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FROM WINDFALL GAINS TO CARBON BORDERS AND BEYOND?

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One of the most important EU instruments for combating climate change is the European Union Emission Trading System (EU ETS), which uses market mechanisms to encourage reductions in greenhouse gas emissions. An important element of the system is to prevent carbon leakage, so that actual emission reductions are achieved at the global level and the rules do not merely lead to a shift in emissions. Consequently, the aim of the study is to examine how the introduction of the Carbon Border Adjustment Mechanism (CBAM) will affect the allocation of free allowances to carbon-intensive industries and the level of state aid for indirect energy costs in order to prevent carbon leakage. The study explores the optimal solution to the resulting export price and indirect cost compensation issues, with consideration given to both climate objectives and the competitiveness of industries. The study concluded that harmonised regulation at EU level is essential to ensure that both Member States and the EU remain competitive in the future.

1. Introduction

Global greenhouse gas (GHG) emissions are steadily increasing. By 2023, they will reach 53.0 Gt CO2eq, representing a 1.9 % (994 Mt CO2eq) increase compared to 2022 levels. Currently, the United States (US), the European Union, India, China, Russia and Brazil are the largest emitters, accounting for almost 63 % of global GHG emissions. In 2023, however, emissions from EU Member States fell by 7.5 %, reducing their share of global emissions to 6.1 %. (Crippa et al., 2024) Is this reduction solely due to the EU's strict climate policy and the evolving rules of the ETS system?

The research is also closely linked to several Sustainable Development Goals (SDGs): SDG 13 (climate action) examines the extent to which parallel quota allocation and support mechanisms delay or promote emission reductions; SDG 9 (industry, innovation and infrastructure) assesses the pressure to invest in clean technologies in energy-intensive industries; SDG 7 (affordable and clean energy) and SDG 12 (responsible consumption and production) analyse the effect of these interventions on energy consumption patterns.

The aim of the study is to present the concerns related to carbon leakage that are apparent within the European Union. What solutions has the EU applied to this problem, and how and to what extent will the introduction of CBAM shape these solutions? It also addresses issues that may arise following the introduction of CBAM, such as the lack of export refunds and the possible elimination of state aid related to indirect ETS costs. It outlines various hypothetical models and proposed solutions to these problematic issues so that EU companies can remain competitive while keeping climate goals in mind. Ultimately, it concludes that, in the short and medium term, a harmonized EU-wide indirect cost compensation system must be introduced, and that, with regard to exports, the CBAM needs to be supplemented or replaced by another solution that is WTO-compatible and acceptable to all parties.

In studies on similar topics, a company-level study (Ferrara and Giua, 2022) confirms that indirect cost compensation has a tangible impact on competition between companies. A Bruegel study (Sgaravatti, 2024) also mentions harmonized, EU-wide minimum regulations for the provision of such compensation as state aid. Many studies state that the introduction of CBAM will cause export problems, which will reduce competitiveness. They then discuss possible solutions. The most discussed of these are export refunds, targeted state aid, and bilateral agreements (Bellora and Fontagné, 2022; Sgaravatti, 2024, Leonelli, 2023). It is important to note that the studies listed above also address the WTO compatibility of these proposed solutions.

There are analogies in the literature to the present study regarding the transfer and compensation of indirect costs (Ferrara and Giua, 2022; Cludius et al. 2020), but these do not cover the examination of the relocation pressure indicator, which can be calculated as the product of the EU-level average indirect cost and its dispersion across countries. I applied the formula in the European Commission's State Aid Guidelines to three policy-relevant indicators in order to compare three different scenarios. I also used standard statistical methods such as weighted average and variance calculations. I then illustrated the results in a bar chart.

At the beginning of the study, I describe the problem of carbon leakage and the solutions that the European Union has applied, is applying, and will introduce in the future to address the problem. I then describe the negative effects of the regulation and use three different hypothetical models to show what the EU needs to focus on in the future.

