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The New European Carbon Border Adjustment Mechanism

- The EU's Carbon Border Adjustment Mechanism will come into effect October 2023
- Trade flows, greenhouse gas emissions, and production in emission-intensive industries will have to adjust
- Carbon leakage is still possible with the CBAM; international cooperation for reducing carbon emissions is key

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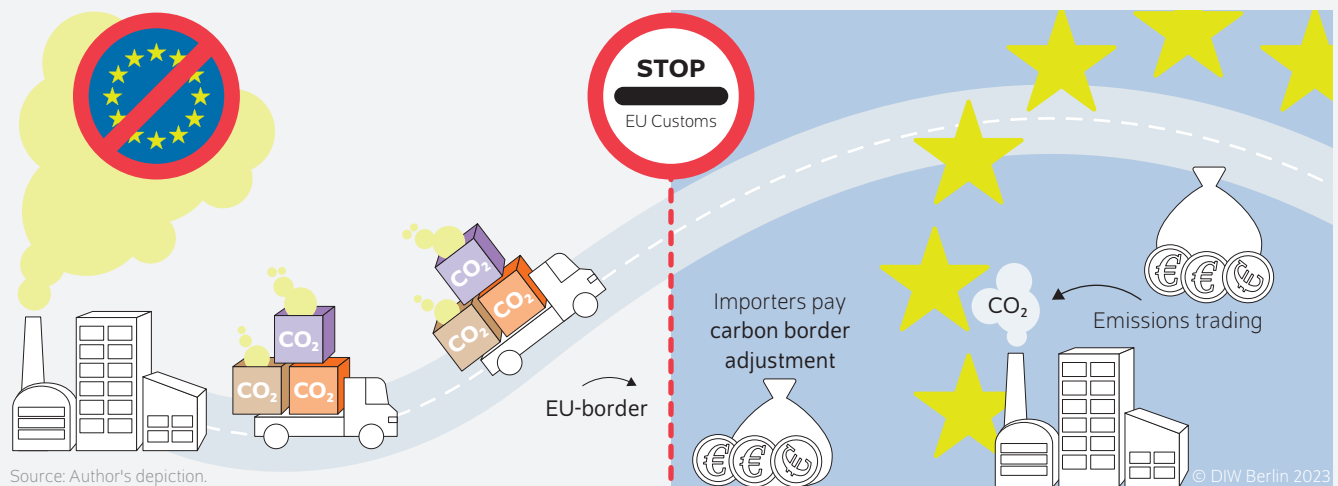
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The New European Carbon Border Adjustment Mechanism

By Robin Sogalla

- The EU Carbon Border Adjustment Mechanism (CBAM) will begin in October 2023
- Simulation shows effects of the new policy instrument on trade flows, greenhouse gas emissions, and production in emission-intensive industries
- CBAM can reduce competitive disadvantages caused by rising carbon prices in the EU and carbon leakage
- CBAM provides limited incentives to third countries, making mechanisms for cooperation key
- CBAM must not be a protectionist instrument and should be accompanied by multilateral cooperation

European Carbon Border Adjustment Mechanism: preventing carbon leakage



FROM THE AUTHORS

„Rising prices of carbon emissions without compensation can result in production shifting from the EU to third countries where carbon costs are lower. A border adjustment mechanism can mitigate this.“

— Robin Sogalla —

MEDIA



Audio Interview with Robin Sogalla (in German)
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The New European Carbon Border Adjustment Mechanism

By Robin Sogalla

ABSTRACT

In October 2023, the EU Carbon Border Adjustment Mechanism (CBAM), a part of the reform of the European Emissions Trading System (EU ETS), will come into effect. Currently, energy-intensive industries do not need to purchase all of the necessary EU ETS allowances on the market to remain globally competitive, as the remaining allowances are freely allocated to them. The CBAM plans to gradually replace free allowances with a price on the carbon emissions embedded in imports. Following a transitional—primarily monitoring—phase, this price on embedded emissions will be gradually introduced from 2026 on the imports of certain products. While the CBAM can mitigate carbon leakage, production declines in greenhouse-gas intensive industries as a result of limiting free allowances, and rising carbon prices, it cannot compensate for them completely. In particular, the CBAM does not provide sufficient protection for exporters to non-EU countries. It is crucial that the CBAM does not lead to trade conflicts that would make multilateral cooperation more difficult. International cooperation is indispensable, as it is the only way to reduce global emissions.

