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Modelling the environmental impact of agri-food trade policies

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Introduction

In the era of globalisation, international trade policies play an important role in shaping the economic and environmental landscape of nations. As environmental concerns become more prominent, it is essential to understand how trade policies impact sustainable development and what approaches need to be taken to achieve a positive effect on the climate and environment.

The objective of this analysis is to assess the impact of international agricultural trade on the achievement of selected climate and environmental goals, which are in line with particular SDGs (mainly Goal 13, but also elements of others related to the environment). Thus, the impact of specific trade agreements based on the implications of current energy and climate policies were assessed using modelling tools, with the analysed outcomes focusing on CO_2 and non-CO_2 emissions (e.g. N_2O, CH_4). This enables an understanding of ways to mitigate GHG emissions through international trade globally and review methods to avoid relocation of pollution sources due to trade shifts.

The approach used is grounded on global development scenarios within one of the Shared Socioeconomic Pathways (SSPs) – SSP1, which implies the implementation of sustainable approaches in foreseen global development. The tool used to model the trade implications is a computable general equilibrium (CGE) model, resembling the global economy with specific sectors and countries.

The following working paper provides arguments for new and better policies for trade, taking into account environmental measures as tools of climate change mitigation.

Policy background

Trade policies have traditionally been designed with economic growth as the primary objective, ensuring that nations can benefit from global markets and improve their GDP. However, with the increasing threat of climate change and environmental degradation, there's a pressing need to intertwine environmental considerations with trade decisions. This shift in focus has led to the emergence of policies that not only look at economic benefits, but also at the environmental implications of trade.

The Kyoto protocol, followed by the Paris Agreement, have increasingly put the climate and environmental aspects in focus, leading to changes in the policies of developed and developing countries, while also having an impact on the rest of our shared planet's countries. In search of efficient climate mitigation measures, various policies are being modified or introduced to make use of existing reserves for the reduction of greenhouse gas emissions as well as other types of environmental pollution.

To mitigate the negative effects of climate change and support the transition to a more sustainable, low-carbon economy, the European Union (EU) is actively pursuing an ambitious climate and energy policy. The EU's climate and energy goals contained in the European Green Deal (European Commission, 2019) aim to make the EU carbon neutral by 2050.

A key aspect of EU climate policy is the commitment to reduce greenhouse gas emissions, with a particular focus on sectors such as energy, transport and agriculture. In the context of trade in agricultural products and foodstuffs, this commitment has a number of implications. Encouraging sustainable farming practices, promoting precision agriculture and investing in research and innovation to develop more climate-friendly farming techniques may be part of the EU's efforts to reduce emissions from agriculture. This could potentially have an impact on production methods and costs in EU agriculture, with implications for the competitiveness of EU products on the international market.

In addition, the EU has been working towards the integration of renewable energy sources into its energy mix. This shift to renewable energy will have an impact on the relatively energy-intensive industry. Measures to promote clean energy may have an impact on production costs, particularly for energy-intensive industries such as food processing. The transition to renewable energy may lead to changes in the cost structure of agricultural and food production, affecting its competitiveness on the global market.

Yet in terms of global trade, the environmental aspects of production are still not being taken into account, thus leaving this aspect outside the regulatory framework. Moreover, the trade liberalisation processes under the World Trade Organization (WTO) do not sufficiently address the environmental aspects of trade. Although they are being discussed, the environmental implications of trade and ways to lessen their negative impact are – from a global perspective – at the preliminary stages.

At the same time, a "carbon leakage" effect is an obvious possibility, as restrictive approaches to production within specific countries or their unions (such as the EU) could lead to the displacement of production associated with higher pollution to countries with less restrictive policies. Thus, with regard to international trade in agricultural products and foodstuffs, the EU's climate and energy policies will also have an impact on trade relations. To tackle such issues, among others, the EU recently explored the concept of a carbon border adjustment mechanism (CBAM), which aims to prevent carbon leakage by imposing a carbon price on certain imported products. Its transitional period has been in force since 1 October 2023, as the European Union regulation on CBAM was adopted on 17 May 2023. The introduction of the CBAM has a

significant impact on businesses importing goods into the EU. This mechanism could have an impact on trade in products through the imposition of additional costs on products that are not in compliance with EU environmental standards. Countries that export products to the EU may face new challenges in complying with these standards or in adapting their production processes to meet the EU's environmental criteria. Once the CBAM becomes fully operational in 2026, EU importers of these products will need to purchase carbon certificates corresponding to the carbon price that would have been paid to produce the goods in the EU, as free allocations are gradually reduced (Matthews, 2023). Yet the idea of including the sector under the CBAM is still being discussed, as applying it to these products is more difficult and could be detrimental. Still, at this point, monitoring the displacement effect is crucial, as Europe strives to achieve the goals of the European Green Deal, which is necessary to ensure avoiding the leakage of greenhouse gases to other countries.

The climate and energy policies of the EU have multiple implications for international trade. Changing agricultural methods and energy sources, along with the introduction of such mechanisms as carbon offsetting, could change agricultural and food production and trade. To remain competitive in the EU market, actors in the global supply chain will need to adapt to the new regulatory environments and sustainability standards as these policies evolve.

The modelling approach and modelling scenarios

General approach

We use a computable general equilibrium model to analyse the long-term effects of trade liberalisation and introduction of carbon import taxes. We employ the CGEBox modelling framework (Britz and van der Mensbrugghe, 2018), an open-source set of models that originated from GTAP-in-GAMS (Lanz and Rutherford, 2016), a GAMS-based version of the GEMPACK-based GTAP model (Hertel, 1997), a standard tool in trade policy analysis. The CGEBox framework includes several modules that implement the standard GTAP model with several extensions, as well as derived models that include a modified preference structure with respect to the original model.

We model the trade liberalisation of the EU with other countries, and look into the effects of carbon tariffs. We are interested in the long-term outcomes of those exercises; while tariff liberalisation may be delayed and spread over several years, some effects – and in particular the capital accumulation from extra investment – can take years to materialise. Therefore, we use G-RDEM, a recursive dynamic CGE model included with CGEBox (Britz and Roson, 2019).

The G-RDEM framework shares many features with the original GTAP model. The important differences include replacing the original CDE private demand system in GTAP with the AIDADS demand system, which allows the capture of non-linear Engel curves, which allow for changing shares of different commodities with the growth of per-capita income, and is therefore suitable for long-term scenarios of economic development, as "keeping constant marginal budget shares would lead to an overestimation of the demand for necessities, such as food, while demand in other sectors will hence be underestimated" (Britz and Roson, 2019). The parameters of this system of preferences are provided with the CGEBox package and discussed in Britz and Roson, 2019.

The CGEBox framework contains several tools that are employed in scenario building for our exercise. The baseline scenarios are automatically calibrated to the GDP and population growth scenarios in Shared Socioeconomic Pathways. When the baseline is calibrated, GDP is fixed to the growth scenario and the labour supply is updated based on population changes (and the structure of the population of each country). Within the baseline run, sectoral productivity shifters are adjusted to account for the target growth. Differences in productivity growth across main sectors (agriculture, industry, services) are differentiated depending on annual growth rate (for example industry is assumed to be more variable than the other sectors, in line with Britz and Rosson, 2019). Our simulations follow SSP1 as the baseline.

Our simulations are run with a default CGEBox closure similar to a standard GTAP closure. As far as the global bank closure is concerned, the allocation of foreign savings follows a rule that the returns on capital are equalised globally with endogenous trade balances (total global trade balances are equal to zero).

Government expenditures are calculated based on exogenous tax rates, while government expenditures are based on the top-level regional household utility function, resulting in endogenous government savings.

For the baseline generation we also implement several additional assumptions. In particular, we allow for debt accumulation from foreign savings, for example capital inflow in a particular period is reflected in increased debt payments over subsequent periods. Savings rates are chosen to depend on growth of income and the age composition of each economy's population. We also enable adjustment of the sectoral shares in the government and investment demand to the income levels (reflecting the fact that high income countries may have a different composition of both of these aggregates, a feature of CGEBox based on an underlying econometric study, Britz and Roson, 2019). We also assume that besides exogeneous growth in population and labour force, and endogenous capital accumulation, elasticity in the supply of natural resources (0.15) is limited to the change in their prices, and there is a fixed level of land available.

Fully fledged EU trade liberalisation and CO_2-based import tariff/production tax

We explore several hypothetical scenarios of large-scale EU trade liberalisation. We also consider the imposition of CO_2-related EU tariffs in agriculture and total trade, including potential retaliation responses and reciprocal tariffs from trading partners. In addition, the analysis includes a CO_2-based production tax to counterbalance the CO_2-related tariffs. In scenarios related to the agri-food sector, the shock was applied as follows (for details, please see tables 9-10 in the Appendix):

- Paddy rice
- Wheat
- Cereal grains n.e.c.
- Vegetables, fruit, nuts
- Oil seeds
- Sugar cane, sugar beet
- Plant-based fibres
- Crops n.e.c.
- Processed rice
- Cattle, sheep, goats, horses
- Animal products n.e.c.
- Raw milk
- Wool, silk-worm cocoons
- Bovine meat products
- Meat products n.e.c.
- Vegetable oils and fats
- Dairy products
- Sugar
- Food products n.e.c.
- Beverages and tobacco products

STARTING FROM THE BASELINE [0], THE FOLLOWING SCENARIOS WERE INTRODUCED (SEE

Figure 1Błąd! Nie można odnaleźć źródła odwołania.):

[0-1] (EU -> WORLD -> EU) agri-food Liberalisation:
This scenario involves reciprocal bilateral trade liberalisation of the agri-food sector between the EU and its trading partners worldwide.

