect competition and no increasing returns to scale, supply in the model equals demand. Since the representative industry takes prices as given (no market power), makes zero profits and does not engage in large scale production, supply is driven by the representative agent's demand.

Crucial to the origin country-sector of the agent's ultimate consumption bundle is the price index. The price index increases with "iceberg" trade costs, which represent transport costs or tariff barriers. The idea behind these iceberg trade costs is that for one unit of a good to arrive in another country, the exporting country must ship the unit plus the proportion of the figurative iceberg which melts entirely during shipment. Moreover, trade flows are governed by trade elasticities which, similar to the elasticity of substitution, determine whether domestic and foreign good varieties are perceived as differentiated or close substitutes: the more the domestic and foreign varieties of the goods differ, the more substantial is the impact of the trade elasticity on trade flows and welfare.[2] Equilibrium trade changes down to the country-sector level are captured by the so-called gravity equation which expresses bilateral trade flows in equilibrium as the outcome of the two countries' gross output, bilateral trade costs and the trade elasticity.

Market clearing under perfect competition implies that in equilibrium, every representative agent receives her utility-maximising consumption basket at the lowest possible price. In the counterfactual model equilibrium, welfare changes as the "gains from trade" are made up by two counter-directional forces. On the one hand, a positive effect of real income on expenditures is assumed to materialize through the removal of frictional tariff barriers, lower prices and thus higher real income translating into an expenditure increase. On the other hand, the positive effect of real income can be dampened by a reduction in tariff revenues as foregone rent-creation.

Three important model features are further highlighted. First, by adjusting bilateral equilibrium trade flows, the model imposes the state of balanced trade. In most cases, a country's bilateral exports outweigh its imports or vice-versa. However, for the sake of comparability of trade, CO2 emission and welfare effects over bilateral country-sector pairs, the model equals out trade imbalances at the country-industry level. Second, the implications of the model being a general equilibrium model, as opposed to a partial equilibrium model are important to point out. The general equilibrium model implements a complete system of demand and supply equations, derived from the representative agent's utility function. Spillover effects across countries and sectors imply that if one industry

[2] In the model, sector-level bilateral trade elasticities are taken from Caliendo & Parro (2015) and are in line with Gallina et al. (2020), Table 24, p. 93.

expands, others must contract (resource constraint). Any price change in the general equilibrium model is assumed to affect demand for all industries' goods (cross-commodity effects), and income effects in consumption, as changes in the price of a good imply changes in consumers' real income. Third, although the global trade pattern includes intermediate goods trade relationships along the value chain, this model simplifies the analysis. As intermediate good linkages are overlooked in the modeling, trade, CO2 emissions, and welfare effects are obtained for country-sector pairs, only.

The modeling procedure is as follows: first, in a calibration step, numerical values are attached to bilateral trade flows and trade elasticities, such that the models can replicate the initial equilibrium. Then, the counterfactual equilibrium is simulated for all quantities and prices of goods and factors for lower tariffs. Finally, trade, CO2 emissions and welfare effects are calculated.

6 Results and Discussion

In the following, first the findings on the interplay of counterfactual general equilibrium changes of trade and CO2 emissions are presented. Static welfare changes follow. Lastly, trade and CO2 emissions, and welfare effects are discussed.

6.1 Results

6.1.1 Trade and CO2 Emissions

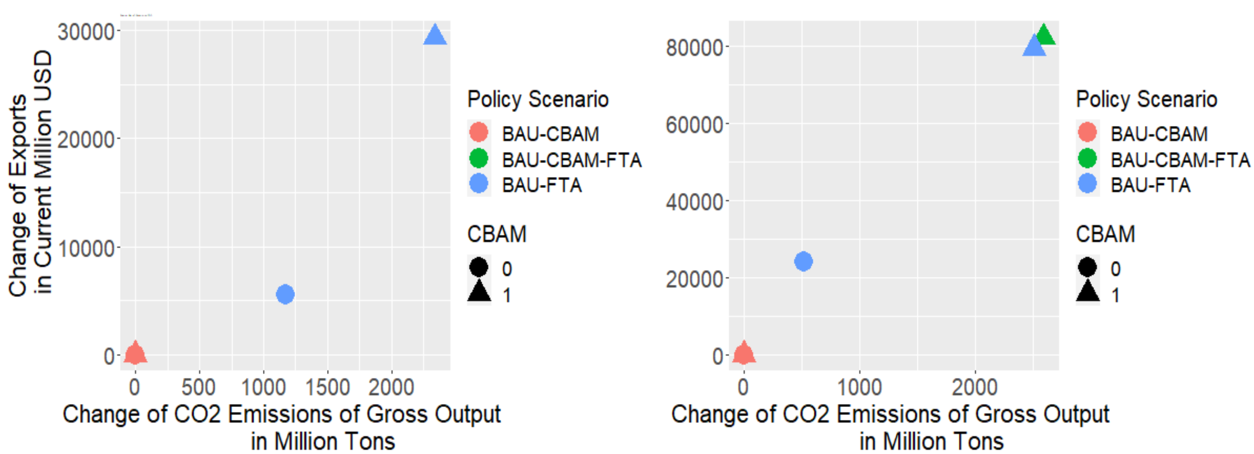

Figure 6.1. *Left panel: Ex-Ante Changes of Exports and India's Production-Based CO2 Emissions to the EU under Three Policy Scenarios. Right panel: Ex-Ante Changes of Exports and India's Production-Based CO2 Emissions in the EU's Exports to India under Three Policy Scenarios. Industry Aggregates Grouped into CBAM- and Non-CBAM Sectors, Base Year 2014. Sources: OECD (2022b) for Exports Data and OECD (2022b) for CO2 Emission Data.*

Figure 6.1 shows the effects of three different policy scenarios on bilateral exports and production-based CO2 emissions, as retrieved in the counterfactual general equilibrium trade model presented in section 5.1. Under a Carbon Border Adjustment Mechanism (CBAM) extending to all product lines within an industry aggregate, exports from India to the EU and CO2 emissions would decrease (see Figure 6.1, left).

This effect would be disproportionately reversed by a hypothetical EU-India Free Trade Agreement (FTA) with a tariff reduction scheme as in Gallina et al. (2020) Scenario 1c. The decrease in CO2 emissions linked to the slight decline in exports from India to the EU would be more than offset by an EU-India FTA. Especially CBAM industries would be affected, with a projected increase in bilateral exports of up to 30 bn. USD (see Figure 6.1, left). Likewise, the EU-India FTA would increase exports from the EU to India by up to 80 bn. USD (see Figure 6.1, right). Comparing the effects of the EU-India FTA to the effects of the CBAM alone reveals that an FTA on top of a CBAM would further increase EU exports to India, in emission-intensive sectors (see Figure 6.1, right).

Compared to the baseline equilibrium, the current CBAM design (BAU-CBAM) would reduce India's overall exports in the new equilibrium by 9 mn. USD, which makes up a meager share of India's overall exports (0.02%). The economies most affected by the modeled CBAM (one which does not include electricity) are Russia, the USA, and China, with a decrease in overall exports of 103, 84 and 39 mn. USD, respectively. Russia would be particularly hurt, with overall exports outside the country decreasing by -0.2% relative to the 2014 value. The loss of exports of non-aligned countries is compensated by an increase of exports of countries implementing the CBAM. Most notably, these are Germany, France, and Italy, with a combined increase in 61 mn. USD of outward trade. In the following, the most important numerical details behind the data points shown in Figure 6.1 are presented.[3]

Overall, the modelled EU-India FTA would decrease India's overall trade flows, by 50 bn. USD, representing an absolute decrease of 1%. This decrease is driven by a reduction of domestic trade within India. When considering within-country trade flows, the absolute and relative decrease of exports from India is the most pronounced among all countries, indicating significant trade diversion from the Indian home market due to the EU-India FTA.[4] Also non-EU countries would face reductions

[3] For more detailed numerical results on trade and CO2 emission changes, see Table C.1 and Table C.2 in Appendix C, respectively.

[4] However, when considering exports out of India alone, as shown in Figure 6.1, the FTA would increase Indian outward exports by 36 bn. USD, resulting in a substantial increase of 7% (refer to

in their cross-border export flows, notably China (-7 bn. USD, -0.02%) and the USA (-6 bn. USD, -0.02%). The EU's exports would be positively affected by the EU-India FTA, with almost all EU countries experiencing a rise in their absolute exports, slight losses due to a decline in home market trade included. The EU's exports to India alone would increase by 103 bn. USD.

In the case of an EU-India FTA under a CBAM, India's exports to the EU would increase by 35 bn. USD, slightly more than under a pure EU-India FTA. Although there is no change in exports from the EU to India under the BAU-CBAM scenario, EU-India exports under the CBAM-FTA scenario increase by 106 bn. USD relative to the CBAM equilibrium, exceeding the BAU-FTA rise in exports by 3 bn. USD. This result is particularly remarkable, as it indicates that an EU-India FTA might have different dynamics on EU-India trade under CBAM tariffs, compared to a standalone CBAM scenario.

As shown in Figure 6.1, CO2 emissions increase in a similar direction to trade flows across all policy scenarios. Therefore, the winners and losers in trade also resemble the winners and losers in CO2 emissions, in the aggregate picture. The CBAM causes a decrease of 5 mn. tons of CO2 emissions in India. CO2 emissions in the EU increase marginally, with Germany showing the highest increase of 0.5 mn. tons. Japan and the USA see increases in CO2 emissions of 3 mn. tons and 5 mn. tons, respectively. Moving from the baseline equilibrium to the hypothetical situation of an EU-India FTA would lead to an increase of India's CO2 emissions by 4 bn. tons (3%), only slightly less than the average increase if only India's cross-border exports were considered (refer to Table C.2). While Russia would experience a slightly higher decrease in CO2 compared to the CBAM (-30 mn. tons under BAU-CBAM vs. -152 mn. tons under BAU-FTA), in the case of an EU-India FTA, China's decrease of exports would be linked to a decline of CO2 emissions by 1 bn. tons (compare BAU-CBAM: -43 mn. tons). This shows that the EU-India FTA is much more powerful in increasing or curbing CO2 emissions than the CBAM can achieve to increase or curb them. Under an EU-India FTA, Germany (+688 mn. tons, +2%) and France (+385 mn. tons, +3%) might see significant relative changes compared to their previous CO2 emission levels. Hence, under an EU-India FTA, while trade diversion would go together with decreases in CO2 emissions, trade creation would also increase CO2 emissions linked to production.

Further analyzed at a more disaggregated country-sector level, several features stand out. First off, for the EU-India case, the changes in trade and CO2 emissions are most pronounced for the chemicals sector (10). For example, India's loss of 8 mn. USD of exports to the EU stems from chemicals, while

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Table C.1, Absolute and Percentage Changes, EU-FTA, All and Only Inter). Out of these Indian exports, 35 bn. USD are destined for the EU market.

only 1 mn. USD is made up of basic metals (14). However, the chemical products contain somewhat less of CO2 than basic metals, with 0.5 mn. tons of CO2 compared to 3 mn. tons. Under an EU-India FTA, India would export 29 bn. USD more of chemical products (linked to 2082 mn. additional tons of CO2) to the EU than in the BAU case, which marks by far the highest increase across all industries. An increase of basic metals (14) exports by 59 mn. USD would be associated with 195 additional mn. tons of CO2.