The European Union (EU) has set a goal to become climate-neutral by 2050. To achieve this goal, the EU Commission proposed the Fit for 55 package, a package of various measures meant to decrease greenhouse gas emissions by 2030 by 55 percent in comparison to 1990.¹ A key component of this reduction is the carbon pricing via the European Emissions Trading System (EU ETS).² However, this carries the risk of greenhouse-gas-intensive industries relocating their production, and thus emissions, abroad due to rising costs. This is known as carbon leakage.

To prevent carbon leakage, the EU is introducing a Carbon Border Adjustment Mechanism (CBAM) on October 1, 2023.³ In a transitional phase from October 2023 to December 2025, importers from non-EU countries will initially be required to report on the carbon emissions embedded in the imports of certain products. From January 2026, a price on these embedded emissions in the amount of the valid EU ETS carbon price will be levied, with the price only applying to the emissions in excess of the freely allocated emission allowances.⁴ Until 2034, freely allocated emission allowances will be gradually reduced to zero, meaning that the border adjustment will be levied on all embedded emissions. This is intended to compensate as much as possible for the cost differences at the border as a result of European carbon pricing.

Such a carbon border adjustment will not only affect carbon leakage, however: Trade flows, real income, and the production level of energy-intensive industries will also be affected. The effects of the emission reduction target laid out in the Fit for 55 package in combination with various options for the

¹ For an overview of the measures, cf. European Commission (available online, accessed on May 22, 2023). This applies to all other online sources in this report unless stated otherwise.

² The EU ETS and CBAM cover also other greenhouse gases. Because CO₂ emissions are the major part, the following text will refer mainly to CO₂ emissions, which should be understood as a reference to all covered greenhouse gases.

³ European Union, "Regulation (EU) 2023/956 of the European Parliament and of the Council of 10 May 2023 establishing a carbon border adjustment mechanism," *Official Journal of the European Union*, vol. 66, L 130 (2023) (available online).

⁴ Industries covered by the CBAM will still receive part of the emission certificates for free. CBAM will only apply to the emissions, which are not covered by free allowances.

$$\text{CBAM} = [(\text{Actual CO}_2\text{-intensity of the producer exporting to the EU (in tons of CO}_2\text{ per produced ton)} - (\text{freely allocated certificates in ETS per produced ton})) \times (\text{produced ton}) \times (\text{ETS-CO}_2\text{-Price}) - (\text{CO}_2\text{-Price, that was paid in the exporting country})]$$

Box

International trade model

The simulation analysis presented is based on a quantitative international trade model. It is a static, computable general equilibrium model. The model combines Ricardian elements of comparative advantage with "new" trade theory, which incorporates the realized economies of scale that arise due to imperfect competition. Moreover, the model maps heterogeneous emission intensities of companies within a sector. Variants of this model have already been used multiple times to analyze trade policy measures¹ and to evaluate climate policy instruments.²

Ideally, the macroeconomic approach would be combined with available disaggregated microdata. The extent to which macroeconomic models adequately represent emission reduction opportunities with significantly higher carbon prices is also critical. Like any model, the macroeconomic model used abstracts from some factors. Therefore, the results should not be interpreted as exact quantitative predictions, but rather as insights into the mechanisms of the effect of European carbon pricing. The most important limitations of the model are described below.

The model is limited to capturing varying emission intensities within individual subsectors to a certain degree of detail. This abstracts from the concrete production technologies. Instead, it is assumed that a share of the fossil fuels can be replaced by other produc-

tion factors. The resulting changes in emission intensity are thus subject to uncertainty. Since this is a static model, the simulations do not consider innovations in emission-reducing technologies. Moreover, the model can only quantify the effects in the new medium-term equilibrium and not the adjustments along the transition pathway. Finally, the use of intermediate products is not modeled, so effects along the value chain cannot be quantified.

