Understanding the Effects of the EUDR on Global Trade and Agricultural Land Use

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Introduction

The European Union (EU) recently implemented the Regulation on Deforestation-free Products (EUDR), a landmark policy aimed at reducing deforestation and forest degradation associated with imported commodities. The EUDR specifically targets agricultural and forest-based commodities, which includes soybeans, wood products, cattle, cocoa, palm oil, coffee, and other products that are traditionally linked to land-use change and deforestation. By implementing stricter trade compliance measures, the EUDR could introduce substantial non-tariff trade barriers (NTBs), influencing global trade dynamics, agricultural production, and land use patterns.

Despite its ambitious environmental goals, the EUDR has created considerable uncertainty among stakeholders. The ambiguity surrounding its enforcement mechanisms, compliance requirements, and potential costs presents significant challenges. Producers and policymakers are concerned about the potential impact of these measures on production, market access, and trade flow. Furthermore, the EUDR's potential to reshape global trade by altering sourcing strategies and affecting the comparative advantages of various exporting nations highlights the need for comprehensive assessments of its implications.

Previous research has shown the significant role of non-tariff barriers in influencing agricultural trade patterns, production structures, and international market dynamics. Trade policies, like the EUDR, will not only alter bilateral trade flows but also have cascading effects that reshape global agricultural markets. Recent literature suggests that compliance-driven trade costs will significantly impact exporting nation's competitiveness, particularly when affecting countries highly reliant on the EU market. However, the full range of indirect market impacts and how exporting nations will adapt their new trade patterns in response to these policies remain limited.

This study addresses these critical knowledge gaps by setting varying levels of hypothetical EUDR compliance costs on global agricultural trade and production. Specifically, the research examines the effects of incremental transaction cost increases on the commodities of major agricultural exporting regions entering the EU. We consider both uniform cost increases for all potential trading partners (assuming some level of compliance costs to access the EU market), as well as tailored scenarios that limit the EUDR transaction cost impact to specific regions and commodity groups based on perceived deforestation risk. We present evidence of potential production reallocation effects of EUDR trade cost scenarios, particularly within the US and EU regions.

Our analysis thus highlights how increased EUDR compliance costs could influence production and bilateral trade flows. By doing so, we can understand the direct and indirect impacts from the EUDR. Then, policymakers and stakeholders can use it to navigate how to balance environmental goals with economic development and trade opportunities

Methodology and Data

We develop global illustrative scenarios of EUDR-induced compliance cost impacts using a global partial equilibrium model of agriculture, forestry, land use, and bioenergy sectors. The model provides substantial detail on the bilateral trade of agriculture and forest commodities and trade cost structure.

Global Biosphere Management Model Description

Specifically, this research builds on recent efforts to further develop the global partial equilibrium land sector model GLOBIOM (the Global Biosphere Management Model), including updated trade calibration steps (Gong et al., 2025).

GLOBIOM represents land use and production possibilities using a spatially explicit representation of global agricultural land use and production. It utilizes crop process model outputs from the Environment Policy Integrated Model (EPIC) and forest productivity, and potential harvest allocations from the Global Forestry Model (G4M). The supply side of the model relies on a geographically explicit representation of land-based activities at a simulation unit scale (sub-county for the United States), where spatial units correspond to state geographic boundaries. Agricultural production is represented by 18 crops (barley, dry beans, cassava, chickpeas, corn, cotton, groundnut, millet, oil palm, potatoes, rapeseed, rice, soybeans, sorghum, sugar cane, sunflower, sweet potatoes, and wheat) and seven types of livestock (bovine meat herd, bovine dairy herd, sheep and goat meat herd, sheep and goat dairy herd, laying hens, broilers, and pigs). Forest products include both raw commodities (pulpwood, sawtimber, and bioenergy logs), semifinished products (e.g., pulp and sawmill residuals) and final products (e.g., paper, panels, and dimensional lumber). These production systems supply regional and global markets for food, feed, forest products and bioenergy. Global and regional market shifts over time are driven by socioeconomic, environmental, and policy change drivers according the Shared Socioeconomic Pathways and Representative Concentration Pathways (IIASA, 2025).

The model has been widely applied to assess the implications of changing socioeconomic conditions (Riahi et al., 2017), regional and global bioenergy policy (Mosnier et al., 2014; Rose et al., 2022), environmental change and trade policy interactions (Baker et al., 2018; Jansens et al., 2020), and greenhouse gas mitigation policies (HavlÍk et al., 2014; EPA, 2024). Complete documentation of the model and supplemental references can be found at the GLOBIOM documentation site (IIASA, 2024).

Trade Simulation

The novel feature of this study lies in its integration of spatially explicit modeling and dynamic trade-flow analysis to assess the potential global implications of EUDR-induced changes in trade costs (and global product allocation). Our scenario design disentangles regional and commodity-specific effects of EUDR cost increases and captures heterogeneous responses across key exporters such as the United States, Brazil, China, and Southeast Asia.

GLOBIOM models ***intensive*** margin (existing bilateral trade flows) and ***extensive*** margin (establishing new trade flows) trade costs. Regions can adjust trade flows according to these cost specifications. The logic of the GLOBIOM trade cost specificication is based on the spatial equilibrium concept for homogeneous goods (Enke, 1951; Samuelson, 1952; Takayama and Judge, 1971). Janssens et al. (2020) illustrates how Scale parameters for non-linear trade expansion costs. By mapping the spatial distribution of land use changes and deforestation patterns at a grid level, it provides precise insights into the environmental and economic consequences of compliance costs. Additionally, the study quantifies how deforestation and production may shift to regions outside the EU's regulatory scope under different scenarios. This clarity is critical for us to identify thresholds between trade reallocation and environmental impacts. The model also simulates how changes in trade policies, such as increased transaction costs, affect commodity flows and production adjustments across regions.

Scenario Design

We apply our integrated framework to estimate agriculture production outcomes under both business-as-usual (BAU) and alternative trade scenarios.

The baseline scenario is defined using population growth, economic development, and market conditions consistent with the Shared Socioeconomic Pathway SSP2 scenario. Baseline trade costs are calibrated to FAO and UNCOMTRADE databases. Costs represent potential transport costs between trading partners as well as existing tariffs and other price-based trade policy instruments from the World Trade Organization.

In out scenarios, to assess the implications of the EUDR, we simulate additional transaction costs imposed specifically on exports to the EU. These range from moderate (25% and 50%) to high (100%, 150%, and 200%) increases in trade transaction costs, representing varying degrees of EUDR compliance stringency. These increased costs are applied exclusively to bilateral trade between exporting regions and the EU, with trade costs for other regions and commodity exchanges remaining at baseline levels. These scenarios particularly focus on assessing how key exporting regions, including the U.S., Brazil, and China, respond to altered trade conditions, capturing both direct and indirect market adjustments through shifts in trade flows and production patterns. Through this framework, we provide insights into potential adaptation responses of major exporters, highlighting shifts in production and market access as regions respond to EUDR induced changes in trade dynamics.

In the following sections, we present the results of our scenario-based simulations, including the trade and production impacts of the EUDR across key regions and commodities. This is followed by a comprehensive discussion of the broader policy implications. Last, we conclude by summarizing key findings.

