

Model-based Lessons on How Policy Measures Affect the Sustainability of Agri-food Trade

Leçons tirées de la modélisation sur l'impact des mesures politiques sur la durabilité du commerce agroalimentaire

Modell-basierte Erkenntnisse wie Politikmassnahmen die Nachhaltigkeit von Agrarhandel beeinflussen

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The sustainability framework of EU Trade Agreements

EU trade agreements, such as Free Trade Agreements or Economic Partnership Agreements (EPAs), incorporate sustainability provisions aiming to enhance cooperation on labour rights, environmental protection and climate policy. These agreements provide duty-free and quota-free access to EU markets, while promoting dialogue on standards, good agricultural practices and rural development.

“ La libéralisation des échanges doit s’accompagner de cadres d’action publique solides... afin d’éviter les répercussions négatives... et de tirer parti des synergies potentielles entre les instruments de politique commerciale. ”

The model-based analyses in the EU TRADE4SD (Trade for Sustainable Development) Horizon 2020 project

underline that such agreements create economic opportunities and facilitate integration into global value chains, especially for developing countries. However, the implementation of sustainability provisions often lacks enforcement mechanisms, and sustainability remains secondary to trade facilitation. While trade policy documents reference the Sustainable Development Goals (SDGs), concrete alignment with targets – such as reducing inequalities (SDG 10), ensuring food security (SDG 2), and combating climate change (SDG 13) – is partial and inconsistent.

The model-based analyses in the EU MATS (Making Agricultural Trade Sustainable) Horizon 2020 project have been part of an integrated micro- and macro-level analysis framework approach, drawing data from a set of country- and commodity-based case studies in Europe, Africa and Latin America. The analyses focusing on trade policies and instruments have also accounted for different concepts of carbon taxes, such as the CBAM (Carbon Border Adjustment Mechanism; Bassi *et al.*, 2025; Häberli *et al.*, 2025), to show what economic and environmental sustainability opportunities (carbon emission reduction potentials) there are when countries cooperate by creating ‘carbon climate clubs’ and support sustainability-supporting technology adoption in the export countries at the

same time. Furthermore, MATS has shown how key EU agri-food sectors (e.g. dairy production) are linked through trade with environmental externalities and production of ecosystem services. MATS has shown that trade agreements could be redesigned in a way that environmental externalities of dairy production are accounted for. However, negative income effects on regional dairy sectors and agricultural households of these trade policy changes need to be considered if a ‘just’ transition is desired. Furthermore, modeling results on the Finnish dairy sector suggest that taxes on dairy exports are less efficient compared to a tax on the Finnish agricultural industry, in terms of their efficiency of dealing with the problem of emissions mitigation.

Economic impacts: Efficiency gains with unequal outcomes

Despite current tendencies for de-globalisation and rising geopolitical uncertainty, the fundamentals are not changing in that trade liberalisation fosters efficiency by reallocating resources reflecting comparative advantage. Economic simulation models applied in TRADE4SD (MAGNET, CGEBox and Aglink-Cosimo; see <https://www.trade4sd.eu>) demonstrate that liberalisation scenarios generally lead to increased Gross Domestic Product

(GDP) and trade volumes across regions. For example, under the EU Vietnam Free Trade Agreement (EVFTA), Vietnam gains significantly in exports and real GDP, while EU exports also increase modestly.

However, these economic benefits are not evenly distributed. Wealthier households and capital-intensive producers tend to benefit more, whereas vulnerable groups may face stagnating or declining real incomes. In Ghana, for instance, the TRADE4SD simulations reveal that lower-income rural households benefit less – or even lose – from liberalisation due to limited market access and weak integration into export-oriented sectors. Without redistributive measures, the simulations suggest that trade can widen domestic income gaps, undermining SDG 10.

In Finland, for example, the MATS analysis of environmentally extended SAM (social accounting matrix) and SAM multiplier analysis suggests that imposing a carbon tax on agricultural production in a northern European region can come with significant distributional effects, impacting primary producers greatly. In future policy design, this needs to be taken on board through more effective targeted policy instruments taking account of distributional issues to compensate identifiable losers from carbon policies instead of imposing non-discriminatory carbon taxes on a country's agriculture as a whole. The fact that this lesson was not heeded and distributional measures institutionalised before the final signing of Mercusor could be seen as a case in point.