2. The problem of carbon leakage

In order to achieve the targets set out in the Paris Agreement, even stricter political, economic and legal measures are needed. A reduction in emissions resulting from measures introduced in one region may also be due to carbon leakage, which does not represent progress at global level, but merely shifts pollution to areas where regulations are less stringent. Carbon leakage is an economic mechanism whereby increased costs and competitive pressure resulting from greenhouse gas emission regulations may encourage companies to relocate their production to non-EU countries with lower environmental standards or to favour products from such countries. This problem may also explain why emissions are falling in EU Member States while continuing to rise globally. Without appropriate countermeasures, emissions relocation could undermine the effectiveness of mitigation efforts.

The phenomenon of carbon leakage can also be interpreted within the conceptual framework of economics as a special case of regulatory arbitrage. In the classic sense, regulatory arbitrage refers to companies optimizing their operations by exploiting cost differences arising from different regulatory environments in different countries or regions (Krugman et al., 2012). A similar effect can be observed in this area when the level of carbon pricing or the extent of compensation varies from country to country. It may be advantageous for companies to relocate their production to a country with less stringent regulations. This phenomenon is also evident in the mechanisms discussed later in this study.

3. How carbon leakage manifested itself in the EU

Emissions from the manufacturing sectors covered by the EU ETS decreased by 7.5 % in 2023 compared to 2022. According to the European Commission, this is due to a combination of lower production and increased efficiency. However, European industrial production also fell by 1.2 % in the same year compared to the previous year. According to the Drahgi report (Draghi, 2024), this is due to the fact that European companies operate with higher relative energy costs than their international competitors. Therefore, it cannot be concluded that the decline in emissions in the European Union is solely the result of effective regulation and continuous decarbonisation efforts. Production costs have also risen as a result of the continuous increase in EU ETS carbon dioxide quota prices over the past five years, which had to be paid in the European Union for emissions related to manufacturing (Raude, 2025). Production costs have also risen as a result of the continuous increase in EU ETS carbon dioxide quota prices over the past 5 y, which had to be paid in the European Union for emissions related to manufacturing (Raude, 2025). High costs have led to a decline in production and highlight the global issue of carbon leakage, as the proportion of imports increases in order to maintain the same volume of products on the EU market. Products from third countries must be manufactured in the same way and, in most cases, result in less regulated GHG emissions, which further increases global emissions. According to data from the European Parliament in 2020, more than 20 % of the EU's total carbon dioxide emissions come from goods and services consumed within the EU but produced outside its borders. This corresponds to approximately 700 Mt CO_2. Another potential form of carbon leakage occurs when a manufacturing company based in the EU relocates to a third country due to high costs and imports its products back into the EU.

3.1 Solutions

In order to reduce carbon leakage, the ETS system seeks to provide special protection to sectors that are both carbon-intensive and exposed to global competition. These include sectors such as steel production industry, cement production, oil refining and the chemical industry. A carbon leakage risk list is used to determine which sectors are eligible for additional support. Several instruments have been introduced under the ETS system to maintain the competitiveness of particularly polluting industries and prevent carbon leakage. One is the allocation of free allowances, and the other is state aid for indirect costs. However, these practices have distorting effects.

3.2 Allocation of free allowances

Some industries received more allowances than they needed in the period 2013-2020, resulting in unexpected profits for them. For example, the cement industry, accumulated a surplus of allowances equivalent to around 100-150,000,000 t of CO2, generating approximately € 3 billion in extra profits (Sgaravatti , 2024). During the same period, the petrochemical sector earned € 0.6 billion in additional revenue from the sale of surplus allowances (LIFE ETX, 2024). These figures also clearly demonstrate that overcompensation related to free allowances occurred during this period, reducing the incentive effect of the system to reduce emissions. Reforms starting in 2021, with the introduction of carbon border mechanism and the parallel phasing out of free allocation of ETS allowances, aims to address this distortionary effect. Another market-distorting aspect of free allocation is that it mainly benefits particularly polluting industries, based on their emissions, while industrial players that are innovative and climate-neutral producers in the same market do not receive the same level of support, such as green steel production. As long as the costs of climate-neutral production methods exceed those of traditional industrial production, they will be at a competitive disadvantage and will require greater support for their introduction (Elkerbout, 2022). In conclusion, free allocation should not only serve to prevent carbon leakage, but could also provide support for climate-neutral technological developments to encourage investment in emission reductions.