[0-2] (EU -> WORLD -> EU) All Commodity Liberalisation:
Similarly to scenario [0-1], this scenario involves bilateral trade liberalisation, but it encompasses all commodities, and not just agri-food products.

[0-2-1] (EU -> WORLD) agri-food CO_2 based tariff + agri-food CO_2 production tax in EU + (EU -> WORLD ->EU) liberalisation of other sectors:
In this scenario, the EU imposes CO_2-based tariffs on agri-food products in its trade with the world. In addition, the EU implements a CO_2 production tax on agri-food products within its borders. Meanwhile, liberalisation efforts apply to other sectors through bilateral agreements between the EU and its trading partners.

[0-2-2] (EU -> WORLD -> EU) agri-food CO_2 based tariff + agri-food CO_2 production tax + (EU -> WORLD ->EU) liberalisation of other sectors:
This scenario is similar to [0-2-1], but also considers reciprocal actions applied by trading partners in response to the EU's introduction of EU CO_2-related tariffs on agri-food commodities.

[0-3-1] (EU -> WORLD) agri-food CO_2 based tariff + agri-food CO_2 production tax in the EU:
In this scenario, the EU imposes CO_2-based tariffs on agri-food products in its trade with the world and implements a CO_2 production tax on agri-food products within its borders. However, there is no liberalisation of trade in other sectors.

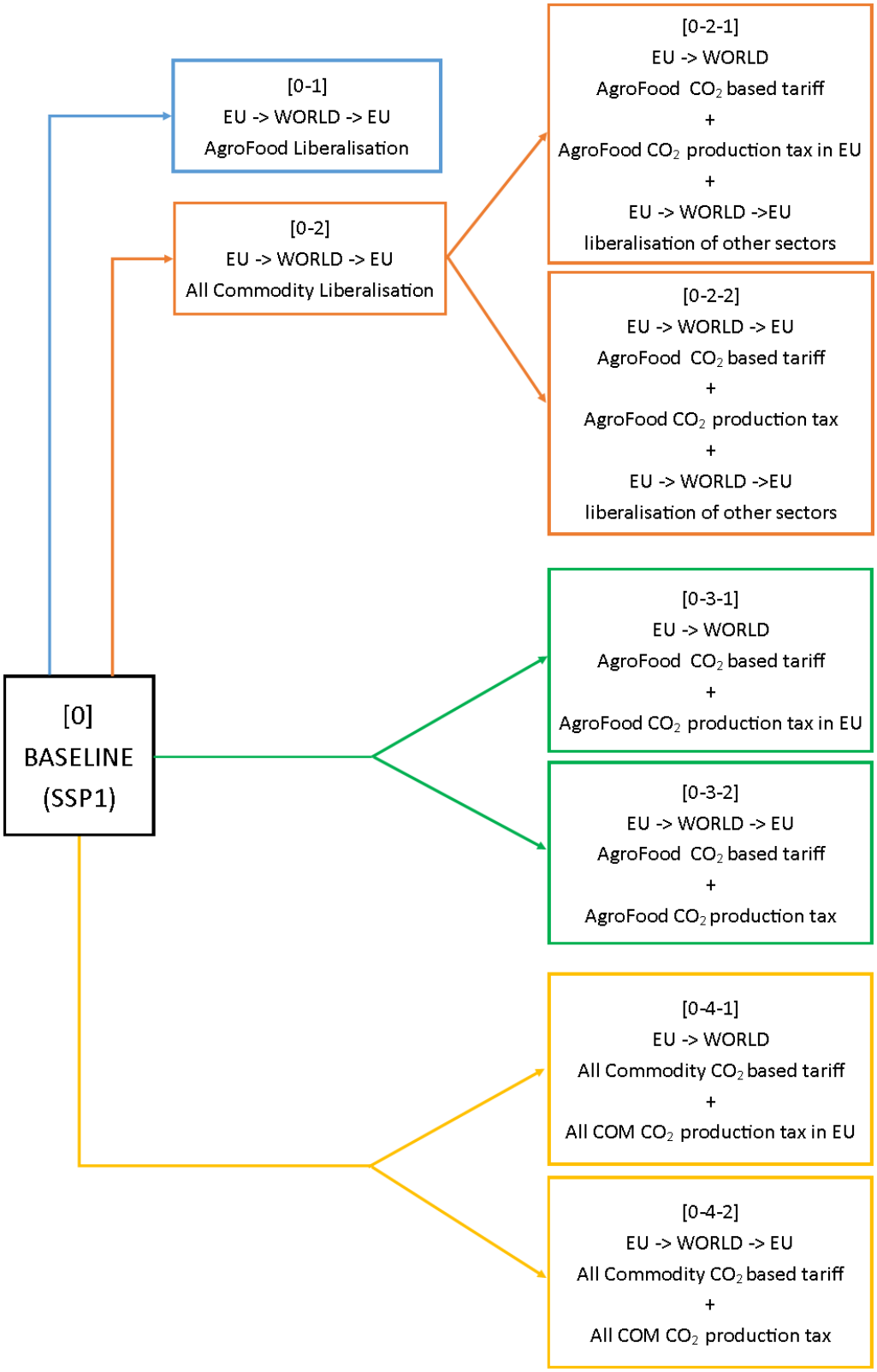
[0-3-2] (EU -> WORLD -> EU) agri-food CO_2 based tariff + agri-food CO_2 production tax:
Similar to [0-3-1], this scenario combines the agri-food CO_2-based tariff and CO_2 production tax, but also considers reciprocal actions applied by trading partners.

[0-4-1] EU -> WORLD All Commodity CO_2 based tariff + All Commodities CO_2 production tax in EU:
This scenario involves the EU imposing CO_2-based tariffs on all commodities in its trade with the world, while also implementing a CO_2 production tax on all commodities within its borders.

[0-4-2] (EU -> WORLD -> EU) All Commodity CO_2 based tariff + All Commodities CO_2 production tax:
Like [0-4-1], this scenario combines the CO_2-based tariffs and the CO_2 production tax on all goods, but also specifies that the EU's trading partners also apply CO_2 tariffs to imports from the EU.

In scenarios involving carbon-rated tariffs and taxes, we apply a $100 USD tariff and a $100 USD production tax per 1 ton of emitted CO_2 equivalent. The results of the simulations are presented in the following subsections.

FIGURE 1: SCENARIOS OF TRADE LIBERALISATION AND CO_2-BASED IMPORT TARIFF/PRODUCTION TAX


[0]
BASELINE
(SSP1)
[0-1]
EU -> WORLD -> EU
AgroFood Liberalisation
[0-2]
EU -> WORLD -> EU
All Commodity Liberalisation
[0-2-1]
EU -> WORLD
AgroFood CO_2 based tariff
+
AgroFood CO_2 production tax in EU
+
EU -> WORLD ->EU
liberalisation of other sectors
[0-2-2]
EU -> WORLD -> EU
AgroFood CO_2 based tariff
+
AgroFood CO_2 production tax
+
EU -> WORLD ->EU
liberalisation of other sectors
[0-3-1]
EU -> WORLD
AgroFood CO_2 based tariff
+
AgroFood CO_2 production tax in EU
[0-3-2]
EU -> WORLD -> EU
AgroFood CO_2 based tariff
+
AgroFood CO_2 production tax
[0-4-1]
EU -> WORLD
All Commodity CO_2 based tariff
+
All COM CO_2 production tax in EU
[0-4-2]
EU -> WORLD -> EU
All Commodity CO_2 based tariff
+
All COM CO_2 production tax

Simulation results

Fully fledged EU trade liberalisation and CO_2-based import tariff/production tax

Economic impacts

GDP

In scenario [0-1], which explores the liberalisation between the EU-27 and the rest of the world, the changes in GDP across the different regions and income groups are minimal. In 2025, global GDP experiences negligible impact, indicating that liberalisation alone does not substantially alter the economic landscape. This trend continues up to 2040, showing that the impact of liberalisation remains limited over time (see Table 1).

Scenario [0-2] illustrates the liberalisation of all goods between the EU-27 and the rest of the world, leading to a small growth in global GDP, with a 0.04% increase relative to the baseline of no liberalisation in 2025, and a 0.07% increase by 2040. The EU-27 benefits significantly from this scenario, with a GDP increase of 0.23% in 2025, and an even more significant increase of 0.66% by 2040.

In scenario [0-2-1], world GDP shows a slight positive trend, increasing by 0.03% in 2025 and 0.07% by 2040. The EU-27 again benefits substantially, with an increase of 0.22% in GDP in 2025, which nearly triples to a 0.58% increase by 2040. This suggests that the EU-27 would gain from a combination of a CO_2-based tariff on products and the liberalisation of other sectors.