Results

For simplicity, we present results for select production regions, bilateral trade flows, commodity groups, and EUDR scenarios, with a primary focus on trade and production responses in the U.S. and EU. A more comprehensive set of trade responses and regional production and land use responses can be found in the supplemental appendix.

Land Use Impacts

While the EUDR is designed to curb deforestation through trade restrictions, its impacts on land use are complex and vary both temporally and spatially. Results from our model simulations indicate that changes in forest area and cropland are marginal in absolute terms, though heterogeneous across regions and time horizons.

The bar chart in Figure 1 shows absolute changes in global forest area over time under each of the five EUDR trade cost scenarios. In the short term 2020–2030, scenarios with higher trade costs (100% to 200%) show small but positive gains in global forest area, up to around 1.5 Mha 2020 in the 200% scenario, which is only approximately 0.04% of total global forest area. These gains reflect early reductions in forest conversion due to weakened export demand for forest-based commodities as well as reduced extensive margin pressure from agricultural land conversion. However, by 2040–2050, the impact of EUDR transaction costs on global forest area begins start to fade, suggesting temporal adjustments in land use and production that may limit the effectiveness of EUDR compliance obligations in saving global forests long term. For example, net forest area even begins to decline in 2050 under even moderate trade cost (25% to 100%). This result also suggests that partial enforcement or inconsistent trade policies will lead to indirect land expansion elsewhere.

In the Figure 3, we show the spatial distribution of these changes and net forest area change by region. The results show that the primary forest preservation benefits are concentrated in Eastern Africa and Southeast Asia, where these regions with high historic deforestation rates and strong trade linkages to the EU in targeted commodities. Under the highest EUDR scenario (200%), forest area gains over 1% appear in these two regions, while the rest of the world shows limited to no impact.

Similar to changes in global forest area, the broader global effect on cropland (Figure 2) is a small but consistent reduction up to -0.4% under the highest trade cost scenario in 2050, with consistent reduction in cropland in most regions of the world driven by suppressed global markets under higher trade costs for EUDR compliance. On net, results show a roughly 1.4 Mha decline in global cropland near term, but a growing reallocation away from crop production over time – up to 4 Mha in 2050. The contraction in cropland begins gradually around 2030 and accelerates through mid-century, indicating that cropland markets are more elastic in the long run. However, this consistent reduction in cropland is somewhat offset by an increase in crop area and crop production in the EU, which extensifies production in response to reduced imports.

