



Conditions for an effective EU regulation on deforestation-free products: Where will it likely reduce deforestation?

Johanna Coenen^{1,10}, U. Martin Persson^{2,10}, Arild Angelsen^{3,4}, Mairon Bastos Lima⁵, Laila Berning⁶, Thomas Kastner⁷, Dario Schulz⁸, Metodi Sotirov⁶, Sven Wunder^{9,4}

- 5 1 Department of Political Science, Stockholm University, Stockholm, 114 19, Sweden
- 2 Physical Resource Theory, Environmental and Energy Sciences, Chalmers University of Technology, 412 96, Gothenburg, Sweden
- 3 School of Economics and Business, Norwegian University of Life Sciences, PO Box 5003, Ås, 1433, Norway
- 4 Center for International Forestry Research (CIFOR), Bogor, 16115, Indonesia
- 10 5 Stockholm Environment Institute, Stockholm, 120 30, Sweden
- 6 Chair of Forest and Environmental Policy, University of Freiburg, Freiburg im Breisgau, 79085, Germany
- 7 Senckenberg Biodiversity and Climate Research Centre, Frankfurt am Main, 60325, Germany
- 8 European Forest Institute, Bonn, 53113, Germany
- 9 European Forest Institute, Barcelona, 08025, Spain
- 15 10 The first two authors contributed equally to this work.

Correspondence to: Johanna Coenen (johanna.coenen@statsvet.su.se)

Abstract

In 2023, the European Union (EU) adopted the Regulation on Deforestation-free Products (EUDR) to curb deforestation and forest degradation linked to its agricultural and wood trade. While existing research has outlined how the regulation is expected to work when implemented from 2027, we still have a weak understanding of how these mechanisms are likely to play out across different country and commodity contexts. This study focuses on the conditions under which different outcomes emerge, encompassing both intended impacts and potential spillover effects. We highlight that the regulation is likely to produce heterogeneous, context-dependent outcomes in reducing future deforestation across commodities and countries, with EU market shares and associated deforestation embodied in EU trade being key conditions. Evaluated in absolute terms, the EUDR may not substantially reduce global deforestation or emissions, but it could be effective in certain contexts. Our results suggest that high EU market shares (e.g., cocoa, coffee) offer leverage, while low market shares (e.g., soy, palm oil) increase risks of market segregation and negative spillovers. The EUDR's most significant source of leverage likely stems from its broader influence on forest and supply-chain governance among multinational companies and non-EU countries. Achieving this wider impact requires coordinated collaboration with both producer and other consumer countries.



1 Introduction

Deforestation caused by the production, trade and consumption of forest-risk commodities (FRCs) is a major driver of climate change and nature loss (IPCC, 2019). A plethora of public and private governance efforts at multiple levels have emerged to halt commodity-driven deforestation. These include pledges like the New York Declaration on Forests, corporate zero-deforestation commitments, third-party sustainability certification schemes, as well as regulations in the countries producing FRCs (Sotirov, Pokorny, Kleinschmit, & Kanowski, 2020). However, despite temporary and regional achievements (Heilmayr, Rausch, Munger, & Gibbs, 2020; Lambin & Furumo, 2023), commodity-driven deforestation remains high, particularly in the tropics (IPCC, 2019; Singh & Persson, 2026).

In response to the limited effectiveness of supply-side and voluntary governance in halting deforestation, there has been a shift towards mandatory policies on the demand-side (Cotta et al. 2022). The EU and several European countries have adopted a new wave of human rights and environmental due diligence (HREDD) regulations (Gustafsson, Schilling-Vacaflor, & Lenschow, 2022; Gustafsson, Schilling-Vacaflor, & Pahl-Wostl, 2024; Schilling-Vacaflor & Lenschow, 2021) with extraterritorial implications to address global forest loss (Berning, Garrett, & Sotirov, 2026; Henn, 2021; Partzsch, Müller, & Sacherer, 2023). The most recent and prominent example of an HREDD law addressing imported deforestation is the EU Regulation on Deforestation-free Products (Regulation EU 2023/115; EUDR).

The main aim of the EUDR is to reduce the EU's impact on deforestation and forest degradation by prohibiting many FRCs from being placed on, made available on, or exported from the EU market if their production involved deforestation or, in the case of wood products, forest degradation after 31st December 2020, or if they were not produced in compliance with applicable laws and regulations in the country of production. The regulation applies to relevant products that contain, have been fed with, or have been made using any of the seven regulated commodities: cattle, cocoa, coffee, oil palm, rubber, soy, and wood. The regulation entered into force in June 2024, but its implementation has so far been postponed by a total of two years, to 30th December 2026. An initial one-year postponement was decided in 2024 and followed by the omnibus process in 2025, which introduced yet another one-year delay, along with further simplifications (European Parliament, 2025).

The EUDR is one of the first regulatory approaches explicitly targeting global supply chains to support the protection of biodiversity and the reduction of climate impacts from deforestation, aligning with key Sustainable Development Goals (SDGs), specifically SDG 15 (Life on Land) and SDG 13 (Climate Action). A key motivation is that the EU, after China, is the world's second-largest importer of deforestation embodied in commodity trade (Singh, Persson, Croft, Kastner, & West, 2024). It is estimated that EU imports of palm oil, soy, natural rubber, cocoa, coffee, and beef—which together with wood products are the commodities covered by the EUDR—were associated with over 150,000 ha deforested annually in 2020-2022 period (Figure 1).

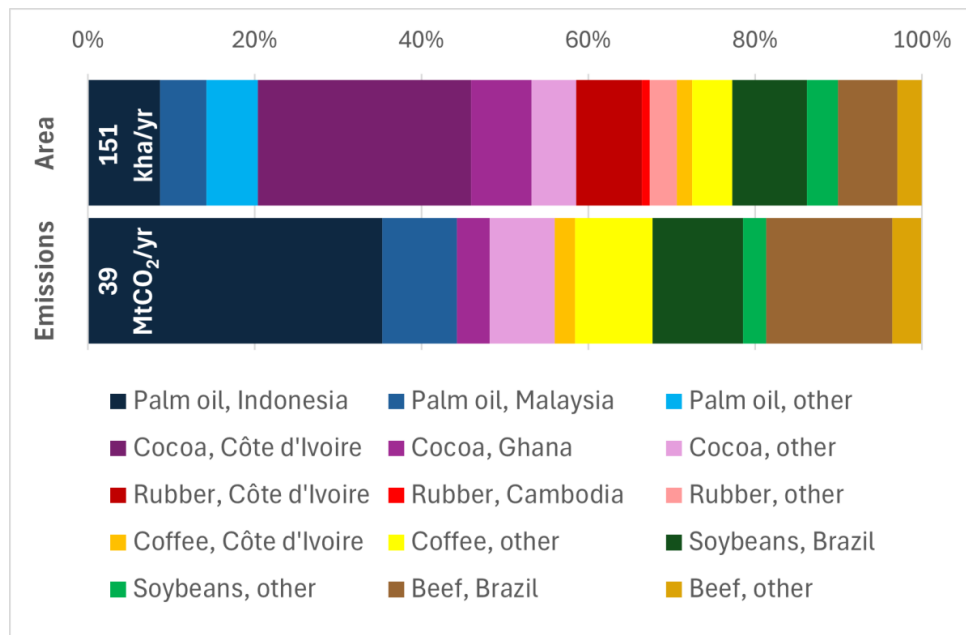


Figure 1. Estimated annual deforestation risk and associated carbon emissions for EU imports of commodities targeted by the EUDR for 2020-2022. Colours denote different commodities; hue indicates origin. Data from Singh et al. (2024). The total EU deforestation footprint of 151,000 ha/yr represents just over 3% of global agriculture-driven deforestation, or 13% of that embodied in international trade of EUDR commodities. Note that this does not include deforestation embodied in imports of products containing leather – estimated to add some 20,000 ha/yr (Laroche et al., 2024) – and deforestation due to wood product imports, for which there is no reliable estimate.

Research on the EUDR is rapidly expanding, identifying scope, bottlenecks and loopholes for implementation (McDermott et al., 2025; Muradian et al., 2025; Schulz et al., 2026; Wojcikiewicz Almeida, Ralile de Figueiredo Magalhães, da Cunha Vollers, & Furtado de Melo, 2025; Zhunusova et al., 2022; Ziegert et al., 2025), and presenting selected case studies (de la Vega, 2026; Moluh Njoya et al., 2025; Weber, 2025; Wojcikiewicz Almeida et al., 2025). This emerging body of literature highlights that the EUDR will play out differently across supply chains and producer country contexts. However, a systematic exploration of the global heterogeneity of outcomes is still lacking. We therefore pose the research question: *Under what conditions can the EUDR be expected to reduce agriculture-driven deforestation associated with EU imports, and potentially globally?* We limit our analysis to the six non-forest commodities covered by the EUDR and associated deforestation as there is a lack of data on the amount and distribution of forest loss and degradation driven by forestry production.

To address this question, we conduct a theory-driven, *ex-ante* evaluation to examine potential pathways of how the EUDR may affect deforestation and its environmental consequences, considering both direct and indirect, positive and negative effects. We then identify key conditions for success along with illustrative examples based on early evidence and take a first step towards a comprehensive *ex-ante* assessment. Using available data on key conditions identified for EUDR effectiveness, or lack thereof, we assess expected variations in its effectiveness, moving beyond the country-specific focus that has been common to most studies.



Our contribution lies in synthesizing the best available theoretical and empirical evidence to provide a novel systematic perspective on how outcomes are expected to vary across commodities and countries, including the potential indirect effects the EUDR can have on deforestation not directly associated with EU consumption. As noted in Figure 1, the total current EU deforestation footprint accounts for just over 3% of total annual agriculture-driven deforestation globally (Singh & Persson, 2026), meaning that even if the EUDR were to reduce the Union's deforestation footprint to zero, global reductions in deforestation would be small. We note this not to discount the substantial impact that the EUDR can have in certain tropical regions, but to stress the importance of assessing the impacts the EUDR may have on forest and supply-chain governance more broadly, as this may potentially be more important than the direct effects in terms of cleaning up EU supply chains.

Below, we briefly describe the methods and materials before presenting empirical evidence on the EU's policy leverage. We conclude that while the EUDR per se might not lead to significant net deforestation reductions globally, it may curb deforestation in certain contexts and contribute to strengthened supply-chain governance more broadly.

2 Methods and materials

To identify key conditions for the EUDR's effectiveness, we review: (1) the main legal text of the EUDR and its impact assessment (European Commission, 2021; Regulation EU 2023/115, Regulation EU 2024/3234, Regulation EU 2025/2650) to identify the main impact pathway of how the EUDR is intended to bring about change, and (2) the recent literature assessing potential impacts of the EUDR, as well as (3) theories and empirical analyses from relevant bodies of knowledge in political science, economics, and land-system science on land-use, forestry and trade governance, to identify and assess the explicit and implicit impact pathways and associated causal mechanisms of the EUDR. More specifically, we consult theories in economics related to land-system science (Angelsen, 2010; P Meyfroidt et al., 2020; Patrick Meyfroidt et al., 2018; Reis et al., 2020; Richards, 2015) and political science literature on the so-called Brussels effect (Bradford, 2015, 2020), as well as the broader literature on Europeanization (Börzel & Risse, 2012; Lavenex, 2014; Risse, 2016), to reflect on the potential impact pathways of the EUDR. We carefully assess spillovers, which are second-order effects of a policy beyond its targeted scope (Bastos Lima, Persson, & Meyfroidt, 2019). We examine both positive and negative spillovers – also sometimes referred to as boosting and leakage effects (Bastos Lima et al., 2019) – on deforestation reductions and environmental impacts.

We synthesize these insights into a Theory of Change (ToC) for the EUDR. ToCs are mental representations that include underlying assumptions, explaining how and why a specific set of activities is expected to sequentially achieve their intended impacts (Mason & Barnes, 2007; Oberlack et al., 2019). While some previous studies on ToCs for the EUDR exist (Muradian et al., 2025; Schulz et al., 2026), our novel contribution here is using the ToC as an analytical lens for exploring the heterogeneous effects of the EUDR. The underlying assumption is that some causal mechanisms may be better suited to specific contexts (Pawson and Tilley, 1997), meaning that the EUDR cannot be expected to be equally effective across supply chains, time, and space. By establishing an understanding of the underlying mechanisms through which the EUDR is expected to generate heterogeneous impacts, the ToC allows us to pinpoint conditions that will affect how the regulation plays out across different contexts.



We do so by combining the understanding of the conditions under which specific impact pathways emerge with relevant empirical data, assessing where the EUDR is more or less likely to reduce commodity-driven deforestation. This assessment is done both through original quantitative analyses of data on commodity-driven deforestation at country level (Singh & Persson, 2026), data on EU imports of the FRCs covered by the EUDR (Comtrade), and the amount of deforestation embodied in these imports (Singh et al., 2024), as well as through more qualitative analyses based on the growing body of empirical case studies on EUDR implementation.

The empirical analysis focuses mainly on a handful of countries and commodities – palm oil from Indonesia and Malaysia, soybeans and beef from Brazil, and cocoa from Côte d'Ivoire and Ghana – which together account for nearly two-thirds of the total EU deforestation footprint in 2020-2022 (Figure 1). If the EUDR is to substantially reduce deforestation driven by EU consumption, it is most relevant to look at these countries and commodities.

The data and analyses underlying the assessments and figures presented below are available in the online supplementary data file. The code for generating the data from its original sources and reproduce the figures is available upon request.

3 Assessing the conditions for heterogeneous EUDR impacts across countries and commodities

Figure 2 provides our visual summary of the EUDR's ToC, based on the reviewed policy documents and academic literature. We differentiate between three overarching impact pathways: (1) a primary market access pathway – as derived from policy documents – but also potential pitfalls and complementary pathways resulting in (2) negative and/or (3) positive spillovers. We describe each pathway, assess its preconditions and likelihood to occur (cf. Table 1), and thus try to identify where a reduction in commodity-driven deforestation seems more or less likely.