Exiobase is the dataset used in this model.³ The database contains information on trade flows, inputs, and the greenhouse gas emissions from production processes according to sector and country. Current customs data from the World Integrated Trade Solutions platform as well as data on carbon prices have been added to the dataset. Overall, the model covers the intranational and international trade of 43 countries as well as five aggregated regions and differentiates between 53 sectors, 44 of which are in manufacturing and 23 in sectors subject to the EU ETS.

The base year for the presented simulation is 2015, so all effects indicate the change from that year. The simulation assumes an EU-wide binding emission cap that reduces greenhouse gas emissions for 2030 by a total of 55 percent compared to 1990 (and 42 percent compared to 2015). Unlike previous climate policy, the binding cap applies to all sectors. This scenario is combined with different CBAM designs. Unlike the gradual introduction of the CBAM until 2034, it is assumed that the carbon border adjustment will replace free allocation starting in 2030.⁴

¹ Cf. Arnaud Costinot and Andrés Rodríguez-Clare, "Trade Theory with Numbers: Quantifying the Consequences of Globalization," in *Handbook of International Economics* (2014): 197–261. (available online). Konstantin Kucheryavyy, Gary Lyn, and Andrés Rodríguez-Clare, "Grounded by Gravity: A Well-Behaved Trade Model with Industry-Level Economies of Scale," *American Economic Journal: Macroeconomics* 15, no. 2 (2023): 372–412.

² Joseph S. Shapiro and Reed Walker, "Why Is Pollution from US Manufacturing Declining? The Roles of Environmental Regulation, Productivity, and Trade," *American Economic Review* 108, no. 12 (2018): 3814–3854 (available online); Farid Farrokhi and Ahmad Lashkaripour, "Can Trade Policy Mitigate Climate Change," *STEG Working Paper Series* (2022) (available online).

³ For a detailed description of the data, cf. Stadler et al., "EXIOBASE 3: Developing a time series of detailed environmentally extended multi-regional input-output tables," *Journal of Industrial Ecology* 22, no. 3 (2018): 502–515 (available online).

⁴ For technical details about the structure of the model as well as further results and descriptions of the data, see Sogalla, "Unilateral Climate Policy and Heterogeneous Firms," *DIW Discussion Paper* (2023) (available online).

concrete design of the CBAM will be simulated in the following section using a quantitative foreign trade model (Box).

Carbon leakage and the European Emissions Trading System

Avoiding carbon leakage is an important aspect when designing unilateral carbon pricing. The potential relocation of industries and the threat of lost jobs are associated with economic and social costs, which reduce climate policy acceptance. Moreover, carbon leakage undermines the effectiveness of a unilateral climate policy: Global, not national, greenhouse emissions are decisive for combating climate change. In an extreme case in which the emissions avoided are completely relocated to a third country, unilateral climate policy would have no effect on global greenhouse gas emissions.

To avoid carbon leakage, energy-intensive industries receive a majority of the allowances needed to cover their emissions

for free.⁵ Thus, so far, the EU ETS has not caused carbon leakage.⁶ However, the free allocation of emission allowances can reduce incentives to switch to low-carbon production technologies.⁷ Furthermore there is no public revenue, which the auctioning of the allowances could generate. Therefore,

⁵ Stefano Verde et al., "Free allocation rules in the EU emissions trading system: what does the empirical literature show?" *Climate Policy* (2022): 439–452 (available online).

⁶ Cf. Helene Naegele and Aleksandar Zaklan, "Does the EU ETS cause carbon leakage in European manufacturing?" *Journal of Environmental Economics and Management*, vol. 93 (2019): 125–147 (available online); Stefano Verde, "The impact of the EU Emissions Trading System on Competitiveness and Carbon Leakage: The Econometric Evidence," *Journal of Economic Surveys*, vol. 34 (2020) (available online); Jonathan Colmer et al., "Does pricing carbon mitigate climate change? Firm-level evidence from the European Union Emissions Trading Scheme," *Discussion Paper Series – CRC TR 224*, no. 232 (2023) (available online); Dechezleprêtre et al., "Searching for carbon leaks in multinational companies," *Journal of Environmental Economics and Management* 112 (2022): 1–20 (available online).