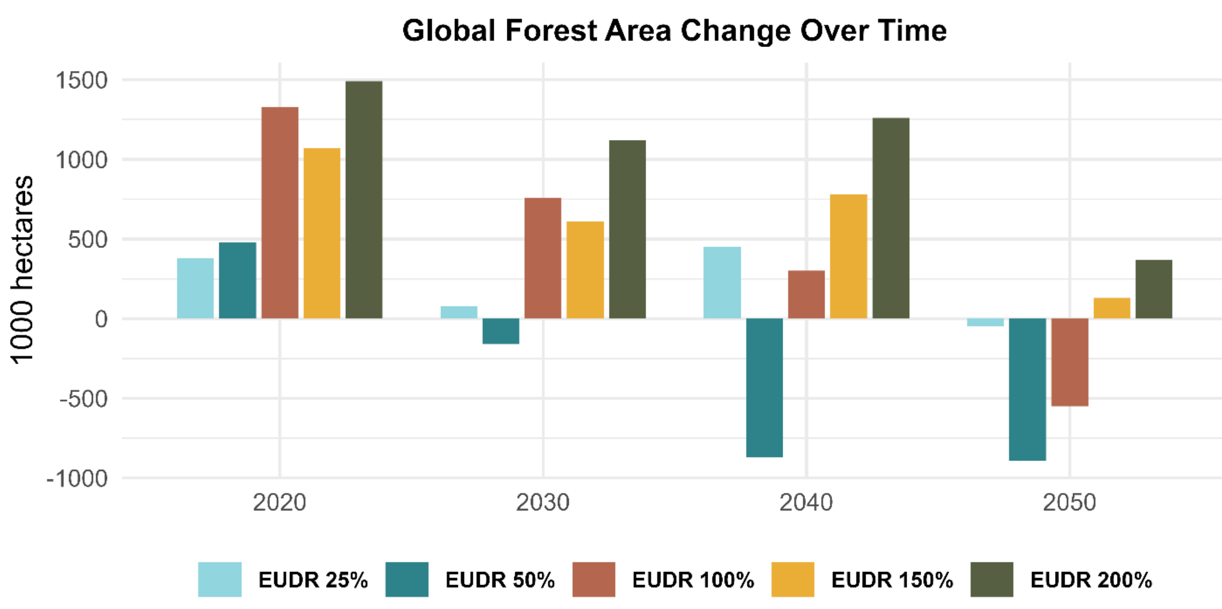

Figure 1: Forest Area Change over Time

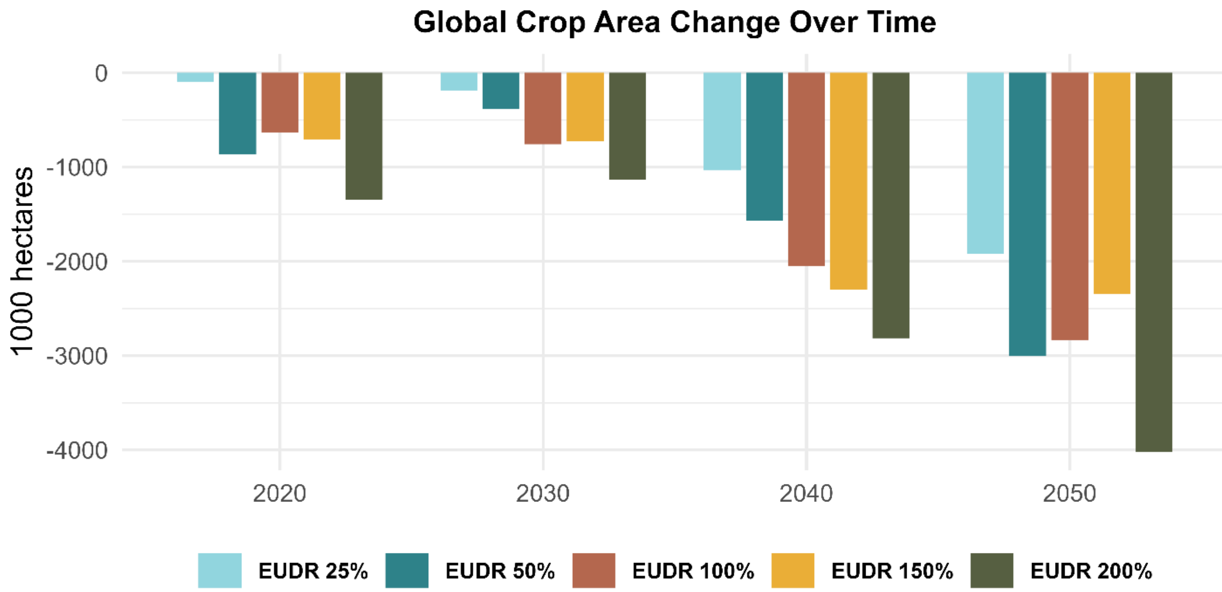

Figure 2 Cropland Area Change over Time

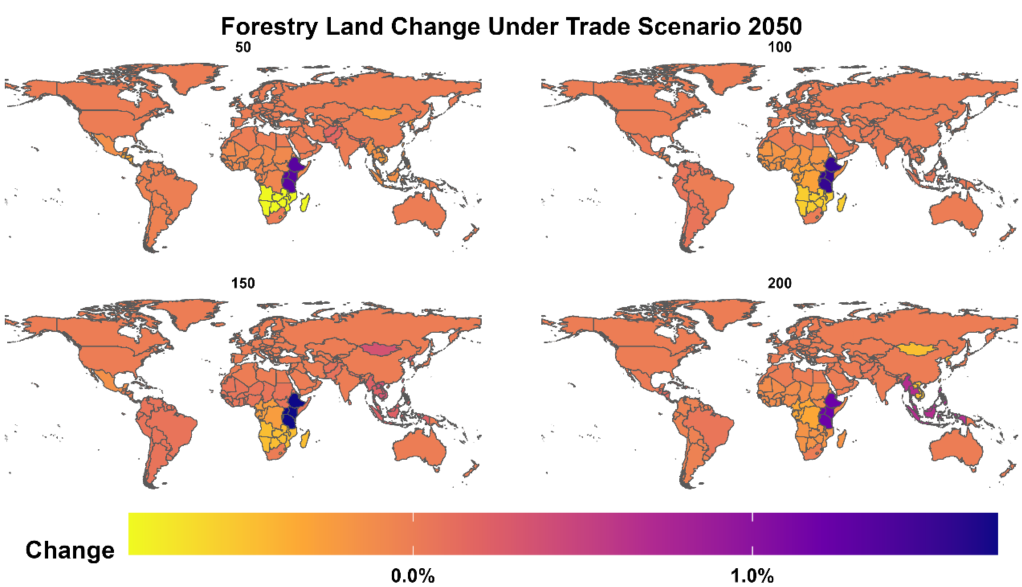

Figure 3: Forestry Land Change Spatial Distribution

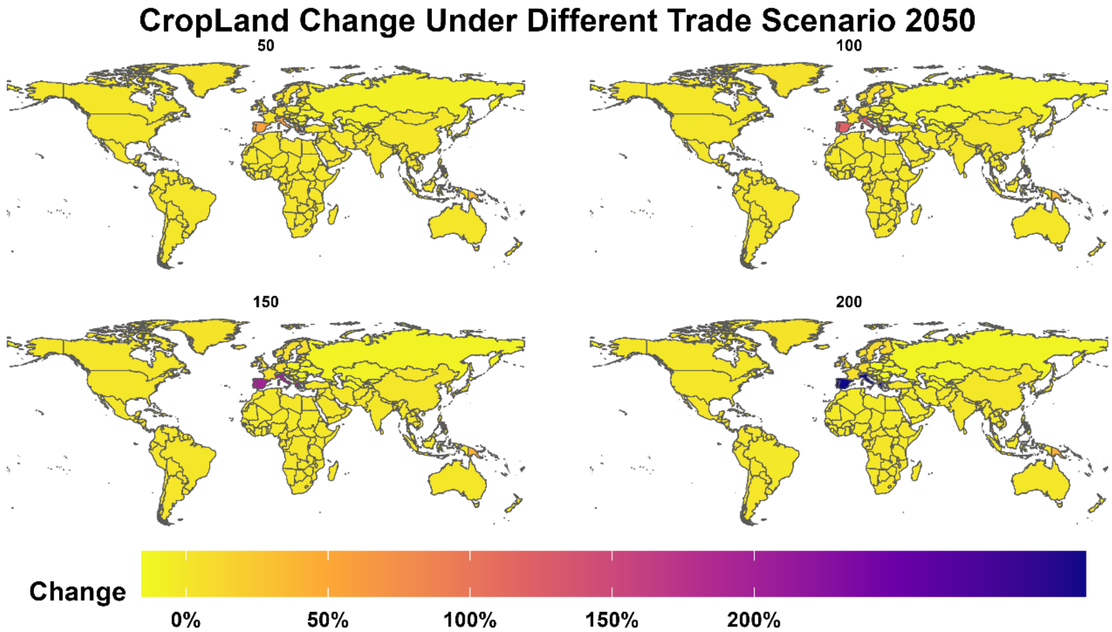

Figure 4: Cropland Change Spatial Distribution

Trade Impacts

The US is a key trading partner with the EU. It is not currently clear whether the US would be classified as a high deforestation risk country or not, especially as recent empirical evidence suggests that agricultural conversion is a relatively small driver of forest loss in the US relative to, other drivers like, urbanization. Hower, the US has seen a large expansion in planted pine forests, in some cases replacing naturally regenerated, lower productivity systems. This type of forest conversion post-harvest is classified as a form of forest degradation under the EUDR, and commodity production resulting from lands that converted from natural forests to plantation systems from natural forests would be prohibited from entering the EU market.

Under the assumption that EUDR regulatory requirements impose new compliance (transaction) costs on US agriculture and forest product suppliers, our results provide illustrative evidence for how these cost change would impact bilateral trade flows.

The imposition of EUDR-related trade costs introduces significant frictions into trans-atlantic trade and leads to observable shifts in U.S. export patterns. In the left side of the Figure 5, under the BAU scenario, U.S. exports of key commodities such as soybeans, corn, and wood-based products will be distributed broadly across major markets, with particularly strong flows to the

EU, China, Mexico, and various Asia-Pacific and Latin American regions. However, under a scenario simulating a 200% increase in trade transaction costs for exports to the EU which makes it more expensive for US producers to access the EU market for certain commodities, the structure of these trade flows changes. In the corresponding Sankey diagram on the right side of Figure 5, there is a notable reduction in U.S. exports to the different EU regions, particularly for soybeans and wood products like wood pellets. These losses are not indicative of a reduction in total U.S. exports but rather by a redirection of trade flows to non-EU markets, such as Mexico. For example, trade previously destined for the EU will be reallocated toward Asia markets in the case of wood-based commodities.

In Figure 6, a more detailed view of U.S. trade adjustment dynamics is provided in the set of heatmaps illustrating percentage changes in U.S. exports by destination region and commodity under the four EUDR cost scenarios (25%, 50%, 150%, and 200%). These figures reinforce the trend observed in the Sankey diagrams and offer a disaggregated perspective across a broader range of bilateral flows. At relatively modest trade frictions (25% and 50%), there are already visible contractions in U.S. exports of wood products to EU regions, particularly to the EU North and South. These reductions intensify with higher trade cost scenarios. At 150% and especially 200%, the heatmaps show widespread negative trade deviations across the EU. For example, soybean exports to the EU Baltic decline sharply, and exports of wood products to EU North also drop steeply. These effects confirm that compliance costs under stringent EUDR scenarios could reduce the flow of U.S.-sourced forest and agricultural commodities in European markets.