3.1 Market access pathway

The EUDR establishes conditional market access by requiring companies that first place certain products (see EUDR Annex I for a complete list) on the EU market or export them to submit a due diligence statement to a member state's designated competent authority, confirming they were produced in compliance with the national laws of the country of origin and sourced from land not deforested or degraded after 31 December 2020 (the cut-off date). Under the EUDR, due diligence obligations entail: (1) the collection of relevant information, including geographic coordinates of the plot of land where the commodities were produced, (2) a risk assessment, and (3) risk mitigation measures. The conditional market access is complemented by a mechanism of international cooperation between the EU and producer countries (Article 30) and a benchmarking system (Article 29), both discussed further below (sections 3.3.2 and 3.3.3).

The intended output of this legal requirement is that companies comply by ceasing to place or make available on the EU market, or export, products covered by the EUDR originating from land deforested or degraded after the regulation's cutoff date. By disciplining EU demand for forest-risk commodities, the regulation is expected to



175 discourage producers from clearing or degrading forests to meet EU market requirements, thereby contributing to reduced greenhouse gas emissions and loss of biodiversity and ecosystem services.

However, there are two main ways by which these intended aims might be circumvented or undercut (Figure 2), one relating to the *outputs* of the regulation and one to its *outcomes* (Schulz et al., 2026). First, if monitoring and enforcement is not effective, FRCs linked to deforestation may still enter EU markets through what is typically
180 called laundering, meaning that the intended outputs (deforestation-free EU supply) are not achieved. Second, the intended outputs may be achieved by FRC producers diverting products originating from cleared land to other markets, through what is often termed market segregation, leading to a failure of the regulation to deliver the intended outcomes (reduced deforestation).



185

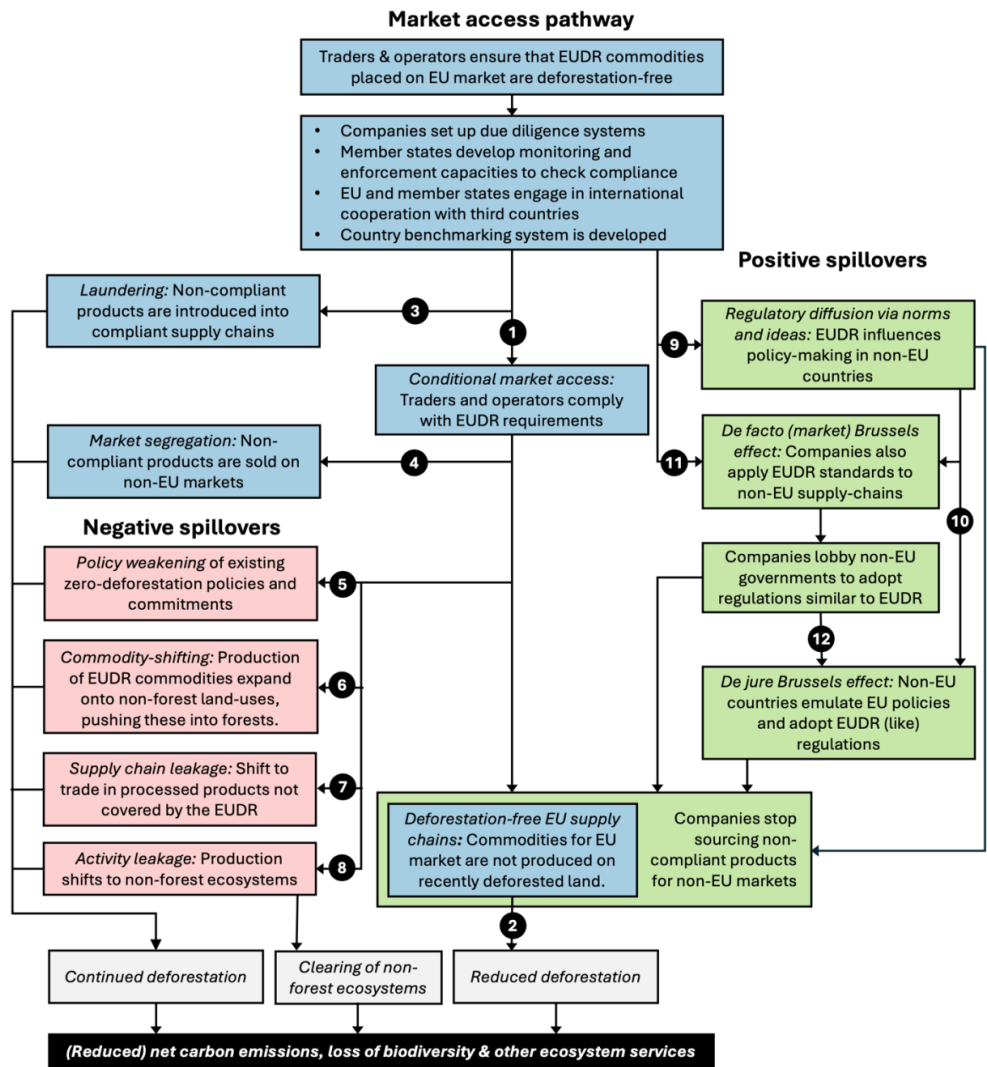


Figure 2. Theory of Change of the EUDR. The blue boxes refer to the main impact pathways, as well as ways this may be undercut or circumvented; the red boxes to negative spillovers, and the green boxes to positive spillovers. Refer to Table 1 below for details on the numbered arrows.

190

3.1.1 Laundering

The mechanism of conditional market access can deliver the intended outputs only to the extent companies are held accountable for non-compliance. First, this requires robust traceability systems and effective monitoring and enforcement. Robust traceability systems pose substantial information requirements (Gardner et al., 2019), with a risk of value chain actors laundering non-compliant products into compliant supply chains if it is possible to conceal the origin of a product (Franca, Persson, Carvalho, & Lentini, 2023).

195



Traceability is more challenging to implement in supply chains with extensive indirect sourcing from local intermediaries, which is particularly the case for the EUDR commodities cocoa and cattle meat (zu Ermgassen et al., 2022). For example, in the case of cattle, owners of multiple properties have been shown to launder cattle through a “clean” property, concealing that it was originally raised on non-compliant properties (Skidmore et al., 2021). The EUDR aims to prevent such laundering by mandating that geolocations of all plots of land be included when a commodity has been produced on different plots of land (Article 9).

Traceability systems also need to detect double-counting, preventing the same EUDR-compliant farm polygon from being used multiple times to conceal non-compliant volumes (see section 4.2.1). Mandatory public or interoperable private traceability systems might mitigate this risk (FERN, 2024). Additionally, checking the plausibility that harvested volumes are produced on reported areas of production, and not artificially inflated, will be an important step to detect laundering. Such monitoring strengthens enforcement by increasing the risk of penalties for misreporting.

Laundering through fraudulent documentation of origin, mixing of compliant and non-compliant products, and reuse of compliant farm polygons can be difficult to detect both for importing companies and supervisory authorities. The incentives for producers and traders to invest in costly traceability systems and reduce opportunities for laundering will be larger where EU represents a major share of total demand. High EU demand may also encourage producer countries to develop national traceability systems (cf. Section 4.3.3), thereby supporting reliable traceability and reducing incentives for laundering.

To assess the incentive that different producer countries have for investing in traceability systems for EUDR compliance, we calculate the EU market share for the countries exporting EUDR commodities to the EU (Figure 3). As can be seen, the EU market share is particularly high in the case of West African cocoa (33-60%). Reflecting this, the cocoa sectors of Côte d’Ivoire and Ghana have already started developing national traceability systems (Ghana Cocoa Board, n.d.; Myers, 2023), which will help reduce the risk of laundering – important for a commodity that is almost exclusively sourced indirectly (zu Ermgassen et al., 2022). Brazilian beef is at the other end of the spectrum, with EU demand constituting less than 1% of the market. In that case, as laundering practices have been widely documented, the risks for laundering under the EUDR are likely to be high. Finally, while the EU market share is also relatively modest for Indonesian and Malaysian palm oil (8-9%) and Brazilian soybeans (12%), the high(er) degree of direct sourcing may mitigate risks of laundering in these contexts.

On the demand side, the EUDR requires EU member-state authorities to conduct compliance checks and impose penalties to deter and sanction non-compliant market participants, including fines, confiscation of goods and revenues, exclusion from public funding, and prohibition of market operations (Art. 25). The EUDR also prescribes a minimum number of inspections for competent authorities (Art. 16). However, a joint investigation by international journalists warns that the EUDR’s implementation may fail due to a lack of staff and resources in some EU member states (Blum, Engert, & Strunz, 2024). The additional time before compliance checks begin may therefore provide an opportunity to strengthen administrative capacities (European Council, 2025).

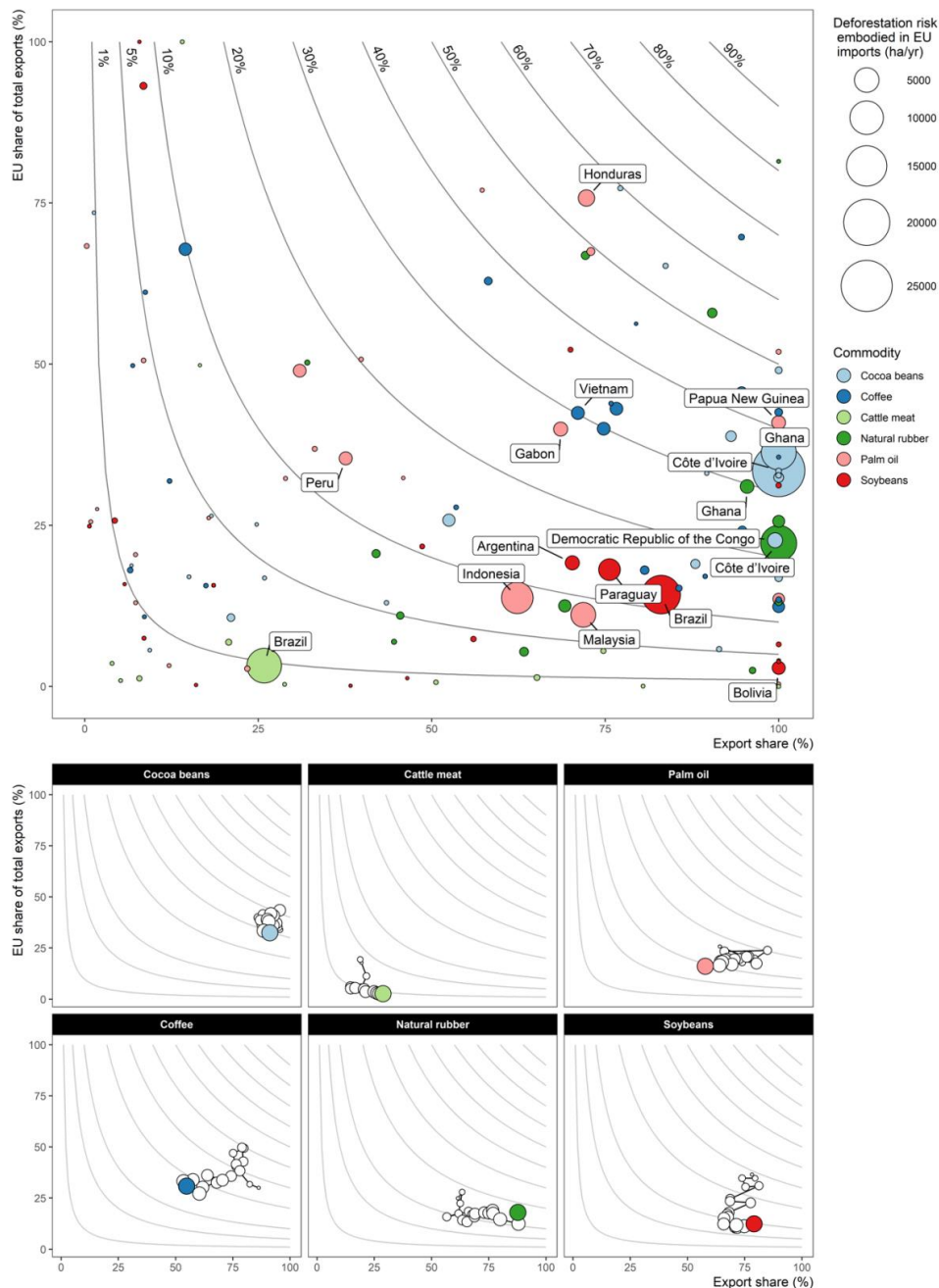


Effective implementation also depends on political will and consistent resource availability for competent authorities across member states, to prevent weak monitoring and enforcement in some member-states creating

240 loopholes for non-compliant imports and exports (Environmental Investigation Agency, 2021). Such uneven implementation across EU member states has been identified for the EU Timber Regulation (EUTR) (McDermott & Sotirov, 2018), but though stakeholders have reported it did result in some laundering (Berning & Sotirov, 2023), the extent of this is not known.

245 Whether this is an EUDR-relevant factor depends on the feasibility to reroute EU imports through weak-enforcement ports. Figure 4 shows that currently a large share of EUDR agricultural FRC imports comes through a handful of EU countries with major ports: in 2022, Germany, the Netherlands, France, Italy, Spain, and Poland together accounted for three quarters or more of import value for all commodities apart from rubber and wood products. We deem it unlikely that it would be logistically feasible, or economically attractive, to reroute a

250 significant share of these massive trade flows through other countries, at least for palm oil and soy products which are both more substantial (in mass) and more concentrated to a few major ports of entry. However, to reduce the risk for laundering, monitoring and enforcement in those respective countries need to be effective, with adequate resources and capacities.