⁷ Jordi Teixidó, Stefano Verde, and Francesco Niccoli, "The impact of the EU Emissions Trading System on low-carbon technological change: the empirical evidence," *Ecological Economics*, vol. 164 (2019): 106347.

Table

Overview of the simulated scenarios

Scenario	Carbon pricing in the EU	CBAM design	
		Affected industries	Assessment base
I No CBAM	EU-wide carbon price on all sectors, which leads to greenhouse gas emissions decreasing by 55 percent compared to 1990	No CBAM	
II Proposed CBAM		Aluminum, iron and steel, fertilizer, cement, energy	Emission intensity of the producers (i.e., the emission intensity of the exporting third country)
II Expanded CBAM		Same as in Scenario II plus polymer, refined products, and other basic chemical products	
II CBAM including EU ETS		All ETS industries	Emission intensity based on production within the EU
II CBAM EU emission intensity		All ETS industries	

NOTE: CBAM stands for Carbon Border Adjustment Mechanism. Industries that are subject to the European Emissions Trading System (EU ETS industries) are aluminum; basic chemical products; cement; ceramics; coke ovens; copper; construction materials; fertilizer; foundries; glass; lead, zinc, tin; non-metallic minerals; other non-ferrous metals; paper production; polymers; precious metals; printed products; pulp production; refined products; and rubber and plastic products.

Source: Author's depiction.

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the practice of free allocations will now be gradually reduced and carbon leakage will instead be addressed via the CBAM.⁸

Challenges in modeling effects of climate policy measures

One measure in the Fit for 55 package is to reduce the emission cap in the EU ETS more quickly, which will lead to higher carbon prices. Multiple effects and interactions are associated with the impact of these higher prices and the CBAM as a new instrument to protect against carbon leakage. There are two general approaches for analyzing these effects and interactions. One is a detailed focus on individual sectors (bottom up) and the other is a macroeconomic look at entire economies (top down).⁹ The advantages of the first approach are that the relevant aspects of production technologies, cost structures, and trade relationships can be depicted. However, this disaggregated view requires a focus on individual sectors; interactions with other sectors are not considered and conclusions about the macroeconomic effects are not possible. The macroeconomic approach used in this study incorporates such feedback effects between sectors. However, this comes at a cost, as individual sectors are modeled in less detail; potentially high cost increases of individual subsectors may be less well captured. Furthermore, the potential to reduce the emission intensity of production processes may be overestimated and the risk of carbon leakage underestimated (Box).

Different CBAM design scenarios

There are multiple possible design scenarios for a CBAM, some of which are analyzed in more detail in this section (Table). Hypothetical scenario I, "NO CBAM," assumes that the EU introduces a binding cap for all greenhouse gas emissions. This cap corresponds to the 55 percent reduction by

2030 relative to 1990, or 42 percent relative to 2015, as defined in the Fit for 55. The scenario assumes that these emission reductions are achieved solely through the incentives of an EU-wide carbon price by abstracting from investment risks, learning effects, infrastructure requirements, and financing barriers. In the other scenarios, various design options for the CBAM are simulated. There are two main questions regarding the concrete design of the CBAM: Which industries should be subject to the new carbon border adjustment? And which tax base should be used to determine the emission intensity of imports?

Scenarios II to IV simulate the effects of different combinations of industries. A key point of discussion at the European level was which products will be subject to the CBAM. In the end, it was agreed that aluminum, iron and steel, fertilizer, hydrogen, electricity, and cement will be subject to the CBAM during the first phase.¹⁰ In scenario II, the CBAM applies to these sectors. While the EU regulation protects the other sectors from carbon leakage by continuing the free allocation of emission allowances, the simulation does not assume this protection for the other sectors.

Scenario III depicts a CBAM with an expanded scope in the medium term. Currently, it is planned to review the inclusion of polymers and organic chemicals following the transitional phase.¹¹ The European Parliament also demanded to end the free allocation of emission allowances to refined products. These products are included in the CBAM in Scenario III.¹² Finally, Scenario IV assumes the CBAM is extended to include all goods subject to the EU ETS.