At the same time, the heatmaps reveal evidence of simultaneous increases in trade to other destinations. Export flows of corn and dry beans grow noticeably toward Southeast Asia, China, and several Africa regions. These counterbalancing gains are especially prominent at the 150% and 200% cost levels, underscoring a reallocation of U.S. export flows rather than a reduction in global trade volumes. Notably, some commodities such as cotton and ground nuts show minimal change in bilateral flows, reflecting stronger competitiveness in global markets.

When it comes to other regions, Brazil is one of the most directly affected regions under the EUDR policy, given its dominant role in global exports of deforestation-linked commodities such as soybeans, sugarcane, and wood-based biomass. Under the BAU scenario, Brazil's exports are heavily concentrated toward the EU, especially the EU Midwest and the EU South, with large trade volumes in soy and sugarcane. Additional destinations include Russia, Northern Africa, and a variety of smaller global markets. However, the imposition of a 200% EUDR-related trade cost dramatically alters these trade flows. The Scenario 200 Sankey diagram (in the appendix) reveals a sharp reduction in Brazil's exports to the EU, particularly for sugarcane to EU North. These flows are partially redirected to alternative destinations such as Russia.

In Figure 7, as EUDR trade costs increase from 25% to 200%, Brazil shows increasingly negative export shifts to EU markets across different commodities. Sugarcane, wood pellets, biomass, and pulp exports to EU destinations all decline substantially. Even at moderate cost levels (50–150%), some of Brazilian exports to the EU are already experiencing huge reductions, e.g. Chemical Pulp, suggesting that compliance uncertainty or risk aversion may lead to preemptive shifts in trade behavior. At 200% cost levels, we can find similar result as sankey diagram in the appendix that Brazil's exports will be redirected to other regions. For example, Brazilian Chemical Pulp exports to Russia will grow up to 80% under 200% cost levels.

Under higher trade costs for traditional suppliers of high-deforestation commodities, some regions find it cost-advantageous to establish or expand new trade relationships with the EU. For example, China's role in trade shifts under the EUDR scenarios. Instead of experiencing a loss of market access, China emerges as a beneficiary of trade reallocation as EU-facing exporters divert commodities to other destinations. Under baseline conditions, China maintains export flows across a diverse set of commodities, including wheat and a wide variety of wood-based and processed pulp products. However, as trade costs into the EU increase under a 200% EUDR scenario, the structure of China's trade expands, particularly in sectors related to wood products. Under the Scenario 200% cost levels, China is filling the supply void created by reduced EU imports from traditional exporters like the U.S., Brazil, and Southeast Asia.

This pattern is further supported by Figure 8, which depicts commodity-by-region export changes across the EUDR cost spectrum. China's exports of processed wood products such as plywood, chemical pulp, and fiberboard show significant increases to the EU market (especially at the 150% and 200% cost levels) while there are only modest gains in traditional agricultural goods like rice or corn. Interestingly, some growth is also seen in exports to regions such as the Middle East and South Korea, which implies that while the policy seeks to reduce deforestation-driven trade, it also reshapes global trade flows by redistributing demand and supply across regions.