255

260

Figure 3. EU market share for EUDR commodities. The top panel displays imported deforestation by EUDR commodities (excluding leather and wood products), with each bubble's position reflecting EU imports from a given producer country in 2022, as a function of the share of production in that country being exported (horizontal axis) and the share of EU imports in total exports (vertical axis). Isolines represent different levels of total EU market share (i.e., the product of the horizontal and vertical axis-values), shown from 1 to 90 percent. All flows with embodied deforestation exceeding 1,000 ha in 2022 are labelled with the country of origin. The bottom panel shows how the average EU market share (across all supplier countries, weighted by embodied deforestation) for



each of the six EUDR commodities analysed have developed during 2001-2022 (increasing circle sizes by year; coloured circles represent the final year). A higher EU market share increases incentives for investing in robust traceability systems for EUDR compliance, reducing risks for laundering (section 3.1.1), reduces opportunities for market segregation (section 3.1.2), and increases the likelihood of a Brussels effect (sections 3.3.2-3). Data from Singh et al. (2024).

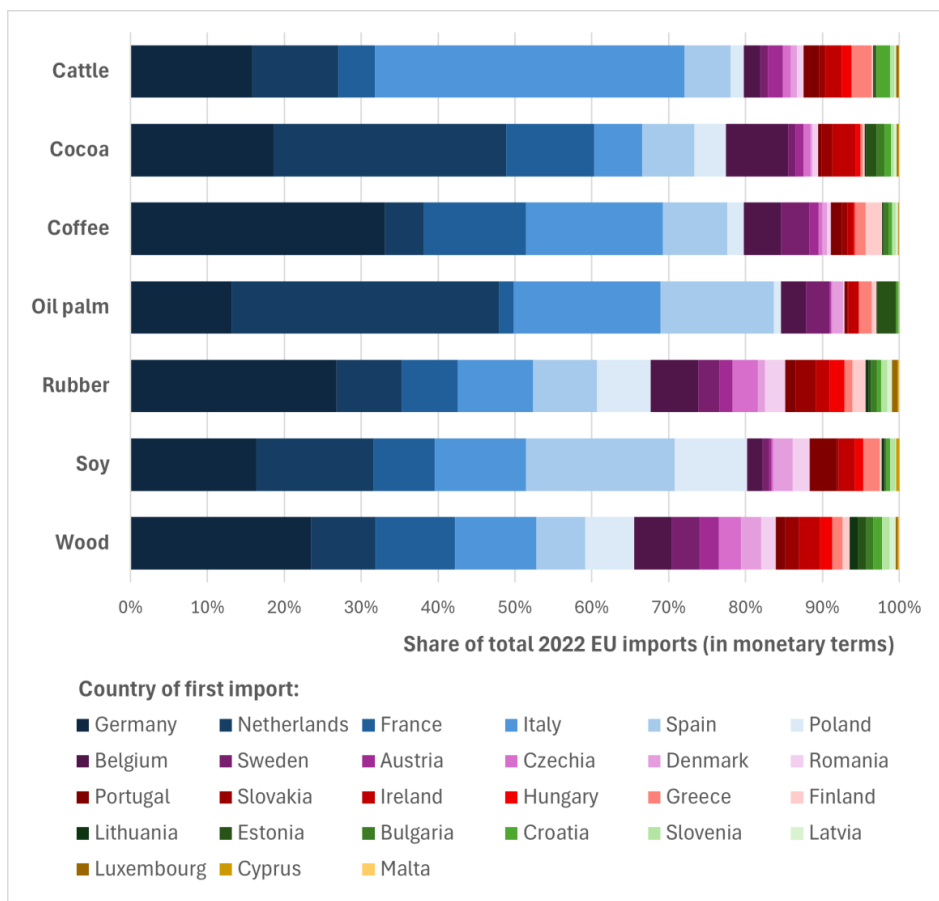


Figure 4. Shares of EUDR commodity imports through EU countries. The share of import value for the seven different EUDR commodities that enter the EU through different member states, highlighting that imports are highly concentrated through a handful of key port countries. Data is for the year 2022, from the UN Comtrade database (United Nations, 2025). The supporting data file includes the same figure based on imports in mass units, showing a very similar pattern.

3.1.2 Market segregation

If producers continue to deforest and sell non-compliant produce to non-EU markets, while redirecting existing EUDR-compliant production towards the EU, the requirements of the regulation will be fully met, but without resulting in the intended reductions in deforestation. Alternatively, companies required to comply with the EUDR may relocate capital and physical assets towards (perceived) lower-risk regions. This retreat could leave producers in high-risk regions still seeking market access reliant on less sustainability-oriented market actors, potentially locking in regional paths of continuous deforestation.



This risk has been described in the literature as supply chain or market segregation (Cesar de Oliveira et al., 2024),
 285 market segmentation (Weber, 2025), supply chain divergence (Bastos Lima & Schilling-Vacaflor, 2024), or policy
 evasion (Schulz et al., 2026). The likelihood of such a market segregation is higher (1) the lower the transaction
 costs of segregating compliant and non-compliant produce and rerouting commodity flows, and (2) the easier it is
 for non-regulated markets—domestic and international—to absorb the decreasing EU demand for non-compliant
 production, as observed in the case of the Amazon Soy Moratorium and the Brazilian Cattle Agreements (Alix-
 290 Garcia & Gibbs, 2017; Cammelli, Levy, Grabs, Valentim, & Garrett, 2022; Gibbs et al., 2015; Villoria, Garrett,
 Gollnow, & Carlson, 2022).

Starting with market absorption, only if the EU market share is larger than the share of production in the export
 country that is EUDR-compliant would market segregation not be fully possible. In this situation, the EU would
 295 demand more compliant products than the producer country can currently supply, and the surplus of non-compliant
 products that the EU no longer demands would exceed existing demand from other markets (domestic and
 international). Using basic economic reasoning, this would in turn drive a price wedge between (relatively costlier)
 compliant and (relatively cheaper) non-compliant products, and hence create an economic incentive (at the margin)
 for producers to avoid future deforestation.

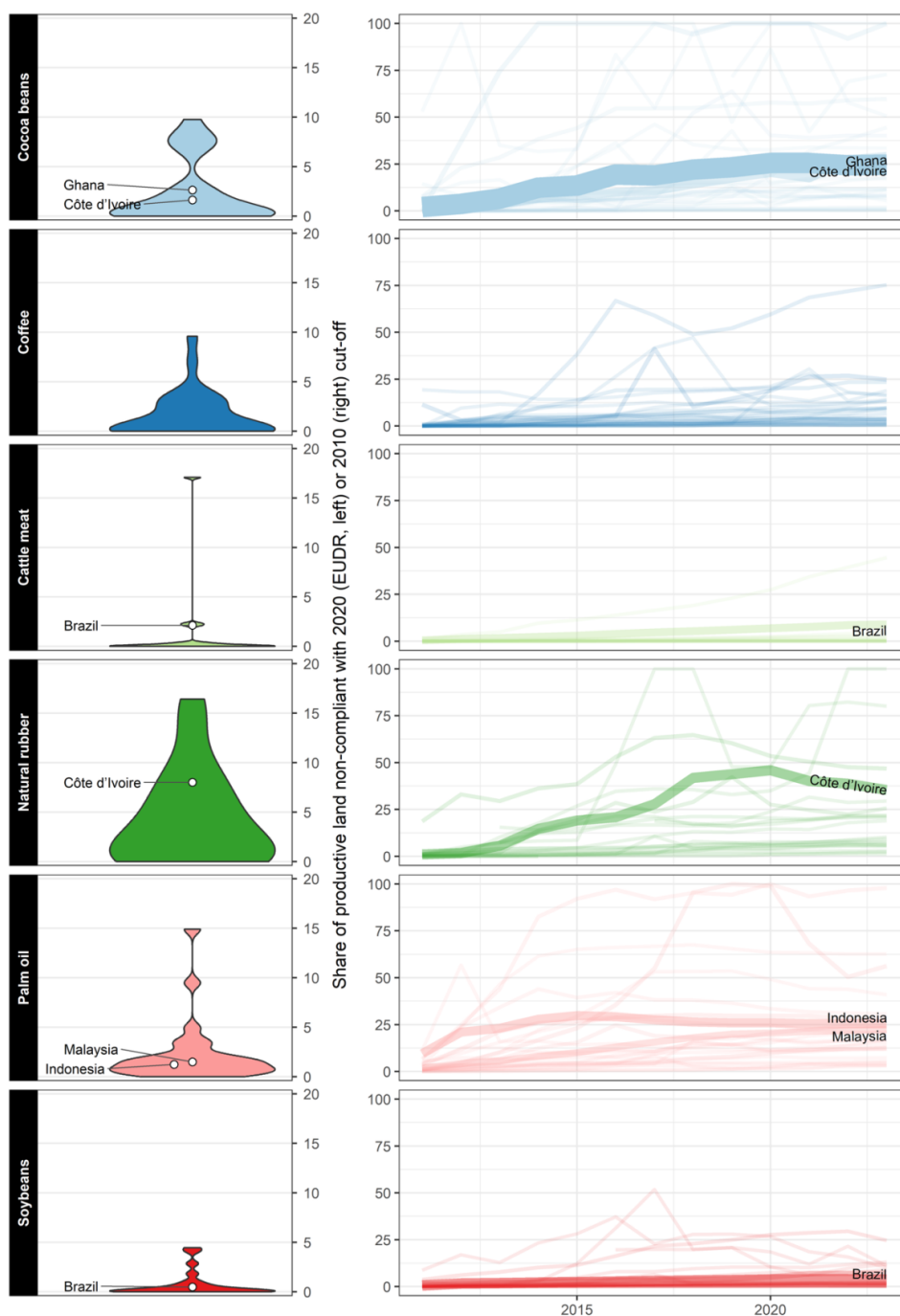
300 As already noted above, the EU market share is relatively modest and/or declining for most EUDR commodities
 and producer countries. Moreover, because the cut-off date for the deforestation-free requirement is so recent (Dec
 31, 2020), the share of production on recently deforested land is also quite low for most commodities and countries
 (see Figure 5). This means that there is sufficient pre-compliant production available to supply the EU, while non-
 305 compliant volumes could be diverted to other markets. For example, the EU market share for Brazilian soy was
 12% in 2022, while we estimate the share of EUDR-compliant production in the same year to be >99%, meaning
 that with a tiny market reallocation of less than 1% of production, Brazilian soy producers would already be out
 of the (deforested) woods.

310 Two factors will moderate the risk for market segregation, however. First, transaction costs: if shifting sourcing
 between regulated and non-regulated markets is costly, this strategy will be less attractive, supply chains will
 overall be stickier, and trading relationships will exhibit more stable sourcing (Reis et al., 2020). Factors related
 to infrastructure, finance, technologies, social networks, consumer preferences, governance institutions, and
 biophysical conditions co-determine supply-chain stickiness and ‘lock-in’ effects (Leijten, dos Reis, Sim, Verburg,
 315 & Meyfroidt, 2022; Reis et al., 2023). For example, the transaction costs of segregating palm oil or soy supply
 chains are high because of practices to mix commodities from different production sites (Gassler & Spiller, 2018).
 Nevertheless, market segregation has already been observed for Brazilian soy. Certified soy tends to be exported
 to northern European countries, while the remaining exports are absorbed by Asian markets, Spain and Brazil’s
 domestic market (Bastos Lima & Schilling-Vacaflor, 2024). Similarly, the national cocoa traceability system in
 320 Ghana already differentiates between *conventional* and *sustainable* produce, facilitating potential market
 segregation under the EUDR (Weber, 2025).



Second, temporal dynamics: we can expect the share of non-compliant production to increase over time, as more land is being deforested (see Figure 5). Especially more recent deforestation frontier countries—where there is less pre-existing, EUDR-compliant production—will more quickly approach a point where non-EU markets cannot absorb the increasing share of production from land deforested after the cut-off date. Figure 5 suggests, based on recent historical trends, that this is more likely to be the case for cocoa, natural rubber, and palm oil, especially if focusing on countries accounting for a large share of deforestation embodied in EU imports. On the other hand, this effect may be mitigated (or even nullified) if the EU market share decreases over time, as has been a structural trend in the world economy overall, and for some FRCs in particular (cattle meat, rubber and soybeans; see Figure 3).

In terms of expected direct EUDR impact, this means that a highly accentuated market segregation is a more likely outcome for Brazilian beef and soy, because of low and decreasing EU market shares, and a large share of existing EUDR-compliant production. For instance, soy previously supplied from new and deforestation-affected frontiers in the Amazon to Europe, at shortest transport distance, may instead be sent the longer way to China, while old-frontier soy from the Brazilian South is shipped to Europe instead. For cocoa, coffee and palm oil, we would on the other hand expect it to be relatively less prevalent, due to the combination of higher EU market shares, more production on recently deforested land, and relatively high transaction costs of segregating compliant and non-compliant production.



Amount of deforestation embodied in EU imports (ha): — 10,000 ■ 30,000 ■ 50,000



Figure 5. Share of non-compliant land, for different cut-off dates, commodities and countries. The lefthand plots show the distribution of the share of productive land in 2022 that have been deforested after the EUDR cut-off date (Dec 31, 2020) across countries, while the righthand plots show how the share of non-compliant land developed over time for a hypothetical 2010 cut-off date (note differences in the vertical axes scales, for each of the six agricultural EUDR commodities. Line width and density (righthand plots) reflect the amount of deforestation embodied in EU imports during 2020-2022, with all consumer country and commodity flows exceeding 10 kha in this period being labelled with the producer country. While the share of land not compliant with the EUDR cut-off is typically low, in particular for countries and commodities linked to major EU imports of embodied deforestation (left), historical deforestation trends show that the share of non-compliant land can increase rapidly over time, as has been the case for cocoa, natural rubber and palm oil producers (right) (although there are also examples where the non-compliant share declines, reflecting expansion of production on compliant, non-forest, land).

4 Negative spillovers

Even where the EUDR is effectively implemented and enforced, leading to a direct reduction in deforestation for EU supply-chains, its impacts—both in terms of overall deforestation and reduced carbon emissions and biodiversity loss—may still be weakened by indirect causal impacts. Leakage—defined as effects of an intervention on non-targeted domains (space, time, commodities, actors) that have the opposite direction of the intended outcome (Bastos Lima et al., 2019; Patrick Meyfroidt et al., 2018)—and policy dismantling may undermine the EUDR’s effectiveness. The following sections categorize and discuss these mechanisms in detail, along with the conditions that shape them.