Scenario V differs from the previous scenarios in its assessment base. In scenarios II to IV, the CBAM is based on the

⁸ European Parliament, "Climate change: Deal on a more ambitious Emissions Trading System (ETS)," press release, 2023 (available online).

⁹ Andreas Löschel, "Role of Auctions: The Role of Numerical Models," in Karsten Neuhoff et al., *The Role of Auctions for Emissions* (Cambridge: Climate Strategies, 2008): 35-40 (available online).

¹⁰ European Union, "Regulation (EU) 2023/956," Annex 1, p. 92.

¹¹ Cf. European Union, "Regulation (EU) 2023/956," Article 30, 2a), p. 86.

¹² Cf. European Parliament, *Amendments adopted by the European Parliament on 22 June 2022 on the proposal for a regulation of the European Parliament and of the Council establishing a carbon border adjustment mechanism, Amendment 26 (COM(2021)0564 – C9-0328/2021 – 2021/0214(COD))* (I) (2022) (available online).

emission intensity of the third country. Scenario V, in contrast, uses reference values based on the average emission intensity within the EU. In the first scenarios, the assessment base of the greenhouse gas emissions emitted in the production process is thus better captured. However, the use of EU reference values would reduce the administrative burden in terms of the data to be collected.

CBAM reduces carbon leakage

If neither the free allocation of emission allowances nor a carbon border adjustment mechanism are used to address carbon leakage risks, carbon prices create incentives for carbon leakage. In Scenario I, each ton of greenhouse gases avoided in the EU ETS industries creates nearly 0.4 tons of additional emissions abroad (Figure 1). In comparison, the CBAM reduces carbon leakage. The more products subject to the CBAM, the less carbon leakage occurs. However, the CBAM becomes significantly less effective if it is based on the lower EU emission intensity from the model result.

CBAM cannot compensate for competitive disadvantages for exporters to non-EU countries

In addition to carbon leakage, the introduction of a more stringent climate policy also has impacts on trade flows and on the production level of the industries that produce goods subject to the EU ETS. Thus, without measures to avoid carbon leakage, a high carbon price leads to more imports of energy-intensive products from non-EU countries (Figure 2). This reduces production in Europe and in particular exports to non-EU countries.

The introduction of the CBAM would make the affected imports more expensive, which reduces imports of goods from the EU ETS industries in all scenarios. In this way, the CBAM protects the competitiveness on the European domestic market. CBAM only prices the emissions embodied in imports. Therefore, it does not compensate for the cost increases of exporters of the affected products to third countries. As the CBAM is only levied on basic materials, there could be negative effects on the competitiveness of downstream industries along the value chain that were not considered in the model simulation.

Negative effects on trade partners mostly for exporters of fossil fuels

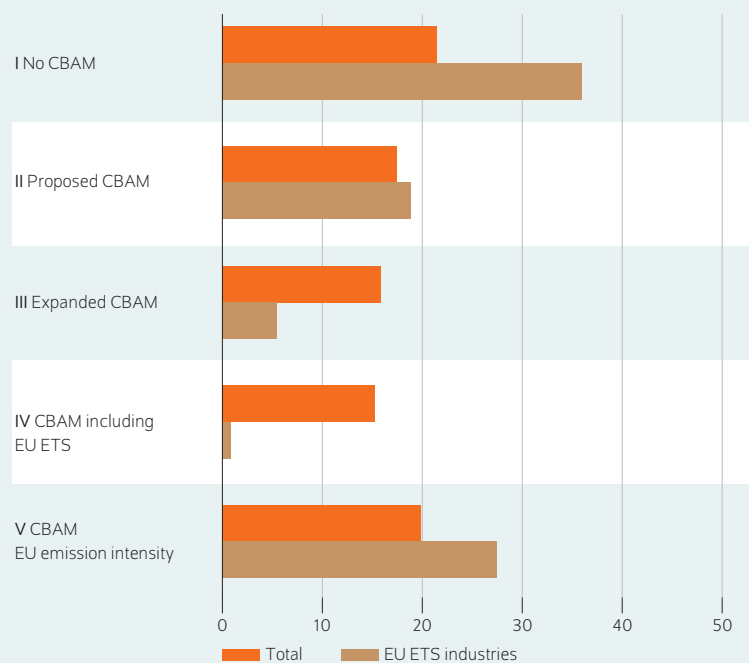
One potential danger of the CBAM is that Europe's trade partners will view it as a protectionist instrument. This could provoke retaliation and, in the worst case, lead to a trade war.