Exporter	Absolute Changes					
	Trade			CO2 Emissions		
	BAU-CBAM	BAU-FTA	CBAM-FTA	BAU-CBAM	BAU-FTA	CBAM-FTA
AUS	−0.5	−11	−11	−0.2	−6	−6
BRA	−2.4	−113	−116	−0.3	−23	−23
CAN	0.9	−72	−71	0.2	−17	−17
CHE	2.3	−202	−200	0.0	−1	−1
CHN	−32.8	−666	−697	−26.4	−676	−701
GBR	11.2	−942	−932	0.1	−6	−6
IDN	−4.2	−76	−80	−0.7	−17	−18
IND	−7.6	29 165	29 177	−0.5	2082	2083
JPN	−24.6	−580	−604	−2.8	−89	−92
KOR	1.9	−175	−173	0.3	−23	−23
MEX	0.3	−91	−91	0.1	−16	−16
NOR	0.8	−47	−47	0.0	−4	−4
ROW	−27.5	−1268	−1296	−2.4	−155	−157
RUS	−93.9	−271	−360	−25.3	−98	−122
TUR	0.3	−205	−205	0.0	−8	−8
TWN	−3.0	−80	−83	−0.8	−29	−30
USA	−75.5	−2146	−2219	−4.0	−164	−168

Table 6.1. *Counterfactual Changes in Exports and Production-Based CO2 Emissions of India's Export Competitors to the EU under an EU CBAM (BAU-CBAM), an EU-India FTA (BAU-FTA), and an EU-India FTA under CBAM (CBAM-FTA) in the Chemical (10) Industry Aggregate, in Current Million USD for Exports and Million Tons for CO2 Emissions.*

Table 6.1 sheds light on the role of the chemicals (10) industry, which sees the highest increase among all sectors under the EU-India FTA. However, merely 0.01% of all exports in this industry aggregate was under current CBAM legislation, in 2014. Under the CBAM modelled, which covers all product lines, India would lose 8 mn. USD of export volume to the EU. Other non-aligned economies would lose even more, notably Russia (94 mn. USD) and the USA (76 mn. USD). Compared to the effects of the CBAM, the FTA would increase chemical exports from India by 29 bn. USD. This is in stark contrast to the reductions in export volume from all other nations. These reductions are much higher than the export reductions incurred under the CBAM. For example, the USA would lose 2 bn. USD in chemicals exports to the EU, which is 28 times the losses incurred under the CBAM. China would incur losses 20 times as high as the losses under CBAM, in case of an EU-India FTA. When modelling the CBAM tariffs as the baseline equilibrium tariffs, India would even gain more from an EU-India FTA than if there was no CBAM in place. By and large, other competing nations would lose more.

Exporter	Absolute Changes					
	Trade			CO2 Emissions		
	BAU-CBAM	BAU-FTA	CBAM-FTA	BAU-CBAM	BAU-FTA	CBAM-FTA
AUS	0.0	−0.1	−0.1	−0.1	−0.1	−0.2
BRA	−0.4	−0.3	−0.7	−0.3	−0.3	−0.6
CAN	0.1	−0.3	−0.2	0.0	−0.1	−0.1
CHE	0.0	−0.2	−0.1	0.0	0.0	0.0
CHN	−1.3	−0.9	−2.3	−9.9	−9.8	−19.5
GBR	0.1	−0.4	−0.3	0.0	−0.1	−0.1
IDN	0.0	−0.1	−0.1	0.0	−0.1	−0.1
IND	−1.0	59.4	59.3	−3.2	195.2	195.2
JPN	−0.1	−0.2	−0.2	−0.2	−1.0	−1.2
KOR	0.1	−0.4	−0.3	0.1	−0.4	−0.4
MEX	0.0	−0.1	−0.1	0.0	−0.1	−0.1
NOR	0.1	−0.5	−0.4	0.0	0.0	0.0
ROW	−1.8	−2.7	−4.5	−0.6	−1.3	−1.8
RUS	−6.0	−2.0	−7.9	−2.3	−1.1	−3.4
TUR	0.0	−0.7	−0.7	0.0	−0.1	−0.1
TWN	−0.2	−0.2	−0.3	−0.3	−0.3	−0.6
USA	−0.1	−0.7	−1.0	0.0	−0.4	−0.5

Table 6.2. *Counterfactual Changes in Exports and Production-Based CO2 Emissions of India's Export Competitors to the EU of an EU CBAM (BAU-CBAM), an EU-India FTA (BAU-FTA), and an EU-India FTA under CBAM (CBAM-FTA) in the Basic Metals (14) Industry Aggregate, in Current Million USD for Exports and Million Tons for CO2 Emissions.*

Table 6.2 sheds light on the role of the basic metals (14) industry, which, given a within-industry coverage ratio of 51% in 2014, is most exposed to the CBAM. Under a CBAM that applies to all iron and steel products, Indian iron and steel exports to the EU are projected to shrink by 1 mn. USD. With 6 mn. USD, Russia's steel exports to the EU would incur the most substantial loss. Import substitution stems from such competitors whose carbon policies align with the EU ETS, such as Great Britain, South Korea, or Norway. A standalone EU-India FTA however reverses the picture. Here, Indian iron and steel exports to the EU would see a rise of 59 mn. USD compared to the BAU equilibrium, while all other non-EU import sources witness declines in their basic metals exports towards the EU. For some exporters, the EU-India FTA in conjunction with the CBAM yields even further reductions: almost all non-EU exporters achieve export changes slightly below the BAU-FTA equilibrium export changes. It is likely that the tariff reductions of the EU-India FTA help India regain competitiveness by offsetting the adverse effects on exports under CBAM compared to those EU trading partners that do not benefit from a reduction of tariff levels due to an FTA.

6.1.2 Welfare

Table 6.3 presents the counterfactual general equilibrium welfare effects of all three modeled policy scenarios of changes in bilateral sector-level tariffs between the EU and India. It is crucial to emphasize that the model abstracts from intermediate trade relationships. As all exports are assumed to be used as final demand at the destination, complex global value chain interlinkages are ignored. The first policy scenario, BAU-CBAM, examines the ex-ante changes in real income associated with CBAM compared to the baseline equilibrium. The second scenario, BAU-FTA, analyzes the real income changes linked to a counterfactual introduction of an EU-India FTA compared to the baseline equilibrium. Lastly, CBAM-FTA explores the changes in real income associated with a counterfactual phase-in of the EU-India FTA under the assumption of CBAM baseline tariffs.

The Carbon Border Adjustment Mechanism (CBAM) is not found to entail changes in real income, at the country-level. Under an EU-India FTA (BAU-FTA), India would experience a static real income loss of 0.05%. However, most EU countries would experience welfare gains associated with an EU-India FTA. The change in real income would be highest for small countries such as Estonia and Lithuania (+0.08%). Among the EU countries, only Croatia would lose welfare (-0.01%). If an EU-India FTA was introduced on CBAM tariffs as a baseline equilibrium (CBAM-FTA), India would lose less real income (-0.04%) compared to the BAU-FTA equilibrium. While Austria, Belgium, and Poland would gain more welfare than in the BAU-FTA case (+0.01 pp. each), Norway and Türkiye would lose (-0.01 pp. each).

Country	Policy Scenario		
	BAU-CBAM	BAU-FTA	CBAM-FTA
AUS	0.00	0.00	0.00
AUT	0.00	0.01	0.02
BEL	0.00	0.04	0.05
BGR	0.00	0.03	0.03
BRA	0.00	0.00	0.00
CAN	0.00	0.00	0.00
CHE	0.00	−0.01	−0.01
CHN	0.00	0.00	0.00
CYP	0.00	0.00	0.00
CZE	0.00	0.02	0.02
DEU	0.00	0.03	0.03
DNK	0.00	0.00	0.00
ESP	0.00	0.01	0.01
EST	0.00	0.08	0.08
FIN	0.00	0.02	0.02
FRA	0.00	0.01	0.01
GBR	0.00	0.00	0.00
GRC	0.00	0.01	0.01
HRV	0.00	−0.01	−0.01
HUN	0.00	0.00	0.00
IDN	0.00	0.00	0.00
IND	0.00	−0.05	−0.04
IRL	0.00	0.00	0.00
ITA	0.00	0.01	0.01
JPN	0.00	0.00	0.00
KOR	0.00	0.00	0.00
LTU	0.00	0.08	0.08
LUX	0.00	0.01	0.01
LVA	0.00	0.06	0.06
MEX	0.00	0.00	0.00
MLT	0.00	0.00	0.00
NLD	0.00	0.02	0.02
NOR	0.00	−0.01	−0.02
POL	0.00	0.00	0.01
PRT	0.00	0.00	0.00
ROU	0.00	0.01	0.01
ROW	0.00	−0.01	−0.01
RUS	0.00	0.00	0.00
SVK	0.00	0.01	0.01
SVN	0.00	0.03	0.03
SWE	0.00	0.02	0.02
TUR	0.00	0.01	0.00
TWN	0.00	0.00	0.00
USA	0.00	0.00	0.00

Table 6.3. *Welfare Effects of an EU CBAM (BAU-CBAM), an EU-India FTA (BAU-FTA), and an EU-India FTA under a CBAM (CBAM-FTA), in Percentage Changes.*

6.2 Discussion

6.2.1 Trade and CO2 Emissions

When evaluating the results, it is essential to consider four crucial points. First, the base year being almost ten years ago warrants an interpretation of the results against the backdrop of a world economy that may have undergone structural changes, including events like Brexit, Covid-19, and the Russian war in Ukraine, which could have impacted trade flows and CO2 emissions, since 2014. Second, the CBAM tariff modeling should be taken with caution since, in 2014, only 0.001% of exports from India to the EU within the chemicals sector aggregate (10) were affected by current CBAM legislation. However, the results can give a preliminary idea of industry aggregates where trade and CO2 emission changes under CBAM may occur. Third, regarding the EU-India FTA, this analysis is limited to tariff reductions only, while "deep" FTAs usually involve the removal of non-tariff barriers or the easing of bilateral FDI rules. These might well work as a grease of trade, and hence increase production-based CO2 emissions. On the other hand, FTAs such as the EU-India FTA contain environmental provisions, which might be linked to eventual reductions in production-based CO2 emissions. Hence, the exclusion of such non-tariff barriers and environmental provisions might distort the overall effect of the EU-India FTA (Felbermayr et al. (2017)). Fourth, while the study assumes the same tariff reduction scheme of Gallina et al. (2020) as a recent ex-ante EU-India FTA study, the actual outcome of the negotiations may differ (Felbermayr et al. (2017)).