4.1.1 Supply chain leakage

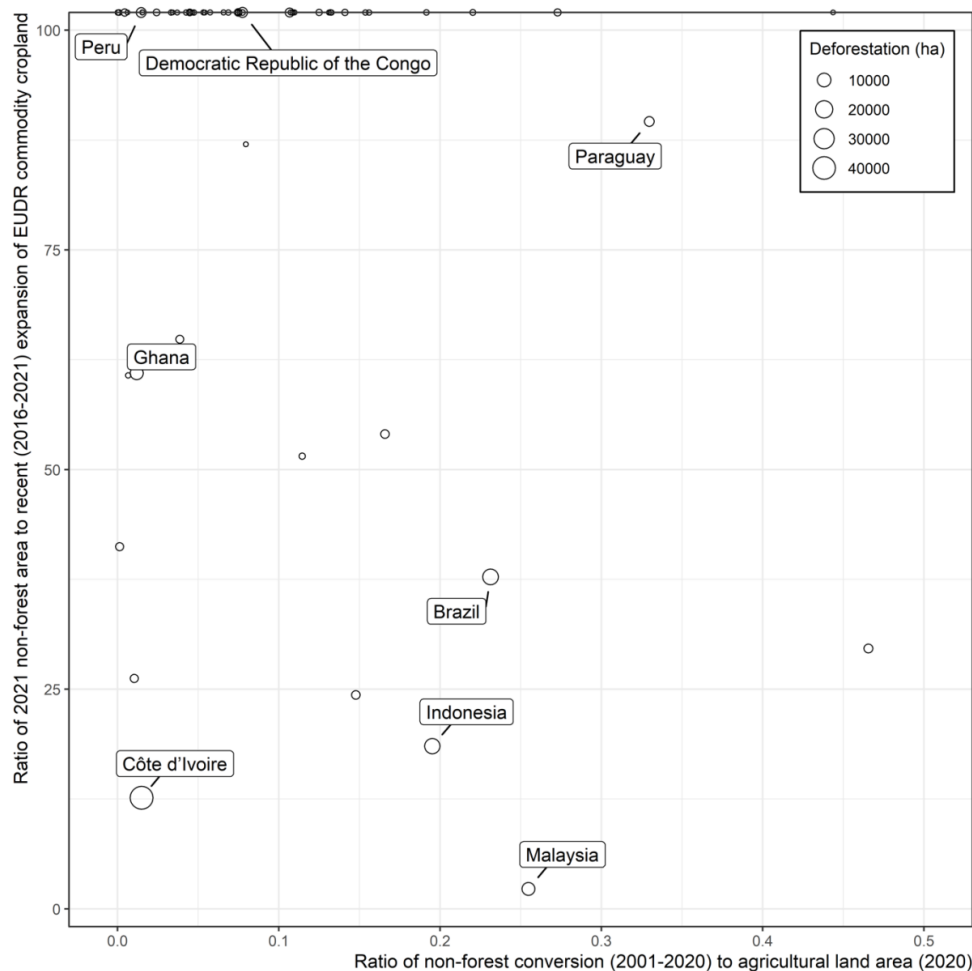
Leakage may occur towards product categories not covered by the EUDR. For example, virgin oils like palm could be mixed into “used cooking oil”, a product category not covered by the EUDR. This risk has been observed in the context of biodiesel production in the EU, which is subject to the Renewable Energy Directive (van Grinsven, van den Toorn, van der Veen, & Kampman, 2020). Trade could also shift to highly processed goods that are currently not covered by the EUDR but contain non-compliant commodities. This trade shift towards more processed products might be desirable from a socio-economic perspective – if it leads to higher value added in countries of production (Ponte, 2022) – but would undermine the EUDR’s environmental effectiveness. This risk is likely higher for the EUDR commodities which are used in highly processed products, such as textiles, footwear, consumer products containing leather as well as (to a lesser extent) rubber and processed food products containing palm oil or cattle meat, which are excluded from the scope of the EUDR (Laroche et al., 2024). For soy used as feed, or for cocoa and coffee, where there is a large processing industry in Europe (see section 3.3.1 below), such a trade shift is, however, unlikely to occur.

4.1.2 Activity leakage to non-forest ecosystems

Another risk is that some commodity production, in response to EUDR implementation, may be relocated to non-forest ecosystems. Although this shift would not increase deforestation directly, it would still represent leakage in terms of carbon emissions and biodiversity loss, which are primary concerns of the Regulation. For precisely this reason, Article 34 envisions a future extension of the EUDR to ‘other wooded land’, like savannahs and shrublands.



385 The risk for this type of leakage is generally higher if commodity profitability is high, production factors such as labour and capital are highly mobile, required investments are low, and production-suitable non-forest land is available (Patrick Meyfroidt et al., 2018; Schulz et al., 2026). Additionally, unfavourable conditions for intensification on compliant land that is already under cultivation will also favour this response pathway. Figure 6 shows a simple assessment of the potential availability and agricultural suitability of natural, non-forest land, suggesting that this risk of leakage is likely to be higher in Brazil, Paraguay, and the Democratic Republic of Congo—three countries that in recent years have exhibited high rates of non-forest ecosystem conversion, primarily to pastures (Kan et al., 2026), and likely lower in Côte d’Ivoire.



395 **Figure 6. Risk for activity leakage to non-forest ecosystems, assessed by the potential availability and suitability of natural non-forest land, by country.** We expect the risk for activity leakage into non-forest ecosystems to be higher the larger the availability of these types of land – here indicated by the ratio between grassland and shrubland area in 2021 (FAOSTAT) and the deforestation pressure that could be deflected into non-forest land (EUDR commodity deforestation in the 5 years prior, 2017-2021) (vertical axis, data points outside the plot range are displayed on top) – and the more suitable that land is for agriculture – here expressed as the ratio between non-forest conversion in the period 2001-2020 (from Kan et al., 2025) and total agricultural area in 2020



(horizontal axis). All countries where EU deforestation embodied in imports of EUDR commodities in the 2020-2022 period exceeded 1,000 ha/yr are labelled. The risk for leakage is thus higher in countries where non-forest land is relatively abundant (in relation to EUDR commodity expansion) and likely more suitable for agricultural production, which seems to be the case particularly for Paraguay and, to a lesser extent, for Brazil and the Democratic Republic of Congo.

4.1.3 Leakage through commodity shifting

Leakage may also occur through indirect land-use change, or commodity shifting, when an intervention affecting land use in one place has spillover effects on land use elsewhere (Patrick Meyfroidt et al., 2018; Richards, 2015). In contrast to activity leakage described above, which alters the behaviour of actors directly targeted by the policy intervention, indirect land-use change occurs due to shifting incentives for actors not directly targeted by the intervention (Bastos Lima et al., 2019). For instance, production may still expand in areas that are compliant with the deforestation cut-off date and applicable laws in producer countries. This, in turn, may push production of commodities either not covered by the EUDR, or covered but not destined for EU markets, into forested areas. In particular, when compliance costs are substantial, producers may shift to cultivating substitute commodities, especially those that are fungible (Garrett et al., 2019). For example, the cultivation of EUDR-excluded commodities like rice, maize and cassava is an important driver of deforestation in some tropical landscapes (Jayathilake, Prescott, Carrasco, Rao, & Symes, 2021; Singh & Persson, 2026). Commodities destined for the EU market could be produced on compliant land, whereas staple crops such as rice, cassava and maize would increase deforestation (Fuchs, Raymond, Winkler, & Rounsevell, 2024). For instance, cocoa expansion is already a significant indirect driver of deforestation in West Africa (Addoah et al., 2025; Renier et al., 2025). Non-EUDR commodities may thus come to be produced more in newly deforested areas.

4.1.4 Weakening of existing zero-deforestation interventions

The EUDR is being introduced into an already complex institutional landscape of both public, private and hybrid policies and commitments aimed at reducing deforestation (Sotirov et al., 2020). As a result, institutional interactions between the EUDR and pre-existing policies are inevitable (Ziegert et al., 2025). A potential negative interaction might be the full or partial dismantling of domestic policies, whether being repealed, amended, less stringently enforced, or discursively delegitimized, in cases where pre-existing environmental standards are actually higher than those of the EUDR (Bauer & Knill, 2013). For instance, certain Brazilian actors have called to revise the Amazon Soy Moratorium to align it with the EUDR, weakening it by changing the cut-off date from 2008 to 2020 and assessing compliance at plot- rather than farm-level. The latter, however, would allow for on-farm deforestation for other land uses than soy, while “updating” the cut-off date would evidently reward speculative deforestation and risk large-scale indirect land-use change as land deforested between 2008 and 2020 becomes available to soy (Ziegert et al. 2025).

5 Positive spillovers

The EUDR can also lead to positive spillovers – reinforcing the policy’s objectives. We present potential positive spillovers operating through markets and norms on both demand- and supply-side governance, contributing to the so-called Brussels effect.



5.1.1 *De facto* Brussels Effect

The ‘Brussels effect’ refers to the replication of EU standards outside its borders, via market and/or regulatory mechanisms (Bradford, 2015, 2020). This concept represents a refined and specified parallel to the ‘California effect’, elucidating how a single frontrunning jurisdiction can influence regulatory standards beyond its borders due to its large market size (Vogel, 2009). According to Bradford (2020, 2015), five conditions are necessary for companies to adopt EU norms and standards beyond EU supply chains and diffuse them to third countries: (1) a large EU market, (2) high EU’s regulatory capacity to develop and enforce its own rules, (3) clear preference for strict standards; (4) effective regulation of inelastic targets (e.g., food or timber markets as consumer markets), and (5) high degree of non-divisibility in production, so it is cheaper if a company standardizes its production or business practices rather than customizing it to each market. When a company cannot adjust its practices or products for different markets due to economic, technical, or legal constraints, it may adopt EU standards because of the EU’s market power. If companies operating across jurisdictions aligned their corporate policies with EU standards, a *de facto* Brussels effect would occur, potentially leading to a *de jure* Brussels effect.

For some EUDR commodities, global markets are often highly concentrated, with a small number of multinational companies playing a dominant role (Folke et al., 2019). When few large multinationals dominate the global market and depend on EU market access, they have more power and stronger incentives to adopt EU standards across the board to avoid operating multiple parallel systems. For coffee, for example, the top-ten multinational roasters represent over 35% of the global trade in green coffee, seven of which have their headquarters in Europe (Panhuisen & Pierrot, 2020). For cocoa, seven transnational companies handle 62% of the global cocoa trade, and consumption is dominated by Europe and North America (Parra-Paitan, Erasmus, Meyfroidt, & Verburg, 2023)(Parra-Paitan et al. 2023).

Therefore, for global supply chains in which European market actors hold significant influence, a *de facto* Brussels effect is relatively more likely to occur. By contrast, although just five large corporate groups control about two thirds of the total refining capacity and export volume of palm oil from Indonesia and Malaysia (Voora, Bermúdez, Farrell, Larrea, & Luna, 2023), the EU market share there is much lower (~10%) than for cocoa and coffee (Figure 3), making any type of Brussels effect less probable. Likewise, for cattle and soy from Brazil, trade is dominated by companies supplying primarily the domestic market, or international markets other than the EU (Lathuillière et al., 2022; zu Ermgassen et al., 2023).

5.1.2 Regulatory diffusion via norms and ideas reinforcing the Brussels effect

While the notion of the Brussels effect builds on the proposition that EU rules are externalized via markets, we also take note of an alternative pathway put forward by the literature on the EU’s role in global environmental governance (Kelemen, 2010; Vogler & Stephan, 2007).

Through its normative power, the EU seeks to shape policies beyond its own borders and to take a leadership role in global environmental governance (Bäckstrand & Elgström, 2013; Parker & Karlsson, 2017). The EU can influence norms, values and principles on global political dynamics and policies beyond EU borders, prompting



non-EU countries and companies to adopt similar standards. Thus, such a norms-driven policy diffusion pathway could reinforce the EUDR's *de facto* and *de jure* Brussels effect.

The diffusion of EU norms to other jurisdictions may involve active promotion through dialogues, information exchanges, and capacity building (Carodenuto, Ziga-Abortta, & Sotirov, 2024; Lavenex, 2014). The provisions under EUDR Article 30 for cooperation with exporter countries contribute to enabling such an effect. Other countries and companies could learn from their EU counterparts and adopt similar practices, due to, for example, reduced costs of information acquisition (Bastos Lima et al., 2019). Countries and companies may adopt more sustainable practices based on the EU's example to minimize their environmental footprint. For such policy convergence to occur, however, EU regulations must be perceived as legitimate and normatively superior by adopting countries (Lavenex, 2014). Non-EU market actors could also benefit from the traceability systems put in place to comply with the EUDR (Vasconcelos, Bastos Lima, Gardner, & McDermott, 2024). Transnational actors like non-governmental organizations (NGOs) and transnational advocacy coalitions can facilitate this mechanism by propagating EU rules internationally and in non-EU countries' domestic politics (Lavenex, 2014). As shown in the case of the EUDR's predecessor, the EU Timber Regulation, companies' compliance can be driven by public pressure from civil society or companies' commitment to the rule of law and sustainable development values (Köthke & Sotirov, 2024; McDermott & Sotirov, 2018). Additionally, active norm promotion can also occur through the inclusion of sustainability chapters in trade agreements between the EU and third parties (Coenen et al., 2023), highlighting that the Brussels effect could be reinforced by other policy instruments.

Although not discussed so far in the literature, it is plausible that comparatively greater reliance on EU markets could also increase the likelihood of norm diffusion, due to closer economic ties and more possibility to influence bilateral or multilateral trade agreements, as well as the importance for producer countries to achieve a low-risk status in the benchmarking system. The EU might have a larger leverage to support emerging economies in their sustainability efforts where EU demand constitutes a larger share of exports (Zinngrebe et al., 2024).

With regards to the EUDR, the European Commission notes that: "To have the greatest impact, Union policy should aim at influencing the global market, not only supply chains to the Union", which in principle indicates the EU's aspiration to leverage the Brussels effect (Regulation EU 2023/115, para 18). However, ongoing political contestations and delays in the implementation of the EUDR further undermine the EU's aspiration to stand out as a leader and role model in global environmental governance.