3.3 State aid for indirect costs

Under the EU ETS, not only do direct emission costs increase, but indirect costs also place a significant burden on industrial production. Energy producers incorporate the cost of purchased allowances into the price of electricity, which is reflected as an additional cost for energy-intensive industries. To offset these costs, the EU state aid framework permits Member States to provide state compensation to the sectors most affected by the ETS Directive for part of the increase in electricity costs. The European Commission has capped this state compensation at 75 % for the period 2021-2030 and has imposed strict conditions on its use. As the granting of support is subject to Member States' discretion, some countries, such as Germany, the Netherlands and Belgium, are applying it and allocating a specific share of their ETS auction revenues to this purpose.

However, other Member States do not provide such compensation for budgetary reasons or due to the structure of their industry. Consequently,, disparities have emerged within the EU regarding the indirect carbon costs incurred by industrial operators in different Member States. The optimal amount of support compensates companies for their indirect costs, but if the support provided exceeds these costs, the state receives unexpected profits. This would reduce the incentive for companies to introduce more environmentally friendly production processes, similar to the overcompensation that occurred with free allocation of allowances, and would also results in a poor distribution of public funds. According to a study conducted between 2014 and 2019, in the 17 EU Member States and the United Kingdom examined, windfall gains are estimated to occur in approximately 15-17 % of subsidies, primarily in Belgium, France, Germany and the United Kingdom (Masciandaro et al., 2025). As a consequence of the above, internal market distortions may also arise. Bruegel analysts (Sgaravatti, 2024) also point out that the compensation framework within the EU should be harmonised, possibly by setting a minimum level, in order to ensure more balanced competitive conditions for industry. This is because in countries where there is no state compensation, production costs rise so much due to high electricity prices that industrial players may relocate to other areas within the EU. According to a 2024 report by Bruegel, regions where electricity prices are lower due to the increased presence of renewable energy sources may become more competitive within the EU, as the carbon costs built into prices are lower. Based on 2024 electricity prices, the study favours Scandinavia and the Iberian Peninsula over Central and Eastern Europe, where most industrial production is currently located. (Sgaravatti, 2024) This may also acts as an incentive to generate electricity from renewable sources rather than fossil fuels.

There has been a controversy over both instruments designed to prevent carbon leakage. Energy-intensive companies have argued that the support provided is insufficient, while environmental activist groups have criticised the policy for contradicting the polluter pays principle (EU, 2023). In general, the "polluter pays principle" conflicts with market competitiveness, so if production costs are higher due to excess emissions, competitiveness deteriorates and this becomes a source of conflict. The fundamental question remains how to strike a balance between programs aimed at industrial competitiveness and EU climate goals, so that the system motivates pollution reduction without undermining the global market position of EU companies.

4. Introduction of the CBAM

The Carbon Border Adjustment Mechanism (CBAM) is a key element of the European Union's 'Fit for 55' climate package, which can be understood as an EU-wide carbon pricing system aimed at promoting decarbonisation efforts and to address carbon leakage. This does not reduce global emissions, but merely shifts them geographically.

The introduction of the CBAM aims to close these regulatory loopholes by requiring importers of products from outside the EU to pay a carbon price determined under the EU Emissions Trading System (EU ETS). Accordingly, importers are required to purchase CBAM certificates, the value of which is based on the average auction price of emission allowances. The certificates essentially function as a quasi-environmental tax, influencing the pricing and demand of the relevant products.