The TRADE4SD models also show that global food access improves overall with trade liberalisation, driven by price reductions and increased food availability, especially in food-importing countries. However, both TRADE4SD and MATS modeling suggest that without complementary policies like supporting technology adoption by farmers in developing countries (e.g. training, advisory services, and locally adapted inputs like seeds and machinery), these gains may undermine local production

systems and threaten long-term food sovereignty and resilience (Bassi et al., 2025).

“ Die Liberalisierung des Handels muss mit starken politischen Rahmenbedingungen einhergehen, um negative Spill-Over-Effekte zu vermeiden und potenzielle Synergien zwischen den handelspolitischen Instrumenten zu nutzen. ”

With a strong focus on understanding local micro-conditions and local sustainability impacts of agricultural trade policies, MATS project models have studied the economic impacts through a combined macro-level and micro-level analysis. The macro-economic assessment was performed with a Computable General Equilibrium model (GDynEP). The findings indicate that implementation of the EU's joint carbon pricing and Carbon Border Adjustment

Mechanism (CBAM) policy may reduce its GDP by -0.2 per cent compared to carbon pricing alone. In Africa, energy-exporting nations could face a -0.36 per cent GDP loss, while countries in the Horn of Africa may experience a 0.10 – 0.12 per cent gain by 2030.

Social impacts: Disparities and distributional consequences

The TRADE4SD social analysis based on the MAGNET model focuses on disaggregated impacts within countries, employing household-level data from Ghana and EU Member States (Portugal and Bulgaria). By integrating household budget surveys into the MAGNET model, the study reveals that trade-induced structural adjustments affect socio-economic groups unequally. In Ghana, urban households with diversified income sources tend to benefit more from trade-induced growth, while rural farming households – especially in the northern regions – are exposed to price volatility and income instability. These findings underscore the importance of tailored social assistance policies and rural development programmes to cushion adverse impacts. These policy measures should be implemented by local governments financed by the EU as part of the trade agreements. Such a ‘compensation mechanism’ would also contribute to



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the acceptance of trade agreements within the EU. For EU countries, the distributional impacts of economic, environmental and social benefits and burdens identified by the TRADE4SD models vary significantly by region and household income level. While EU consumers may benefit from lower food prices, small-scale farmers may struggle with intensified competition. Similar effects might occur looking at the employment impact of trade policies where some regions might face a boost in employment while others suffer from increasing unemployment. Policies supporting diversification, upskilling and rural infrastructure are critical to ensuring equitable outcomes. However, in order to compensate for these distributional effects, regional development measures are needed that go well beyond the rural development programmes implemented under the CAP to date.

Example 1 on income and labour conditions.

A case study on dairy production in MATS, covering Algeria, Germany and the USA focused on income creation and the social conditions of workers. In the case of Algeria, MATS found that in order to improve social conditions, such as by increasing the salary level closer to the average income at the country level, productivity and farm size would need to increase. This could be realised for instance via the EU supporting farmer capacity building in Algeria through improved agricultural production practices, the production and purchase of more nutritious feed in Algeria, as well as technology adoption for more effective climate resilience in the dairy value chain. Specifically, the modeling suggests that labour costs would increase (as a result of higher salary), and that – in order to offset this higher labour cost – milk productivity would need to increase by 36 per cent, and that the average Algerian farm size would need to increase by 177 per cent. These changes combined would result in a higher unit production cost (1.01 USD/kg, as opposed to 0.81 USD/kg in the BAU scenario) as well as a higher revenue, leading to improved profitability overall. This increase in

productivity and farm size, if applied to the existing number of farms, would allow Algeria to become self-sufficient in milk production under current market conditions.

Environmental impacts: Mixed outcomes and policy trade-offs

The CGEBox model (Britz and van der Mensbrugghe, 2018), in the TRADE4SD project provides analysis insights into the environmental implications of trade liberalisation, focusing on greenhouse gas (GHG) emissions and water pollution. The modelling exercises consider different scenarios, including full EU trade liberalisation and the introduction of carbon-based tariffs.

“Trade liberalisation must be accompanied by strong policy frameworks ... to avoid negative spillovers ... and leverage potential synergies among trade policy instruments.”

A key finding of the TRADE4SD analysis is that liberalisation tends to increase emissions in EU partner countries due to production expansion, particularly in high-emission sectors like meat and dairy. Further, and consistent with complementary MATS modeling results, carbon leakage would be substantive, by emissions shifting from regulated (EU) to unregulated (non-EU) regions. Without corrective measures such as technology transfer, collaborative instrument implementation through country-climate-clubs with non-EU countries to minimise leakage (CBAM), and accompanied sustainability impact assessments, EU climate goals could be undermined (Bassi *et al.*, 2025; Steiner, 2025). The TRADE4SD models also suggest that water

pollution linked to intensified fertiliser use also increases under liberalisation scenarios, especially in countries lacking environmental regulations and here in particular the group of ‘low-income countries’ in the global South.