5.1.3 *De jure* Brussels effect

The aforementioned *de facto* Brussels effect could be reinforced by a *de jure* Brussels effect, where other jurisdictions adopt EU standards, leading to 'regulatory convergence' (Bradford, 2015, 2020). The *de jure* Brussels effect requires sufficient domestic political support for policy change in non-EU countries (Carodenuto et al. 2024). Sustainability-oriented consumer preferences in non-EU countries may foster countries' receptiveness to EU rules. A *de jure* Brussels effect can be reinforced by civil society campaigns that expose how commodity traders relocate non-compliant commodity flows to different markets rather than improving practices across the board (Bastos Lima & Schilling-Vacaflor, 2024).



However, current prospects for a EUDR *de jure* Brussels effect in other consumer countries remain slim. Research found little prospects for the occurrence of the Brussels effect on deforestation policies in China, for example (Vasconcelos et al., 2024). That notwithstanding, others have noted that at least China's domestic certification schemes are increasingly aligned with the EUDR (BellaTerra, 2025). In the UK, although the Forest Risk Commodity Regulation draws inspiration from and partially converges with the EUDR, its implementation is pending as secondary legislation has been delayed (Table 1).

The EUDR could positively affect public environmental and supply chain governance in producer countries, too. A potentially significant positive spillover effect is the advancement of national databases and traceability systems to support compliance with the EUDR (Grabs, 2025), promoting supply chain transparency and reinforcing monitoring of forest conservation beyond EU market requirements. Additionally, the EUDR could encourage producer countries' governments to improve the stringency and enforcement of domestic laws to reduce deforestation and forest degradation rates, aiming to ease compliance for companies, or achieve a better country benchmarking classification (e.g. from high-risk to standard-risk). This might help them to maintain EU market access as companies may try to avoid sourcing from high-risk areas. Numerous producer countries like Vietnam, Thailand, Brazil, Ghana and Malaysia have taken first steps to align their national governance frameworks or traceability systems with the EUDR requirements (Table 1). However, improved traceability might also facilitate market segregation (Weber, 2025).

A comparable trend of changing domestic governance in anticipation of better EU market access and eased compliance has been evident in the case of Voluntary Partnership Agreements (VPAs) under the EU Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan. Through VPAs, the EU aimed to improve the regulatory capacity of timber-exporting countries to enforce their own domestic laws, and Ghana and Cameroon entered VPA negotiations to not lose EU market access (Carodenuto et al., 2024). This demonstrates that producer countries can be willing to change their forest governance to not lose market access. However, VPA-signing countries reduced the share of timber exports to the EU and redirected trade to other markets, with little impact on reducing forest loss (Abman, Jenkins, & Lundberg, 2026).

The EU's attempt to export its rules and standards may be perceived as neocolonial and met with domestic opposition, like in the case of Cameroon's VPA, where the EU did not accept the national timber legality assurance systems (Carodenuto et al., 2024). In the context of the EUDR, Indonesia accused the EU of 'regulatory imperialism' (Berning & Sotirov, 2024), and Brazil criticised the complexity and costs of implementing the EUDR (Azevedo-Ramos & Murakami Lima, 2024). This indicates that the benchmarking system instead may risk fuelling supply-chain leakage (section 4.2.1) where producer countries disengage with EU markets. Again, the likelihood of this happening depends on the EU market share, as this determines the incentive for reducing the risk score to ease market access. If companies disengage from (perceived) high-risk regions, the impact could be especially detrimental to smallholders (Zhunusova et al., 2022).

Through partnerships and structured dialogues with producer countries, as envisioned in Article 30 of the EUDR, the EU and its member states can actively support national legal and governance reforms that enhance forest



governance and address underlying domestic factors of deforestation, including through the Team Europe Initiatives¹. Ultimately, the effectiveness of these international dialogues and partnerships will be shaped by their perceived legitimacy, sensitivity to local contexts, available financial resources, and the willingness of both EU and producer countries to engage in cooperation (Carodenuto et al., 2024; Polo Villanueva et al., 2023).

4 Synthesis: Where will the EUDR more likely reduce deforestation?

Our theory-driven, *ex-ante* evaluation suggests that the effectiveness of the EUDR will vary across commodity supply chains and countries, as the mechanism for the main market access pathway, as well as positive and negative spillovers, are conditional on factors which vary across contexts (producer regions and commodity supply chain structures). Table 1 summarizes the mechanisms, conditions and empirical examples illustrating these variations.

Focusing on the commodities and regions with particularly high deforestation risks in EU imports, as outlined in Figure 1, we summarize our findings on the likelihood of the EUDR reducing deforestation in Table 2. Overall, the EUDR is likely to have a substantial effect on cocoa and coffee-driven deforestation, particularly in West Africa. In these supply chains, the high EU market share reduces the risk for widespread market segregation – especially as the share of production on recently cleared land is relatively high and increasing. Moreover, the EUDR has already incentivized investments in better traceability systems (which may mitigate the risk for laundering, despite the large share of indirect sourcing), while the dominance of European-based multinationals in the global supply chains for these commodities increases the likelihood of a *de facto* Brussels effect. Both supply-chain and activity leakage is also expected to be limited, due to tariff escalation for coffee and cocoa products, and low potential for non-forest conversion in major producer countries.

At the other end of the spectrum, we have soy and beef from South America (particularly Brazil), where a low EU market share and a high share of existing compliant production mean market segregation is a more likely output, laundering risks are significant, and activity leakage risks are larger due to already rampant clearing on non-forest ecosystems. Additionally, there have already been pushes for EUDR-motivated policy weakening, and the prospects for a Brussels effect are low.

In between we have palm oil, where the EU market share is higher (especially for smaller producers with a substantial EU deforestation footprint, such as Papua New Guinea, Gabon and Honduras), the share of non-compliant production is expected to increase rapidly, and high transaction costs for segregating supply would increase the likelihood of a direct impact on deforestation. However, dominance of non-EU corporations and political opposition to the EUDR reduce chances for positive spillovers or a Brussels effect.

The fact that risks for leakage are lower in contexts where the potential for a direct EUDR effect is largest increases the chances that the EUDR will in fact have an impact on deforestation, in particular for coffee and cocoa (accounting for 45% of the total EU deforestation footprint in 2020-2022) and potentially also for palm oil (representing an additional 20%). As noted, a high EU market share for these commodities in major deforestation-

¹ See <https://zerodeforestationhub.eu/projects/overview/>



600 risk producer regions is a key factor, decreasing the risk for market segregation and increasing the likelihood of a Brussels effect (both de facto and de jure). Notably, over a third (36%) of the EU's total deforestation footprint for agricultural EUDR commodities in 2022 is from countries where exports account for over 80% of total demand, and the EU accounts for a quarter or more of total exports.

605 **Table 1. Potential EUDR underlying mechanisms, required conditions, and examples illustrating effects.**

Rows in blue refer to the main impact pathways, rows in red refer to negative spillovers, and rows in green refer to positive spillovers.

Arrow number (see Figure 2)	Mechanism	Conditions	Illustrative example
1	Conditional market access	- Robust traceability systems - Effective monitoring and enforcement of compliance across EU member states - EU market share relative to supply of EUDR-compliant production - Transaction costs for segregating supply	Cocoa, Côte d'Ivoire: For EUDR compliance, <i>Conseil du Café et Cacao</i> (regulatory body) introduced electronic cards to trace beans from farms to export ports, while guaranteeing floor prices (Myers, 2023). Cocoa, Ghana: Ghana Cocoa Board is developing a traceability system (Ghana Cocoa Board, n.d.). Coffee, Costa Rica: First EUDR-compliant coffee shipment sent to Italy, from georeferenced farms (UNDP, 2024).
2		- Low demand on alternative non-compliant markets to offset EU demand drop; price drop for non-compliant products reduces deforestation incentive (links to conditions for supply-chain leakage (point 9 below).	Cocoa, Côte d'Ivoire: Ivorian cocoa producers depend heavily on EU, which imported 60% of beans in 2019 (Renier et al., 2023) and have few attractive alternatives. This lowers incentives for new land clearing. EU export shares are exceptionally high for palm oil from Honduras (~70%) and Papua New Guinea (60-70%), and cocoa from Cameroon (~50%) (Fig.3), increasing likelihood of EUDR impacts.
3	Laundering	- Gaps in traceability and monitoring - EU market share (incentives for investing in traceability systems) - Degree of indirect sourcing - Concentration of EU imports	Timber, Brazil, Peru and Russia: Laundering into “compliant” supply chains through fraudulent documentation of the origin or fraudulent mixing – practices that have been documented for European (World Forest ID, n.d.), Peruvian (Global Witness, 2019), and Brazilian timber (Franca et al., 2023). Cocoa, West Africa: Cocoa from deforested land in Liberia is reportedly transported into Côte d'Ivoire and mixed with local certified produce (Africa Science News, 2024).



4	Market segregation	Low EU market share in combination with low costs associated with shifting supply to non-EU markets (low transaction costs / low stickiness of supply chains).	Cocoa, Ghana: The national cocoa traceability system may segment markets, sending “sustainable” EUDR-compliant cocoa to the EU and “conventional” cocoa to other markets (Weber, 2025) Palm oil, Indonesia: Producers shift supply to domestic markets (e.g., biodiesel, oleochemicals), supported by government policies promoting downstream processing and reduced export dependence (Benedict & Heilmayr, 2024). EU import restrictions on Indonesian palm oil have minimal impact on deforestation (-1.6%) due to market segregation (Busch et al., 2022).
5	Policy weakening of existing zero-deforestation policies	- Policy incoherence with existing (zero-deforestation) policies (e.g., cut-off dates) Interest groups that lobby for amendment of pre-existing policies and/or lack of advocacy coalitions in producer countries supporting forest conservation policy	Soy in Brazil: Some Brazilian actors propose revising the Amazon Soy Moratorium to align it with the EUDR, weakening the former by a) changing the cut-off date from 2008 to 2020 and b) assessing compliance at plot-, rather than farm-level (Oliveira et al., 2024). Peru’s amendment of Forest and Wildlife Law: In response to the EUDR, Peru amended a 2022 bill to facilitate land-tenure formalization by reclassifying informally occupied Amazonian forest lands as agricultural, effectively legalising past deforestation (Peña Alegria, 2024).
6	Leakage through commodity-shifting	Displacement of production - Mobile production factors or inputs (labour and capital) - Suitable biophysical and infrastructural conditions for producing non-targeted FRCs Price effect - Higher rent for producing non-targeted commodities compared to targeted commodities - Suitable biophysical and infrastructural conditions for producing non-targeted FRCs	Cocoa, West Africa: Farmers grow EUDR-compliant cocoa on ‘old’ cleared land, while shifting food crops to protected forests to maintain food security (Addoah et al., 2025; Renier et al., 2025). Rice, maize, and cassava production may shift to newly deforested areas as EU-demanded commodities are grown on compliant land, with non-EUDR crops driving additional deforestation (Fuchs et al., 2024).
7	Supply chain leakage – product categories	- Availability of product categories not covered by the EUDR, but potentially containing FRCs - For highly-processed products: Value upgrading outside EU	Coffee: Instant coffee entailing FRCs entering EU as processed food (soluble coffee is not subject to the EUDR). Leather: About two-thirds of deforestation embodied in EU imports of leather products comes from tanned hides, covered by the EUDR, and the remaining one-third from consumer



			products, excluded from the EUDR; suggesting trade may shift toward consumer products (Laroche et al., 2024).
8	Activity leakage	- Mobile production factors or inputs (labour and capital) - Availability and accessibility of land - Suitable biophysical and infrastructural production conditions - Unfavourable conditions for intensification of agricultural production on compliant land already under cultivation	Soy, Brazil: Expansion of soybean production from the Amazon to the Cerrado, driven by mobile capital and labor, favorable conditions for soy cultivation, and higher rent for soy compared to forest conservation (Alix-Garcia & Gibbs, 2017; le Polain de Waroux et al., 2017). Indonesia: Evidence of significant leakage also exist for Indonesia's forest moratorium (Leijten, Sim, King, & Verburg, 2021).
9	Regulatory diffusion via norms and ideas	- EU rules resonate with non-EU importing country and are perceived as legitimate or normatively superior - Transnational actors and domestic interest groups advocate for and support norm diffusion - Coalitions in government in support of policy change	Cocoa, palm oil, soy and cattle, United Kingdom (UK): The UK is developing a Forest Risk Commodity regime under the Environment Act 2021, but secondary legislation to operationalize these requirements has been delayed, and the law focuses only on illegal deforestation (Barclay, 2023). UK-based retailers and timber traders are calling for aligning with EU regulations (Retail Soy Group, 2024). Côte d'Ivoire: Civil society organizations expressed support for the traceability requirement in the EUDR draft, indicating that domestic interest groups advocate for and support EU sustainability standards (Zei, Doumbia, & Traore, 2022).
10		- Coalitions in government in support of policy change - Interest groups who translate norms into concrete laws and policies	
11	De facto Brussels effect	- Multinational companies have a high level of exposure to the EU market - These companies operate supply chains across multiple jurisdictions with divergent regulatory requirements - Compliance and segregation costs associated with maintaining different standards for different markets are high - Companies adopt stricter regulatory standards (e.g. those of the EU) across their global operations	Natural rubber, Ivory Coast, Ghana, Nigeria, Liberia, Indonesia, and Thailand: Despite the decisions to delay the EUDR, Michelin Group decided to apply the EUDR as initially planned, starting January 2025, to all-natural rubber used in its tires and products, not only in Europe but worldwide (Michelin, 2024). Soy, Argentina: After the adoption of the EUDR, about half of all soy producers (~30.000), members of the Visión Sectorial del Gran Chaco Argentino (VISEC), aligned with the EUDR and committed to supplying deforestation-free soy to Europe and important Asian markets, mainly to avoid costs for new segregation silos and plants (TFA, 2024).