Trade Flow: USA

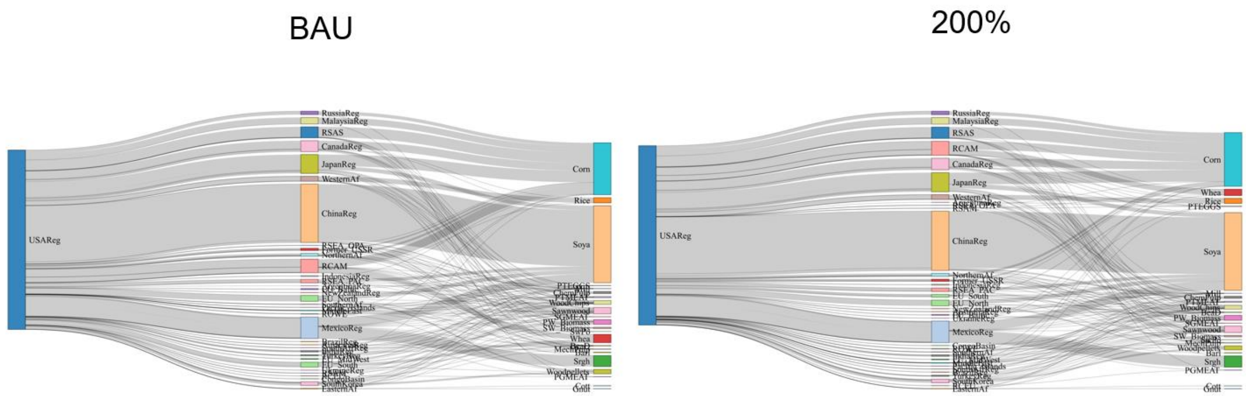

Figure 5: US BAU vs 200% US Trade Flow

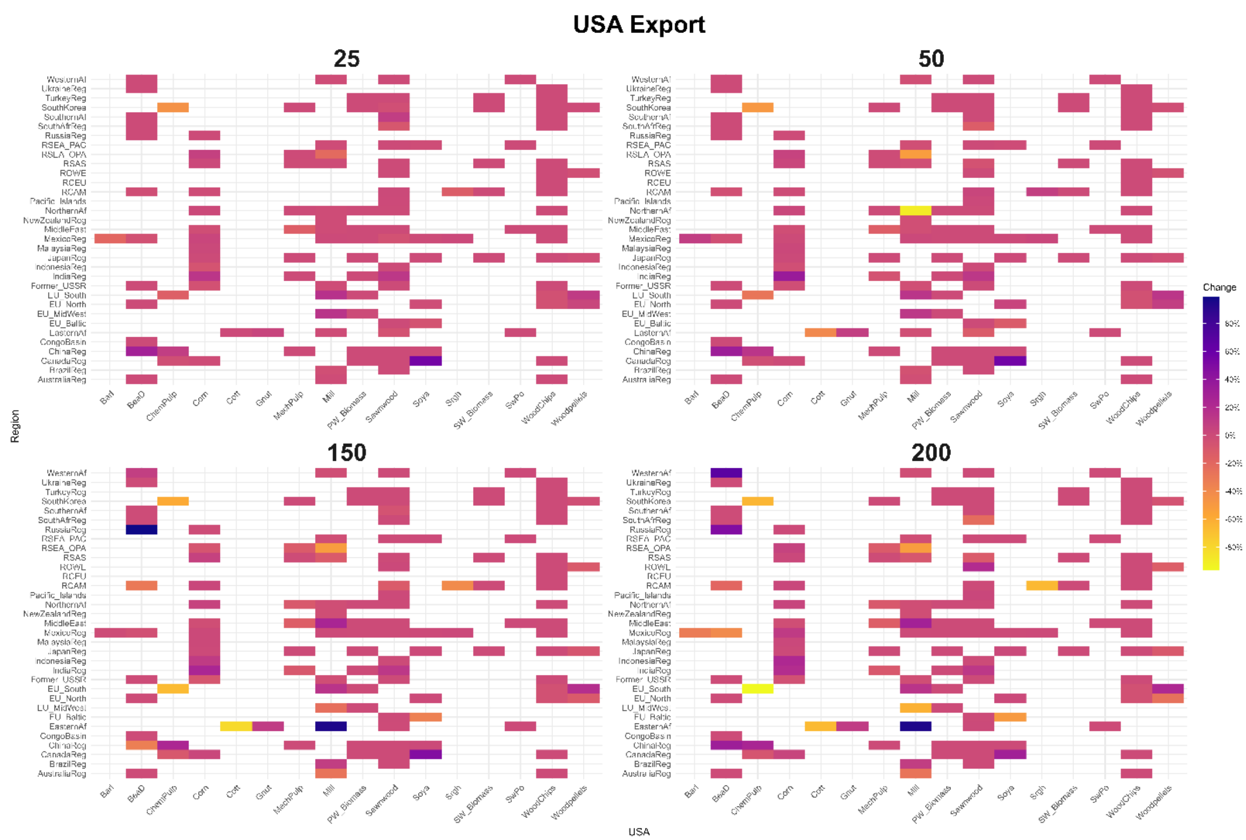

Figure 6: US bilateral trade heatmap -- % difference from BAU in 2050

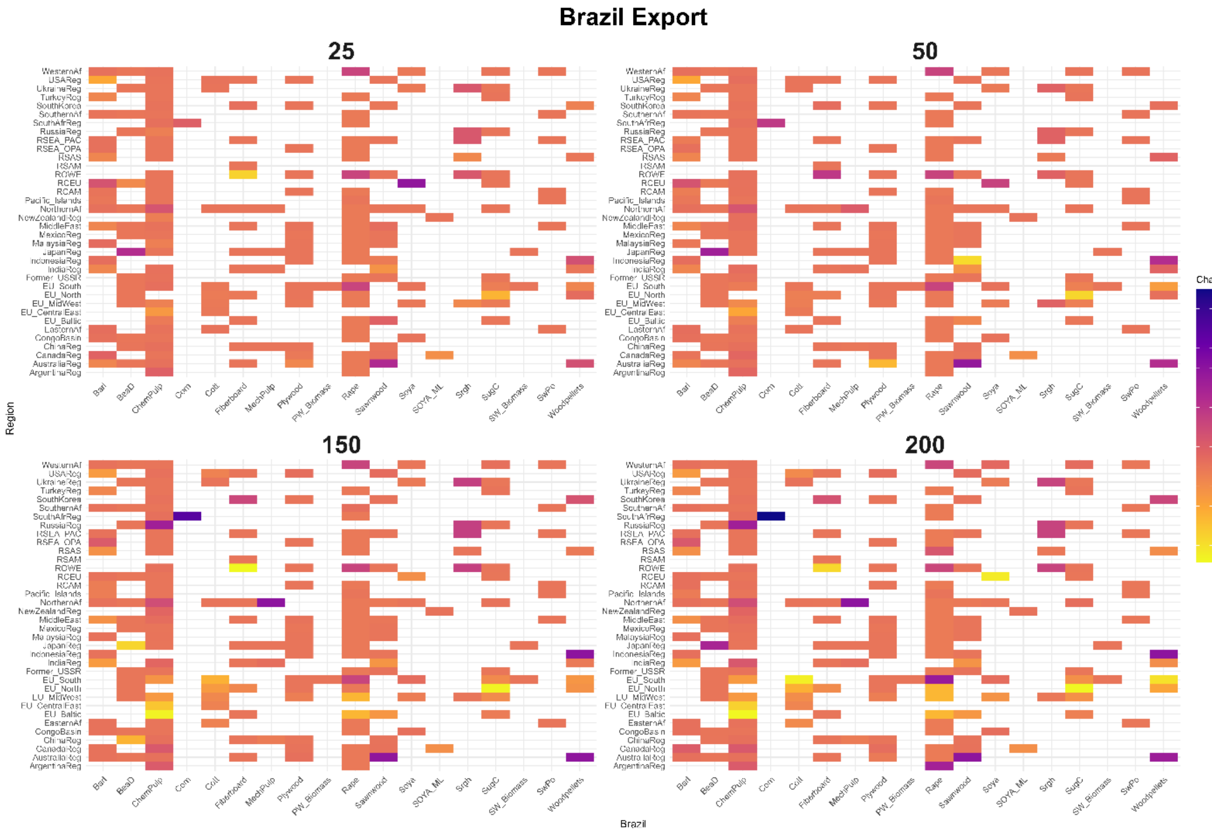

Figure 7: Brazil bilateral trade heatmap -- % difference from BAU in 2050

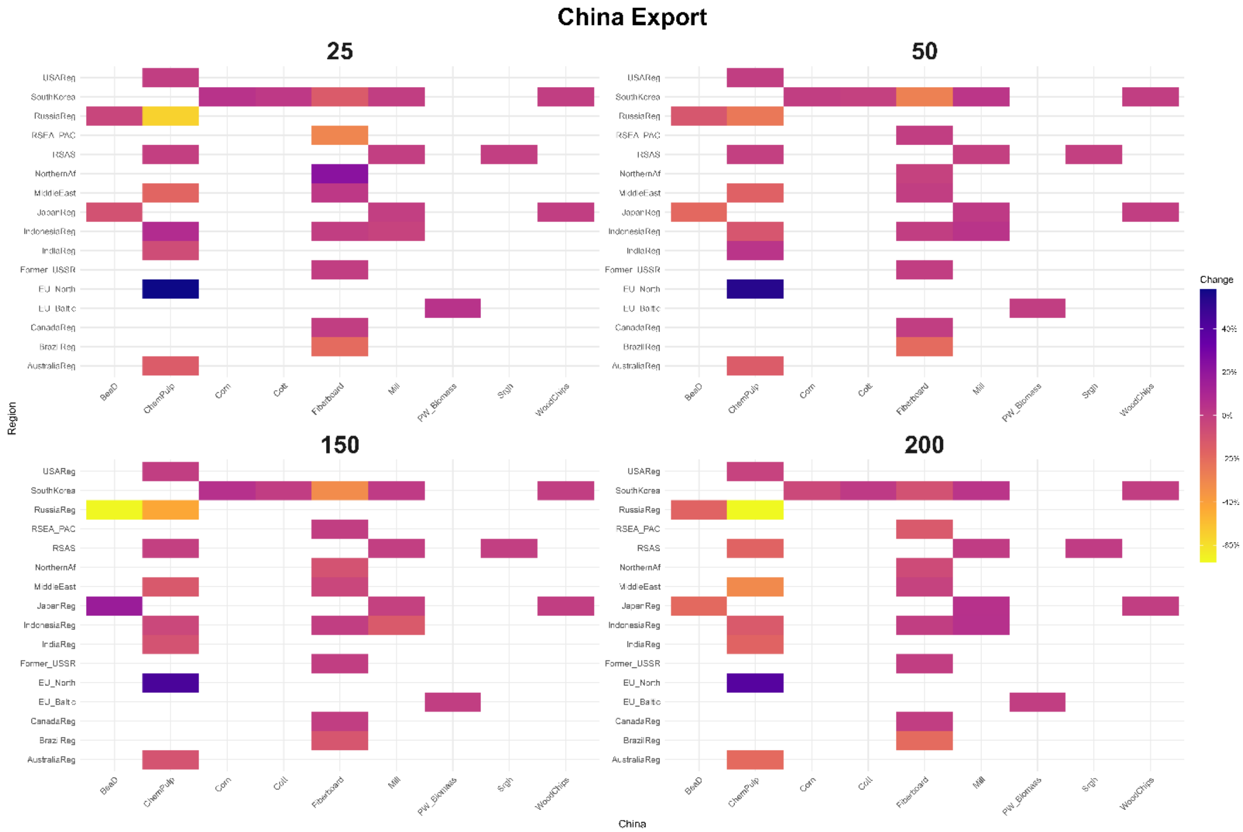

Figure 8: China bilateral trade heatmap -- % difference from BAU in 2050

Production Impacts

Trade reallocations resulting from lasting EUDR compliance costs also shift agriculture and forest commodity production heterogeneously across regions and commodity groups.