Real income losses as a result of more stringent European climate policies are small for most of the EU's trading partners, even with the CBAM (Figure 3). While exporters of fossil fuels to the EU will be affected by the low demand as a result of the emission reductions in the EU, this negative effect would occur with any emission-reducing measure and is not due to the CBAM. However, the CBAM could

Figure 1

Carbon leakage rate of various CBAM designs

Carbon leakage in percent



Note: The figure shows the carbon leakage rate for achieving the Fit for 55 target without a carbon border adjustment mechanism as well as the design options for the CBAM described in the table. The carbon leakage rate is the ratio of emission changes outside the EU to emission changes within the EU. EU ETS industries are the industries that are subject to the European Emissions Trading System (EU ETS) (cf. note in the table).

Source: Figure based on simulation results in Robin Sogalla, "Unilateral Climate Policy and Heterogeneous Firms," Working Paper (2023) (available online).

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A carbon border adjustment reduces carbon leakage compared to carbon pricing that does not compensate industries.

pose major challenges to individual countries that are particularly dependent on basic materials exports.¹³ This effect could be mitigated by using part of the revenue generated by the EU ETS and, later, the CBAM, to finance the transition to low-carbon production in non-EU countries. In contrast, the effects for the USA and China are low. Both countries have a higher real income as a result of the most stringent carbon pricing in the EU, even with the CBAM.

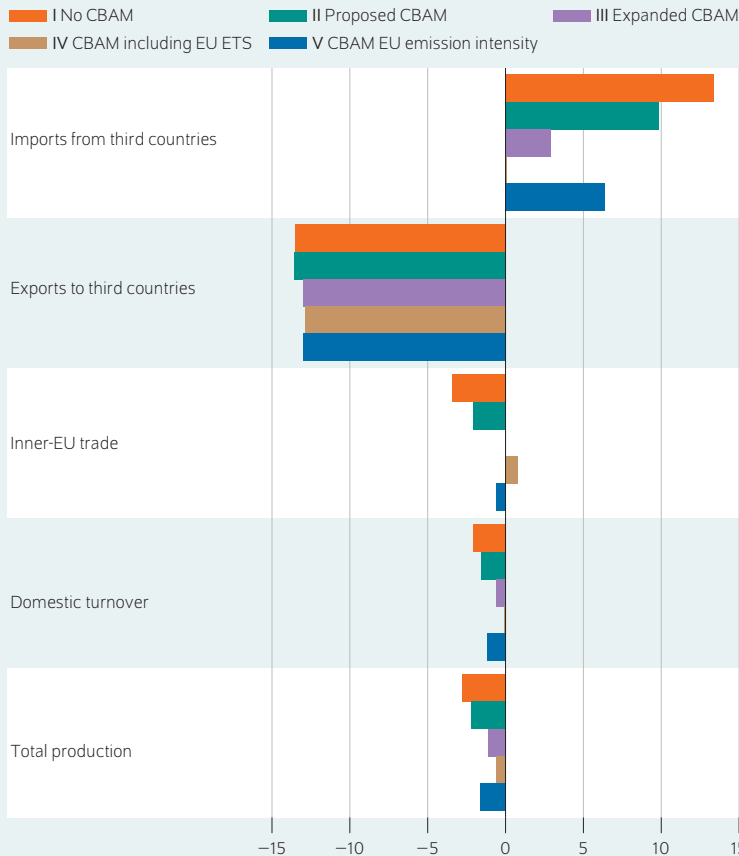
Marginal effect on global greenhouse gases

The global greenhouse gases avoided in Scenario I total three percent. Compared to the decline of 42 percent within the EU, these savings are small. By mitigating carbon leakage, the CBAM results in higher emissions savings. However, even with a CBAM for all EU ETS products (Scenario IV), the savings are only 3.3 percent. Therefore, the EU acting alone on climate policy cannot substantially reduce global emissions.