The findings of this study regarding the EU-India Free Trade Agreement (FTA) can be compared to existing literature on the ex-ante effects of an EU-India FTA. In terms of data on bilateral trade flows and the FTA tariff reduction scenario, this study resembles Gallina et al. (2020), most. However, Gallina et al. (2020) considers trade in intermediate goods, while this study focuses on final goods trade at a sector level. Felbermayr et al. (2017) also model trade and welfare effects linked to tariff reductions of a hypothetical EU-India FTA. Yet, Felbermayr et al. (2017) use a larger model with more country-sector pairs and consider the lowering of non-tariff barriers in addition to tariff reductions.

In terms of the magnitude of changes in exports from India to the EU, the results of this study fall between the findings of Gallina et al. (2020) and Felbermayr et al. (2017). The magnitude of increases of exports from India to the EU (+35 bn. USD, 7%) falls in between the range of the results by Gallina et al. (2020) (+6 bn. EUR, 15%) and Felbermayr et al. (2017) (+83 bn. USD, 91%). While the difference to Gallina et al. (2020) consists mainly in the fact that their model structure accounts for trade in intermediate goods, as opposed to only final goods trade at a sector level assumed here, Felbermayr et al. (2017)'s model is larger both in terms of country-sector pairs and trade liberalisation: in addition to tariff reductions, they model the lowering of non-tariff barriers, which is found to drive the results. The consequences of not accounting for intermediates might be seen when ranking changes in trade flows by sector. Gallina et al. (2020) find absolute rises in exports from India to the EU to be most pronounced in textiles (6), chemicals (10) and basic metals (14), while this model finds exports in chemicals (10), coke and refined petroleum products (9) and mining and quarrying, non-energy producing products (4) to rise, the most.

Other than in Felbermayr et al. (2017), a decline of India's exports to Brazil, China and Russia is not found. In line with Felbermayr et al. (2017), this model finds that under an EU-India FTA, exports from extra-EU countries other than India to the EU would decline. Notably China and the USA would export less to the EU. In line with Felbermayr et al. (2017), a rise of India's exports to Türkiye is confirmed. Türkiye profits from a customs agreement with the EU, under which lower tariffs due to an EU-India FTA would apply also to India's exports to Türkiye. According to Gallina et al. (2020), an EU-India FTA would reduce domestic EU trade by about 6 bn. USD. This study obtains an even higher decline in domestic EU trade: Germany alone would lose intra-EU imports of about 6 bn. USD. These declines are driven entirely by the export boost to the Indian market of 104 bn. USD, an increase even higher than the +94 bn. USD projected in Felbermayr et al. (2017).

The findings of this study regarding the Carbon Border Adjustment Mechanism (CBAM) can be compared to existing literature on the ex-ante trade, CO2 emissions, and welfare effects of the CBAM. Regarding India's exports to the EU under CBAM, this study shows a 0.002% decline, which is similar in direction to Korpar et al. (2023) (-0.03%). Both Korpar et al. (2023) and this study find a decrease in India's CO2 emissions associated with the CBAM (-0.3% and -0.05%, respectively). The findings also align with Korpar et al. (2023) regarding CO2 emissions of the EU. An important difference to Korpar et al. (2023) is that CO2 emissions are assumed to be an exogenous side-effect of production, and not driven by leakage through the fossil-fuel-price channel. According to this channel, reduced energy demand of emission-constrained regions (the EU) depresses international fuel prices, which in turn triggers additional energy demand and emissions in unconstrained countries, such as India.

With regards to the debate of trade effects vs. CO2 emission impacts linked to the EU-India FTA, the results suggest that a CBAM as introduced is too weak when measured in terms of tariff reductions to significantly affect India's aggregate exports to the EU. Overall, the slight CBAM tariff augmentations are found not to be impactful enough compared to the much larger FTA tariff reductions of up to 90% to make a substantial difference. Looking at the sector-level, it is found that an EU-India FTA would entail substantial trade-creation, particularly in the chemicals sector for India, while other countries would lose export volume to the EU. Compositional shifts between country-sector pairs in CBAM industries might induce changes in global trade patterns such that for some chemical firms and iron and steel producers in India, the interplay of the CBAM and the trade-enhancing effects of the EU-India FTA may be relevant. Most importantly, on the other side of the coin, the favorable trading conditions of the FTA come at the expense of increased CO2 emissions. These emission increases induced by trade liberalization counteract the intended goal of CBAM to reduce global CO2 emissions.

As proposed by Copeland (2021), the plots of the gross CO2 emissions of industries suggest that the dirtiest industries are the ones most exposed to trade, in the EU-India case, as well. The plotted CO2 emission intensities for Indian industries are in line with Barrows & Ollivier (2018). Using emission intensity data at the firm-product level, Barrows & Ollivier (2018) find that emission intensity in India dropped significantly between 1990-2010 through reallocations across firms. Copeland (2021), Figure 6 document that in India, a considerable share of CO2 emission reduction is attributable to composition effects. Regarding the CBAM costs which India might face, the middle panel foreshadows that if the EU's CO2 emission intensity reference values were used (refer to section 2.2.2), the CBAM might be associated with lower costs for India. Moreover, this study would agree that the EU Commission has been right in identifying sectors most affected by the CBAM (basic metals) and those most responsive to the CBAM and the EU-India FTA due to their dynamics under trade liberalization (chemicals). A pollution haven effect (Copeland & Taylor (1994)) is found in the sense that the CBAM, as a symbol of increased environmental standards, reduces exports of pollution-intensive goods. In addition, India's consistently higher CO2 emissions in production (see Figure 3.1) justify the political demand for the EU CBAM as portrayed in section 2.2.1.

6.2.2 Welfare

The gains from trade associated with the FTA tariff reduction scheme in the quantitative trade model are -0.05% for India's case and range between -0.01% to 0.08% for individual EU countries (see Table 6.3). The increase in the EU countries' real income resembles the one found in Gallina et al. (2020) (0.02%). Gallina et al. (2020)'s main model with tariff revenues finds welfare gains for India (0.1%). Felbermayr et al. (2017) also find an increase in real income of about USD 28 bn. (1%), valued at 2015 prices, for India.

In an Armington model, Balistreri & Rutherford (2012) find welfare losses of 2% for non-coalition countries due to border carbon adjustment (BCA). The findings in this paper do not speak for welfare losses, albeit some countries lose some trade volume. The hypothesis of Lanzi et al. (2012) that BCAs cause competitiveness losses for non-acting countries is largely confirmed for Russia, which is substantially exposed to CBAM. Part of the (burden of) emission reductions is indeed shifted to CBAM target countries. Simola (2021) uses BACI trade data at the HS6 6-digit disaggregation level and estimates annual CBAM costs to India to make up 220 mn. EUR, with 192 mn. EUR related to the steel industry alone. Using a partial equilibrium approach, this methodology multiplies the volume of EU imports of a product with the emission intensity of the product and the carbon price of the CBAM certificate. In light of the results of this study showing a 8 mn. USD decrease of FOB exports, the magnitude of India's losses of 220 mn. EUR seems slightly upward-biased. This could be because, unlike the general equilibrium approach of this study, a partial equilibrium approach does not account for supply- and demand spillovers between country-sector pairs. The general equilibrium model captures such third-country effects in the multilateral resistance terms in the gravity equations.

Contrasting the measured negative welfare effects of India in Table 6.3 with the results in the literature (Gallina et al. (2020), Korpar et al. (2023)), one might conclude that the model in this study underestimates gains from trade. The decline in tariff revenue might be a first reason for India's negative welfare effects. In their model with intermediate input-output linkages, Gallina et al. (2020) find an absolute tariff revenue decrease for India. In their tariff elimination scenario, Felbermayr et al. (2017) find India's tariff revenue to decrease by 0.36 percentage points. Second, there is the possibility that trade diversion from the Indian home market might explain part of India's negative welfare effects under the EU-India FTA scenario. Moreover, a further reason for India's losses from trade might be related to the concept of positive optimal tariff levels (Gros (1987), Helpman & Krugman (1989)). Using a fictitious example of an import tariff for a group of countries, Costinot & Rodríguez-Clare (2014) demonstrates that welfare is highest when maintaining a tariff level of around 20% (see Costinot & Rodríguez-Clare (2014), Figure 4.1, p. 228). Moreover, the optimal tariff size is found to differ depending on the model structure. In the BCA scenario of Balistreri & Rutherford (2012), the Armington structure indicates small coalition gains and large non-coalition losses compared to a Melitz (2003) -type monopolistic competition framework. The explanation for this difference can be traced to the assumption of national product differentiation and hence, the existence of large optimal tariffs. This implies significant room for the policy authority to exercise market power through a beggar-thy-neighbor tariff (Balistreri & Markusen (2009)). Balistreri & Rutherford (2012) shows that this is not the case in monopolistic competition models.

Regarding the model structure, the comparison of the Armington (1969) -style model to a Melitz (2003) -model type opens a debate on the scientific gain from models accounting for firm heterogeneity. In addition to effects associated with inter-industry reallocations driven by comparative advantage, a model featuring heterogeneous firms can capture intra-industry reallocations of market shares and productive resources. In trade research, robust and persistent differences in productivities, size, and export behavior among firms have been empirically shown. More recently, a vivid debate on whether and how aggregate effects of trade on CO2 emissions differ from the effects at the firm level has emerged (Balistreri & Rutherford (2012), Copeland (2021)). In theory, as regulated-region (EU ETS) prices increase, non-regulated regions (India) experience a lowering of the export threshold, inducing a reallocation of resources between differently productive plants. Relative to unregulated regions, productivity falls in regulated regions. If the EU places restrictions on the import of energy-intensive goods from India, production costs in India rise and thus raise the threshold for export engagement. Again, this reallocates resources between more versus less productive plants within the industry. A popular hypothesis is that competitive effects of subglobal policy might thus be magnified under a heterogeneous firms structure (Balistreri & Rutherford (2012)). Comparing the Armington-style model to a Melitz (2003) -type model with monopolistic competition, Balistreri & Rutherford (2012) find larger carbon leakage rates and larger competitiveness effects related to climate policy in the latter model. The Armington model is found to limit trade responses relative to the initial calibration point, thus failing to account for the productivity changes predicted by the Melitz structure. Relative to an Armington structure, the intra-industry reallocation of non-coalition resources into more productive firms increases overall productivity, which translates into overall non-coalition welfare improvements. Moreover, firm-level heterogeneity models have found evidence for technique effects in India. Martin (2011) finds that within a given industry and year, plants with higher total factor productivity have lower fuel expenditure per dollar of output in a study on the impact of trade on GHG emissions by Indian manufacturing firms. Using detailed firm-product emission intensity data from India in a monopolistic competition framework, Barrows & Ollivier (2018) find that the effects of technological upgrading on CO2 emission intensity differ at the industry- and firm levels. While on the one hand, pro-competitive market developments lead to an improvement in the aggregate emission intensity across firms, on the other hand, product mix increases emission intensity within firms. However, the extent to which technique effects are driven by real income gains from trade have remained unclear Copeland (2021)). Therefore, further innovations might lie in accounting for firm heterogeneity. Given the comparably large composition effects of India, abstracting from sectoral heterogeneity does not seem to be a big problem in terms of the loss of important results. In any case, considering the rise in CO2 emissions in the case of an EU-India FTA, strong technique effects might be required to curb the negative emission externalities between the EU and India.