The imposition of EUDR-related trade costs not only reconfigures global trade flows but also affects domestic production. Figure 9 shows the percent change in crop and livestock production across selected commodities for the U.S. region under various EUDR trade cost scenarios. Crop sectors experience negligible change as a whole, with variations typically within 3%. However, there are a few notable exceptions. Groundnut production increases significantly up to 12% under the most stringent (200% cost) scenario. This shift reflects substitution effects, as U.S. producers adjust to altered export demand and take advantage of marginal gains with increased competitiveness.

Conversely, production of wheat, dry beans, and rice declines under all EUDR scenarios. These are among the most affected commodities in terms of lost export potential to the EU. Wheat and dry beans, in particular, have the highest reductions of up to 4% and 8% respectively. Dairy products remain largely unaffected, with meat and dairy production showing near-zero change across all scenarios.

In contrast to relatively negligible changes in production response in the U.S, the EU exhibits substantial and regionally heterogeneous production shifts in their response to EUDR induced trade cost. As shown in Figure 10, the EU Midwest region experiences significant increase in oilseeds and rapeseeds production, with output rising over 50% in the most stringent (200%) scenario. This suggests a substitution response as trade constraints reduce access to foreign supplies, particularly from Brazil, driving EU producers to expand production in sectors historically dependent on imports. In Figure 11, the production of EU South shifts are similarly, with sugarcane and cereal crops expanding dramatically up to 80% under the 200% trade cost scenario.

Other crop and livestock production increases include dry bean, corn, dairy, meat, and other grains production. On the contrary, The EU Baltic region (Figure 12) shows production decline for most crop and livestock production more than 50% except cereals. In Figure 13, the EU North region responds more moderately and shows small but consistent increases in most crops up to 2%, and modest declines in dairy products up to 5%. Although EU North is not a major production hub for targeted EUDR commodities, this region still contributes to intra-EU supply shifts and plays a significant role in meeting overall demand within the EU. The EU Central East, shown in Figure 14, exhibits some interesting shifts, with millet and sorghum production surging nearly 40% and oilseeds and rapeseeds decreasing by over 40% in the highest-cost scenarios. These changes reflect the region’s adaptability to step in as a replacement source for millet and sorghum imports under EUDR constraints and to reallocate land and labor from oilseeds and rapeseeds production.

We note, however, that these production impacts are hypothetical and illustrative, and may not reflect policy priorities or institutional constraints within the EU that might limit crop mix or land use changes at this scale. Nonetheless, these results do highlight potential supply-side responses that could occur if the implementation of EUDR imposes higher compliance costs to access the EU market. This is especially true for high-deforestation risk commodities like oilseeds, where EU member states could increase domestic production.