12	De jure Brussels effect	- Governments' receptiveness to corporate lobbying - Availability of institutional channels through which interest groups can lobby for their preferences - In producer countries: High EU market share (or prospects to increase it) and advocacy coalitions supporting policy change	Coffee, rubber, cocoa, Vietnam: The country stands out as a strong example of how the EUDR reinforces national deforestation policies, shifting focus from illegal logging to broader deforestation risks in agriculture. In 2024, it launched a traceability system for coffee, with plans to expand to cocoa and rubber (Li, Carter, Schneider, Labaste, & Campbell, 2025). Rubber, Thailand: Thailand's government supports rubber producers in complying with the EUDR by mapping production areas and collecting geolocation data, mitigating risks of market exclusion (European Forest Institute, 2024). Additionally, Thailand is drafting a mandatory HREDD law (Business & Human Rights Resource Centre, 2025), reflecting its effort to remain competitive and align with international standards, even if not directly driven by the EUDR. Soy and beef, Brazil: The Agro Brasil + Sustentável Platform has been launched to improve traceability of products like soy and beef. Although still in development, it could align it with the EUDR. At the state level, the public platform SeloVerde compiles data from state and federal agencies to enhance transparency and traceability of agricultural supply chains (Li, Schneider, Labaste, Campbell, & de Vries, 2025). Palm oil, Indonesia: Private palm oil producers have used the EUDR to encourage the government to improve their management of smallholder in value chains. They are collaborating on a national dashboard covering mills, companies, and smallholders, alongside a government programme to help smallholders comply with the EUDR. Producers have also urged the government to mandate that at least 10%-20% of commodities to European markets come from smallholders (TFA, 2024). Palm oil, Malaysia: The government has taken steps to align its palm oil sustainability standard, the Malaysian Sustainable Palm Oil (MSPO), with the EUDR. In 2025, it also launched MSNR Trase, a digital system to trace natural rubber from plantations to end products
----	-------------------------	--	---



			and support EUDR compliance (Li, Schneider, et al., 2025).
--	--	--	--

Table 2: Likelihood of the EUDR for reducing deforestation across different commodities and countries, distinguishing supporting (+) and constraining factors (-)

	Commodities & countries	Explanation
Higher	Cocoa, West Africa	+ High and stable EU market share; historically rapidly increasing share of production on deforested land + Ghana and Côte d'Ivoire are investing in EUDR compliant traceability systems + Potential for intensification, and low risk for activity leakage into non-forest ecosystems (Ghana and Côte d'Ivoire) + High market concentration of EU-based companies - High degree of indirect sourcing
	Coffee, West Africa	+ High and stable EU market share; historically rapidly increasing share of production on deforested land + Relatively high costs of segregating compliant and non-compliant production + High market concentration of EU-based companies - Prevalence of indirect sourcing
Medium	Palm oil, Southeast Asia	+ Relatively high, and stable EU market share; historically rapidly increasing share of production on deforested land + Already existing traceability systems (e.g., for certified products), though mixing is a problem + Large material flows, costly to reroute + Moderate degree of indirect sourcing ± Relatively high transaction costs for segregating supply, but already happening ± Moderate potential for intensification - High market concentration, but not to EU-based companies
	Rubber, West Africa	± Relatively high, but somewhat decreasing EU market share; historically rapidly increasing share of production on deforested land + One of the world's largest buyers of natural rubber, Michelin, committed to apply the EUDR to its rubber products not only in Europe but worldwide
Lower	Cattle, Brazil	- Very low and decreasing EU market share - High share of production on not recently deforested land - Very high degree of indirect sourcing, means large risks for both market segregation and laundering. - Laundering practices already prevalent - High market concentration, but not to EU-based companies - Already extensive expansion on non-forest land (e.g., Cerrado) - Risk of supply chain leakage for highly-processed or not-covered leather products



	Soy, Brazil	+ Already existing traceability systems (e.g., for certified products), though mixing is a problem + Relatively high transaction costs for segregating supply, but already happening + Large material flows, costly to reroute – Relatively high, but decreasing EU market share – Extensive production on not recently deforested land – Given that the EUDR is weaker than the pre-existing ASM makes additional impacts of the EUDR unlikely. – Risks of activity leakage to the Cerrado exist, as much of this biome is not covered by the EUDR. – Instead of the EUDR raising the bar, it risks lowering it (dismantling or weakening of the ASM); main consumer, China, is unlikely to follow EU's path
--	----------------	--

5 Conclusion

Although a well-implemented EUDR might become effective in promoting deforestation-free EU supply chains, its design cannot fully and consistently mitigate the risk that forest-risk commodities are continuously produced and supplied for non-EU markets, especially where EU market shares are low and/or declining. Therefore, the

615 EUDR may become effective in reducing deforestation associated with EU consumption and trade. However, this may not translate into significant net reductions in overall deforestation, carbon emissions, or biodiversity loss at the global level. That is partly because the commodities responsible for the largest share of global deforestation, such as cattle (beef and leather), as well as staple crops not covered by the EUDR, are linked to a relatively small and declining EU market shares.

620 Nevertheless, this rather bleak prospect on the EUDR's aggregate impacts at the global scale should not obscure the likely substantial heterogeneity in its effects across countries and commodities, which points to specific contexts in which the regulation would be more effective in curbing deforestation. Rather than evaluating the EUDR only in absolute terms, we emphasize the importance of identifying where it is relatively more effective,

625 such as in producer countries where the EU represents a key export market, risks of market segregation are low, and incentives to strengthen public and private supply chain governance are consequently higher. Overall, we expect the EUDR's potential to reduce deforestation to be greatest for cocoa and coffee from West Africa, followed by moderate reductions for palm oil from Southeast Asia and rubber from West Africa, while its leverage is expected to be lowest for cattle and soy from Brazil and most other Latin American countries.

630 Recognizing that the EU cannot effectively address global deforestation alone implies that evaluating the EUDR solely against global deforestation rates may set an unrealistic standard. This shifts the focus towards the positive indirect effects the regulation could possibly come to have. Beyond its direct role in "cleaning up" EU supply chains, the EUDR may have broader influence on forest and supply-chain governance among multinational

635 companies and non-EU countries. Policy diffusion across multiple export and domestic markets, whereby other countries and companies emulate the EU's standards (Brussels effect), and/or further develop their own and stronger standards, would be critical. For the majority of the six analysed commodities, the EU's share of global demand is relatively small and declining, making it essential for the EU to collaborate with producer countries and other consumer countries to reduce deforestation.



640

While we have focused on the EUDR's potential effects on deforestation in this study, more research is required to investigate the EUDR's effects on forest degradation. Moreover, our study does not address issues around legal compliance with national laws in producer countries, which is difficult to monitor and verify in practice – not the least because of complex national land tenure systems. This remains an important avenue for future research, given known synergies and trade-offs between the EUDR and existing public and private regulations (Ziegert et al. 2025).

650

Although we have not discussed the politics and power dynamics underlying the EUDR (Berning & Sotirov, 2024), we acknowledge that the EUDR bears power dynamics that should also be critically scrutinized as an instrument of extraterritorial control, and as a driver of power consolidation benefitting large-scale agribusiness and plantation economies that may be better equipped to provide commodity geolocation data than disadvantaged small-scale producers. Comprehensive sustainability assessments of the EUDR will thus also need to investigate the potential socio-economic effects of the EUDR, such as the risk of excluding smallholders from supply chains (Ayompe et al., 2024; Zhunusova et al., 2022), as well as benefits, such as strengthening cooperative support systems (Moluh Njoya et al., 2025). Future case studies will be important for assessing the EUDR's likely future effectiveness, extending beyond better-studied contexts like Brazil to understudied ones, such as rubber production in West Africa. Our analysis provides a basis for future research to examine how the identified impact pathways and spillovers unfold after EUDR implementation and align with stakeholders' experiences.

Data availability

660

The data supporting the findings of this study are provided as supplementary material accompanying this article.

Author contributions

665

Conceptualization: J.C., U.M.P.; investigation: J.C., U.M.P. (lead), A.A., M.B.L., L.B., T.K., D.S., M.S., S.W. (contributing); data curation: U.M.P.; formal analysis, J.C., U.M.P.; visualization: J.C. & U.M.P. (lead), D.S. & S.W. (contributing); methodology: J.C., U.M.P.; writing – original draft: J.C., U.M.P.; writing – editing: J.C., U.M.P., A.A., M.B.L., L.B., T.K., D.S., M.S., S.W.

Competing interests

The authors declare that they have no conflict of interest.

Acknowledgements

670

This work was funded by the Belmont Forum project 'Building an evidence-base for deforestation-free landscapes: supporting equitable outcomes in and beyond commodity supply-chains (BEDROCK), funded through the Swedish Research Council for Sustainable Development (Formas, grant no. 2022-02563) (U.M.P., M.B.L.), Research Council Norway (RCN, grant no. 343013) (A.A.), and German Research Foundation (DFG, grant no. KA 4815/2-1) (T.K.). D.S., L.B., M.S., and S.W. acknowledge funding from the European Research Executive Agency under HORIZON Research and Innovation Actions (grant no.101060765; CLEVER project); T.K. and



675 U.M.P from the German Federal Ministry for Economic Cooperation and Development (grant no. GS22 E1070-0060/029); and J.C. from the Programme to Promote the Internationalization of Female Early Career Researchers of Leuphana University Lüneburg, and the Wallenberg Foundation under the project ‘Corporate Accountability in Global Supply Chains’ (grant no. MMW 2023-0060).

680

References

- Abman, R., Jenkins, H., & Lundberg, C. (2026). The limits of cross-border environmental policies: Trade diversion as leakage. *Journal of Environmental Economics and Management*, 137, 103298. <https://doi.org/10.1016/j.jeem.2026.103298>
- 685 Addoah, T., Lyons-White, J., Cammelli, F., Kouakou, K. M. P., Carodenuto, S., Thompson, W. J., ... Garrett, R. D. (2025). Is the Implementation of Cocoa Companies’ Forest Policies on Track to Effectively and Equitably Address Deforestation in West Africa? *Sustainable Development*. <https://doi.org/10.1002/sd.3380>
- Africa Science News. (2024). *Cocoa beans from Côte d’Ivoire to the EU depleting forested land in neighboring Liberia*. Retrieved from <https://africasciencenews.org/cocoa-beans-from-cote-divoire-to-the-eu-depleting-forested-land-in-neighboring-liberia/>
- 690 Alix-Garcia, J., & Gibbs, H. K. (2017). Forest conservation effects of Brazil’s zero deforestation cattle agreements undermined by leakage. *Global Environmental Change*, 47, 201–217. <https://doi.org/10.1016/j.gloenvcha.2017.08.009>
- Angelsen, A. (2010). Policies for reduced deforestation and their impact on agricultural production. *Proceedings of the National Academy of Sciences of the United States of America*, 107(46), 19639–19644. <https://doi.org/10.1073/pnas.0912014107>
- Ayompe, L. M., Nkongho, R. N., Wandum, L. M., Orang, B. O., Fiaboe, K. K. M., Tambasi, E. E., ... Egoh, B. N. (2024). Complexities of sustainable palm oil production by smallholders in sub-Saharan Africa. *Sustainable Development*, 32(1), 529–541. <https://doi.org/10.1002/sd.2674>
- 700 Azevedo-Ramos, C., & Murakami Lima, R. Y. (2024). Brazil’s mixed reactions to the EU deforestation-free regulation: Balancing compliance costs and the urgency of deforestation action. *One Earth*, 7(11), 1917–1922. <https://doi.org/10.1016/j.oneear.2024.10.014>
- Bäckstrand, K., & Elgström, O. (2013). The EU’s role in climate change negotiations: From leader to “ladiator.” *Journal of European Public Policy*, 20(10), 1369–1386. <https://doi.org/10.1080/13501763.2013.781781>
- 705 Barclay, S. (2023). Introduction of Forest Risk Commodities regulations. Retrieved January 29, 2026, from <https://questions-statements.parliament.uk/written-statements/detail/2023-12-12/hcws117>
- Bastos Lima, M. G., Persson, U. M., & Meyfroidt, P. (2019). Leakage and boosting effects in environmental governance: A framework for analysis. *Environmental Research Letters*, 14(10). <https://doi.org/10.1088/1748-9326/ab4551>
- 710 Bastos Lima, M. G., & Schilling-Vacaflor, A. (2024). Supply chain divergence challenges a ‘Brussels effect’ from Europe’s human rights and environmental due diligence laws. *Global Policy*, 15(2), 260–275. <https://doi.org/10.1111/1758-5899.13326>
- Bauer, M. W., & Knill, C. (2013). Understanding Policy Dismantling: An Analytical Framework. In *Dismantling Public Policy: Preferences, Strategies, and Effects*. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780199656646.003.0002>
- 715