Scenario [0-2-2] introduces reciprocal actions from the EU's trading partners to the CO_2-related tariff and production tax. Global GDP increases modestly by 0.03% in 2025 and by 0.07% in 2040. The EU-27 witnesses growth under this scenario, with a 0.22% increase in GDP in 2025 and a 0.58% increase by 2040.

Scenario [0-3-1] involves the introduction of CO_2-based tariffs between the EU-27 and the rest of the world, without any trade liberalisation. The global economy remains unaffected in terms of GDP for both 2025 and 2040. The EU-27 experiences a slight positive impact in the short term with a 0.01% increase in GDP in 2025, but this turns into a -0.04% decrease by 2040.

In scenario [0-3-2], the introduction of a CO_2-based tariff and production tax is followed by reciprocal actions from the EU's trading partners. Global GDP shows a slight positive impact in the short term, with a 0.01% increase in 2025, which remains stable til 2040. The EU-27 observes a short-term positive impact with a 0.05% increase in GDP in 2025, but this shifts to a -0.03% decrease by 2040.

Scenario [0-4-1] sees the imposition of CO_2-based tariffs on all goods traded between the EU-27 and the rest of the world. This results in a significant negative impact on the global GDP, with a -0.07% change in 2025 and a more substantial -0.22% by 2040. The EU-27 faces severe challenges, with a -0.44% decrease in GDP in 2025, deepening to a -0.87% decrease by 2040.

In the final scenario [0-4-2], CO_2-based tariffs are imposed on all goods, followed by reciprocal tariffs from the rest of the world. This scenario leads to a significant decrease in world GDP, showing a -0.07%

change in 2025 and a -0.23% by 2040. The EU-27 experiences a significant fall, with a -0.40% decrease in GDP in 2025, worsening to -1.08% by 2040.

Overall, these scenarios depict varied impacts of different trade liberalisation and tariff imposition policies on the global economy and the EU-27. The EU-27 tends to benefit from liberalisation policies, but faces significant challenges when CO_2-based tariffs are imposed, in particular when reciprocated by trading partners.

TABLE 1: GDP, REAL %-CHANGE BETWEEN BASELINE AND SCENARIOS.

	[0-1] EU->WORLD->EU agri-food liberalisation		[0-2] EU->WORLD->EU All COM liberalisation		[0-2-1] EU->WORLD agri-food CO_2 based tariff + liberalisation of other sectors		[0-2-2] EU->WORLD->EU agri-food CO_2 based tariff + liberalisation of other sectors		[0-3-1] EU->WORLD agri-food CO_2 based tariff		[0-3-2] EU->WORLD->EU agri-food CO_2 based tariff		[0-4-1] EU->WORLD All COM CO_2 based tariff		[0-4-2] EU->WORLD->EU All COM CO_2 based tariff	
Income groups/regions	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040
World	0.01%	0.01%	0.04%	0.07%	0.03%	0.07%	0.03%	0.07%	0.00%	0.00%	0.01%	0.01%	-0.07%	-0.22%	-0.07%	-0.23%
Upper middle income	0.00%	0.02%	0.02%	0.00%	0.02%	0.00%	0.02%	0.00%	0.00%	0.01%	0.00%	0.03%	-0.02%	-0.13%	-0.01%	-0.03%
High income	0.00%	-0.01%	0.00%	-0.07%	-0.01%	-0.07%	-0.01%	-0.07%	0.00%	0.00%	0.00%	0.00%	0.02%	0.07%	0.02%	0.08%
Low income	0.01%	-0.04%	-0.03%	0.07%	-0.04%	0.11%	-0.04%	0.10%	0.01%	0.07%	0.00%	-0.01%	0.00%	-0.19%	-0.03%	-0.57%
EU-27	0.06%	0.05%	0.23%	0.66%	0.22%	0.58%	0.22%	0.58%	0.01%	-0.04%	0.05%	-0.03%	-0.44%	-0.87%	-0.40%	-1.08%
Lower middle income	0.01%	0.01%	-0.02%	0.14%	-0.03%	0.18%	-0.03%	0.17%	0.00%	0.06%	0.00%	0.04%	-0.01%	-0.51%	-0.02%	-0.63%
ROW	-0.01%	-0.10%	-0.05%	-0.36%	-0.07%	-0.42%	-0.07%	-0.41%	-0.02%	-0.16%	-0.03%	-0.16%	-0.07%	-0.34%	-0.10%	-0.42%

Source: own calculations

In the scenario focusing on liberalisation alone, changes in GDP remain minimal, suggesting that such policies do not dramatically reshape the economic landscape. However, comprehensive liberalisation between the EU and the rest of the world reveal potential for growth, especially in the EU-27, with mixed results across regions and income groups. The integration of CO_2-based tariffs with other liberalisation measures presents a complex picture, highlighting the importance of balancing both short- and long-term effects as well as distributional impacts across different sectors and regions.

In scenarios that emphasise reciprocal measures to CO_2-based tariffs, the results show a combination of modest positive effects in the short term, followed by more pronounced negative effects in the long term, in particular for the EU. When only tariffs are imposed on products, with no accompanying liberalisation, the impact on global GDP remains neutral, but low-income regions show potential long-term positive effects. The introduction of CO_2-based tariffs on all goods leads to a significant negative impact on global GDP, especially in scenarios with reciprocal tariffs by trading partners. In particular, these tariffs pose serious economic challenges for the EU, with drastic reductions in GDP. In conclusion, these simulations underline the complexity of trade policy implementation and emphasise the need to consider both global and region-specific impacts.

Consumption

In Scenario [0-1], there is a minimal increase in worldwide consumption, showing a 0.04% rise in 2025 and tapering to a 0.02% growth by 2040. For the EU-27, consumption rises moderately by 0.12% in 2025, maintaining a positive trend with a slight increase to 0.14% in 2040 (see Table 2).

Scenario [0-2] presents a small but stable uplift in global consumption of 0.15% from 2015 to 2040. The EU-27 experiences a substantial benefit, with consumption increasing by 0.83% in 2025 and escalating further to 1.35% in 2040.

In Scenario [0-2-1], total world consumption sees a moderate rise from 0.14% in 2015 to 0.16% by 2040. The EU-27 gains significantly, with a 0.80% increase in 2025, which further amplifies to 1.29% in 2040.

Scenario [0-2-2] exhibits a slight enhancement in global consumption levels, with a 0.14% increase in 2025 and a minor improvement to 0.15% by 2040. The EU-27 again benefits noticeably, with consumption growing from 0.77% in 2025 to 1.27% in 2040.

In Scenario [0-3-1], most regions and income groups, including in global terms, experience negligible changes in consumption. However, the EU-27 sees minor fluctuation, with a -0.01% decrease in 2025 followed by a 0.02% increase in 2040.

Scenario [0-3-2] results in modest changes across various regions and income groups. On a global scale, consumption slightly increases by 0.03%, remaining constant until 2040. The EU-27 observes a moderate boost in consumption, starting at 0.06% in 2025 and diminishing slightly to 0.05% in 2040.

In Scenario [0-4-1], global consumption develops a negative trend, decreasing from -0.04% in 2025 to -0.22% by 2040. Contrastingly, the EU-27 experiences a significant downturn, with consumption plummeting from -0.39% in 2025 to -0.74% in 2040.

Scenario [0-4-2] features a gradual decline in global consumption, starting from a slight -0.01% decrease in 2025 deepening to -0.24% by 2040. The EU-27, however, faces contrasting fortunes, observing a positive change in consumption, starting at 0.03% in 2025 and rising to 0.04% in 2040.

Looking more closely at the different scenarios for the impact on global consumption by 2040, it is hard to miss the pattern: the EU-27 often emerges as the main beneficiary. Different scenarios predict

different outcomes. Scenarios such as [0-2] and [0-2-1] show a relatively modest increase in global consumption. In particular, the EU-27 enjoys the lion's share of these benefits. On the other hand, scenarios such as [0-4-1], in which carbon-based tariffs and taxes are applied to all goods, present a more worrying outlook. They show a significant drop in consumption, with the brunt of the impact falling on lower-middle-income regions. But it is not all negative. The results suggest that low-income regions could benefit under certain scenarios. However, as we extend the time horizon, the challenges for these regions become more pronounced.

In summary, the position of the EU-27 looks relatively stable and often positive, while the results for the other regions are mixed.

TABLE 2: TOTAL CONSUMPTION, %-CHANGE BETWEEN BASELINE AND SCENARIOS.