7 Conclusion

This paper evaluates whether the EU CBAM keeps its promised effects regarding economic and environmental target conflicts, first, as a standalone tool and second, in the context of a hypothetical EU-India FTA. To evaluate these questions, a multi-country multi-sector general equilibrium trade model is used. It appears that the CBAM is effective in slightly decreasing CO2 emissions in India's production due to a decrease in exports from India to the EU.

A hypothetical EU-India FTA is found to increase trade between the EU and India and CO2 emissions, substantially. Under an EU-India FTA that applies to all tariff lines in the chemicals industry, chemicals exports in both directions are found to increase most, in absolute terms. Exports from the basic metals industry aggregate follow. Hence, against the backdrop of the EU-India FTA, the CBAM's objectives to curb global CO2 emissions might be counteracted: as CO2 emission decreases under CBAM are more than offset by the FTA, the economic perspective "wins" over the EU's environmental concerns. It appears that tariff reductions of 90% in the chemicals and basic metals sector aggregates would weigh way heavier than comparably small CBAM import tariffs, which are moreover applied to 51% of India's basic metals exports and a mere 0.001% of India's chemicals exports to the EU.

Concerning the ex-ante impacts of the EU-India FTA on welfare, implications regarding the optimal model choice can be derived. The Armington model indicates a welfare reduction for India. A first step towards more plausible trade, CO2 emission and welfare effects would be to use a trade model that includes trade in intermediate inputs. Furthermore, a heterogeneous firm model featuring firm-level product differentiation might be better suited to evaluate welfare effects. In addition, such a model could shed more light on the role of technique effects due to both the CBAM and the EU-India FTA.

While considering the model's limitations, the results allow to draw some conclusions for policymakers. When the EU-India FTA is introduced on top of CBAM, the EU needs to be prepared to find the right answers to concerns as the ones raised by the Indian trade partners. In the current geopolitical world order in which an EU-Russia FTA or an EU-China FTA seems distant, under the EU-India FTA, Indian steel exporters tend to benefit, also if a CBAM is in place. Most importantly, the planned EU-India FTA may lead to significant increases in trade and CO2 emissions. Also, a lesson for CBAM policymakers can be derived. The EU's existing and planned trade agreements might well shape CO2 emissions to a degree which the CBAM as currently designed can probably not reverse. Against the impact of FTAs, CBAM as currently designed runs short of achieving CO2 emission reduction targets on the path to the EU's "Fit for 55" goal. Given both the strong trade and CO2 emission effects of the potential EU-India FTA, and considering the debate on optimal tariffs, from an environmental policy perspective, there might be some room for negotiation for the EU to advocate smaller tariff reductions for industry aggregates covered by the CBAM, such as basic metals or chemicals.

Appendix

A The Counterfactual General Equilibrium Trade Model

A.1 The Armington Model

Consider a world economy comprising $i = 1, \dots, n$ countries, each endowed with Q_i units of a distinct good $i = 1, \dots, n$.

Preferences. Each country is populated by a representative agent whose preferences are represented by a Constant Elasticity of Substitution (CES) utility function:

$$C_j = \left(\sum_{i=1}^{n} \psi_{ij}^{(1-\sigma)/\sigma} \, C_{ij}^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)} \qquad (1)$$

where C_{ij} is the demand for good i in country j; $\psi_{ij} > 0$ is an exogenous preference parameter; and $\sigma > 1$ is the elasticity of substitution between goods from different countries. The associated consumer price index is given by

$$P_j = \left(\sum_{i=1}^{n} \psi_{ij}^{1-\sigma} \, P_{ij}^{1-\sigma} \right)^{1/(1-\sigma)} \qquad (2)$$

where P_{ij} is the price of good i in country j.

Trade Costs. International trade between countries is subject to iceberg trade costs. To sell one unit of a good in country j, firms from country i must ship $\tau_{ij} \geq 1$ units, with $\tau_{ii} = 1$. For there to be no arbitrage opportunities, the price of good i in country j must be equal to $P_{ij} = \tau_{ij} P_{ii}$. The domestic price P_{ii} of good i, in turn, can be expressed as a function of country i 's total income, Y_i, and its endowment: $P_{ii} = Y_i / Q_i$. Combining the two previous expressions one gets

$$P_{ij} = \frac{Y_i \tau_{ij}}{Q_i}. \qquad (3)$$

Trade Flows. Let X_{ij} denote the total value of country j 's imports from country i. Given CES utility, maximizing utility subject to the budget constraint $E_i = P_i C_i = X_i$ for each country, we obtain optimal demand, and thus bilateral trade flows

$$X_{ij} = \left(\frac{\psi_{ij} P_{ij}}{P_j}\right)^{1-\sigma} E_j \qquad (4)$$

where $E_j \equiv \sum_{i=1}^{n} X_{ij}$ is country j 's total expenditure. Combining Equation 2 - Equation 4, we obtain

$$X_{ij} = \frac{\left(Y_i \tau_{ij}\right)^{1-\sigma} \chi_{ij}}{\sum_{l=1}^{n} \left(Y_l \tau_{lj}\right)^{1-\sigma} \chi_{lj}} E_j,$$

where $\chi_{ij} \equiv \left(Q_i / \psi_{ij}\right)^{\sigma-1}$. To prepare the general analysis of Section 3, one can let $\varepsilon \equiv \partial \ln\left(X_{ij}/X_{ij}\right) / \partial \ln \tau_{ij}$ denote the elasticity of imports relative to domestic demand, X_{ij}/X_{ij}, with respect to bilateral trade costs, τ_{ij}, holding income levels fixed. ε is referred to as the trade elasticity. In this Armington model, it is simply equal to $\sigma - 1$. Using the previous notation, one can rearrange the expression above as

$$X_{ij} = \frac{\left(Y_i \tau_{ij}\right)^{-\varepsilon} \chi_{ij}}{\sum_{l=1}^{n} \left(Y_l \tau_{lj}\right)^{-\varepsilon} \chi_{lj}} E_j. \qquad (5)$$

Equation 5 is the so-called **gravity equation**.

Competitive Equilibrium. In the competitive equilibrium, budget constraint and goods market clearing imply $Y_i = E_i$ and $Y_i = \sum_{j=1}^{n} X_{ij}$, respectively, for all countries i. Together with Equation 5, these two conditions imply

$$Y_i = \sum_{j=1}^{n} \frac{\left(Y_i \tau_{ij}\right)^{-\varepsilon} \chi_{ij}}{\sum_{l=1}^{n} \left(Y_l \tau_{lj}\right)^{-\varepsilon} \chi_{lj}} Y_j. \qquad (6)$$

This results in a system of n equations with n unknowns, $\mathrm{Y} \equiv \{Y_i\}$. According to Walras's Law, one of these equations is redundant, implying that income levels are only determinable up to a constant. Once income levels are known, expenditure levels, $\mathrm{E} \equiv \{E_i\}$, can be computed using the budget constraint, while bilateral trade flows, $\mathrm{X} \equiv \left\{X_{ij}\right\}$, can be derived using the gravity equation. This concludes the description of the Armington model.

Quantifying the Welfare Implications Using the Gravity Equation

Now, it is illustrated how the gravity equation can be used to quantify the welfare consequences of globalization. For simplicity, a shock to trade costs from $\tau \equiv \left\{\tau_{ij}\right\}$ to $\tau' \equiv \left\{\tau'_{ij}\right\}$ is assumed. The same analysis generalizes in a straightforward manner to preference and endowment shocks. To quantify the welfare consequences of a trade shock in each country j, two steps are taken. First, changes in real consumption, $C_j \equiv E_j/P_j$, are inferred from changes in macro variables, X and Y. Second, changes in macro variables are computed.

Welfare. In this model, welfare changes in country j, correspond to percentage changes in real consumption. Such changes correspond to the equivalent variation associated with a foreign shock (expressed as a share of expenditure before the shock). Namely, percentage changes in real consumption measures the percentage change in income that the representative agent would be willing to accept in lieu of the shock to happen.

The initial finding indicates that changes in real consumption can be deduced using only two key measures: (i) observed changes in the proportion of spending on domestic products, denoted as $\lambda_{ij} \equiv X_{ij}/E_j$; and (ii) the trade elasticity present in the gravity equation, represented by ε.

Let us begin by assuming an infinitesimal alteration in trade costs from τ to $\tau + d\tau$. The price index equation reveals

$$\begin{aligned} dlnP_j &= \frac{1}{1-\sigma} dln\left(\sum_{i=1}^{n} \psi_{ij}^{1-\sigma} P_{ij}^{1-\sigma}\right) \\ &= \frac{1}{1-\sigma} \frac{\sum_{i=1}^{n} \psi_{ij}^{1-\sigma} P_{ij}^{1-\sigma} (1-\sigma) dlnP_{ij}}{\sum_{i=1}^{n} \psi_{ij}^{1-\sigma} P_{ij}^{1-\sigma}} \\ &= \sum_{i=1}^{n} \frac{\psi_{ij}^{1-\sigma} P_{ij}^{1-\sigma}}{\sum_{i=1}^{n} \psi_{ij}^{1-\sigma} P_{ij}^{1-\sigma}} dlnP_{ij} \\ &= \sum_{i=1}^{n} \lambda_{ij}\, d\ln P_{ij} \end{aligned}$$

Here, the last equation utilized a combination of Equation 2 and Equation 4, while $\lambda_{ij} \equiv X_{ij}/E_j$ represents the portion of expenditure on goods from country i in country j.

This equation can be further simplified. From the relationship between foreign and domestic trade shares, we can derive the following expression for the derivative of the bilateral price index:

$$\begin{aligned} dln\lambda_{ij} - dln\lambda_{jj} &= dln\left(\psi_{ij}^{1-\sigma} P_{ij}^{1-\sigma} P_j^{1-\sigma}\right) - dln\left(\psi_{jj}^{1-\sigma} P_{jj}^{1-\sigma} P_j^{1-\sigma}\right) \\ &= (1-\sigma)\left(dlnP_{ij} - dlnP_{jj}\right) \\ &\Leftrightarrow \\ \frac{dln\lambda_{ij} - dln\lambda_{jj}}{1-\sigma} + dlnP_{jj} &= dlnP_{ij} \end{aligned}$$

As a result, when substituted into the expression for the derivative of the national price index, the following expression solely in terms of the domestic trade share and domestic price index is obtained:

$$\begin{aligned} dlnP_j &= \sum_{i=1}^{n} \lambda_{ij} \left(\frac{dln\lambda_{ij} - dln\lambda_{jj}}{1-\sigma} + dlnP_{jj} \right) \\ &= \frac{\sum_{i=1}^{n} d\,\lambda_{ij} - dln\lambda_{jj}}{1-\sigma} + dlnP_{jj} \\ &= \frac{-dln\lambda_{jj}}{1-\sigma} + dlnP_{jj} \end{aligned}$$

where the conditions $\sum_{i=1}^{n} \lambda_{ij} = 1$ and $\sum_{i=1}^{n} \lambda_{ij}\, dln\lambda_{ij} = \sum_{i=1}^{n} d\,\lambda_{ij} = 1$ are satisfied.