Both the TRADE4SD and MATS analyses of the CBAM suggest that it is key to internalising environmental costs and leveling the playing field. Further, MATS suggests a potential extension of CBAM to the agri-food sector would be highly complex, requiring careful design to avoid trade distortions and food insecurity in vulnerable regions (Carlson *et al.*, 2023; Häberli *et al.*, 2025). MATS’ analysis of CBAM also shows how the carbon emission reduction potentials can be achieved while minimising carbon leakage, as part of cooperation between EU and African countries, accompanied by EU efforts that support the adoption of sustainable production methods in African countries (Bassi *et al.*, 2025). More specifically, to meet the targets of the Fit-for-55 plan, policies should include both a CBAM and efforts to form as many ‘country climate clubs’ as possible, especially in Africa and other carbon-intensive regions. This should be done with the goal of building a global commitment to carbon neutrality, originating from a stimulus towards decarbonisation at country level. Additionally, by sustaining technology transfer and the diffusion of best practices in agricultural production in less developed regions, the inclusion into a climate club could be complemented by *ad hoc* support instruments to make the carbon neutrality pathway compatible with a more inclusive and ‘just’ development transition. This would result in typical win-win solutions with environmental gains followed by positive welfare effects (Bassi *et al.*, 2025).

To go beyond a tunnel-view on environmental impacts only, the MATS modeling approach has integrated macro-modeling with multiple qualitative case-based modeling approaches to explore underlying land-use and other environmental as well as social

sustainability implications at individual actor levels, as the following examples illustrate.

Example 2 on environmental impacts regarding water usage.

Qualitative modelling using system maps (system dynamics) offer insights into the dynamic interrelations across sustainability indicators, and hence on the transformative potential of policy interventions in the form of more sustainable agricultural trade policies. In Tunisian olive oil production, the establishment of export targets has dual consequences. On the one hand, increased production benefits farmers, particularly large and export-oriented operations, through trade. However, on the other hand, the production level guaranteed by the export targets results in higher water demand and competition regarding the use of water. This leads to water stress, especially in relation to observed climate change impacts. To address water stress, strategies could include improving irrigation efficiency, adopting ecologically responsible practices and shifting away from water-intensive monoculture practices. Diversifying agricultural activities and ensuring that small-scale farms have access to export markets are two ways that can offset potential declines in revenue caused by water stress. For policymakers, it seems especially important to account not only for agricultural water needs but also for competing water uses in the economy, recognising the issue from a holistic perspective.

Example 3 on environmental impacts related to ecosystem services as a function of land use changes.

The use of sectoral models (i.e. models that represent impacts which arise from activities in a given sector, here the dairy sector) in MATS helps to identify the sustainability impacts of land use changes, for example those that occurred in Finland (North Ostrobothnia) because of the expansion of agriculture. The analysis indicates that ecosystem services deteriorated in terms of carbon storage and habitat quality (declining by 3.3 per cent and 8 per cent, respectively), and nitrogen and phosphorus exports (increasing by

almost 6 per cent and 3 per cent, respectively).

The need for integrated policy approaches: From trade-offs to synergies

The complementary modeling evidence from both TRADE4SD and MATS underscores that trade liberalisation must be accompanied by strong enforceable policy frameworks (multi-lateral and bi-lateral institutions that are assumed to work under modeling assumptions) to avoid negative spillovers, such as carbon leakage, while accounting for distributional effects and leveraging potential synergies among trade policy instruments.

On the need for integrated policy approaches, the modeling efforts from MATS suggest that sustainable agricultural trade is closely tied to sustainable domestic agricultural production, encompassing social dimensions like labour standards and salaries, and environmental factors such as water availability and soil

erosion. Yet a global approach is needed that ensures domestic and international considerations. Policies should employ a dual strategy grounded in sustainability impact assessments, combining external mechanisms like the CBAM with internal measures that encourage change within countries, and to deliver an emission mitigation that is part of a 'just' transition. Domestic support initiatives could include farmer training programmes, financial support for the adoption of sustainable production practices, and support for fair trading practices, aligning with EU directives aimed at improving governance and tackling human rights and environmental challenges.