	[0-1] EU->WORLD->EU agri-food liberalisation		[0-2] EU->WORLD->EU All COM liberalisation		[0-2-1] EU->WORLD agri-food CO_2 based tariff + liberalisation of other sectors		[0-2-2] EU->WORLD->EU agri-food CO_2 based tariff + liberalisation of other sectors		[0-3-1] EU->WORLD agri-food CO_2 based tariff		[0-3-2] EU->WORLD->EU agri-food CO_2 based tariff		[0-4-1] EU->WORLD All COM CO_2 based tariff		[0-4-2] EU->WORLD->EU All COM CO_2 based tariff	
Income groups/regions	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040
World	0.04%	0.02%	0.15%	0.15%	0.14%	0.16%	0.14%	0.15%	0.00%	0.00%	0.03%	0.03%	-0.04%	-0.22%	-0.01%	-0.24%
Upper middle income	0.03%	0.04%	0.11%	-0.03%	0.10%	-0.01%	0.11%	-0.01%	0.00%	0.00%	0.03%	0.06%	0.06%	-0.08%	0.14%	0.10%
High income	0.01%	-0.01%	-0.07%	-0.15%	-0.07%	-0.14%	-0.07%	-0.14%	0.00%	0.00%	0.01%	0.01%	0.01%	0.13%	0.03%	0.15%
Low income	0.05%	-0.16%	0.11%	-0.04%	0.04%	0.00%	0.07%	0.00%	-0.03%	0.00%	0.01%	-0.11%	0.25%	0.48%	0.22%	-0.12%
EU-27	0.12%	0.14%	0.83%	1.35%	0.80%	1.29%	0.77%	1.27%	-0.01%	0.02%	0.06%	0.05%	-0.39%	-0.74%	-0.42%	-1.08%
Lower middle income	0.06%	-0.07%	0.04%	0.16%	0.00%	0.22%	0.01%	0.23%	0.01%	0.02%	0.03%	-0.01%	-0.02%	-0.82%	-0.02%	-1.01%
ROW	0.01%	-0.01%	-0.01%	-0.15%	-0.06%	-0.20%	-0.06%	-0.20%	-0.05%	-0.09%	-0.04%	-0.07%	0.04%	-0.34%	-0.05%	-0.45%

Source: own calculations

Import

In scenario [0-1], world imports observe a slight increase of 0.26% in 2025, and the trend continues to 2040 with a 0.15% increase, reflecting a positive yet diminishing impact on global trade. The EU-27 experiences a noteworthy growth in imports, with a 0.63% increase in 2025 and a 0.65% increase in 2040, signifying the considerable positive effects of liberalisation in this region.

In Scenario [0-2], world imports significantly rise by 1.14% in 2025, continuing to 2040 at a slightly reduced rate of 1.08%. The EU-27 benefits greatly, with imports increasing by 3.49% in 2025 and further to 4.25% in 2040, highlighting the substantial gains from full liberalisation in this region.

Scenario [0-2-1] leads to a 1.15% increase in world imports in 2025, and a 1.11% increase in 2040. The EU-27 stands out with a remarkable 3.52% increase in imports in 2025, which escalates to 4.36% in 2040, demonstrating the significant positive impact of agri-food CO_2-based tariffs and sectoral liberalisation on the region.

In Scenario [0-2-2], world imports experience a 1.12% increase in 2025 and a 1.10% increase in 2040. The EU-27 sees a substantial increase of 3.44% in imports in 2025, which rises further to 4.27% in 2040, underscoring the positive effects of the policy measures on the region.

Scenario [0-3-1] results in a small 0.07% increase in world imports in 2025, slowing down to a 0.06% increase in 2040. For the EU-27, imports increase by 0.14% in 2025, and improve to a 0.33% increase in 2040, reflecting a steady positive trend.

In Scenario [0-3-2], world imports see a 0.24% increase in 2025, and a 0.17% increase in 2040. The EU-27 experiences growth in imports of 0.58% in 2025, remaining fairly consistent at 0.66% in 2040, indicating a continuous benefit from the implemented policies.

Scenario [0-4-1] shows a modest 0.10% increase in world imports in 2025, but a significant -0.35% decline by 2040. The EU-27 sees a slight increase of 0.08% in imports in 2025, but faces a downturn with a decline of -0.29% in 2040, signifying a shift from initial gains to long-term challenges.

In scenario [0-4-2], world imports grow by 0.27% in 2025, yet face a notable -0.42% decline in 2040. The EU-27 experiences a minor increase of 0.25% in imports in 2025, but this reverses to a significant decline by 2040 (percentage missing due to text cut-off), presenting a complex impact over time.

The different scenarios show both positive and negative trends for world imports between 2025 and 2040. Scenario [0-1] shows an increase in world imports, but at declining rates, with a gradually positive but decreasing impact over time. In particular, the EU-27 benefits throughout from the liberalisation of the sector, with significant increases in imports. Scenario [0-2] and similar variants reflect a significant increase in world imports, highlighting a significant and persistent impact on world imports, especially for the EU-27. High-income regions, however, face challenges with initial declines in imports, but show signs of recovery by 2040. For low-income regions, most scenarios predict favourable long-term impacts on import levels, although there are some exceptions. Lower middle-income regions generally see an increase in imports in 2025, with a possible decline by 2040. The rest of the world (ROW) experiences mixed impacts, often facing challenges as 2040 approaches. Finally, scenarios such as [0-4-1] and [0-4-2] predict sharp reversals from positive trends in 2025 to significant declines in imports by 2040, signalling overarching negative impacts of carbon related tariffs and taxes for several regions.

TABLE 3: IMPORT, %-CHANGE BETWEEN BASELINE AND SCENARIOS.

	[0-1] EU->WORLD->EU agri-food liberalisation		[0-2] EU->WORLD->EU All COM liberalisation		[0-2-1] EU->WORLD agri-food CO_2 based tariff + liberalisation of other sectors		[0-2-2] EU->WORLD->EU agri-food CO_2 based tariff + liberalisation of other sectors		[0-3-1] EU->WORLD agri-food CO_2 based tariff		[0-3-2] EU->WORLD->EU agri-food CO_2 based tariff		[0-4-1] EU->WORLD All COM CO_2 based tariff		[0-4-2] EU->WORLD->EU All COM CO_2 based tariff	
Income groups/regions	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040
World	0.26%	0.15%	1.14%	1.08%	1.15%	1.11%	1.12%	1.10%	0.07%	0.06%	0.24%	0.17%	0.10%	-0.35%	0.27%	-0.42%
Upper middle income	0.24%	0.16%	1.35%	1.18%	1.41%	1.19%	1.41%	1.19%	0.06%	-0.01%	0.29%	0.17%	0.52%	-0.43%	1.18%	-0.14%
High income	0.06%	0.01%	-0.31%	-0.13%	-0.30%	-0.14%	-0.31%	-0.15%	0.03%	-0.02%	0.05%	0.00%	-0.15%	0.10%	-0.14%	0.03%
Low income	0.15%	-0.17%	0.61%	0.27%	0.66%	0.38%	0.61%	0.35%	0.20%	0.08%	0.12%	-0.10%	2.03%	1.81%	1.56%	0.73%
EU-27	0.63%	0.65%	3.49%	4.25%	3.52%	4.36%	3.44%	4.27%	0.14%	0.33%	0.58%	0.66%	0.08%	-0.29%	0.25%	-0.48%
Lower middle income	0.25%	-0.02%	0.57%	0.81%	0.49%	0.86%	0.48%	0.86%	0.14%	0.06%	0.14%	0.03%	0.00%	-1.46%	-0.24%	-1.90%
ROW	0.06%	-0.12%	0.15%	-0.31%	0.00%	-0.19%	-0.01%	-0.18%	-0.14%	-0.05%	-0.12%	0.01%	0.06%	-1.04%	-0.36%	-1.21%

Source: own calculations

Exports

In Scenario [0-1], the world sees a modest increase in exports, 0.26% in 2025, dropping to a 0.15% increase by 2040, illustrating a declining global trend. The EU-27 experiences a growth in exports from 0.43% in 2025 to 0.44% in 2040, showing a stable and positive impact of liberalisation on exports.

In Scenario [0-2], world exports rise significantly by 1.14% in 2025, with a slight decrease to 1.08% by 2040, indicating a robust and quite stable global impact. The EU-27 witnesses a surge in exports from 1.36% in 2025 to a stronger 2.33% in 2040, denoting a consistent and substantial positive effect from liberalisation covering all commodities.

Scenario [0-2-1] presents a world export growth of 1.15% in 2025, diminishing slightly to 1.11% in 2040, reflecting a significant and stable global influence. For the EU-27, exports escalate from 1.62% in 2025 to an even higher 2.39% in 2040, demonstrating a steady and noteworthy positive response to the policy.

In Scenario [0-2-2], there is a notable increase in world exports by 1.12% in 2025, with a slight dip to 1.10% by 2040, indicating a considerable and fairly constant global benefit. The EU-27 sees a boost in exports from 1.53% in 2025 to 2.30% in 2040, highlighting a sustained and remarkable positive impact.

Scenario [0-3-1] leads to a slight increase in world exports of 0.07% in 2025, decreasing marginally to 0.06% by 2040, showing a limited global effect. The EU-27 experiences a minimal increase in exports, growing from 0.01% in 2025 to 0.06% in 2040, depicting a small yet gradually increasing positive impact.

In Scenario [0-3-2], world exports increase moderately by 0.24% in 2025, declining to 0.17% in 2040, indicating a positive but decreasing global trend. The EU-27 observes a significant increase in exports at 0.59% in 2025 and 0.41% in 2040, suggesting a substantial but slightly diminishing positive effect.