Consequently, changes in real consumption, $C_j \equiv E_j/P_j$, in country j can be expressed as

$$d\ln C_j = \left(d\ln E_j - d\ln P_{ij}\right) + \left(d\ln\lambda_{jj}/(1-\sigma)\right) \tag{7}$$

Since there are no domestic trade costs, $\tau_{ij} = \tau'_{ij} = 1$, and trade is balanced, $Y_j = E_j$, equation (3) implies that the first term equals zero. In the simple Armington model, changes in real consumption depend solely on the variation in the relative price of imported versus domestic goods, P_j^M/P_{jj}, which is contingent on the share of expenditure on domestic goods, λ_{ij}, and the elasticity of substitution, σ. By employing Equation 7 and the definition of the trade elasticity $\varepsilon \equiv \sigma - 1$, one can derive

$$d\ln C_j = -\frac{d\ln\lambda_{jj}}{\varepsilon} \tag{8}$$

Since this expression holds for any infinitesimal shock, the welfare consequences of significant changes from τ to τ′ can be inferred by integrating the preceding formula:

$$\hat{C}_j = \hat{\lambda}_{ij}^{-1/\varepsilon}\,, \tag{9}$$

where $\hat{v} \equiv v'/v$ indicates the proportional change in any variable v between the initial and counterfactual equilibria. This analysis demonstrates that for any alteration in trade costs, two statistics - the trade elasticity, ε, and the changes in the share of expenditure on domestic goods, λ_{jj}- are adequate for inferring welfare changes.

Macroeconomic Indicators. At this juncture, it is established that, contingent on the trade elasticity, ε, fluctuations in real consumption are uniquely determined by alterations in λ_{jj}. The subsequent discussion outlines how gravity models can be utilized to anticipate the impact of trade shocks on trade flows in general and the share of expenditure on domestic goods, λ_{jj}, in particular. This approach has recently gained popularity, as highlighted by Dekle et al. (2008). One can regard this methodology as an "exact" rendition of Jones's hat algebra.

Let $\lambda_{ij} \equiv X_{ij}/\sum_l X_{lj}$ denote the portion of expenditure on goods from country i in country j. Given that the gravity equation holds in both the initial and the counterfactual equilibria, the expression is as follows:

$$\begin{aligned} dln\lambda_{ij} &= dln\left(\psi_{ij}^{1-\sigma} P_{ij}^{1-\sigma} P_j^{1-\sigma}\right) \\ &= (1-\sigma)\left(dlnP_{ij} - dlnP_j\right) \\ &= (1-\sigma)\left(dlnP_{ij} - \sum_{i=1}^{n} \lambda_{ij}\, \mathrm{dln}P_{ij}\right) \\ &\Leftrightarrow \\ \hat{\lambda}_{ij} &= \frac{\left(\hat{Y}_i \hat{\tau}_{ij}\right)^{-\varepsilon}}{\sum_{l=1}^{n} \lambda_{lj} \left(\hat{Y}_l \hat{\tau}_{lj}\right)^{-\varepsilon}}. \end{aligned} \tag{10}$$

Alternate Calculation:

$$\begin{aligned} \lambda'_{ij} &= \frac{\left(Y'_i \tau'_{ij}\right)^{1-\sigma} \chi'_{ij}}{\sum_{l=1}^{n} \left(Y'_l \tau'_{lj}\right)^{1-\sigma} \chi'_{lj}} \\ &= \frac{\left(Y_i \tau_{ij}\right)^{1-\sigma} \chi_{ij} \left(\hat{Y}_i \hat{\tau}_{ij}\right)^{1-\sigma}}{\sum_{l=1}^{n} \left(Y_l \tau_{lj}\right)^{1-\sigma} \chi_{lj} \left(\hat{Y}_l \hat{\tau}_{lj}\right)^{1-\sigma}} \\ &= \frac{\lambda_{ij} \left(\hat{Y}_i \hat{\tau}_{ij}\right)^{1-\sigma}}{\sum_{l=1}^{n} \lambda_{lj} \left(\hat{Y}_l \hat{\tau}_{lj}\right)^{1-\sigma}} \\ &\Leftrightarrow \\ \hat{\lambda}_{ij} &= \frac{\lambda'_{ij}}{\lambda_{ij}} = \frac{\left(\hat{Y}_i \hat{\tau}_{ij}\right)^{-\varepsilon}}{\sum_{l=1}^{n} \lambda_{lj} \left(\hat{Y}_l \hat{\tau}_{lj}\right)^{-\varepsilon}}. \end{aligned}$$

In the counterfactual equilibrium, Equation 6 further implies

$$\begin{aligned} Y'_j &= \sum_{i=1}^{n} \lambda'_{ji}\, Y'_i \\ &\Leftrightarrow \\ \hat{Y}_j Y_j &= \sum_{i=1}^{n} \hat{\lambda}_{ji}\, \lambda_{ji} \hat{Y}_i Y_i \end{aligned}$$

Combining the two previous expressions yields

$$\hat{Y}_j Y_j = \sum_{i=1}^{n} \frac{\lambda_{ji} \left(\hat{Y}_j \hat{\tau}_{ji}\right)^{-\varepsilon} \hat{Y}_i Y_i}{\sum_{l=1}^{n} \lambda_{li} \left(\hat{Y}_l \hat{\tau}_{li}\right)^{-\varepsilon}}. \quad (11)$$

Despite the effects of trade costs, endowments, and preference shifters on bilateral trade flows, as indicated by τ_{ij} and χ_{ij} in Equation 5, Equation 11 shows that counterfactual changes in income, $\hat{Y} \equiv \{\hat{Y}_i\}$, can be computed as the solution of a system of non-linear equations without the need to estimate any of these parameters. The initial expenditure shares, λ_{ij}, the initial income levels, Y_i, and the trade elasticity, ε, are all that is required to determine changes in income levels (up to normalization). With changes in income levels, one can then compute changes in the shares of expenditure on goods from different countries, $\hat{\lambda}_{ij}$, and changes in real consumption, $\hat{C}_j$, using equations Equation 10 and Equation 9, respectively.

Assuming a single factor of production, labor, in the Armington model, income equals labor income $Y_i = w_i L_i$. With fixed endowments, one has $Y_i{}' = w'{}_i L_i = \hat{Y}_i Y_i = \hat{w}_i \frac{L_i}{L_i} w_i L_i = \hat{w}_i Y_i$, and Equation 11 can be rewritten as

$$\hat{w}_j Y_j = \sum_{i=1}^{n} \frac{\lambda_{ji} \left(\hat{w}_j \hat{\tau}_{ji}\right)^{-\varepsilon} \hat{w}_i Y_i}{\sum_{l=1}^{n} \lambda_{li} \left(\hat{w}_l \hat{\tau}_{li}\right)^{-\varepsilon}}. \quad (12)$$

A.2 The Armington Model with Tariffs

Trade Costs. Let us consider a world economy akin to the model described above. In this scenario, trade flows can be subject to import tariffs, leading to the generalization of Equation 3 as follows:

$$P_{ij} = \frac{Y_i \tau_{ij} \left(1 + t_{ij}\right)}{Q_i}, \quad (13)$$

where Y_i denotes factor income in country i, representing GDP net of tariff revenues, and $t_{ij} \geq 0$ signifies the ad-valorem tariff imposed by country j on goods from country i. Throughout the remainder of this section, $\phi_{ij} \equiv \tau_{ij}\left(1 + t_{ij}\right)$ denotes the total trade costs between country i and j.

Trade Flows. Given CES utility, the value of bilateral trade flows (inclusive of tariffs) is expressed by the following gravity equation:

$$X_{ij} = \frac{\left(Y_i \phi_{ij}\right)^{-\varepsilon} \chi_{ij}}{\sum_{l=1}^{n} \left(Y_l \phi_{lj}\right)^{-\varepsilon} \chi_{lj}} E_j \quad (14)$$

Competitive Equilibrium. When import tariffs are present, budget balance now demands $E_j = Y_j + T_j$, where $T_j \equiv \sum_{i=1}^{n} \frac{t_{ij}}{1+t_{ij}} X_{ij}$ represents the total tariff revenues in country j. The goods market clearing condition necessitates $Y_i = \sum_{j=1}^{n} \frac{1}{1+t_{ij}} X_{ij}$. Together with Equation 14, these two conditions imply:

$$
\begin{aligned}
T_j \quad &\equiv \sum_{i=1}^{n} \frac{t_{ij}}{1+t_{ij}} \frac{\left(Y_i \phi_{ij}\right)^{-\varepsilon} \chi_{ij}}{\sum_{l=1}^{n} \left(Y_l \phi_{lj}\right)^{-\varepsilon} \chi_{lj}} \left(Y_j + T_j\right) \\
&= \frac{\sum_{i=1}^{n} \frac{t_{ij}}{1+t_{ij}} \frac{\left(Y_i \phi_{ij}\right)^{-\varepsilon} \chi_{ij}}{\sum_{l=1}^{n} \left(Y_l \phi_{lj}\right)^{-\varepsilon} \chi_{lj}} Y_j}{1 - \left(\sum_{i=1}^{n} \frac{t_{ij}}{1+t_{ij}} \frac{\left(Y_i \phi_{ij}\right)^{-\varepsilon} \chi_{ij}}{\sum_{l=1}^{n} \left(Y_l \phi_{lj}\right)^{-\varepsilon} \chi_{lj}}\right)} \\
&= \frac{\pi_j}{1 - \pi_j} Y_j
\end{aligned}
$$

Here, $\pi_j \equiv \sum_{i=1}^{n} \frac{t_{jj}}{1+t_{ij}} \frac{(Y_i \phi_i)^{-\theta} \chi_{ij}}{\sum_{l-1}^{n} \left(Y_i \phi_j\right)^{-t} x_j} \in (0,1)$ indicates the share of tariff revenues in country j's total expenditure. Consequently, $E_j = Y_j + T_j = Y_j + \frac{\pi_j}{1-\pi_j} Y_j = \frac{1}{1-\pi_j} Y_j$, leading to the following generalization of Equation 6:

$$
Y_i = \sum_{j=1}^{n} \frac{1}{1+t_{ij}} \frac{\left(Y_i \phi_{ij}\right)^{-\varepsilon} \chi_{ij}}{\sum_{l=1}^{n} \left(Y_l \phi_{lj}\right)^{-\varepsilon} \chi_{lj}} \frac{Y_j}{1-\pi_j}, \tag{15}
$$

This concludes the description of a competitive equilibrium with import tariffs.