It is important to emphasise that the primary objective of the mechanism, as distinct from customs duties and other trade regulation instruments, is not to regulate market consumption or protect EU products, but rather to encourage the reduction of carbon dioxide emissions and support the transition to low-emission economic models. At the same time, the CBAM indirectly contributes to maintaining the competitiveness of EU manufacturers and also encourages third countries to adopt environmentally friendly technologies. The mechanism aligns financial incentives with environmental objectives, promoting sustainable development and innovation.

For Hungary, CBAM provides an opportunity to strengthen its domestic climate policy objectives and improve its competitiveness on the global market. The mechanism will encourage industrial players to use cleaner technologies by offering them a financial incentive. From 2026, CBAM will become a source of revenue for the Community budget: 25 % of the amount collected will go to the Member States and 75 % to the Union, similar to customs revenues.The products covered by the mechanism include cement, electricity, fertilisers, iron and steel products, and hydrogen. From 1 October 2023, importers were required to report the release of these products for free circulation or import in processed form of these products to the European Commission on a quarterly basis. From 1 January 2026, only economic operators with authorised CBAM reporting status will be permitted to release these products for free circulation.

4.1 What impact will this have on previous measures to prevent carbon leakage?

The introduction of CBAM marks a turning point in terms of indirect cost compensation and free quota allocation. Following its introduction, it will be possible to pay the same carbon price as in the EU for the carbon dioxide emissions embodied in imported products. At the same time, free allowances will be phased out in the EU sectors concerned. The pace of allocation reduction will be as follows: in 2026, 2.5 % of the free quota amount for the sectors concerned will be withdrawn, in 2027 5 %, and in 2028 10 %.

The pace will then accelerate: 22.5 % in 2029, 48.5 % in 2030, 61 % in 2031, 73.5 % in 2032, 86 % in 2033, and finally, free allocation will be completely phased out by 2034. This means that from 2034 onwards, EU manufacturers in the sectors concerned will have to purchase allowances for all their emissions, while importers will pay the same carbon cost at the border. With these measures, the CBAM will take over the role of a tool for preventing carbon leakage. However, it is important to note that this phase-out is limited to products covered by the CBAM, while other ETS sectors will continue to receive free allowances under the existing rules. The phasing out is expected to strengthen the incentive for emission-reducing investments, but may also cause temporary competitiveness tensions. However, one particularly problematic group is EU companies exporting to markets outside the EU. This is because the CBAM does not provide relief for export products, meaning that after 2034, EU manufacturers will bear the full carbon cost in foreign markets, while their competitors in third countries will not necessarily do so. It follows from the above-mentioned regulation that it focuses mainly on protecting the internal market.

The Commission's original CBAM proposal focused mainly on direct emissions (scope 1), but under pressure from the European Parliament, indirect emissions (scope 2) were also included in the regulation for certain sectors, in particular those resulting from electricity consumption. However, value chain emissions (scope 3) were generally excluded from the scope of the CBAM, with the exception of embedded emissions from certain raw materials, which had to be included in product-level accounting. However, this rule was not extended to all industries. Under the current regulations of the, there is only a reporting obligation for direct and indirect emissions for all products covered by the CBAM until 2026. From 2026 onwards, only cement and fertilisers will be subject to a levy on indirect emissions. This means that, for example, aluminium imported from outside the EU will only be subject to a levy on direct CO_2 emissions, while aluminium produced in the EU will be subject to the ETS cost included in the price of electricity in addition to direct emissions. Under these circumstances, state compensation for indirect costs remains vital for EU industry, as without it, it could once again find itself at a competitive disadvantage. The possibility of support must be maintained until the decarbonisation of electricity production reduces the carbon intensity of electricity to a greater extent. However, according to the preamble to the CBAM Regulation, the EU's longer-term climate policy objective is that carbon costs should be fully reflected in the prices of both domestically produced and imported products, which means that the various forms of compensation will have to be phased out in the longer term. This means that, in parallel with the final extension of the carbon duty, the second carbon leakage protection tool will also be phased out, avoiding the creation of parallel support systems. However, this is only likely in the longer term, in line with the pace of CBAM expansion.