Scenario [0-4-1] leads to a slight increase in world exports of 0.10% in 2025, turning significantly negative to -0.35% by 2040, showing a shift in global trends. The EU-27, however, faces challenges, with a decrease in exports dropping from -0.22% in 2025 to -1.28% in 2040, indicating growing difficulties over time.

In Scenario [0-4-2], there is a moderate increase in world exports of 0.27% in 2025, but by 2040 the situation worsens with a -0.42% decrease, illustrating a negative shift in global trends. Despite this, upper middle-income regions experience a growth from 0.92% in 2025 to 1.27% in 2040, showing a contrary positive trend. However, the EU-27 faces a tough situation, with exports falling from a -0.15% decrease in 2025 to a -0.35% decrease in 2040, highlighting a challenging environment.

Across the different scenarios presented, there is a consistent theme regarding the dynamics of world trade. Scenario [0-1] shows a decline in the positive impact on world exports over time, with different income regions experiencing fluctuating trade dynamics. Upper-middle-income regions show steady but moderate positive effects on exports, while low-income regions benefit initially but struggle in the long run. The EU-27 consistently benefits from liberalisation. In contrast, Scenario [0-2] and its variants show significant boosts to world exports, with most regions experiencing substantial positive effects. Upper middle-income and low-income regions in particular benefit in the long run. However, high-income regions face challenges over time. Scenarios [0-3-1] and [0-3-2] both show minimal increases in global exports, with impacts declining or stabilising over time. In the case of scenarios [0-4-1] and [0-4-2], there is a notable shift from short-term benefits to long-term challenges, with significant declines in exports by 2040. Interestingly, while the global trend often turns negative, some regions – especially upper middle-income – seem to buck the trend, showing resilience or even growth. In essence, while general trends can be inferred from global data, region-specific nuances often play a crucial role in understanding the full impact of trade dynamics.

TABLE 4: EXPORT, %-CHANGE BETWEEN BASELINE AND SCENARIOS.

	[0-1] EU->WORLD->EU agri-food liberalisation		[0-2] EU->WORLD->EU All COM liberalisation		[0-2-1] EU->WORLD agri-food CO_2 based tariff + liberalisation of other sectors		[0-2-2] EU->WORLD->EU agri-food CO_2 based tariff + liberalisation of other sectors		[0-3-1] EU->WORLD agri-food CO_2 based tariff		[0-3-2] EU->WORLD->EU agri-food CO_2 based tariff		[0-4-1] EU->WORLD All COM CO_2 based tariff		[0-4-2] EU->WORLD->EU All COM CO_2 based tariff	
Income groups/regions	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040
World	0.26%	0.15%	1.14%	1.08%	1.15%	1.11%	1.12%	1.10%	0.07%	0.06%	0.24%	0.17%	0.10%	-0.35%	0.27%	-0.42%
Upper middle income	0.18%	0.14%	1.85%	1.07%	1.81%	1.12%	1.80%	1.13%	0.07%	0.05%	0.12%	0.20%	0.89%	0.80%	0.92%	1.27%
High income	0.15%	0.04%	0.43%	-0.41%	0.36%	-0.41%	0.35%	-0.41%	0.05%	0.05%	0.07%	0.03%	-0.50%	-0.22%	-0.50%	-0.15%
Low income	0.32%	-0.10%	1.26%	0.76%	1.08%	0.74%	1.13%	0.77%	0.12%	-0.04%	0.17%	-0.10%	1.64%	1.71%	1.64%	1.20%
EU-27	0.43%	0.44%	1.36%	2.33%	1.62%	2.39%	1.53%	2.30%	0.01%	0.06%	0.59%	0.41%	-0.22%	-1.28%	0.43%	-1.91%
Lower middle income	0.35%	-0.01%	1.00%	0.90%	0.85%	0.92%	0.85%	0.94%	0.18%	0.06%	0.20%	0.03%	0.42%	-1.13%	0.39%	-1.39%
ROW	0.38%	0.04%	0.93%	0.35%	0.89%	0.33%	0.87%	0.32%	0.31%	0.01%	0.33%	0.01%	0.64%	0.42%	0.51%	0.08%

Source: own calculations

Environmental impacts

Emissions

Total emissions (CO_2 and non-CO_2 emissions [CO_2-equ])

In the year 2025 under scenario [0-1], there is no noticeable change in global emissions resulting from the implementation of agri-food liberalisation policies between the EU and its global trading partners. Upper middle-income countries see a slight decrease in emissions, while low-income countries experience an increase. The EU-27 observes an increase in emissions, while the other income groups remain relatively stable. By 2040, global emissions are experiencing a minor decrease, mainly influenced by the decrease in emissions in low-income countries and the EU-27. Upper middle-income countries and high-income countries also see slight changes in their emissions.

Scenario [0-2], which involves the introduction of a full commodity liberalisation policy, leads to a reduction in global emissions by 0.07% in 2025 and 0.12% in 2040. The upper middle-income countries benefit the most initially, with a significant decrease in emissions. High-income countries initially see a slight increase in emissions, but this trend reverses by 2040. Low-income countries experience an increase in emissions, while the EU-27 sees a significant decrease in 2025, followed by a substantial increase in 2040. Lower middle-income countries experience a decrease in emissions in both years.

Under scenario [0-2-1], involving the CO_2-based tariff and production tax, there is a downward trend in global emissions, with a decrease of -0.09% in 2025 and -0.11% in 2040. Upper middle-income regions and the EU-27 show a favourable response with a decrease in emissions, while high-income regions show a mixed response. Low-income regions experience an increase in emissions, and lower middle-income countries see a decrease in 2025 and stabilisation by 2040.

In scenario [0-2-2], there is a general decreasing trend in emissions, with a 0.09% reduction in 2025 and a 0.11% reduction by 2040 at the global level. Upper middle-income countries and the EU-27 see a significant decrease in emissions, while high-income countries initially see an increase, later reversing the trend. Low-income countries experience an increase in emissions, and lower middle-income regions see a decrease in 2025, stabilising by 2040.

Scenario [0-3-1] shows varied impacts across regions, with negligible changes in global emissions. Upper middle-income and high-income regions experience slight increases, while low-income regions see a more significant increase. The EU-27 experiences a decrease in emissions, and lower middle-income countries see a moderate increase. The impact of the CO_2-based tariff on the agri-food sector leads to different results across regions.

In scenario [0-3-2], there is a modest reduction in global emissions in 2025, neutralised by 2040. Upper middle-income countries show an initial reduction, while high-income regions experience a steady increase. Low-income countries see a significant increase in 2025, reversing by 2040. The EU-27 experiences a significant reduction in emissions, and lower middle-income countries see stabilisation by 2040.

Scenario [0-4-1] presents dramatic differences across regions, with a steady increase in global emissions. Upper middle-income and high-income countries experience significant increases, while low-income regions see a dramatic increase. The EU-27 experiences a significant decrease in emissions, and lower middle-income countries see growth. The unilateral imposition of a CO_2-based tariff leads primarily to a significant reduction in EU-27 emissions, with increases in other regions.

In scenario [0-4-2], there are consistent increases in global emissions, with upper middle-income and high-income regions experiencing significant increases. Low-income countries see a notable increase, while the EU-27 experiences a drastic drop in emissions. Lower middle-income countries experience growth in 2025, followed by a marginal decline in 2040. The bilateral CO_2-based mechanism leads to a significant reduction in EU-27 emissions, with varying degrees of emissions growth in other sectors.

TABLE 5: TOTAL EMISSIONS, %-CHANGE BETWEEN BASELINE AND SCENARIOS.

	[0-1] EU->WORLD->EU agri-food liberalisation		[0-2] EU->WORLD->EU All COM liberalisation		[0-2-1] EU->WORLD agri-food CO_2 based tariff + liberalisation of other sectors		[0-2-2] EU->WORLD->EU agri-food CO_2 based tariff + liberalisation of other sectors		[0-3-1] EU->WORLD agri-food CO_2 based tariff		[0-3-2] EU->WORLD->EU agri-food CO_2 based tariff		[0-4-1] EU->WORLD All COM CO_2 based tariff		[0-4-2] EU->WORLD->EU All COM CO_2 based tariff	
Income groups/regions	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040
World	0.00%	-0.01%	-0.07%	-0.12%	-0.09%	-0.11%	-0.09%	-0.11%	0.00%	0.00%	-0.02%	0.00%	0.12%	0.13%	0.12%	0.12%
Upper middle income	-0.03%	0.01%	-0.08%	-0.19%	-0.08%	-0.17%	-0.08%	-0.18%	0.01%	0.00%	-0.03%	0.02%	0.63%	0.83%	0.74%	1.20%
High income	0.00%	-0.01%	0.03%	-0.12%	0.05%	-0.10%	0.05%	-0.11%	0.01%	0.01%	0.02%	0.01%	1.32%	1.67%	1.24%	1.66%
Low income	0.20%	-0.24%	0.22%	0.45%	0.11%	0.61%	0.13%	0.52%	0.04%	0.16%	0.10%	-0.17%	1.18%	3.92%	0.91%	3.10%
EU-27	0.18%	0.10%	-0.24%	0.46%	-0.81%	0.07%	-0.71%	0.12%	-0.37%	-0.22%	-0.31%	-0.26%	-9.81%	-13.80%	-9.93%	-14.63%
Lower middle income	0.00%	-0.05%	-0.15%	-0.07%	-0.11%	-0.01%	-0.12%	-0.02%	0.02%	0.03%	0.03%	0.00%	0.54%	0.33%	0.50%	-0.04%
ROW	0.09%	-0.02%	-0.12%	-0.22%	-0.14%	-0.30%	-0.14%	-0.30%	0.08%	-0.09%	0.07%	-0.10%	1.41%	3.30%	1.31%	3.20%

Source: own calculations

CO_2 emissions

The bilateral liberalisation policies between the EU and the world exhibit varied impacts on CO_2 emissions across different economic sectors. Globally, emissions stay relatively constant in 2025 and decrease slightly by 0.01% by 2040. The EU-27, specifically, witnesses a consistent increase in emissions, growing by 0.07% in both 2025 and 2040. Upper-middle-income, high-income, low-income, and lower middle-income countries all experience fluctuations in their emission levels, with increases and decreases ranging from -0.01% to -0.20%. However, these changes are not substantial, given the small percentage points involved.