- BellaTerra. (2025). *Insights on EU Deforestation Regulation (EUDR) Requirements for Trade Flows Linked to China*. Retrieved from https://www.fern.org/fileadmin/uploads/fern/Documents/2025/Insights_on_EU_Deforestation_Regulation_EUDR_Requirements_for_Trade_Flows_Linked_to_China.pdf
- 720 Benedict, J. J., & Heilmayr, R. (2024). *Indonesian palm oil exports and deforestation*. Retrieved from <https://trase.earth/insights/indonesian-palm-oil-exports-and-deforestation>
- Berning, L., Garrett, R. D., & Sotirov, M. (2026). How Does the European Union's Pluralistic Institutional System Influence Policy Change? The Case of the European Union Regulation on Deforestation-Free Products. *Sustainable Development*, 34(S1), 1362–1378. <https://doi.org/10.1002/sd.70236>
- 725 Berning, L., & Sotirov, M. (2023). Hardening corporate accountability in commodity supply chains under the European Union Deforestation Regulation. *Regulation & Governance*, 17(4), 870–890. <https://doi.org/10.1111/rego.12540>
- Berning, L., & Sotirov, M. (2024). The coalitional politics of the European Union Regulation on deforestation-free products. *Forest Policy and Economics*, 158, 103102. <https://doi.org/10.1016/j.forpol.2023.103102>
- 730 Blum, P., Engert, M., & Strunz, B. (2024). Kampf gegen Entwaldung droht zu scheitern. Retrieved March 6, 2024, from <https://www.tagesschau.de/investigativ/ndr-wdr/holz-mafia-eu-100.html>
- Börzel, T. A., & Risse, T. (2012). From Europeanisation to Diffusion: Introduction. *West European Politics*, 35(1), 1–19. <https://doi.org/10.1080/01402382.2012.631310>
- Bradford, A. (2015). Exporting standards: The externalization of the EU's regulatory power via markets. *International Review of Law and Economics*, 42(3), 158–173. <https://doi.org/10.1016/j.irl.2014.09.004>
- 735 Bradford, A. (2020). *The Brussels Effect: How the European Union Rules the World*. New York: Oxford University Press.
- Busch, J., Amarjargal, O., Taheripour, F., Austin, K. G., Siregar, R. N., Koenig, K., & Hertel, T. W. (2022). Effects of demand-side restrictions on high-deforestation palm oil in Europe on deforestation and emissions in
- 740 Indonesia. *Environmental Research Letters*, 17(1), 014035. <https://doi.org/10.1088/1748-9326/ac435e>
- Business & Human Rights Resource Centre. (2025). *Thailand: Govt. to introduce mandatory human rights and environmental due diligence legislation aiming to push for responsible business practices*. Retrieved from <https://www.business-humanrights.org/en/latest-news/thailand-govt-to-mandatory-human-rights-and-environmental-due-diligence-legislation-aiming-to-push-for-responsible-business-practices/>
- 745 Cammelli, F., Levy, S. A., Grabs, J., Valentim, J. F., & Garrett, R. D. (2022). Effectiveness-equity tradeoffs in enforcing exclusionary supply chain policies: Lessons from the Amazonian cattle sector. *Journal of Cleaner Production*, 332, 130031. <https://doi.org/10.1016/j.jclepro.2021.130031>
- Carodenuto, S., Ziga-Abortta, F. R., & Sotirov, M. (2024). External Europeanization through timber trade agreements: Tracing causality in environmental governance reform. *Political Geography*, 109, 103065. <https://doi.org/10.1016/j.polgeo.2024.103065>
- 750 Cesar de Oliveira, S. E. M., Nakagawa, L., Lopes, G. R., Visentin, J. C., Couto, M., Silva, D. E., ... West, C. (2024). The European Union and United Kingdom's deforestation-free supply chains regulations: Implications for Brazil. *Ecological Economics*, 217, 108053. <https://doi.org/10.1016/j.ecolecon.2023.108053>



- 755 Coenen, J., Sonderegger, G., Newig, J., Meyfroidt, P., Challies, E., Bager, S., ... Zaehring, J. (2023). Toward spatial fit in the governance of global commodity flows. *Ecology and Society*, 28(2), art24. <https://doi.org/10.5751/ES-14133-280224>
- de la Vega, P. (2026). The European Union deforestation regulation: The impact on Argentina. *Ecological Economics*, 240, 108836. <https://doi.org/10.1016/j.ecolecon.2025.108836>
- 760 Environmental Investigation Agency. (2021). *The Italian Job. How Myanmar timber is trafficked through Italy to the rest of Europe despite EU laws*. Retrieved from <https://eia-international.org/wp-content/uploads/The-Italian-Job-2021-SPREADS.pdf>
- European Commission. (2021). *IMPACT ASSESSMENT minimising the risk of deforestation and forest degradation associated with products placed on the EU market*. Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021SC0326&qid=1727163336725>
- 765 European Forest Institute. (2024). *Thailand's natural rubber producers are preparing for new market requirements*. Retrieved from <https://efi.int/sites/default/files/files/publication-bank/2024/Briefing%20-%20Thailand%E2%80%99s%20natural%20rubber%20producers%20are%20preparing%20for%20new%20market%20requirements.pdf>
- 770 European Parliament. (2025). Deforestation law: Parliament adopts changes to postpone and simplify measures. Retrieved December 19, 2025, from <https://www.europarl.europa.eu/news/en/press-room/20251211IPR32168/deforestation-law-parliament-adopts-changes-to-postpone-and-simplify-measures>
- FERN. (2024). *Transformative traceability: How robust traceability systems can help implement the EUDR and fight the drivers of deforestation*. Retrieved from https://www.fern.org/fileadmin/uploads/fern/Documents/2024/Transformative_traceability_How_robust_traceability_systems_can_help_implement_the_EUDR_and_fight_the_drivers_of_deforestation.pdf
- 775 Folke, C., Österblom, H., Jouffray, J., Lambin, E. F., Adger, W. N., Scheffer, M., ... de Zeeuw, A. (2019). Transnational corporations and the challenge of biosphere stewardship. *Nature Ecology & Evolution*, 3(10), 1396–1403. <https://doi.org/10.1038/s41559-019-0978-z>
- 780 Franca, C. S. S., Persson, U. M., Carvalho, T., & Lentini, M. (2023). Quantifying timber illegality risk in the Brazilian forest frontier. *Nature Sustainability*, 6(11), 1485–1495. <https://doi.org/10.1038/s41893-023-01189-3>
- Fuchs, R., Raymond, J., Winkler, K., & Rounsevell, M. (2024). The EU's new anti-deforestation law has severe 785 loopholes that could be exploited by the forthcoming EU-MERCOSUR trade agreement. *Environmental Research Letters*, 19(9). <https://doi.org/10.1088/1748-9326/ad69ab>
- Gardner, T. A., Benzie, M., Börner, J., Dawkins, E., Fick, S., Garrett, R., ... Wolvekamp, P. (2019). Transparency and sustainability in global commodity supply chains. *World Development*, 121, 163–177. <https://doi.org/10.1016/j.worlddev.2018.05.025>
- 790 Garrett, R. D., Levy, S., Carlson, K. M., Gardner, T. A., Godar, J., Clapp, J., ... Villoria, N. (2019). Criteria for effective zero-deforestation commitments. *Global Environmental Change*, 54, 135–147. <https://doi.org/10.1016/j.gloenvcha.2018.11.003>
- Gassler, B., & Spiller, A. (2018). Is it all in the MIX? Consumer preferences for segregated and mass balance certified sustainable palm oil. *Journal of Cleaner Production*, 195(1169), 21–31. 795 <https://doi.org/10.1016/j.jclepro.2018.05.039>



- Ghana Cocoa Board. (n.d.). Cocoa Farmers Embrace Ghana Cocoa Traceability System (GCTS). Retrieved May 21, 2025, from <https://cocobod.gh/news/cocoa-farmers-embrace-ghana-cocoa-traceability-system-gcts>
- Gibbs, H. K., Rausch, L., Munger, J., Schelly, I., Morton, D. C., Noojipady, P., ... Walker, N. F. (2015). Brazil's soy moratorium. *Science*, 347(6220), 377–378. <https://doi.org/10.1126/science.aaa0181>
- 800 Global Witness. (2019). New analysis shows illegal logging of the Peruvian Amazon is continuing at a rapid pace. Retrieved June 17, 2025, from <https://globalwitness.org/en/press-releases/new-analysis-shows-illegal-logging-of-the-peruvian-amazon-is-continuing-at-a-rapid-pace/>
- Grabs, J. (2025). The Construction of Compliance with the European Union Deforestation Regulation in Global Coffee Value Chains. *Regulation and Governance*. <https://doi.org/10.1111/rego.70103>
- 805 Gustafsson, M.-T., Schilling-Vacaflor, A., & Lenschow, A. (2022). Foreign corporate accountability: The contested institutionalization of mandatory due diligence in France and Germany. *Regulation & Governance*. <https://doi.org/10.1111/rego.12498>
- Gustafsson, M.-T., Schilling-Vacaflor, A., & Pahl-Wostl, C. (2024). Governing transnational water and climate risks in global supply chains. *Earth System Governance*, 21, 100217.
- 810 <https://doi.org/10.1016/j.esg.2024.100217>
- Heilmayr, R., Rausch, L. L., Munger, J., & Gibbs, H. K. (2020). Brazil's Amazon Soy Moratorium reduced deforestation. *Nature Food*, 1(12), 801–810. <https://doi.org/10.1038/s43016-020-00194-5>
- Henn, E. V. (2021). Protecting forests or saving trees? The EU's regulatory approach to global deforestation. *Review of European, Comparative & International Environmental Law*, 30(3), 336–348.
- 815 <https://doi.org/10.1111/reel.12413>
- IPCC. (2019). Summary for Policymakers. In P. R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, ... J. Malley (Eds.), *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems* (pp. 1–36). Cambridge University Press.
- 820 <https://doi.org/10.1017/9781009157988.001>
- Jayathilake, H. M., Prescott, G. W., Carrasco, L. R., Rao, M., & Symes, W. S. (2021). Drivers of deforestation and degradation for 28 tropical conservation landscapes. *Ambio*, 50(1), 215–228. <https://doi.org/10.1007/s13280-020-01325-9>
- 825 Kan, S., Levy, S. A., Mazur, E., Samberg, L., Persson, U. M., Sloat, L., ... Kastner, T. (2026). Overlooked and overexploited: Extensive conversion of grassland and wetland driven by global food, feed, and bioenergy demand. *Proceedings of the National Academy of Sciences*, 123(9), e2521183123. <https://doi.org/10.1073/pnas.2521183123>
- Kan, S., Meng, J., Persson, U. M., Chen, B., Levy, S. A., Mazur, E., ... Kastner, T. (2025). Identifying global hotspots of agricultural expansion into non-forest ecosystems. *Nature Communications*, 16(1), 10739.
- 830 <https://doi.org/10.1038/s41467-025-65769-x>
- Kelemen, R. D. (2010). Globalizing European Union environmental policy. *Journal of European Public Policy*, 17(3), 335–349. <https://doi.org/10.1080/13501761003662065>
- Köthke, M., & Sotirov, M. (2024). How and Why Do Economic Operators Comply With EU Law? Analysis of Firm-Level Responses to the EU Timber Regulation in Germany. *JCMS: Journal of Common Market Studies*, 62(6), 1594–1614. <https://doi.org/10.1111/jcms.13585>
- 835



- Lambin, E. F., & Furumo, P. R. (2023). Deforestation-Free Commodity Supply Chains: Myth or Reality? *Annual Review of Environment and Resources*, 48(1). <https://doi.org/10.1146/annurev-environ-112321-121436>
- Laroche, P. C. S. J., Gómez-Suárez, M., Persson, U. M., Pendrill, F., Schwarzmüller, F., Schulp, C. J. E., & Kastner, T. (2024). Accounting for trade in derived products when estimating European Union's role in driving deforestation. *Ecological Economics*, 224, 108288. <https://doi.org/10.1016/j.ecolecon.2024.108288>
- 840 Lathuillière, M. J., Suavet, C., Biddle, H., Su, N., Prada Moro, Y., Carvalho, T., & Ribeiro, V. (2022). *Brazil soy supply chain (2004-2020) (Version 2.6) [Data set]*. Trase. <https://doi.org/10.48650/DCE3-JJ97>
- Lavenex, S. (2014). The power of functionalist extension: how EU rules travel. *Journal of European Public Policy*, 21(6), 885–903. <https://doi.org/10.1080/13501763.2014.910818>
- 845 le Polain de Waroux, Y., Garrett, R. D., Graesser, J., Nolte, C., White, C., & Lambin, E. F. (2017). The Restructuring of South American Soy and Beef Production and Trade Under Changing Environmental Regulations. *World Development*. <https://doi.org/10.1016/j.worlddev.2017.05.034>
- Leijten, F., dos Reis, T. N. P., Sim, S., Verburg, P. H., & Meyfroidt, P. (2022). The influence of company sourcing patterns on the adoption and effectiveness of zero-deforestation commitments in Brazil's soy supply chain. *Environmental Science & Policy*, 128, 208–215. <https://doi.org/10.1016/j.envsci.2021.10.032>
- 850 Leijten, F., Sim, S., King, H., & Verburg, P. H. (2021). Local deforestation spillovers induced by forest moratoria: Evidence from Indonesia. *Land Use Policy*, 109, 105690. <https://doi.org/10.1016/j.landusepol.2021.105690>
- Li, B., Carter, S., Schneider, T., Labaste, S., & Campbell, O. (2025). *What Is the EU Deforestation Regulation? 8 Key Questions, Answered*. Retrieved from <https://www.wri.org/insights/explain-eu-deforestation-regulation>
- 855 Li, B., Schneider, T., Labaste, S., Campbell, O., & de Vries, J. (2025). Compliance with the EU Deforestation Regulation Is Feasible, Underway — and Must Go On. Retrieved January 29, 2026, from <https://forestpolicy.org/article/compliance-eu-deforestation-regulation-feasible-underway-and-must-go>
- Mason, P., & Barnes, M. (2007). Constructing Theories of Change: Methods and Sources. *Evaluation*, 13(2), 151–170. <https://doi.org/10.1177/1356389007075221>
- 860 McDermott, C. L., Addoah, T., Agyarko-Kwarteng, T., Asare, R., Assanvo, A., Lima, M. B., ... Winkel, G. (2025). Equity in unilateral value chain policies: A monitoring framework for the EUDR and beyond. *Forest Policy and Economics*, 174, 103469. <https://doi.org/10.1016/j.forpol.2025.103469>
- McDermott, C. L., & Sotirov, M. (2018). A political economy of the European Union's timber regulation: Which member states would, should or could support and implement EU rules on the import of illegal wood? *Forest Policy and Economics*, 90, 180–190. <https://doi.org/10.1016/j.forpol.2017.12.015>
- 865 Meyfroidt, P., Börner, J., Garrett, R., Gardner, T., Godar, J., Kis-Katos, K., ... Wunder, S. (2020). Focus on leakage and spillovers: informing land-use governance in a tele-coupled world. *Environmental Research Letters*, 15(9), 090202. <https://doi.org/10.1088/1748-9326/ab7397>
- Meyfroidt, Patrick, Roy Chowdhury, R., de Bremond, A., Ellis, E. C., Erb, K. H., Filatova, T., ... Verburg, P. H. (2018). Middle-range theories of land system change. *Global Environmental Change*, 53, 52–67. <https://doi.org/https://doi.org/10.1016/j.gloenvcha.2018.08.006>
- 870 Michelin. (2024). Michelin has decided to apply the European regulation on imported deforestation (EUDR) in 2025, as initially planned. Retrieved January 29, 2026, from [https://natural-rubber.michelin.com/news-michelin-has-decided-to-apply-the-european-regulation-on-imported-deforestation-eudr-in-2025-as-](https://natural-rubber.michelin.com/news-michelin-has-decided-to-apply-the-european-regulation-on-imported-deforestation-eudr-in-2025-as-initially-planned)
- 875 initially-planned