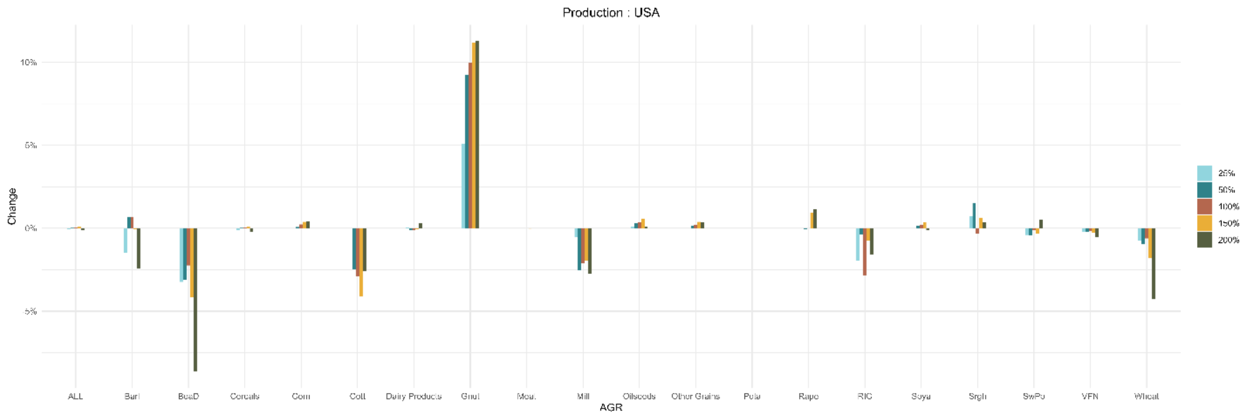

Figure 9: US Production

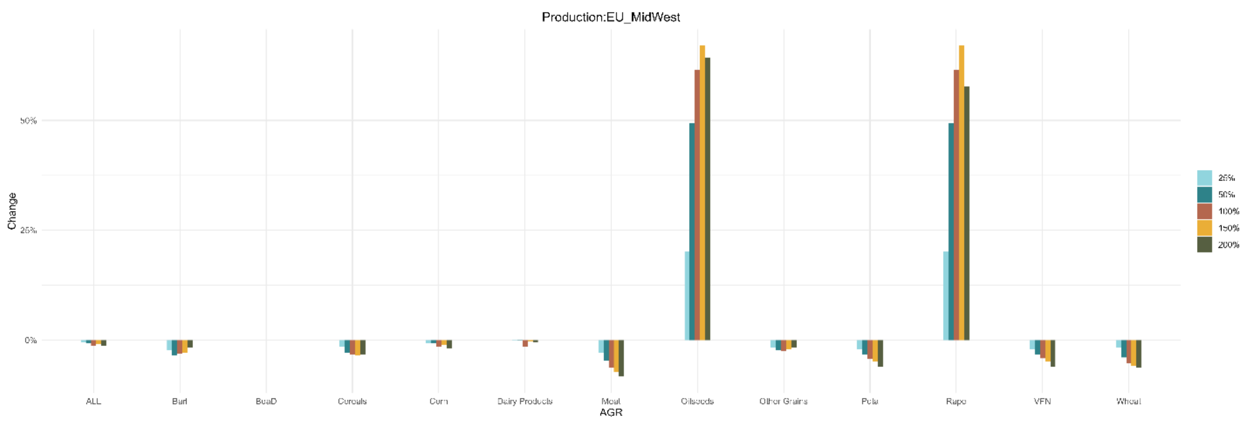

Figure 10: EU Midwest Production

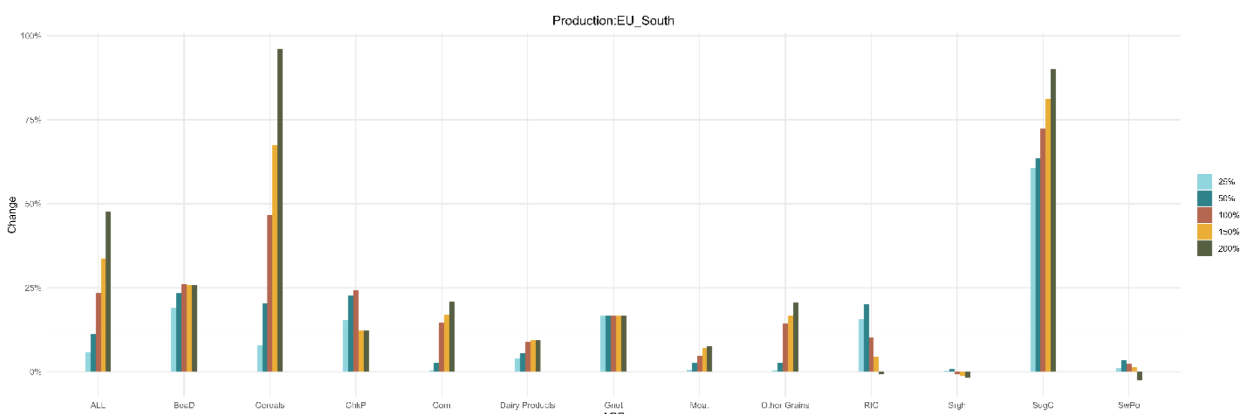

Figure 11: EU South Production

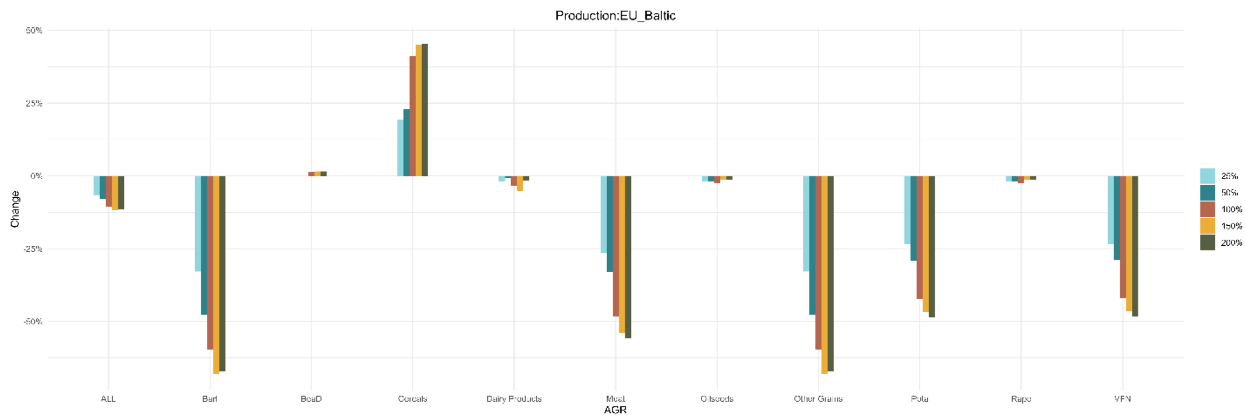

Figure 12: EU Baltic Production

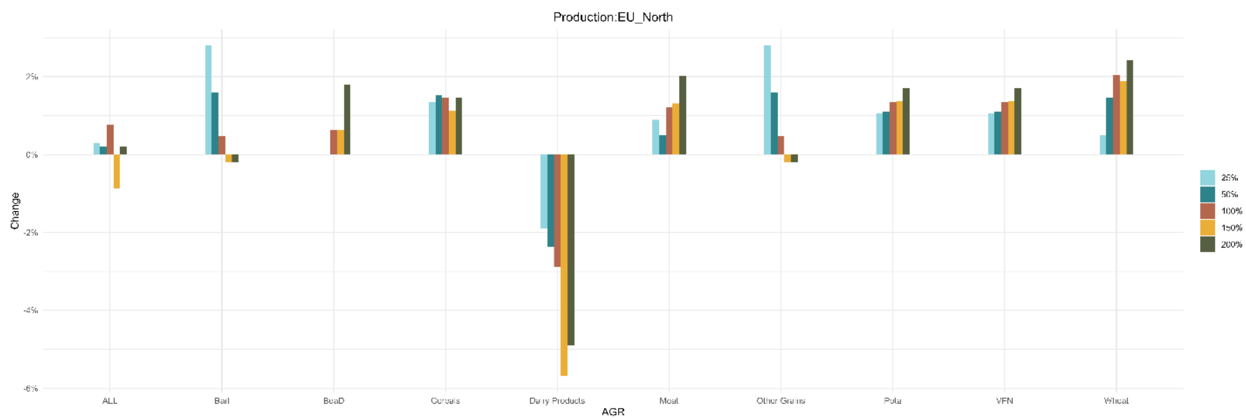

Figure 13: EU North Production

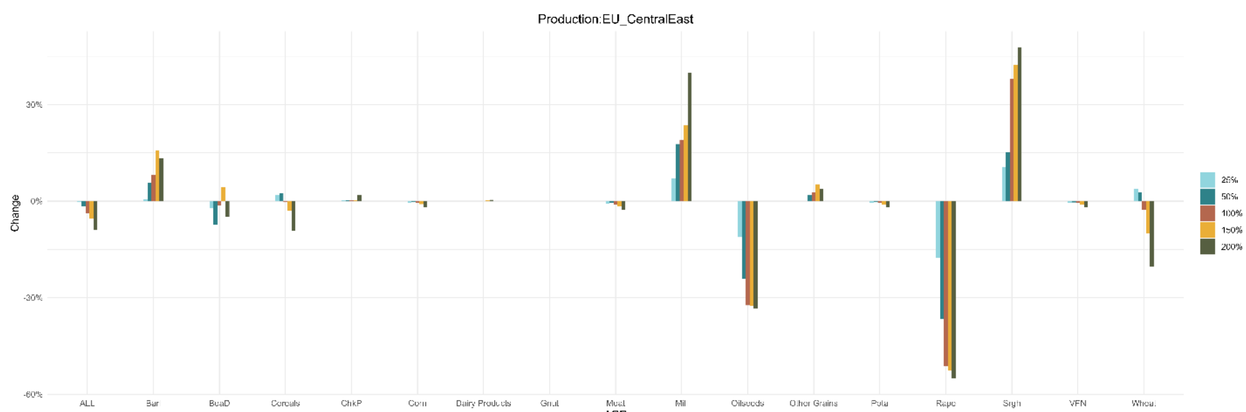

Figure 14: EU Central East Production

Discussion

Our analysis presents the complex global trade, production, and environmental implications of the EUDR policy. By using a partial-equilibrium model GLOBIOM across multiple scenarios of increasing trade compliance costs, we reveal significant shifts in global trade patterns, production dynamics, and environmental outcomes resulting from the EUDR.