Welfare. Finally, to determine the welfare change resulting from the alteration in import tariffs, we can begin with Equation 7. By integrating and considering that $E_j = Y_j / \left(1 - \pi_j\right)$, we get:

$$
\hat{C}_j = \left(\frac{1 - \pi_j}{1 - \pi_j'}\right) \hat{\lambda}_{jj}^{-1/\varepsilon}, \tag{16}
$$

where the share of tariff revenues in the initial and counterfactual equilibria is denoted by $\pi_j = \sum_{i=1}^{n} \frac{t_{ij}}{1+t_{ij}} \lambda_{ij}$ and $\pi_j' = \sum_{i=1}^{n} \frac{t_{ij}'}{1+t_{ij}'} \lambda_{ij} \hat{\lambda}_{ij}$, respectively. Like in the preceding section, we can compute welfare changes using only a few sufficient statistics. It is not necessary to estimate all structural parameters of the model to evaluate the welfare effect of an arbitrary tariff change.

Macroeconomic variables. Once changes in factor income are determined, we can calculate changes in expenditure shares using Equation 14:

$$\hat{\lambda}_{ij} = \frac{\left(\hat{Y}_i \hat{\phi}_{ij}\right)^{-\varepsilon}}{\sum_{l=1}^{n} \lambda_{lj} \left(\hat{Y}_l \hat{\phi}_{lj}\right)^{-\varepsilon}} \tag{17}$$

Now, let us consider an arbitrary change in import tariffs from $\mathrm{t} \equiv \{t_{ij}\}$ to $\mathrm{t}' \equiv \{t'_{ij}\}$. To compute proportional changes in factor income, $\hat{\mathrm{Y}} \equiv \{\hat{Y}_i\}$, we can once again use the exact hat algebra. In the counterfactual equilibrium, Equation 15 further implies:

$$\begin{aligned} Y'_j &= \sum_{i=1}^{n} \frac{1}{1+t'_{ij}} \lambda'_{ji} \frac{Y'_i}{1-\pi'_j} \\ &\Leftrightarrow \\ \hat{Y}_j Y_j &= \sum_{i=1}^{n} \frac{1}{1+t'_{ij}} \hat{\lambda}_{ji} \lambda_{ji} \frac{\hat{Y}_i Y_i}{1-\pi'_j} \end{aligned} \tag{18}$$

where the share of tariff revenues in the counterfactual equilibrium is itself denoted by:

$$\pi'_i = \sum_{j=1}^{n} \frac{t'_{ji}}{1+t'_{ji}} \frac{\lambda_{ji}\left(\hat{Y}_j \hat{\phi}_{ji}\right)^{-\varepsilon}}{\sum_{l=1}^{n} \lambda_{li} \left(\hat{Y}_l \hat{\phi}_{li}\right)^{-\varepsilon}}.$$

By combining the two preceding expressions, we can derive the following:

$$\hat{Y}_j Y_j = \sum_{i=1}^{n} \frac{1}{1+t'_{ij}} \frac{\lambda_{ji}\left(\hat{Y}_j \hat{\phi}_{ji}\right)^{-\varepsilon}}{\sum_{l=1}^{n} \lambda_{li} \left(\hat{Y}_l \hat{\phi}_{li}\right)^{-\varepsilon}} \frac{\hat{Y}_i Y_i}{1-\pi'_i}, \tag{19}$$

From the combination of the previous expressions, one can solve for $\hat{\mathrm{Y}} \equiv \{\hat{Y}_i\}$ (up to a normalization). Although the previous system of equations is not as concise as Equation 11, it still does not directly depend on preference shifters, endowments, or trade costs. All that is necessary to determine changes in factor income levels, $\hat{Y}_i$, are the initial expenditure shares, λ_{ij}, the initial factor income levels, Y_i, and the trade elasticity, ε.

B Data

B.1 The Bilateral Industry-Level Tariff Scheme

Importer	BAU	BAU-CBAM	BAU-FTA	CBAM-FTA
AUT	0.006568564	0.006681694	0.000656856	0.000668169
BEL	0.006568564	0.006681694	0.000656856	0.000668169
BGR	0.005985144	0.006088226	0.000598514	0.000608823
CYP	0.005050687	0.005137675	0.000505069	0.000513767
CZE	0.012739946	0.012959367	0.001273995	0.001295937
DEU	0.006568564	0.006681694	0.000656856	0.000668169
DNK	0.006568564	0.006681694	0.000656856	0.000668169
ESP	0.006568564	0.006681694	0.000656856	0.000668169
EST	0.004349702	0.004424617	0.00043497	0.000442462
FIN	0.006568564	0.006681694	0.000656856	0.000668169
FRA	0.006568564	0.006681694	0.000656856	0.000668169
GRC	0.006568564	0.006681694	0.000656856	0.000668169
HRV	0.004688702	0.004769455	0.00046887	0.000476946
HUN	0.013028401	0.01325279	0.00130284	0.001325279
IRL	0.006568564	0.006681694	0.000656856	0.000668169
ITA	0.006568564	0.006681694	0.000656856	0.000668169
LTU	0.004349702	0.004424617	0.00043497	0.000442462
LUX	0.006568564	0.006681694	0.000656856	0.000668169
LVA	0.005008239	0.005094496	0.000500824	0.00050945
MLT	0.005159301	0.00524816	0.00051593	0.000524816
NLD	0.006568564	0.006681694	0.000656856	0.000668169
POL	0.00514645	0.005235087	0.000514645	0.000523509
PRT	0.006568564	0.006681694	0.000656856	0.000668169
ROU	0.032624011	0.033185897	0.003262401	0.00331859
SVK	0.005279151	0.005370074	0.000527915	0.000537007
SVN	0.005159301	0.00524816	0.00051593	0.000524816
SWE	0.006568564	0.006681694	0.000656856	0.000668169

Table B.1. *The Bilateral Tariff Scheme between India and the EU, exemplary for the Basic Metals (14) Industry Aggregate. Average Tariffs across Products within the Industry Aggregate. Sources: Felbermayr et al. (2022a) and UN (2023) for BAU and BAU-FTA, OECD (2016), Table B2, pp. 154-156 and OECD (2022b) for CBAM tariffs in BAU-CBAM and CBAM-FTA.*

BAU. To establish the BAU equilibrium tariffs, the bulk of aggregate industry-level bilateral tariffs is taken from Felbermayr et al. (2022a) ("appl_tau_2014_weighted.dta"). As primary sources, these tariffs draw upon MFN and preferential tariffs between all country-sector pairs from UN (2023) and reflect the year 2014. Both data and code are available in the paper's replication package Felbermayr et al. (2022b). Wherever bilateral country-sector tariffs are missing (e.g., ROW and CHE), MFN bilateral tariffs (applied rates) from UN (2023) are employed. Wherever tariffs are missing (e.g., the USA or sometimes, the EU) or implausible, e.g., agricultural tariffs > 0 within the EU single market), either the sample average across all non-EU countries (USA), across all EU-countries is taken or the EU single market tariffs are set to 0.

BAU-CBAM. Starting from the BAU bilateral country-sector tariffs, CBAM tariffs are then calculated as follows. First, CBAM tariffs are assumed to be a product of the countries' carbon price differential and the exporter's CO2 intensity (Larch & Wanner (2017) and Korpar et al. (2023)). OECD (2016), Table B2, pp. 154-156 provides world carbon price differentials in the form of (sub-)national-level ETS prices for 2012. CHE and NOR are assumed to have the same ETS price as the EU. ETS countries outside the EU are AUS (CPM), CAN (Quebec), CHN (7 provinces), GBR (EU ETS), JPN (Tokyo and Saitama), KOR, USA (California and RGGI). For CHN, JPN and the USA, the averages of all subnational emission trading schemes are assumed. For each country-sector, CO2 intensities are obtained from OECD (2022b).

BAU-FTA. Tariffs for an EU-India FTA are calculated by subtracting the following tariff reduction scheme for each targeted country-sector pair. In line with Gallina et al. (2020), Scenario 1c, it is assumed that both EU and India lower tariffs in all goods sectors by 90%, but:

- motor vehicles (19) and other transport equipment (20): both EU and India -50%
- crops and animals (1): EU -10%, India -20%
- fishing and aquaculture (2): EU -90%, India -70%
- food, beverages, and tobacco (5): EU -40%, India -30%

CBAM-FTA. Tariffs of the EU-India FTA under CBAM are then calculated by applying the FTA to the BAU-CBAM tariffs according to the scenario above. This scenario resembles the currently most likely situation of an EU-India FTA phased in after a CBAM which has been in place for some years, already.

B.2 The Industry Conversion Scheme

This study works with the simplifying assumption that - no matter whether the tariff code pertains to the list of CBAM goods or not - all products within an industry aggregate are fully affected by a CBAM tariff. However, as outlined in Annex I of the EU Commission's CBAM proposal, not every gross industry aggregate is affected by CBAM, equally.

To calculate the CBAM coverage ratios, i.e., the percentage extent to which exporter countries' industries are exposed to CBAM, it is necessary to use more granular trade data. While the CBAM industry as outlined in the EU Commission proposal are defined at the CN 8-digit level (EUCOM (2021), Annex I), the OECD (2022a) nomenclature only contains broader industry aggregates. To bridge this gap, this paper proposes an industry conversion scheme to translate BACI trade data of 2014 at the HS6 6-digit level (Gaulier & Zignago (2010)) to the industry aggregation scheme as in

OECD (2022a). The industry aggregation scheme rests upon the conversion table "BTDIxE_Industries.pdf" which can be found in OECD (2021).

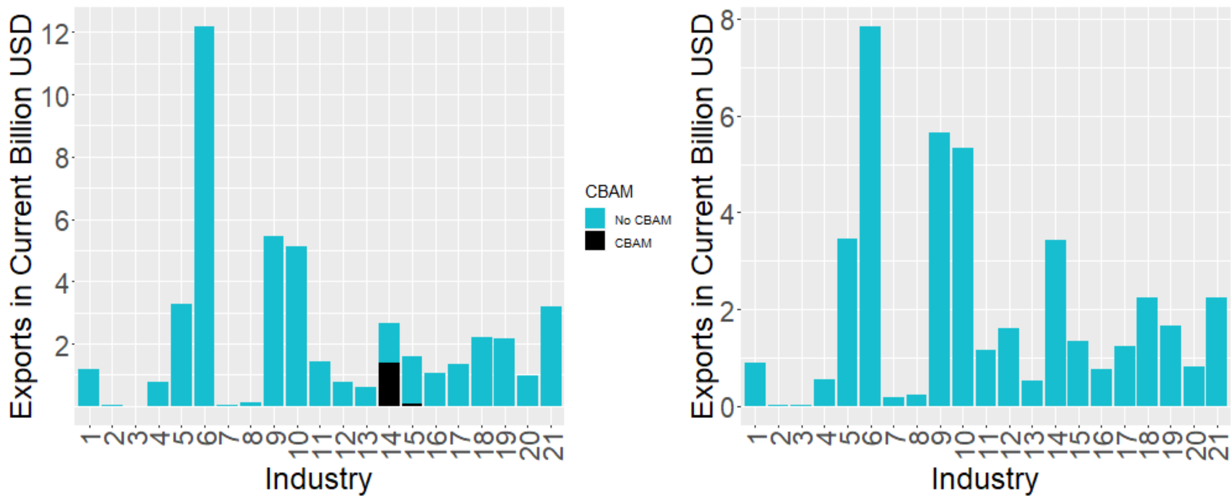

Figure B.1. *Left Panel: CBAM Coverage in Goods Exports from India to the EU in 2014. Sources: BACI (Gaulier & Zignago (2010)) for Export Data and OECD (2021) for the Conversion Scheme from UN Comtrade HS6 6-Digits to the ISIC4 Rev. 4 2-Digit Industry Aggregation. Right Panel: Goods Exports from India to the EU in 2014. Source: OECD (2022a).*

Figure B.1 compares the sector-level exports from India to the EU as to BACI export data (Gaulier & Zignago (2010)) and the baseline BAU equilibrium trade flows retrieved from the OECD ICIO tables (OECD (2022a)). To produce the left panel of Figure B.1, the HS6-to-ISIC Rev. 4 conversion scheme (OECD (2021))) matches the HS6 codes of the BACI version 202301 trade flows (Gaulier & Zignago (2010)) to the OECD industry aggregation scheme which is used in the main analysis of this paper. There are some noteworthy differences between the sectoral decomposition of India's exports retrieved by different trade data. While according to the concorded BACI data, total goods exports from India to the EU make up 46 bn. USD in 2014, the BAU equilibrium data state 34 bn. USD. It is important to retain from this that using this industry conversion scheme might distort the results, to some extent.