- Moluh Njoya, H., Cristóbal Reyes, S., Hien, K. A., Ollendorf, F., Tokou, B. A., Adou Yao, C. Y., ... Löhr, K. (2025). Can cooperative membership foster compliance with New European Union regulations on deforestation-free production? Evidence from cocoa farmers in Western Côte d'Ivoire. *Trees, Forests and People*, 20, 100897. <https://doi.org/10.1016/j.tfp.2025.100897>
- 880 Muradian, R., Cahyafitri, R., Ferrando, T., Grottera, C., Jardim-Wanderley, L., Krause, T., ... Vela-Almeida, D. (2025). Will the EU deforestation-free products regulation (EUDR) reduce tropical forest loss? Insights from three producer countries. *Ecological Economics*, 227, 108389. <https://doi.org/10.1016/j.ecolecon.2024.108389>
- Myers, A. (2023). Cote d'Ivoire implements electronic payment cards for cocoa farmers. Retrieved June 10, 2025, from <https://www.confectionerynews.com/Article/2023/02/09/cote-d-ivoire-implements-electronic-payment-cards-for-cocoa-farmers/>
- Oberlack, C., Breu, T., Giger, M., Harari, N., Herweg, K., Mathez-Stiefel, S.-L., ... Schneider, F. (2019). Theories of change in sustainability science: Understanding how change happens. *GALA - Ecological Perspectives for Science and Society*, 28(2), 106–111. <https://doi.org/10.14512/gaia.28.2.8>
- 890 Oliveira, G. M., Ziegert, R. F., Pacheco, A., Berning, L., Sotirov, M., Dürr, J., ... Börner, J. (2024). Blind spots in the EU's Regulation on Deforestation-free products. *Nature Ecology & Evolution*, 8(8), 1382–1383. <https://doi.org/10.1038/s41559-024-02465-x>
- Panhuysen, S., & Pierrot, J. (2020). *Coffee Barometer 2020*. Retrieved from <https://hivos.org/assets/2021/01/Coffee-Barometer-2020.pdf>
- 895 Parker, C. F., & Karlsson, C. (2017). The European Union as a global climate leader: confronting aspiration with evidence. *International Environmental Agreements: Politics, Law and Economics*, 17(4), 445–461. <https://doi.org/10.1007/s10784-016-9327-8>
- Parra-Paitan, C., Erasmus, K. H. J., Meyfroidt, P., & Verburg, P. H. (2023). Large gaps in voluntary sustainability commitments covering the global cocoa trade. *Global Environmental Change*, 81(March), 102696. <https://doi.org/10.1016/j.gloenvcha.2023.102696>
- 900 Partzsch, L., Müller, L. M., & Sacherer, A.-K. (2023). Can supply chain laws prevent deforestation in the Democratic Republic of the Congo and Indonesia? *Forest Policy and Economics*, 148, 102903. <https://doi.org/10.1016/j.forpol.2022.102903>
- Pawson, R., & Tilley, N. (1997). *Realistic evaluation*. London: Sage.
- 905 Peña Alegría, P. G. (2024). (Mis)Adapting Domestic Law to Meet New International Environmental and Trade Rules: How Peru Changed Its Environmental and Land Use Rights Laws in Response to the European Union Deforestation Regulation. *Journal of Environmental Law*. <https://doi.org/10.1093/jel/eqae019>
- Polo Villanueva, F. D., Tegegne, Y. T., Winkel, G., Cerutti, P. O., Ramcilovic-Suominen, S., McDermott, C. L., ... Giessen, L. (2023). Effects of EU illegal logging policy on timber-supplying countries: A systematic review. *Journal of Environmental Management*, 327, 116874. <https://doi.org/10.1016/j.jenvman.2022.116874>
- 910 Ponte, S. (2022). The hidden costs of environmental upgrading in global value chains. *Review of International Political Economy*, 29(3), 818–843. <https://doi.org/10.1080/09692290.2020.1816199>
- Reis, T. N. P. dos, de Faria, V. G., Russo Lopes, G., Sparovek, G., West, C., Rajão, R., ... do Valle, R. S. T. (2021). Trading deforestation—why the legality of forest-risk commodities is insufficient. *Environmental Research Letters*, 16(12), 124025. <https://doi.org/10.1088/1748-9326/ac358d>
- 915



- Reis, T. N. P. dos, Meyfroidt, P., zu Ermgassen, E. K. H. J., West, C., Gardner, T., Bager, S., ... Godar, J. (2020). Understanding the Stickiness of Commodity Supply Chains Is Key to Improving Their Sustainability. *One Earth*, 3(1), 100–115. <https://doi.org/10.1016/j.oneear.2020.06.012>
- Reis, T. N. P. dos, Ribeiro, V., Garrett, R. D., Kuemmerle, T., Rufin, P., Guidotti, V., ... Meyfroidt, P. (2023). Explaining the stickiness of supply chain relations in the Brazilian soybean trade. *Global Environmental Change*, 78, 102633. <https://doi.org/10.1016/j.gloenvcha.2022.102633>
- Renier, C., Addoah, T., Guye, V., Garrett, R., Van Den Broeck, G., Zu Ermgassen, E. K. H. J., & Meyfroidt, P. (2025). Direct and indirect deforestation for cocoa in the tropical moist forests of Ghana. *Environmental Research: Food Systems*, 2(2), 025006. <https://doi.org/10.1088/2976-601X/add01b>
- Renier, C., Vandromme, M., Meyfroidt, P., Ribeiro, V., Kalischek, N., & Zu Ermgassen, E. K. H. J. (2023). Transparency, traceability and deforestation in the Ivorian cocoa supply chain. *Environmental Research Letters*, 18(2). <https://doi.org/10.1088/1748-9326/acad8e>
- Retail Soy Group. (2024). Letter to The Rt Hon Steve Reed MP. Retrieved May 21, 2025, from https://www.retailsoygroup.org/wp-content/uploads/2024/07/240725_Letter-to-Steve-Reed.pdf
- Richards, P. (2015). What Drives Indirect Land Use Change? How Brazil's Agriculture Sector Influences Frontier Deforestation. *Annals of the Association of American Geographers*, 105(5), 1026–1040. <https://doi.org/10.1080/00045608.2015.1060924>
- Risse, T. (2016). *Domestic Politics and Norm Diffusion in International Relations: Ideas do not float freely* (1st ed.). Routledge. <https://doi.org/10.4324/9781315623665>
- Schilling-Vacaflor, A., & Lenschow, A. (2021). Hardening foreign corporate accountability through mandatory due diligence in the European Union? New trends and persisting challenges. *Regulation & Governance*, 1–17. <https://doi.org/10.1111/rego.12402>
- Schulz, D., Coenen, J., Bastos Lima, M., Berning, L., Börner, J., Cramm, M., ... Wunder, S. (2026). Not an easy ride: Economic research priorities for pro-environmental trade regulation. *Forest Policy and Economics*, 192(103682). <https://doi.org/10.1016/j.forpol.2025.103682>
- Singh, C., & Persson, U. M. (2026). Global patterns of commodity-driven deforestation and associated carbon emissions. *Nature Food*, 7(2), 138–151. <https://doi.org/10.1038/s43016-026-01305-4>
- Singh, C., Persson, U. M., Croft, S., Kastner, T., & West, C. D. (2024). Commodity-driven deforestation, associated carbon emissions and trade 2001-2023 (2.1) [Data set]. <https://doi.org/10.5281/zenodo.4250531>
- Skidmore, M. E., Moffette, F., Rausch, L., Christie, M., Munger, J., & Gibbs, H. K. (2021). Cattle ranchers and deforestation in the Brazilian Amazon: Production, location, and policies. *Global Environmental Change*, 68, 102280. <https://doi.org/10.1016/j.gloenvcha.2021.102280>
- Sotirov, M., Pokorný, B., Kleinschmit, D., & Kanowski, P. (2020). International forest governance and policy: Institutional architecture and pathways of influence in global sustainability. *Sustainability*, 12(17). <https://doi.org/10.3390/su12177010>
- TFA. (2024). *How to make Europe's deforestation regulation work: Producer perspectives on three commodities from three continents Perspectives*. Retrieved from <https://weforum.ent.box.com/s/opf8tbpwqluwyhc9ysq4hpcdtwarozjl>
- UNDP. (2024). *Costa Rica exports first batch of deforestation-free coffee*. Retrieved from <https://climatepromise.undp.org/news-and-stories/costa-rica-exports-first-batch-deforestation-free-coffee>
- United Nations. (2025). UN Comtrade Database. Retrieved January 29, 2026, from <https://comtradeplus.un.org/>



- van Grinsven, A., van den Toorn, E., van der Veen, R., & Kampman, B. (2020). *Used Cooking Oil (UCO) as biofuel feedstock in the EU*. Delft. Retrieved from https://cedelft.eu/wp-content/uploads/sites/2/2021/04/CE_Delft_200247_UCO_as_biofuel_feedstock_in_EU_FINAL-v5.pdf
- 960 Vasconcelos, A. A., Bastos Lima, M. G., Gardner, T. A., & McDermott, C. L. (2024). Prospects and challenges for policy convergence between the EU and China to address imported deforestation. *Forest Policy and Economics*, 162, 103183. <https://doi.org/10.1016/j.forpol.2024.103183>
- Villoria, N., Garrett, R., Gollnow, F., & Carlson, K. (2022). Leakage does not fully offset soy supply-chain efforts to reduce deforestation in Brazil. *Nature Communications*, 13(1). [https://doi.org/10.1038/s41467-022-](https://doi.org/10.1038/s41467-022-33213-z)
- 965 33213-z
- Vogel, D. (2009). *Trading up: Consumer and environmental regulation in a global economy*. Cambridge, Mass.: Harvard University Press.
- Vogler, J., & Stephan, H. R. (2007). The European Union in global environmental governance: Leadership in the making? *International Environmental Agreements: Politics, Law and Economics*, 7(4), 389–413.
- 970 <https://doi.org/10.1007/s10784-007-9051-5>
- Voorra, V., Bermúdez, S., Farrell, J. J., Larrea, C., & Luna, E. (2023). *Global market report. Palm oil prices and sustainability*. Retrieved from <https://www.iisd.org/system/files/2023-06/2023-global-market-report-palm-oil.pdf>
- Weber, K. (2025). Environmental Supply Chain Regulations in a Changing Market Environment: Exploring the EU's Regulatory Power in the Cocoa Sector in Ghana. *JCMS: Journal of Common Market Studies*.
- 975 <https://doi.org/10.1111/jcms.70031>
- Wojcikiewicz Almeida, P., Ralile de Figueiredo Magalhães, G., da Cunha Vollers, L., & Furtado de Melo, V. (2025). *The Normative and Regulatory Challenges for the Implementation of the European Deforestation-Free Regulation in Third Affected Countries*. Cham: Springer Nature Switzerland.
- 980 <https://doi.org/10.1007/978-3-032-08458-3>
- World Forest ID. (n.d.). *Unlocking transparency, exposing material risk: Key findings from timber market study*. Retrieved from https://learn.worldforestid.org/wp-content/uploads/2025/04/WFID_InsightBriefing_April_2025_v10b-3.pdf
- Ze, P., Doumbia, Y., & Traore, B. (2022). *Support for the geolocation requirement in the draft EU regulation on deforestation free supply chains*. Retrieved from [https://ongidef.org/wp-content/uploads/2022/02/Lettre-](https://ongidef.org/wp-content/uploads/2022/02/Lettre-aux-membres-du-conseil-et-du-parlement-europeen_Finale.pdf)
- 985 [aux-membres-du-conseil-et-du-parlement-europeen_Finale.pdf](https://ongidef.org/wp-content/uploads/2022/02/Lettre-aux-membres-du-conseil-et-du-parlement-europeen_Finale.pdf)
- Zhunusova, E., Ahimbisibwe, V., Sen, L. T. H., Sadeghi, A., Toledo-Aceves, T., Kabwe, G., & Günter, S. (2022). Potential impacts of the proposed EU regulation on deforestation-free supply chains on smallholders, indigenous peoples, and local communities in producer countries outside the EU. *Forest Policy and Economics*, 143, 102817. <https://doi.org/10.1016/j.forpol.2022.102817>
- 990 Ziegert, R. F., Berning, L., Cramm, M., Wunder, S., Azevedo-Ramos, C., & Sotirov, M. (2025). Meshing or Clashing Gears? Design (In)Coherences Between the Regulation on Deforestation-Free Products and Third Country Environmental Regulations. *Environmental Policy and Governance*. <https://doi.org/10.1002/eet.70041>
- 995 Zinngrebe, Y., Berger, J., Bunn, C., Felipe-Lucia, M. R., Graßnick, N., Kastner, T., ... Lakner, S. (2024). Prioritizing partners and products for the sustainability of the EU's agri-food trade. *One Earth*, 7(4), 674–686. <https://doi.org/10.1016/j.oneear.2024.03.002>



- zu Ermgassen, E. K. H. J., Bastos Lima, M. G., Bellfield, H., Dontenville, A., Gardner, T., Godar, J., ... Meyfroidt, P. (2022). Addressing indirect sourcing in zero deforestation commodity supply chains. *Science Advances*, 8(17), 1–16. <https://doi.org/10.1126/sciadv.abn3132>
- 1000 zu Ermgassen, E. K. H. J., Suavet, C., Biddle, H., Su, N., Prada Moro, Y., Ribeiro, V., ... Lathuillière, M. J. (2023). *Brazil beef supply chain (2010-2020) (Version 2.2) [Data set]*. Trase. <https://doi.org/10.48650/AYAA-HH56>