The full liberalisation of trade in goods between the EU and its global trading partners results in a slight drop in global CO_2 emissions, with a decrease of -0.01% in 2025 and -0.02% in 2040. The EU-27 observes a robust upward trend, with emissions increasing by 0.49% in 2025 and 1.45% in 2040. Low-income regions see a continuous and significant increase in their emissions, while upper middle-income regions experience a pronounced decrease. High-income regions and lower middle-income regions also see changes in their emission levels, but these are relatively moderate.

Under the [0-2-1] scenario, there is a minimal downward trend in global emissions, with a reduction of 0.02% in 2025 and 0.01% in 2040. The EU-27 displays a marked increase in CO_2 emissions, growing by 0.34% in 2025 and 1.29% in 2040. Low-income areas also show a robust growth pattern in emissions, while upper middle-income regions experience a decrease. High-income and lower middle-income regions witness fluctuations in their emission levels.

In the [0-2-2] scenario, a slight reduction in global emissions is noted, with upper middle-income regions experiencing a relatively large decrease. The EU-27 follows a growth path in emissions, with an increase of 0.36% in 2025 and 1.31% in 2040. Low-income regions show resilience and growth in emissions, while high-income regions and lower middle-income regions experience changes in their emission levels.

The [0-3-1] scenario produces a spectrum of mild emissions effects globally, with upper middle-income and high-income regions showing stability in their emission levels. The EU-27 experiences a reduction in emissions, while low-income regions shows a subtle shift over the years. Lower middle-income regions see a small increase in emissions.

In the [0-3-2] scenario, the world's emissions decrease slightly in 2025 but stabilise by 2040. The EU-27 sees a prolonged decline in emissions, reflecting a commitment to reducing CO_2 emissions and promoting greener trade practices. Upper middle-income countries and low-income regions experience fluctuations in their emission levels, while high-income regions show resilience.

The [0-4-1] scenario leads to an increase in global CO_2 emissions, with the world experiencing an initial spike followed by a gradual adjustment. The EU-27 sees a significant reduction in emissions, while upper middle-income, high-income, and low-income regions all experience increases in their emission levels. Lower middle-income countries see a dramatic shift in their emissions over time.

In the [0-4-2] scenario, there is a moderate increase in global emissions, with the EU-27 continuing to reduce its emissions significantly. Upper middle-income and high-income countries see relentless rises in their emissions, while low-income regions experience dramatic increases. Lower middle-income regions initially increase their emissions, but later show a decrease, suggesting a potential recalibration towards greener strategies.

TABLE 6: CO_2 EMISSIONS, %-CHANGE BETWEEN BASELINE AND SCENARIOS.

	[0-1] EU->WORLD->EU agri-food liberalisation		[0-2] EU->WORLD->EU All COM liberalisation		[0-2-1] EU->WORLD agri-food CO_2 based tariff + liberalisation of other sectors		[0-2-2] EU->WORLD->EU agri-food CO_2 based tariff + liberalisation of other sectors		[0-3-1] EU->WORLD agri-food CO_2 based tariff		[0-3-2] EU->WORLD->EU agri-food CO_2 based tariff		[0-4-1] EU->WORLD All COM CO_2 based tariff		[0-4-2] EU->WORLD->EU All COM CO_2 based tariff	
Income groups/regions	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040
World	0.00%	-0.01%	-0.01%	-0.02%	-0.02%	-0.01%	-0.02%	-0.01%	0.00%	0.00%	-0.01%	0.00%	0.18%	0.10%	0.15%	0.09%
Upper middle income	-0.02%	0.01%	-0.08%	-0.21%	-0.09%	-0.20%	-0.09%	-0.20%	0.00%	0.00%	-0.03%	0.02%	0.58%	0.77%	0.55%	0.92%
High income	0.01%	-0.01%	0.02%	-0.10%	0.02%	-0.09%	0.02%	-0.09%	0.00%	0.00%	0.01%	0.00%	1.22%	1.57%	1.10%	1.55%
Low income	0.20%	-0.07%	0.87%	0.89%	0.69%	0.91%	0.75%	0.90%	-0.04%	0.03%	0.07%	-0.06%	4.52%	8.65%	4.26%	7.78%
EU-27	0.07%	0.07%	0.49%	1.45%	0.34%	1.29%	0.36%	1.31%	-0.06%	-0.03%	-0.06%	-0.09%	-7.71%	-12.15%	-7.34%	-12.49%
Lower middle income	0.01%	-0.06%	-0.09%	-0.02%	-0.07%	0.04%	-0.08%	0.03%	0.02%	0.03%	0.02%	0.00%	0.63%	0.07%	0.62%	-0.09%
ROW	0.05%	-0.03%	0.03%	0.01%	0.01%	-0.06%	0.01%	-0.06%	0.03%	-0.09%	0.03%	-0.10%	1.60%	3.52%	1.40%	3.32%

Source: own calculations

N_2O emissions [CO_2-equ]

In the [0-1] scenario, global N_2O emissions exhibit a marginal increase of 0.05% in 2025, shifting to a slight decrease of -0.06% by 2040. The EU-27 region experiences an initial increase of 0.52% in 2025, before reversing to a decrease of -0.24% in 2040. The upward trend of the upper middle-income group, with an increase from 0.43% in 2025 to 0.67% in 2040, and the continuous decrease in high-income regions, from a decrease of -0.21% in 2025 to -0.31% in 2040, are notable. Low-income countries and lower middle-income countries also follow a decreasing trend in emissions.

In the [0-2] scenario, global N_2O emissions show a small increase of 0.06% in 2025, stabilising to no change by 2040. The EU-27 displays a significant decrease of -0.54% in 2025, followed by an unexpected increase of 0.67% in 2040. The upper middle-income regions see an increase in emissions from 0.57% in 2025 to 0.64% in 2040, while high-income areas and low-income countries experience reductions in emissions.

Under the [0-2-1] scenario, global N_2O emissions increase from 0.05% in 2025 to 0.27% in 2040. The EU-27 faces a dramatic decrease in emissions, with drops of -12.47% in 2025 and -11.55% in 2040. Upper middle-income and high-income regions, as well as low-income areas, all see increases in emissions, with upper middle-income regions experiencing a significant increase from 1.36% in 2025 to 1.57% in 2040.

In the [0-2-2] scenario, global N_2O emissions rise from 0.04% in 2025 to 0.23% in 2040. The EU-27 experiences substantial reductions, with a decrease of -11.11% in 2025 and -10.54% in 2040. Both upper middle-income and high-income regions experience increases in emissions, although the high-income regions show a notable slowdown from 1.13% in 2025 to 0.27% in 2040.

In the [0-3-1] scenario, global N_2O emissions shift from a reduction of -0.16% in 2025 to an increase of 0.14% by 2040. The EU-27 experiences significant reductions, decreasing by 8.16% in 2025 and 9.29% in 2040. Upper middle-income and high-income regions, along with low-income regions, all exhibit increases in emissions.

The [0-3-2] scenario reveals a moderate upward trajectory in global N_2O emissions, increasing from 0.03% in 2025 to 0.17% in 2040. The EU-27 displays a steady downward trend, with a decrease of -10.31% in 2025 intensifying to -11.73% in 2040. Upper middle-income regions, high-income regions, and low-income regions all experience increases in emissions.

In the [0-4-1] scenario, global N_2O emissions decrease significantly by 0.30% in 2025, with a smaller decrease of -0.05% in 2040. The EU-27 shows a pronounced decline, with emissions falling by 11.84% in 2025 and a greater decrease of -14.34% in 2040. Upper middle-income regions, high-income regions, and low-income regions see increases in emissions.

Finally, in the [0-4-2] scenario, there is a small decrease in global N_2O emissions, from -0.12% in 2025 to -0.04% in 2040. The EU-27 again displays a strong downward trend, with a -14.41% decrease in 2025 and an -18.07% decrease in 2040. Upper middle-income regions, high-income regions, and low-income regions exhibit increases in emissions, while lower middle-income regions see a slight increase in 2025 and a decrease by 2040.