B.2 The Role of the CBAM in India-EU Trade

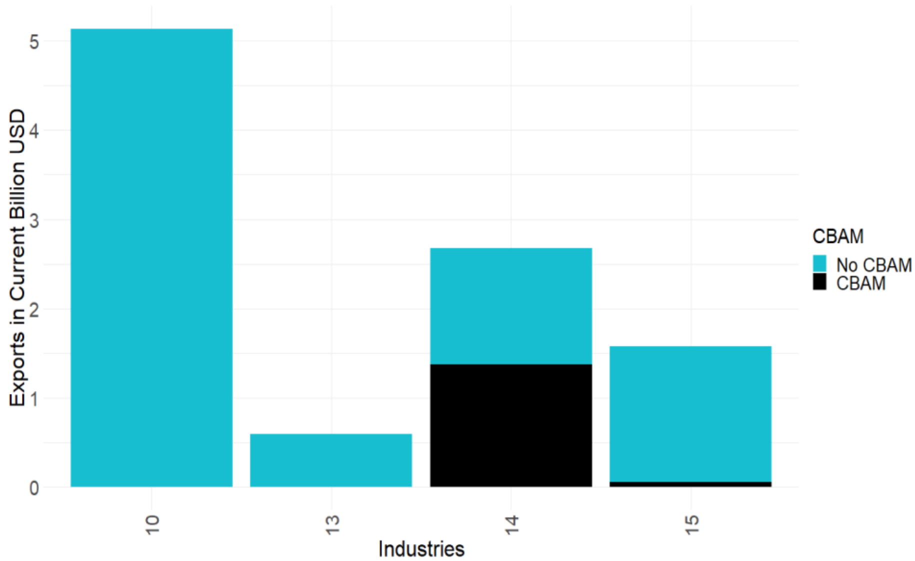

Figure B.2. *CBAM Coverage in Goods Exports from India to the EU in 2014. Sources: BACI (Gaulier & Zignago (2010)) for the Export Data and OECD (2021) for the Conversion Scheme from UN Comtrade HS6 6-Digits to the ISIC4 Rev. 4 2-Digit Industry Aggregation.*

Exploiting the sector-level detail the BACI data (Gaulier & Zignago (2010)) offer, Figure B.2 shows the coverage ratio of CBAM in India's exports to the EU by industries, in 2014. In 2014, 52% of India's basic metals (14) aggregate export value fell under the current CBAM, rendering it the highest within-industry coverage ratio among all Indian industries. In contrast, CBAM applies only to 5% of India's fabricated metals (15) exports, 0.04% of India's other non-metallic mineral products (13), largely made up by cement, and a mere 0.01% of India's chemicals (10) exports, largely driven by fertilizers.

As seen above, the highest coverage ratio of CBAM under Indian industry exports occurs in the basic metals (14) industry aggregate. The CBAM tackles over 100 iron and steel HS6 6-digit tariff lines (Cosbey et al. (2021)). This is followed by fabricated metal products (15) with a within-industry coverage ratio of 3.6%. The CBAM covers 22 aluminium HS6 6-digit tariff lines. The other non-metallic mineral products (13, covering four HS6 6-digit tariff lines of cement) and chemicals (10, covering three HS6 6-digit tariff lines of ammonia, one of potassium nitrate and eleven fertilizers) make up negligible shares of India's exports to the EU, with within-industry coverage ratios of 0.01% each (Cosbey et al. (2021)). Compared to all other CBAM industries, the ratio of CBAM exposure across product groups of 87% in basic metals (14) and 9% in fabricated metal products (15), in 2014 are confirmed by Simola (2021) who estimates a share of 90% of India's CBAM exports in steel products, followed by 10% in aluminium, in 2019. In the BACI data, fertilizers and cement make up negligible shares (4% combined). According to the BACI data, India’s total exports of CBAM goods to the EU make up 1.4 bn. USD in 2014, roughly resembling the estimate of 3 bn. EUR for 2019 obtained with Eurostat data (Simola (2021)).

Considering these within-industry coverage ratios is crucial when interpreting the results. Under the current CBAM legislation, Indian chemicals exports are thus far less exposed to CBAM than assumed in the model. An extension to this study would apply the each within-industry CBAM coverage ratio to each sectoral CBAM tariffs. To arrive at the alternative BAU-CBAM tariffs, the CBAM tariffs would be multiplied with the CBAM coverage ratio within each OECD (2022a) industry aggregate. Moreover, BACI trade data (Gaulier & Zignago (2010)) might come in handy since they offer a more detailed picture of exports across product groups than do the industry aggregates as offered in OECD (2022a).

C Additional Results

C.1 Changes in Trade and CO2 Emissions

Exporter	Absolute Changes						Percentage Changes					
	BAU-CBAM		BAU-FTA		CBAM-FTA		BAU-CBAM		BAU-FTA		CBAM-FTA	
	All	Only Inter	All	Only Inter	All	Only Inter	All	Only Inter	All	Only Inter	All	Only Inter
AUS	−0.7	−0.7	−464	−464	−451	−451	0.000	0.000	0.0	−0.1	0.0	−0.1
AUT	7.9	5.5	1935	2087	2004	2153	0.001	0.003	0.2	1.0	0.2	1.0
BEL	23.0	14.5	8944	9581	9286	9916	0.002	0.005	0.8	3.0	0.8	3.1
BGR	1.2	0.4	656	737	688	769	0.001	0.001	0.5	2.1	0.6	2.2
BRA	−3.0	−3.0	−466	−466	−540	−540	0.000	−0.001	0.0	−0.2	0.0	−0.2
CAN	1.3	1.3	−493	−493	−486	−486	0.000	0.000	0.0	−0.1	0.0	−0.1
CHE	3.3	2.4	−427	−427	−613	−420	0.000	0.001	0.0	−0.1	0.0	−0.1
CHN	−38.9	−38.9	−6892	−6892	−6812	−6812	0.000	−0.002	0.0	−0.3	0.0	−0.3
CYP	0.0	0.0	−3	3	−3	2	0.000	0.000	0.0	0.0	0.0	0.0
CZE	4.7	2.4	961	1110	1001	1148	0.001	0.002	0.2	0.7	0.2	0.8
DEU	67.8	27.8	29 297	32 961	30 206	33 834	0.001	0.002	0.4	2.4	0.4	2.4
DNK	2.3	1.3	540	717	559	734	0.000	0.001	0.1	0.5	0.1	0.5
ESP	19.0	6.0	4051	6060	4247	6245	0.001	0.001	0.2	1.5	0.2	1.5
EST	0.6	0.2	565	571	583	588	0.001	0.001	1.0	3.1	1.1	3.2
FIN	9.6	2.7	2052	2311	2101	2353	0.002	0.003	0.4	2.4	0.4	2.4
FRA	47.8	24.8	10 849	13 137	11 350	13 618	0.001	0.003	0.2	1.6	0.2	1.7
GBR	23.7	11.7	−1326	−1326	−1333	−1345	0.000	0.002	0.0	−0.2	0.0	−0.2
GRC	2.1	1.3	298	453	353	508	0.001	0.002	0.1	0.6	0.1	0.7
HRV	0.5	0.3	−60	−7	−60	−6	0.001	0.001	−0.1	0.0	−0.1	0.0
HUN	4.0	1.8	69	261	82	272	0.001	0.002	0.0	0.2	0.0	0.2
IDN	−4.4	−4.4	−743	−743	−701	−701	0.000	−0.002	0.0	−0.3	0.0	−0.3
IND	−9.6	−9.6	−49 563	35 761	−45 956	37 242	0.000	−0.002	−1.3	7.4	−1.2	7.8
IRL	6.7	2.6	461	860	425	820	0.001	0.001	0.1	0.3	0.1	0.3
ITA	28.4	8.4	6292	9310	6555	9557	0.001	0.001	0.2	1.6	0.2	1.6
JPN	−26.2	−26.2	−1898	−1898	−1904	−1904	0.000	−0.003	0.0	−0.2	0.0	−0.2
KOR	2.1	2.1	−1669	−1669	−1625	−1625	0.000	0.000	0.0	−0.2	0.0	−0.2
LTU	2.2	1.0	1265	1289	1314	1337	0.003	0.004	1.5	5.0	1.5	5.1
LUX	0.3	0.2	39	46	40	47	0.000	0.000	0.0	0.0	0.0	0.0
LVA	0.4	0.2	476	482	491	498	0.001	0.001	0.8	3.4	0.8	3.5
MEX	0.4	0.4	−181	−181	−175	−175	0.000	0.000	0.0	0.0	0.0	0.0
MLT	0.0	0.0	19	29	20	30	0.000	0.000	0.1	0.2	0.1	0.2
NLD	22.1	10.7	4265	4943	4470	5138	0.001	0.003	0.2	1.2	0.3	1.2
NOR	1.4	0.9	−102	−102	−992	−100	0.000	0.001	0.0	−0.1	−0.1	−0.1
POL	12.5	4.4	767	1774	800	1800	0.001	0.002	0.1	0.8	0.1	0.8
PRT	2.3	1.1	181	508	179	505	0.001	0.001	0.0	0.6	0.0	0.6
ROU	2.6	0.8	833	947	872	984	0.001	0.001	0.2	1.3	0.2	1.4
ROW	−32.8	−32.8	−10 943	−10 943	−10 903	−10 903	0.000	−0.001	−0.1	−0.3	−0.1	−0.3
RUS	−103.4	−103.4	−772	−772	−843	−843	−0.003	−0.021	0.0	−0.2	0.0	−0.2
SVK	1.9	1.1	−17	1	−14	3	0.001	0.001	0.0	0.0	0.0	0.0
SVN	0.9	0.5	317	377	329	389	0.001	0.002	0.3	1.3	0.3	1.3
SWE	4.8	2.7	2277	2356	2224	2301	0.000	0.001	0.2	1.1	0.2	1.1
TUR	0.4	0.4	4955	5552	−338	−338	0.000	0.000	0.3	2.5	0.0	−0.2
TWN	−3.6	−3.6	−808	−808	−796	−796	0.000	−0.001	−0.1	−0.2	−0.1	−0.2
USA	−84.4	−84.4	−5682	−5682	−5798	−5798	0.000	−0.004	0.0	−0.2	0.0	−0.2