In my opinion, complete phasing out would not necessarily be the best decision if we want to keep the competitiveness of EU businesses in mind. I will use three models to illustrate the impact of different regulatory solutions on electricity prices, industrial relocation and export prices. The models apply to the period following the introduction of CBAM and cover the entire EU.

The standard deviation of electricity costs, which shows the standard deviation and variance of industrial electricity costs increased by carbon costs within the EU. It illustrates the differences in energy costs between companies in different Member States.The relocation pressure index expresses the economic incentive for relocating production within the EU based on the difference in energy costs. The index takes into account the standard deviation of electricity costs, the energy intensity of industries and their gross value added.

The change in the export price difference measures how much the cost and price position of products manufactured in the EU changes on the world market as a result of regulations. It illustrates how the average carbon cost component per tonne of product for EU producers develops and what price advantage or disadvantage this represents compared to a non-EU competitor.

Basic formulas and definitions used to prepare the models:

Residual (indirect) carbon cost per product unit (€/t):

$$R_i=(1-A_i)\cdot P\cdot C_i\cdot E \tag{1}$$

$(A_i) =$ compensation rate $(0\ldots0.75)$,

$(P) =$ EUA price $(€/tCO_2)$,

$(Ci) = CO_2$ factor of electricity (tCO_2/MWh),

$(E) =$ electricity intensity (MWh/t).

EU-weighted average and standard deviation:

$$\mu = \sum_i w_i R_i \tag{2}$$

$$D = \sqrt{\sum_i w_i (R_i - \mu)^2} \tag{3}$$

Relocation pressure:

$$RLI=\mu \quad D \tag{4}$$

Export price disadvantage:

$$EPD=\mu \tag{5}$$

- The scenarios on which the analysis is based (analysis shown in Figure 1):
- Based on current regulations: compensation varies by country (Ai).
- With the introduction of an EU minimum: (Ai ' = max (Ai, m)) (e.g. m=0.50).
- Full harmonisation: (Ai " = 0.75) (the EU directive ceiling).
- Stylised parameters for the numerical example
- EU price P=80 €/tCO_2; electricity intensity E=5 MWh/t.
- Countries, weights (wi): DE 0.25, FR 0.15, ES 0.15, PL 0.20, IT 0.15, HU 0.10.
- Electricity CO_2 factor (Ci) (tCO_2/MWh): DE 0.35, FR 0.10, ES 0.20, PL 0.60, IT 0.30, HU 0.40.
- Current regulation: (Ai): DE 0.75, FR 0.50, ES 0.50, PL 0.00, IT 0.25, HU 0.00.
- EU minimum: (m=0.50)   (Ai '=max (Ai , 0.50).
- Full harmonisation: (Ai "=0.75).
- The data are provided in Tables 1 to 3.

Table 1: Residual costs per country (€/t of product)

Scenario \ Country	DE	FR	ES	PL	IT	HU
Current regulations	35.00	20	40	240	90	160
EU minimum	35	20	40	120	60	80
Full harmonisation	35	10	20	60	30	40

Table 2: Aggregate indicators (EU-weighted)

Indicator\Scenario	Current regulation	EU minimum	Full harmonisation
Average (μ, €/t)	95.25	58.75	33.75
Standard deviation (D, €/t)	82.64	34.84	16.04
Relocation pressure(RLI=μ·D, $(€/t)^2$)	7,871	2,046.9	541.4
Export price disadvantage (EPD=μ, €/t)	95.2	58.75	33.75

Table 3: Indices (Current regulation = 100)