TABLE 7: N_2O EMISSIONS, %-CHANGE BETWEEN BASELINE AND SCENARIOS.

Source: own calculations

	[0-1] EU->WORLD->EU agri-food liberalisation		[0-2] EU->WORLD->EU All COM liberalisation		[0-2-1] EU->WORLD agri-food CO_2 based tariff + liberalisation of other sectors		[0-2-2] EU->WORLD->EU agri-food CO_2 based tariff + liberalisation of other sectors		[0-3-1] EU->WORLD agri-food CO_2 based tariff		[0-3-2] EU->WORLD->EU agri-food CO_2 based tariff		[0-4-1] EU->WORLD All COM CO_2 based tariff		[0-4-2] EU->WORLD->EU All COM CO_2 based tariff	
Income groups/regions	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040
World	0.05%	-0.06%	0.06%	0.00%	0.05%	0.27%	0.04%	0.23%	-0.16%	0.14%	0.03%	0.17%	-0.30%	-0.05%	-0.12%	-0.04%
Upper middle income	0.43%	0.67%	0.57%	0.64%	1.36%	1.57%	1.30%	1.55%	0.33%	0.43%	1.17%	1.59%	0.55%	0.67%	1.41%	1.99%
High income	-0.21%	-0.31%	-0.05%	-0.41%	1.49%	0.52%	1.13%	0.27%	0.82%	0.58%	0.99%	0.39%	0.96%	0.92%	1.16%	0.83%
Low income	-0.33%	-0.67%	-0.51%	-0.56%	0.33%	0.75%	0.30%	0.60%	0.60%	1.23%	0.49%	0.50%	0.35%	1.05%	0.10%	0.18%
EU-27	0.52%	-0.24%	-0.54%	0.67%	-12.47%	-11.55%	-11.11%	-10.54%	-8.16%	-9.29%	-10.31%	-11.73%	-11.84%	-14.34%	-14.41%	-18.07%
Lower middle income	-0.38%	-0.62%	-0.39%	-0.55%	0.20%	0.31%	0.10%	0.18%	0.21%	0.78%	0.12%	0.12%	0.22%	0.57%	0.16%	-0.12%
ROW	-0.17%	-0.07%	-0.14%	-0.04%	0.77%	0.81%	0.74%	0.80%	0.74%	0.79%	0.73%	0.79%	0.77%	1.08%	0.76%	1.10%

CH_4 emissions [CO_2-equ]

In scenario [0-1], which focuses on the liberalisation of agri-food trade between the EU and global partners, CH_4 emissions see varied responses across different regions. Globally, the impact is minimal initially, with no change in 2025, but a modest reduction in emissions by 2040. Within the EU-27, a significant reduction is observed with a -1.18% decrease in 2025, though this falls to a -0.33% decrease by 2040. Upper middle income and high-income regions, however, experience increases in emissions, particularly upper middle-income regions which see a 0.26% increase in 2025, growing to a 0.42% increase by 2040. Low-income and lower middle-income countries both follow a downward trend throughout the period, contributing to the global reduction in emissions.

Under scenario [0-2], which expands the liberalisation to all goods traded between the EU and global partners, global CH_4 emissions see a consistent decrease, though slight, with a -0.04% reduction in 2025 and a -0.05% reduction by 2040. The EU-27 region experiences a pronounced downward trend, with emissions decreasing by 2.03% in 2025, though this lessens to a -0.60% decrease in 2040. Upper middle-income regions, on the other hand, see a consistent increase in emissions, and low-income regions experience a steady decline, helping contribute to the global reduction.

In scenario [0-2-1], there is a varied impact on CH_4 emissions, with a global decrease of -0.08% in 2025, reversing to an increase of 0.08% by 2040. The EU-27 experiences a dramatic decrease in emissions, with a -10.75% reduction in 2025 and a -10.30% reduction by 2040. Upper middle income and low-income regions, however, see significant increases in emissions, particularly upper middle-income regions which experience a 0.72% increase in 2025, growing to a 1.00% increase by 2040.

Scenario [0-2-2] also sees varied responses, with a global decrease of -0.08% in 2025, turning into a 0.06% increase by 2040. The EU-27 again experiences a significant reduction in emissions, while upper middle income and low-income regions see increases. High-income regions experience an increase in 2025 but see a significant slowdown in emission growth by 2040.

In scenario [0-3-1], the global response is initially a decrease of -0.11% in 2025, shifting to a 0.10% increase by 2040. The EU-27 sees a significant and consistent decrease in emissions, while upper middle income, low-income, and lower middle-income countries all experience increases in emissions.

The [0-3-2] scenario results in a slight global decrease of 0.04% in 2025, shifting to a 0.07% increase by 2040. The EU-27 sees a deep and consistent reduction in emissions, while upper middle income and low-income countries experience increases in emissions. High-income countries see an increase in 2025 but a significant slowdown in emission growth by 2040.

In scenario [0-4-1], there is a slight global decrease of -0.11% in 2025, turning into a 0.03% increase by 2040. The EU-27 experiences a sharp decline in emissions, while upper middle-income, low-income, and lower middle-income countries all see increases in emissions.

Similar to the previous scenario [0-4-2], there is a global decrease of -0.07% in 2025 and a slight decrease of -0.02% by 2040. The EU-27 experiences a significant decrease in emissions, while upper middle income, low-income, and lower middle-income countries see increases in emissions, although in lower middle-income countries this drops to 0.00% by 2040.

Throughout these scenarios, it is evident that the EU-27 consistently experiences significant reductions in CH_4 emissions, aligning with its liberalisation and environmental policies. Upper middle income and low-income regions generally see increases in emissions, though there are variations and

complexities in the trends, indicating the multifaceted nature of global emissions and the impact of trade and economic policies.

TABLE 8: CH_4 EMISSIONS, %-CHANGE BETWEEN BASELINE AND SCENARIOS.

Source: own calculations

	[0-1] EU->WORLD->EU agri-food liberalisation		[0-2] EU->WORLD->EU All COM liberalisation		[0-2-1] EU->WORLD agri-food CO_2 based tariff + liberalisation of other sectors		[0-2-2] EU->WORLD->EU agri-food CO_2 based tariff + liberalisation of other sectors		[0-3-1] EU->WORLD agri-food CO_2 based tariff		[0-3-2] EU->WORLD->EU agri-food CO_2 based tariff		[0-4-1] EU->WORLD All COM CO_2 based tariff		[0-4-2] EU->WORLD->EU All COM CO_2 based tariff	
Income groups/regions	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040	2025	2040
World	0.00%	-0.05%	-0.04%	-0.05%	-0.08%	0.08%	-0.08%	0.06%	-0.11%	0.10%	-0.04%	0.07%	-0.11%	0.03%	-0.07%	-0.02%
Upper middle income	0.26%	0.42%	0.30%	0.42%	0.72%	1.00%	0.73%	1.01%	0.23%	0.32%	0.69%	1.01%	0.40%	0.46%	0.85%	1.21%
High income	0.05%	-0.08%	0.10%	-0.15%	0.66%	0.15%	0.53%	0.07%	0.35%	0.20%	0.50%	0.14%	0.71%	0.54%	0.84%	0.50%
Low income	-0.22%	-0.42%	-0.35%	-0.20%	0.32%	1.08%	0.30%	0.99%	0.52%	1.26%	0.45%	0.78%	0.49%	1.29%	0.19%	0.51%
EU-27	-1.18%	-0.33%	-2.03%	-0.60%	-10.75%	-10.30%	-10.32%	-9.99%	-7.12%	-8.15%	-9.69%	-9.95%	-10.78%	-12.51%	-13.25%	-14.56%
Lower middle income	-0.16%	-0.49%	-0.24%	-0.45%	-0.01%	0.18%	-0.02%	0.11%	0.15%	0.68%	0.07%	0.09%	0.24%	0.66%	0.12%	0.00%
ROW	-0.06%	-0.04%	-0.08%	-0.05%	0.42%	0.47%	0.41%	0.47%	0.45%	0.50%	0.45%	0.50%	0.64%	0.78%	0.63%	0.78%

Conclusions

The integration of Sustainable Development Goals (SDGs) into global trade agreements through cross-compliance mechanisms represents a transformative approach towards sustainable trade. Conditional market access that hinges on technological advancements in environmental protection ensures that international commerce contributes positively to environmental stewardship. Therefore, cross-compliance not only encourages nations to invest in green technologies, but also aligns global trade practices with the urgent need for environmental sustainability.

It is imperative for the European Union to rigorously evaluate the environmental impact of trade agreements, particularly with countries that have high levels of pollution. Aligning such agreements with the SDG goals would not only reinforce the EU's commitment to sustainable development, but also promote environmental accountability in international trade. This consideration could lead to a more sustainable trade ecosystem that supports environmental objectives globally.

Countries that choose to implement CO_2-based tariffs as a measure to combat climate change should be prepared for potential retaliatory actions from trading partners. Such feedback could manifest in the form of both CO_2-specific and more general non-CO_2 tariffs, underscoring the complex dynamics of international trade relations in the context of environmental regulation. This highlights the need for a multilateral approach to carbon pricing and emissions tariffs, in order to minimise conflict and promote the widespread adoption of environmentally responsible trade practices.