¹³ Guilherme Magacho, Etienne Espagne, and Antoine Godin, "Impacts of the CBAM on EU trade partners: consequences for developing countries," *Climate Policy* (2023) (available online).

Figure 2

Production and trade effects in the EU ETS industries In percent



Note: The figure shows the effects of imports and exports from/to third countries as well as intra-European trade and domestic production in the EU ETS industries (cf. the note in the table). All effects are given in percentage changes from the baseline. The scenarios considered are the same as in Figure 1 (cf. note).

Source: Figure based on simulation results in Robin Sogalla, "Unilateral Climate Policy and Heterogeneous Firms," Working Paper (2023) (available online).

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CBAM reduces emission-intensive imports and production declines in EU ETS industries as a result of carbon pricing.

Conclusion: Prevent trade disputes and enable multilateral cooperation

There is much to suggest that without a suitable instrument to protect against carbon leakage, the rising carbon prices in the EU ETS will result in carbon leakage in non-EU countries. CBAM can mitigate carbon leakage and production declines in the affected industries. As the planned CBAM would only apply to imports, however, it does not offer a sufficient solution for preventing a decline in exports of emission-intensive firms. In addition, the CBAM initially only applies to basic materials. This leaves the risk that it will be partially circumvented by importing intermediate goods, which would weaken its protective effect.

Regarding the design, a balance should be struck between the high administrative costs of collecting data on the emission intensity of third countries exporting to the EU and the effectiveness of carbon border adjustment in regard to carbon leakage.

In addition to these practical questions, it is decisive when designing the CBAM that trade partners do not view it as a protectionist instrument. This is not only important to avoid countervailing protectionist measures related to income losses, but it is also indispensable to avoid trade disputes to succeed in transitioning to climate neutrality. For example, the EU imports many key technologies, such as batteries and raw materials necessary for the energy transition.¹⁵ Moreover, the climate crisis can only be combated by multilateral and, in the best case, global solutions. Therefore, it should be welcomed that the preamble to the legislative proposal highlights possibilities for multilateral cooperation.¹⁶ Even if such cooperation seems difficult due to the strong variation in carbon pricing,¹⁷ there are also positive signals, such as the introduction of the world's largest emission trading system in China.

The EU's climate policy should consider the effects on possible collaborations with other countries. Thus, it is also decisive from a climate policy perspective that the CBAM is not perceived as a protectionist instrument.

One possibility could be deeper cooperation on a bilateral or sectoral level or via new platforms such as the G7-initiated Climate Clubs, in which multiple countries join forces with their climate policies.¹⁴ Important for all initiatives is that they are not perceived as an isolationist instrument of Western countries and that they encourage other countries to join.

¹⁴ More suggestions on global cooperation can be found in Heiner von Lüpke, Charlotte Aebischer, and Karsten Neuhoﬀ, "Collective Action: New Guiding Principles for International Climate Finance," *DIW Weekly Report*, no. 32 (2021): 229–236 (available online).