Index \ Scenario	Current regulation	EU minimum	Full harmonisation
Electricity cost variance (D)	100	42.	19.
Relocation pressure (RLI)	100.	26.	6.9
Export price disadvantage (EPD)	100	61.7	35.4

1. Model: Based on current Member State practices. Roughly half of Member States provide state compensation to eligible sectors for indirect costs incurred, typically at a rate close to the maximum allowed (60-75 %), while the rest provide little or no compensation. There are also differences in electricity prices and their carbon intensity. In some countries, most of the electricity comes from renewable sources, so the ETS cost is low, while in others (Poland, Greece) fossil fuel-based electricity generation dominates. The latter is characterised by high carbon dioxide costs. These two factors determine how much indirect costs industrial players bear. In this model, the standard deviation of electricity costs is high, as there are large differences in electricity costs within the EU. This also reflects the existence or absence of compensation. In the study, this model has the highest variance index (100), indicating unequal competitive conditions. Internal relocation incentives are also strong, as the cost differences between Member States are significant, which may encourage companies to relocate their production within the EU. This phenomenon is also supported by Bruegel's analysis, which shows that regions with high renewable energy values may have an advantage due to low carbon costs and may be potential locations for businesses. Based on this, it can be concluded that differences in production costs between countries distort the internal market and competition. This indicator is also at its highest level, which clearly shows the risk of internal carbon leakage. The export price disadvantage, as the third indicator, is also significant because the EU does not compensate for the carbon costs of exported products, so prices include the costs of ETS allowances and indirect costs. In this model, the export price difference indicator is the most unfavourable, meaning that the price of EU products may be significantly higher than the prices of competitors in third countries due to carbon costs alone. If this situation persists, EU companies will face a significant cost disadvantage in export markets, which could lead to a decline in their market share and have a negative impact on profits.

2. Model: Based on the assumption that the EU will introduce a mandatory minimum level of indirect cost compensation. The minimum level should be 50 %, so countries that have not compensated so far are now obliged to do so. Member States that have provided higher compensation so far may continue to do so. In this scenario, the differences between countries will decrease, but they will not disappear completely. The model also assumes that most countries will provide only the minimum required, with a few exceptions. The variation in electricity costs will decrease moderately, as the difference between the lowest and highest industrial energy costs will be smaller. There are no extreme cases, as all Member States provide some compensation. There will still be differences, as some countries will continue to reimburse 75 % while the minimum is 50 %, but the dispersion of costs will be reduced by about half compared to model 1. As a result, industrial energy costs will be much more balanced within a more uniform framework. Internal relocation incentives will weaken as cost differences between countries are reduced, making it less worthwhile for companies to relocate production. Due to minimum regulation, the cost situation of energy-intensive companies improves in all Member States. The export disadvantage is also reduced, as all EU exporters benefit from this support, reducing the carbon cost that has to be built into the price of export products. This will also reduce the global competitive disadvantage of EU products compared to the previous model. It is important to note, however, that although the export disadvantage will be reduced, it will not disappear completely, as the compensation is not 100 % and companies will continue to bear the full cost of direct emissions. The global competitive disadvantage of EU companies will be reduced but will remain. Overall, this model represents an improvement on the previous one and demonstrates that setting an EU minimum level strengthens the global competitiveness of companies.