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Appendices

Sectoral aggregation

All scenarios use the same sectoral aggregation (as shown below), which is fully disaggregated into 65 sectors as in the GTAP10 database.

TABLE 9: SECTORAL AGGREGATION

Sector	Short name
Paddy rice	pdr
Wheat	wht
Cereal grains n.e.c.	gro
Vegetables, fruit, nuts	v_f
Oil seeds	osd
Sugar cane, sugar beet	c_b
Plant-based fibres	pfb
Crops n.e.c.	ocr
Cattle, sheep, goats, horses	ctl
Animal products n.e.c.	oap
Raw milk	rmk
Wool, silk-worm cocoons	wol
Forestry	frs
Fishing	fsh
Coal	coa
Oil	oil
Gas	gas
Other Extraction (formerly omn)	oxt
Bovine meat products	cmt
Meat products n.e.c.	omt

Vegetable oils and fats	vol
Dairy products	mil
Processed rice	pcr
Sugar	sgr
Food products n.e.c.	ofd
Beverages and tobacco products	b_t
Textiles	tex
Wearing apparel	wap
Leather products	lea
Wood products	lum
Paper products, publishing	ppp
Petroleum, coal products	p_c
Chemical products	chm
Basic pharmaceutical products	bph
Rubber and plastic products	rpp
Mineral products n.e.c.	nmm
Ferrous metals	i_s
Metals n.e.c.	nfm
Metal products	fmp
Computer, electronic, optical products	ele
Electrical equipment	eeq
Machinery and equipment n.e.c.	ome
Motor vehicles and parts	mvh
Transport equipment n.e.c.	otn
Manufactures n.e.c.	omf
Electricity	ely
Gas manufacture, distribution	gdt

Water	wtr
Construction	cns
Trade	trd
Accommodation, food, service activities	afs
Transport n.e.c.	otp
Water transport	wtp
Air transport	atp
Warehousing, support activities	whs
Communication	cmn
Financial services nec	ofi
Insurance (formerly isr)	ins
Real estate activities	rsa
Business services nec	obs
Recreational and other serv	ros
Public Administration, defense	osg
Education	edu
Human health, Social work act	hht
Dwellings	dwe

Regional aggregation

Fully fledged EU trade liberalisation and CO_2-based import tariff/production tax

TABLE 10: COUNTRIES AGGREGATION FOR FULLY FLEDGED EU TRADE LIBERALISATION AND CO_2-BASED IMPORT TARIFF/PRODUCTION TAX

Countries	Income group (long name)	Income group (short name)
Albania	Upper middle income	Up_mid_inc
Argentina	Upper middle income	Up_mid_inc
Armenia	Upper middle income	Up_mid_inc
Azerbaijan	Upper middle income	Up_mid_inc
Belarus	Upper middle income	Up_mid_inc
Brazil	Upper middle income	Up_mid_inc
Botswana	Upper middle income	Up_mid_inc
China	Upper middle income	Up_mid_inc
Colombia	Upper middle income	Up_mid_inc
Costa Rica	Upper middle income	Up_mid_inc
Dominican Republic	Upper middle income	Up_mid_inc
Ecuador	Upper middle income	Up_mid_inc
Georgia	Upper middle income	Up_mid_inc
Guatemala	Upper middle income	Up_mid_inc
Jamaica	Upper middle income	Up_mid_inc
Jordan	Upper middle income	Up_mid_inc
Kazakhstan	Upper middle income	Up_mid_inc
Mexico	Upper middle income	Up_mid_inc
Mauritius	Upper middle income	Up_mid_inc
Malaysia	Upper middle income	Up_mid_inc

Namibia	Upper middle income	Up_mid_inc
Peru	Upper middle income	Up_mid_inc
Paraguay	Upper middle income	Up_mid_inc
Russian Federation	Upper middle income	Up_mid_inc
Thailand	Upper middle income	Up_mid_inc
Turkey	Upper middle income	Up_mid_inc
United Arab Emirates	High income	High_income
Australia	High income	High_income
Bahrain	High income	High_income
Brunei Darassalam	High income	High_income
Canada	High income	High_income
Switzerland	High income	High_income
Chile	High income	High_income
United Kingdom	High income	High_income
Hong Kong	High income	High_income
Israel	High income	High_income
Japan	High income	High_income
Korea	High income	High_income
Kuwait	High income	High_income
Norway	High income	High_income
New Zealand	High income	High_income
Oman	High income	High_income
Panama	High income	High_income
Puerto Rico	High income	High_income
Qatar	High income	High_income
Saudi Arabia	High income	High_income
Singapore	High income	High_income

Trinidad and Tobago	High income	High_income
Taiwan	High income	High_income
Uruguay	High income	High_income
United States of America	High income	High_income
Burkina Faso	Low income	Low_income
Ethiopia	Low income	Low_income
Guinea	Low income	Low_income
Madagascar	Low income	Low_income
Mozambique	Low income	Low_income
Malawi	Low income	Low_income
Rwanda	Low income	Low_income
Togo	Low income	Low_income
Uganda	Low income	Low_income
Zambia	Low income	Low_income
Austria	European Union 27	EU-27
Belgium	European Union 27	EU-27
Bulgaria	European Union 27	EU-27
Cyprus	European Union 27	EU-27
Czech Republic	European Union 27	EU-27
Germany	European Union 27	EU-27
Denmark	European Union 27	EU-27
Spain	European Union 27	EU-27
Estonia	European Union 27	EU-27
Finland	European Union 27	EU-27
France	European Union 27	EU-27
Greece	European Union 27	EU-27
Croatia	European Union 27	EU-27

Hungary	European Union 27	EU-27
Ireland	European Union 27	EU-27
Italy	European Union 27	EU-27
Lithuania	European Union 27	EU-27
Luxembourg	European Union 27	EU-27
Latvia	European Union 27	EU-27
Malta	European Union 27	EU-27
Netherlands	European Union 27	EU-27
Poland	European Union 27	EU-27
Portugal	European Union 27	EU-27
Romania	European Union 27	EU-27
Slovakia	European Union 27	EU-27
Slovenia	European Union 27	EU-27
Sweden	European Union 27	EU-27
Benin	Lower middle income	Low_mid_inc
Bangladesh	Lower middle income	Low_mid_inc
Bolivia	Lower middle income	Low_mid_inc
Cote d'Ivoire	Lower middle income	Low_mid_inc
Cameroon	Lower middle income	Low_mid_inc
Egypt	Lower middle income	Low_mid_inc
Ghana	Lower middle income	Low_mid_inc
Honduras	Lower middle income	Low_mid_inc
Indonesia	Lower middle income	Low_mid_inc
India	Lower middle income	Low_mid_inc
Iran Islamic Republic of	Lower middle income	Low_mid_inc
Kenya	Lower middle income	Low_mid_inc
Kyrgyzstan	Lower middle income	Low_mid_inc

Cambodia	Lower middle income	Low_mid_inc
Lao People's Democratic Republic	Lower middle income	Low_mid_inc
Sri Lanka	Lower middle income	Low_mid_inc
Morocco	Lower middle income	Low_mid_inc
Mongolia	Lower middle income	Low_mid_inc
Nigeria	Lower middle income	Low_mid_inc
Nicaragua	Lower middle income	Low_mid_inc
Nepal	Lower middle income	Low_mid_inc
Pakistan	Lower middle income	Low_mid_inc
Philippines	Lower middle income	Low_mid_inc
Senegal	Lower middle income	Low_mid_inc
El Salvador	Lower middle income	Low_mid_inc
Tajikistan	Lower middle income	Low_mid_inc
Tunisia	Lower middle income	Low_mid_inc
Tanzania	Lower middle income	Low_mid_inc
Ukraine	Lower middle income	Low_mid_inc
Zimbabwe	Lower middle income	Low_mid_inc
Viet Nam	Lower middle income	Low_mid_inc
Venezuela	The rest of the World	ROW
South Central Africa	The rest of the World	ROW
Rest of Central America	The rest of the World	ROW
Caribbean	The rest of the World	ROW
Central Africa	The rest of the World	ROW
Rest of East Asia	The rest of the World	ROW
Rest of Eastern Africa	The rest of the World	ROW
Rest of Eastern Europe	The rest of the World	ROW

Rest of EFTA	The rest of the World	ROW
Rest of Europe	The rest of the World	ROW
Rest of North America	The rest of the World	ROW
Rest of North Africa	The rest of the World	ROW
Rest of Oceania	The rest of the World	ROW
Rest of South Asia	The rest of the World	ROW
Rest of South African Customs	The rest of the World	ROW
Rest of Southeast Asia	The rest of the World	ROW
Rest of South America	The rest of the World	ROW
Rest of Former Soviet Union	The rest of the World	ROW
Rest of the World	The rest of the World	ROW
Rest of Western Africa	The rest of the World	ROW
Rest of Western Asia	The rest of the World	ROW
South Africa	The rest of the World	ROW

List of Tables