Both TRADE4SD and MATS modeling suggests that the economic valuation of externalities, including both social and environmental impacts, can play a vital role in driving sustainability-oriented trade policy design – and their acceptance, as Mercusor indicates. When such valuations of external effects are integrated into policy frameworks, they create



Liberalisation without measures can easily lead to inequality © Pop & Zebra, License Unsplash.

market-based incentives for adopting sustainable practices. These policies align economic interests with environmental and social benefits, encouraging farmers and other value chain businesses to transition to sustainable methods. Noting the key role of sustainable finance for this transition, trade-related investment policies should include Sustainable Impact Assessments (SIAs), building on lessons learned from Sustainable Investment Facilitation Agreements (SIFAs, e.g. currently in place between the EU and Ghana) that evaluate and account for these externalities to guide effective decision-making.

MATS modeling work highlights the complexity of systems-based impacts, in that sustainable agricultural production practices can reduce production costs while increasing land productivity and minimising environmental harm, for example in the case of dairy. Yet in other cases we have examples of conflicting sustainability impacts (in the cases of mango and avocado farming) as farmers' adoption of sustainability certification can also provide them

with incentives to increase deforestation (Yuhai and Steiner, 2025). However, current trade rules typically fail to distinguish products by the nature of their production in terms of adoption of sustainable production practices, thereby hindering the global scaling of such sustainable practices adoption through market reward mechanisms. Modernising trade rules to give sustainable products a competitive advantage while accounting for the sustainability implications of such trade rules from a systems perspective would therefore be desirable.

How to implement an integrated policy approach?

EU trade policy reform holds the potential to advance sustainable development goals (SDGs), presenting significant costs of inaction in the face of current geopolitical uncertainty. We observe that trade liberalisation efforts risk falling short of SDG targets without being accompanied by social and environmental safeguards. The complementary modeling results from

both the TRADE4SD and MATS projects demonstrate that economic, environmental and social gains from trade are achievable yet depend on the policy context, requiring coherent policy solutions that are impact-assessment-based while accounting for distributional effects.

Our key recommendations arising from both TRADE4SD and MATS modeling are that integrated policy approaches are needed and desirable in terms of their pay-off, because of current external effects and conflicting sustainability impacts. First, policy coherence should be improved, with trade, agricultural, climate and development policies becoming aligned to support multiple sustainability dimensions. Second, interventions are needed to accompany trade policies, in particular targeted investment and income support into local value chains. This entails rural investment into infrastructure and supporting the adoption of more sustainable production standards among farmers. This could be achieved through supporting capacity-building among smallholder farmers and marginalised



When numbers meet reality: Modelling market effects © Transly Translation Agency, License Unsplash.

groups (e.g. female entrepreneurs) to enable them to benefit from market access and trade. Third, environmental safeguards are needed, in terms of stricter enforcement of environmental standards. This means that EU policymakers need to provide support for functioning local institutions and financial support for green technology adoption. Further, a cooperative and multi-stakeholder based implementation of market-based instruments (e.g. carbon pricing as part of larger country-climate-clubs) is needed to mitigate environmental impacts while accounting for the distributional effects of these instruments. Fourth, multi-stakeholder engagement from across the global value chains needs to be supported, resulting in more inclusive policy design involving farmers, civil society and local authorities that increases trade policy legitimacy and

effectiveness. Finally, institutionalised sustainability impact assessment of trade regimes is important (*ex-ante* and *ex-post*) to increase the trust, efficacy and legitimacy of trade agreements (Steiner, 2025).

What else is needed to implement an integrated policy approach that is more sustainable than at present? Making agricultural trade a vehicle for economic, social and environmental sustainability requires a profound revision of trade agreements. Future policy design should embrace multidimensional impact assessments and be built on institutional and multi-stakeholder cooperation, to address three inter-connected key challenges. First, there is a need for data and more data transparency. Second, there are governance challenges with regard to impact

assessment and monitoring, in terms of their costs being unequally distributed across value chain actors and enforcing institutions lacking in quality. Third, there is the question of multi-stakeholder support for policy design and implementation. Through an integrated policy approach that addresses these issues, trade can become a true catalyst for a fairer, greener and more resilient global food system.