A key outcome we identified in this study is the reallocation of production and EU exports. Commodities previously destined for the EU, particularly soybeans, wood products, and sugarcane from countries such as Brazil and the U.S. are redirected towards alternative markets, such China, Russia, and North Africa. Impacted countries adjust exports by seeking new market opportunities and reach to a new equilibrium. These results reveal a critical limitation of unilateral regulatory measures and potential unanticipated environmental impacts of production shifts.

One unintended consequence of the EUDR is substantial intensive and extensive crop production expansion within the EU. Regions including the EU Midwest, EU South, and EU Central East significantly increase domestic crop production, particularly in cereals, oilseeds, rapeseed, and sugarcane, as a response to reduced imports from outside EU. While this trend enhances regional self-sufficiency, it also raises land-use intensification and could exacerbate environmental challenges within the EU.

Indirect market impacts emerged prominently in our analysis. Global forest cover gains were modest, primarily concentrated in Eastern Africa and Southeast Asia, and these benefits diminished over time, particularly under less stringent regulatory scenarios. These spatial findings reinforce the earlier conclusion: without coordinated global measures, the EUDR is likely to relocate, rather than eliminate deforestation, especially in the early implementation period. Moreover, they point to the potential for intra-regional leakage within the EU, where countries not experiencing direct trade shocks still intensify production in response to regional demand shifts. This spatial fragmentation of environmental impact underscores the limitations of unilateral trade regulation as a primary tool for reducing global deforestation.

Conclusions

EUDR represents a significant step towards aligning trade practices with environmental challenges. However, its effectiveness as a standalone mechanism for global deforestation could be limited if the main result is increased compliance costs (or transactions costs) of accessing the EU market. Our analysis shows the importance of broader international policy coordination to achieve comprehensive and lasting environmental outcomes.

Overall, our results suggest that U.S. agricultural production is not much affected by the EUDR, due in part to its broad export base and capacity to redirect products toward other markets. But commodity-specific impacts are not negligible, such as dry beans which see a reduction of up to 3% and groundnuts which increases up to 14%. The combination of trade diversion and minor production losses in EU-reliant crops how the indirect influence of climate-oriented trade policies can impact on non-target regions. As for the EU, our study demonstrates that the EUDR significantly impacts trade dynamics and will lead to a substantial reallocation of exports away from the EU towards other markets. As agricultural production intensifies within the EU as regions compensate for import reductions, this will create potential environmental pressures locally. Meanwhile, global land use adjustments are spatially uneven and modest overall.

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Appendix

A1 Trade Flow

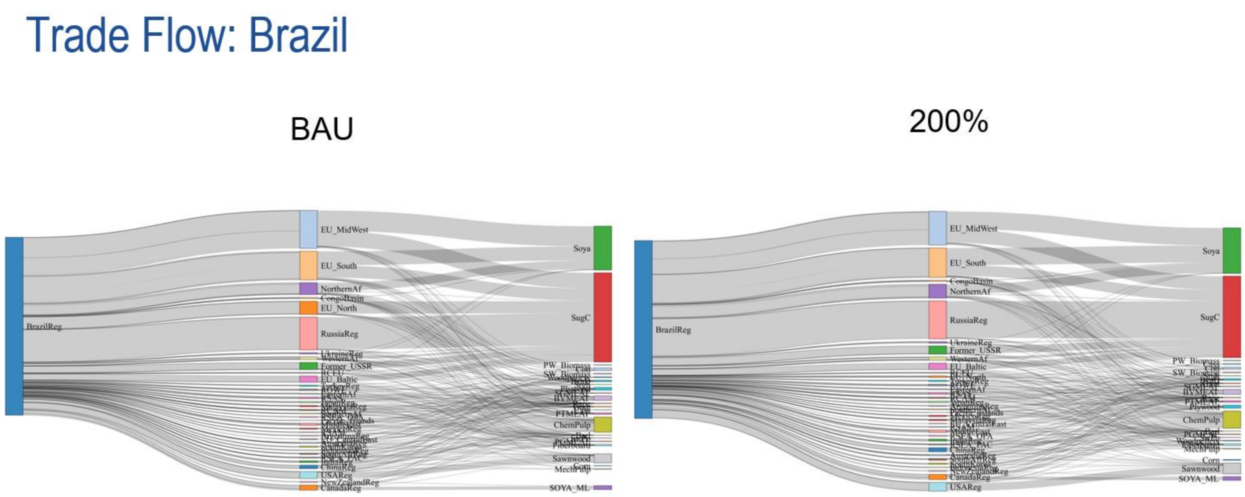

Figure A1: Brazil BAU vs 200% US Trade Flow

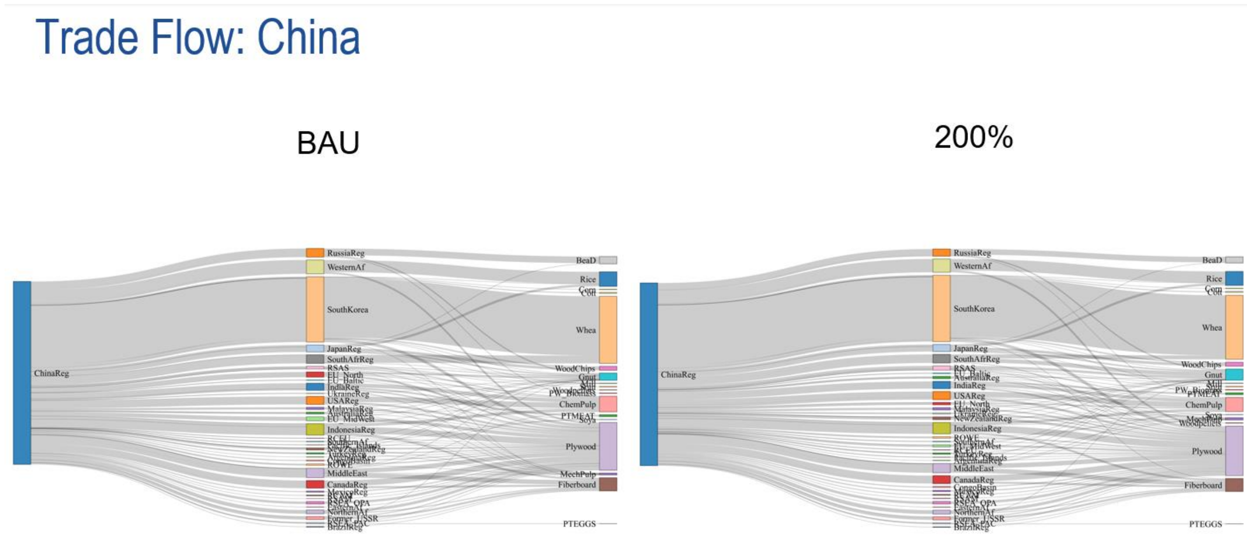

Figure A2: China BAU vs 200% US Trade Flow

A2 EU Region Defination

EU Baltic: Estonia, Latvia, Lithuania

EU Central East: Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia

EU Midwest: Austria, Belgium, Germany, France, Luxembourg, Netherlands

EU North: Denmark, Finland, Ireland, Sweden, United Kingdom

EU South: Cyprus, Greece, Italy, Malta, Portugal, Spain