3. In this scenario, the EU applies indirect cost compensation uniformly across the board. This would either be financed from a central EU fund from ETS revenues, or Member States would apply the same rules and support rates in a harmonised manner. The model assumes that harmonisation would be achieved at the highest level, meaning that all eligible installations would receive 75 % support. The variation in electricity costs would then be low. The burden of industrial electricity costs in the EU would be virtually equalised, as indirect costs would be reimbursed at a uniform rate and in a uniform manner in all countries. The only factors that would cause differences in the price of electricity would be the base price or the cost of electricity generation. Internal relocation incentives would be minimised, effectively eliminating the competitive advantage between Member States. The export price disadvantage would also be significantly reduced. As a result of full harmonisation, all exporters would receive high compensation, so EU companies would bear the lowest possible indirect costs in their products, making EU products much more competitive on the world market. Mostly only ETS costs remain for businesses. In conclusion, the higher and more uniform the compensation, the more internal market distortions are reduced. The global competitiveness of EU industry is also strengthened, giving companies time to implement investments in decarbonisation. Of course, the implementation of the above models also involves financing issues, which are not covered in this study. In any case, there is a need to compensate for indirect costs in a more harmonised way than at present. This could include conditions that support renewable energy production and use over fossil fuels. By this I mean that industrial players who use electricity produced from renewable energy sources should receive a higher proportion of compensation. However, it is important to note that this would only be a short-term solution, as the EU's climate policy goals require a different solution in the longer term.

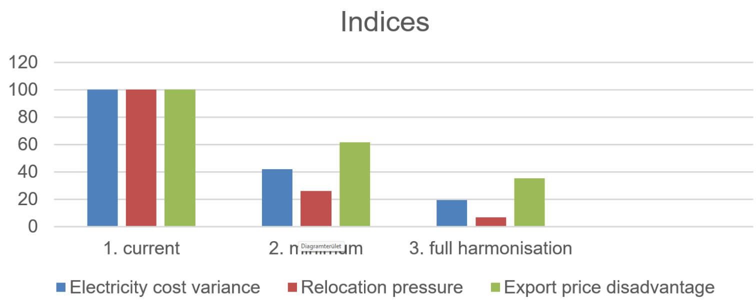

Figure 1: Scenario index variations

5. The impact of CBAM and US protective tariffs on the functioning of the global economy

The interaction between decarbonisation tariffs and US protective tariffs could play out on several levels, with serious economic and geopolitical consequences.

The aim of the CBAM is to level the playing field for producers both within and outside the EU by imposing internal prices on imported products through carbon-intensive tariffs. The US protective tariffs, on the other hand, primarily serve to protect domestic industry for political and economic reasons. While these two mechanisms serve different purposes, but together they could distort global trade flows as companies seek new markets to avoid the burden of one or the other tariff. CBAM can also be seen as hidden protectionism. If these coincide with classic protective tariffs and the new US tariffs, this could increase international political tensions and trade disputes, for example in the form of WTO disputes. If the world's major economic players such as the EU, the US and China pursue different customs strategies, global trade could break up into regional blocs, making multilateral cooperation increasingly difficult. The CBAM and US protective tariffs serve different purposes, but together they could reinforce economic fragmentation, making it more difficult to harmonise global environmental and trade regulations.

6. Conclusion

Despite the fact that emissions are falling in the European Union, global GHG emissions continue to rise. This phenomenon is not only due to technological efficiency, but also to a decline in production and hidden carbon leakage. The ETS system has attempted to remedy the problem of emissions shifting with two types of instruments. However, both free allocation of allowances and state support for indirect costs have led to overcompensation and market distortion, as well as hindering decarbonization investments. The introduction of CBAM and, in parallel, the phasing out of free allocation may provide a solution to the previous problems, but unfortunately it has also created new obstacles. The three models analyzed above clearly illustrate the need for regulatory harmonization in the short term so that the EU does not completely sacrifice competitiveness in the name of emission reduction until global regulations are established in this area. In summary, a regulatory spiral has developed around the issue of carbon leakage, as the side effects of new regulations create new problems, which then require further regulation. This is a self-perpetuating regulatory process that makes the system increasingly complex. In the short term, therefore, an export-neutral solution, green industry subsidies, the extension and harmonization of regulations, and infrastructure developments could yield positive results. In the long term, however, the full implementation of carbon costs, the elimination of compensation, and the launch of climate-neutral capacities are necessary for the EU to make a meaningful contribution to the global 1.5 °C target, embark on a climate-neutral path, and maintain the competitiveness of its industry.

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