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Further Reading

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Summary

Model-based Lessons on How Policy Measures Affect the Sustainability of Agri-food Trade

 In an era marked by intensifying global interdependence, trade policy has emerged as a decisive force influencing agricultural development, food security, environmental integrity and social equity. The European Union (EU), as a major actor in global agricultural trade, has embraced a dual agenda: to promote trade in food and agricultural products and to foster sustainable development. However, while EU trade agreements increasingly reflect sustainability principles, critical gaps remain in understanding the implications of trade liberalisation through the lens of the EU's Sustainable Development Goals (SDGs).

This article synthesises the model-based findings of the two TRADE4SD and MATS H2020 projects as both are focusing on social, environmental and economic impacts of international agricultural trade and trade policies in complementary ways. The article demonstrates that while liberalised trade can improve market efficiency and food availability, it can also exacerbate inequality and environmental degradation if not accompanied by robust institutional and financial support measures. The model-based results affirm that EU trade policy must adopt an integrated approach – embedding economic, social and environmental dimensions in its framework while accounting for local conditions – to fully realise the potential of trade as a driver of sustainable development.

Leçons tirées de la modélisation sur l'impact des mesures politiques sur la durabilité du commerce agroalimentaire

 À l'ère de l'interdépendance mondiale croissante, la politique commerciale s'impose comme un facteur déterminant du développement agricole, de la sécurité alimentaire, de l'intégrité environnementale et de l'équité sociale. L'Union européenne (UE), acteur majeur du commerce agricole mondial, poursuit un double objectif: promouvoir les échanges de produits alimentaires et agricoles et favoriser le développement durable. Toutefois, si les accords commerciaux de l'UE intègrent de plus en plus les principes de durabilité, des lacunes importantes subsistent quant à la compréhension des implications de la libéralisation des échanges au regard des Objectifs de développement durable (ODD) de l'UE.

Cet article synthétise les résultats modélisés de deux projets Horizon 2020, TRADE4SD et MATS, qui analysent de manière complémentaire les impacts sociaux, environnementaux et économiques du commerce agricole international et des politiques commerciales. L'article démontre que si la libéralisation des échanges peut améliorer l'efficacité des marchés et la disponibilité alimentaire, elle peut aussi exacerber les inégalités et la dégradation de l'environnement si elle n'est pas accompagnée de mesures de soutien institutionnelles et financières robustes. Les résultats de la modélisation confirment que la politique commerciale de l'UE doit adopter une approche intégrée – comprenant dans son cadre les dimensions économiques, sociales et environnementales tout en tenant compte des conditions locales – pour exploiter pleinement le potentiel du commerce en tant que moteur du développement durable.

Modell-basierte Erkenntnisse wie Politikmassnahmen die Nachhaltigkeit von Agrarhandel beeinflussen

 In einer Zeit zunehmender globaler Verflechtungen hat sich die Handelspolitik zu einer entscheidenden Kraft entwickelt, die die landwirtschaftliche Entwicklung, die Ernährungssicherheit, die Umweltintegrität und die soziale Gerechtigkeit beeinflusst. Die Europäische Union (EU) hat als wichtiger Akteur im globalen Agrarhandel eine doppelte Agenda verfolgt: die Förderung des Handels mit Lebensmitteln und Agrarprodukten und die Förderung einer nachhaltigen Entwicklung. Doch obwohl die Handelsabkommen der EU zunehmend Nachhaltigkeitsprinzipien widerspiegeln, bestehen nach wie vor erhebliche Wissenslücken hinsichtlich der Auswirkungen der Handelsliberalisierung aus Sicht der EU-Ziele für nachhaltige Entwicklung (SDGs).

Dieser Artikel fasst die modellbasierten Ergebnisse der beiden Projekte TRADE4SD und MATS H2020 zusammen, die sich beide auf komplementäre Weise mit den sozialen, ökologischen und wirtschaftlichen Auswirkungen des internationalen Agrarhandels und der Handelspolitik befassen. Der Artikel zeigt, dass liberalisierter Handel zwar die Markteffizienz und die Verfügbarkeit von Lebensmitteln verbessern kann, aber auch Ungleichheit und Umweltzerstörung verschärfen kann, wenn er nicht von robusten institutionellen und finanziellen Unterstützungsmaßnahmen begleitet wird. Die modellbasierten Ergebnisse bestätigen, dass die EU-Handelspolitik einen integrierten Ansatz verfolgen muss, der wirtschaftliche, soziale und ökologische Dimensionen in ihren Rahmen einbezieht und gleichzeitig den lokalen Gegebenheiten Rechnung trägt, um das Potenzial des Handels als Motor für nachhaltige Entwicklung voll auszuschöpfen.