Table C.1. *Counterfactual Changes in Exports under an EU CBAM (BAU-CBAM), an EU-India FTA (BAU-FTA), and an EU-India FTA under a CBAM (CBAM-FTA). All: Exports include Intra-Country Trade. Only Inter: only Exports Beyond the Country's Borders. Absolute Changes in Current Million USD.*

Exporter	Absolute Changes BAU-CBAM		Absolute Changes BAU-FTA		Absolute Changes CBAM-FTA		Percentage Changes BAU-CBAM		Percentage Changes BAU-FTA		Percentage Changes CBAM-FTA	
	All	Only Inter	All	Only Inter	All	Only Inter	All	Only Inter	All	Only Inter	All	Only Inter
AUS	−0.3	−0.3	−19	−19	−29	−29	−0.001	−0.001	−0.1	−0.1	−0.1	−0.1
AUT	0.0	0.0	69	69	71	71	0.001	0.001	2.3	2.3	2.4	2.4
BEL	0.1	0.1	193	194	200	201	0.003	0.003	4.3	4.3	4.4	4.5
BGR	0.0	0.0	31	31	32	32	0.001	0.001	1.2	1.2	1.2	1.3
BRA	−0.8	−0.8	−44	−44	−52	−52	−0.003	−0.003	−0.2	−0.2	−0.2	−0.2
CAN	0.2	0.2	−33	−33	−37	−37	0.001	0.001	−0.1	−0.1	−0.1	−0.1
CHE	0.0	0.0	−1	−1	−1	−1	0.000	0.000	−0.1	−0.1	−0.1	−0.1
CHN	−43.0	−43.0	−1029	−1029	−1115	−1115	−0.007	−0.007	−0.2	−0.2	−0.2	−0.2
CYP	0.0	0.0	1	1	1	1	0.000	0.000	0.2	0.2	0.2	0.2
CZE	0.0	0.0	73	73	75	76	0.001	0.001	1.3	1.3	1.3	1.4
DEU	0.5	0.4	688	689	711	712	0.001	0.001	1.7	1.8	1.8	1.8
DNK	0.0	0.0	12	12	12	12	0.000	0.000	0.3	0.3	0.3	0.3
ESP	0.2	0.2	297	298	306	306	0.001	0.001	2.5	2.5	2.5	2.6
EST	0.0	0.0	3	3	3	3	0.000	0.000	0.3	0.3	0.3	0.3
FIN	0.0	0.0	45	45	46	46	0.001	0.001	1.5	1.5	1.5	1.6
FRA	0.2	0.2	385	385	397	398	0.002	0.002	2.6	2.7	2.7	2.8
GBR	0.1	0.1	−11	−11	−11	−11	0.000	0.000	0.0	0.0	0.0	0.0
GRC	0.0	0.0	28	28	28	28	0.000	0.000	0.7	0.7	0.7	0.7
HRV	0.0	0.0	7	7	7	7	0.000	0.000	1.0	1.0	1.0	1.0
HUN	0.0	0.0	39	40	41	41	0.001	0.001	2.0	2.0	2.0	2.1
IDN	−0.9	−0.9	−30	−30	−35	−35	−0.003	−0.003	−0.1	−0.1	−0.1	−0.1
IND	−4.9	−4.9	3852	3868	3668	3684	−0.004	−0.004	3.0	3.1	2.9	2.9
IRL	0.0	0.0	14	14	14	14	0.000	0.000	0.6	0.6	0.6	0.6
ITA	0.1	0.1	170	171	176	176	0.001	0.001	1.1	1.1	1.1	1.1
JPN	−3.2	−3.2	−130	−130	−133	−133	−0.004	−0.004	−0.2	−0.2	−0.2	−0.2
KOR	0.4	0.4	−38	−38	−37	−37	0.001	0.001	−0.1	−0.1	−0.1	−0.1
LTU	0.0	0.0	12	12	12	12	0.001	0.001	2.5	2.5	2.6	2.6
LUX	0.0	0.0	2	2	2	2	0.000	0.000	0.5	0.5	0.5	0.6
LVA	0.0	0.0	2	2	3	3	0.000	0.000	0.6	0.6	0.6	0.7
MEX	0.1	0.1	−28	−28	−30	−30	0.000	0.000	−0.1	−0.1	−0.1	−0.1
MLT	0.0	0.0	0	0	0	0	0.000	0.000	0.1	0.2	0.1	0.2
NLD	0.3	0.2	392	393	407	407	0.003	0.002	3.9	4.0	4.1	4.1
NOR	0.0	0.0	−6	−6	−6	−6	0.001	0.001	−0.2	−0.2	−0.2	−0.2
POL	0.1	0.1	213	213	219	220	0.001	0.001	1.4	1.4	1.4	1.4
PRT	0.0	0.0	30	30	31	31	0.001	0.001	1.2	1.2	1.2	1.3
ROU	0.1	0.1	96	96	99	99	0.002	0.002	2.5	2.5	2.6	2.6
ROW	−4.4	−4.4	−287	−287	−323	−323	−0.001	−0.002	−0.1	−0.1	−0.1	−0.1
RUS	−29.8	−29.8	−152	−152	−183	−183	−0.032	−0.032	−0.2	−0.2	−0.2	−0.2
SVK	0.0	0.0	16	16	17	17	0.001	0.001	1.0	1.0	1.0	1.0
SVN	0.0	0.0	4	4	4	4	0.000	0.000	0.7	0.7	0.7	0.7
SWE	0.0	0.0	48	48	49	49	0.000	0.000	2.0	2.1	2.0	2.1
TUR	0.0	0.0	333	333	−16	−16	0.000	0.000	1.7	1.8	−0.1	−0.1
TWN	−1.3	−1.3	−42	−42	−44	−44	−0.007	−0.007	−0.2	−0.3	−0.3	−0.3
USA	−4.6	−4.6	−255	−255	−265	−265	−0.002	−0.002	−0.1	−0.1	−0.1	−0.1

Table C.2. *Counterfactual Changes in CO2 Emissions under an EU CBAM (BAU-CBAM), an EU-India FTA (BAU-FTA), and an EU-India FTA under a CBAM (CBAM-FTA). All: Exports include Intra-Country Trade. Only Inter: only Exports Beyond the Country's Borders. Absolute Changes in Million Tons of CO2.*

Industry	Absolute Changes								
	BAU-CBAM			BAU-FTA			CBAM-FTA		
	EU	India	ROW	EU	India	ROW	EU	India	ROW
1	0.0	0.0	0.0	51	−40	5	51	−40	5
2	0.0	0.0	0.0	5	−6	0	5	−5	1
3	0.0	0.0	0.0	0	−189	0	0	−45	0
4	0.0	0.0	0.0	1547	−3689	25	1547	−3401	2321
5	0.0	0.0	0.0	445	−80	34	445	−80	26
6	0.0	0.0	0.0	385	−150	30	385	−130	8
7	0.0	0.0	0.0	15	−160	2	15	−155	2
8	0.0	0.0	0.0	12	−1813	1	12	−1800	3
9	0.0	0.0	0.0	2484	−910	298	2484	−610	0
10	−7.6	0.0	−0.6	29 165	−64 939	479	29 177	−63 839	44
11	0.0	0.0	0.0	71	−150	2	71	−150	0
12	0.0	0.0	0.0	110	−1201	10	110	−1159	1
13	−0.2	0.0	0.0	12	−73	2	12	−69	0
14	−1.0	0.0	−0.2	59	−920	37	59	−880	4
15	0.0	0.0	0.0	55	−1207	3	55	−1177	1
16	0.0	0.0	0.0	118	−681	6	118	−679	1
17	0.0	0.0	0.0	47	−2447	3	47	−2405	1
18	0.0	0.0	0.0	171	−6372	13	171	−6282	4
19	0.0	0.0	0.0	35	−220	4	35	−216	0
20	0.0	0.0	0.0	2	−22	0	2	−22	0
21	0.0	0.0	0.0	20	−55	1	20	−54	1
22	0.0	0.0	0.0	0	0	0	0	0	0

Table C.3. *Counterfactual Changes in Exports of India under an EU CBAM (BAU-CBAM), an EU-India FTA (BAU-FTA), and an EU-India FTA under a CBAM (CBAM-FTA) by Industry Aggregate and Destination, in Current Million USD.*

Industry	Absolute Changes								
	BAU-CBAM			BAU-FTA			CBAM-FTA		
	India	EU	ROW	India	EU	ROW	India	EU	ROW
1	0.0	0.0	0.0	18	−44	5	18	−44	−1
2	0.0	0.0	0.0	4	−4	0	4	−4	0
3	0.0	0.0	0.0	132	0	0	132	0	0
4	0.0	0.0	0.0	5281	−637	25	5387	−637	−460
5	0.0	0.0	0.0	78	−424	34	78	−424	−6
6	0.0	0.0	0.0	127	−233	30	127	−233	−3
7	0.0	0.0	0.0	168	−14	2	168	−14	0
8	0.0	0.0	0.0	1971	−12	1	1972	−12	−1
9	0.0	0.0	0.0	670	−1955	298	673	−1955	0
10	0.0	253.5	4.6	77 184	−22 222	479	79 898	−21 998	−16
11	0.0	0.0	0.0	155	−54	2	155	−54	0
12	0.0	0.0	0.0	1517	−94	10	1522	−94	−1
13	0.0	3.2	0.1	70	−11	2	70	−9	0
14	0.0	11.7	1.2	996	−50	37	998	−39	0
15	0.0	1.5	0.0	1296	−48	3	1299	−48	0
16	0.0	0.0	0.0	1433	−63	6	1434	−63	0
17	0.0	0.0	0.0	3132	−36	3	3140	−36	0
18	0.0	0.0	0.0	8998	−142	13	9038	−142	−2
19	0.0	0.0	0.0	222	−34	4	222	−34	0
20	0.0	0.0	0.0	31	0	0	31	0	0
21	0.0	0.0	0.0	90	−16	1	90	−16	0
22	0.0	0.0	0.0	−1	−5	0	−1	−5	0

Table C.4. *Counterfactual Changes in Exports of the EU under an EU CBAM (BAU-CBAM), an EU-India FTA (BAU-FTA), and an EU-India FTA under a CBAM (CBAM-FTA) by Industry Aggregate and Destination, in Current Million USD.*

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