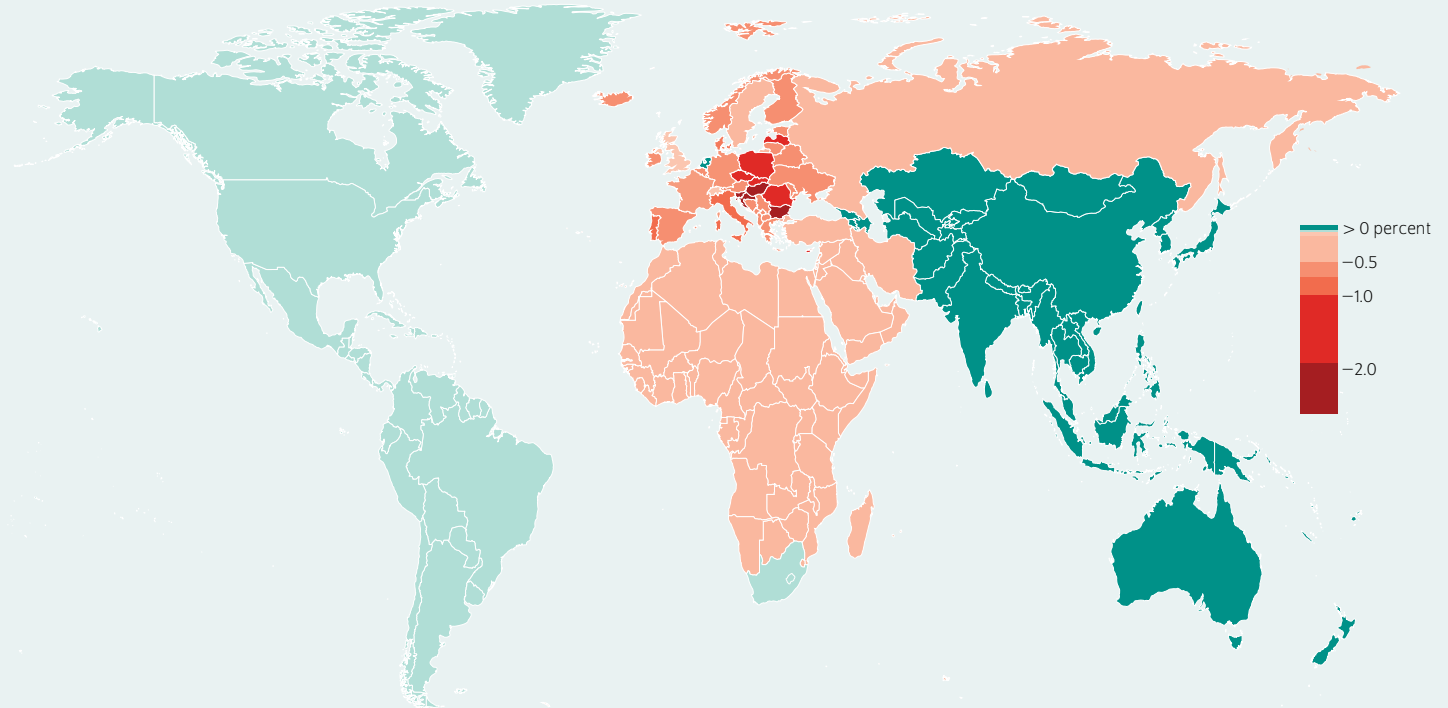
¹⁵ Cf. EU Commission, *Critical Raw Materials for Strategic Technologies and Sectors in the EU – A Foresight Study* (2020) (available online) and Lukas Menkhoff and Marius Zeevaert, "Germany Can Increase Its Raw Material Import Security of Supply," *DIW Weekly Report*, no. 49/50 (2022): 317–325 (available online).

¹⁶ "The establishment of the CBAM calls for the development of bilateral, multilateral and international cooperation with third countries. For this purpose, a forum of countries with carbon pricing instruments or other comparable instruments ('Climate Club') should be set up, in order to promote the implementation of ambitious climate policies in all countries and pave the way for global carbon pricing framework." European Union, "Regulation (EU) 2023/956," p. 64.

¹⁷ Currently, 23 percent of global greenhouse gas emissions are taxed or subject to an emissions trading system. Prices vary depending on the region. Cf. World Bank, *State and Trends of Carbon Pricing 2022* (Washington, DC: 2022) (available online).

Figure 3

Real income effects of the Fit for 55 emission reduction combined with the proposed CBAM (Scenario II) In percent



Note: The figure shows the percentage change in real income by country for the Fit for 55 reduction target combined with the proposed CBAM compared to the baseline. Real income is calculated using nominal income and the price index. A majority of African countries, as well as countries in South America, Southeast Asia, and the Middle East, were aggregated in the dataset, so the effects shown only indicate the regional average for these countries.

Source: Figure based on simulation results in Robin Sogalla, "Unilateral Climate Policy and Heterogeneous Firms," Working Paper (2023) (available online).

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Even with a border adjustment, there are few negative effects on European trade partners.

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