The Likely Impacts of the EU Deforestation Regulation

Christopher L. Gilbert

Preliminary draft: 18 February 2024
This revision: 26 February 2024

Abstract

The EU Deforestation Regulation (EUDR) will introduce stringent due diligence requirements on the import of seven major tropical agricultural commodities into the EU with the objective of limiting deforestation in the producing countries. The greatest impact is likely to be in cocoa and coffee where Europe is responsible for a large share of world consumption; and in palm oil which has driven substantial deforestation. The commodity supply chains are complex. In particular, crop produced by smallholder farmers is aggregated prior to export. Tracking the deforestation status of these aggregated packets is a major and potentially costly undertaking. It is likely that this will involve some restructuring of supply chains, favouring large farms over smallholdings and international trading companies over nationally-based exporters. These developments are seen by some producing country governments as imperialistic. EUDR-compliant supplies will earn a premium and this will raise prices for European consumers. Producers who are able to comply will benefit from the premium but will bear the compliance cost. Overall there will be a net pecuniary loss. Deforestation benefits will only emerge as new planting takes place and will depend on whether other consuming countries introduce similar legislation.

SAIS Europe, Johns Hopkins University, via Beniamino Andreatta 3, 40126 Bologna, Italy.
Email: christopher.gilbert@jhu.edu

This paper has been prepared for the 2024 meeting of the Agricultural Economics Society, Edinburgh, 18-20 March 2024. It draws on analysis previously discussed in a workshop "Reshaping Eco-Social Paradigm towards Innovation and Sustainability" at the University of Shkodër, Albania, 7-8 November, 2023. I am grateful to Robin Dand for comments on the initial draft.

1. Introduction

The EU Deforestation Regulation (EUDR) is a regulation of the European Parliament enacted on 31 May 2023 (European Union, 2023). Article 1 of the Regulation sets out two objectives:

- minimization of the EU's contribution to deforestation and forest degradation worldwide, thereby contributing to a reduction in global deforestation; and
- reduction of the EU's contribution to greenhouse gas emissions and global biodiversity loss.

In section 2, I outline the operation of the EUDR. Section 3 provides a brief introduction to the literature on deforestation. It reports evidence that deforestation has tended to decline over the past two decades but still remains important. Increases in pasture for the production of cattle meat production have been the single most important driver of deforestation with palm oil production as the second most important driver. The EU, and Europe more generally, have seen net increases in forest cover over the past two decades, but may be seen as responsible for deforestation through the import of commodities that have benefited from deforestation. Section 4 reports estimates of forestation embodied in European imports. Palm oil is the single most important cause of this embodied deforestation, followed by cocoa, soybeans and coffee.

Section 5 turns to the problems that will be faced in implementing the EUDR. The first major issue is the availability of detailed forest cover maps to allow assessment of the deforestation status of each producer's commodity sales. The EUDR requires that European importers ensure EUDR-compliance. The implied due diligence process requires the importer to be able to track imports back to the individual producers. The vast majority of imports of EUDR commodities are indirect and involve supply chain intermediaries. Product is aggregated at each step in the chain. Accurate tracking of the deforestation status of aggregated commodity parcels will be a complicated and potentially costly undertaking. There are fears that this may result in European importers choosing to source from plantations rather than smallholders or other smallholders where this is possible.

The EUDR is explicitly extra-territorial. It is resented and even seen as imperialistic by some producer countries. Voluntary agreements that certify sustainability are an alternative. The best known is the Roundtable on Sustainable Palm Oil (RSPO). I discuss this voluntary approach in section 6. There is at best mixed evidence that the RSPO limits deforestation, and the premium obtained by certified producers appears insufficiently large to make certification attractive to smallholders. Its proponents hope that the EUDR will be more successful but risk that deforestation may undermine respect for the sovereignty of producing nations.

I look at the likely impact of the EUDR from two perspectives. First, in section 7, I set out a simple model which can be used to evaluate the welfare impacts in terms of the (possible) gains to producers and the costs imposed on European consumers. The model

pivots on the premium that emerges between EUDR-compliant and non-compliant supplies. There will be no impact in the short run on global commodity supplies and little impact on demand so prices outside Europe should be unaffected. European consumers are made unambiguously worse off though payment of the premium. Those producers that supplied the EU market prior to the EUDR and who continue to supply compliant product will gain additional revenue but bear additional costs. Producers of non-compliant product who would have previously supplied European markets are worse off. It is not possible to say in advance whether producers as a group will benefit or lose from the Regulation but any benefit will be less than the loss to consumers. The EUDR premium is likely to be highest in cocoa and palm oil but there is no current basis for estimating its likely magnitude.

Secondly in section 8, I look at the impacts on deforestation. I suggest that, in the absence of comparable controls in other major consuming countries, the main impact of the Regulation in the beef, natural rubber, and soybean markets will be diversion of non-compliant supplies to non-European markets with little or no impact on deforestation. In cocoa, coffee and palm oil, any deforestation benefits will only emerge over time as new planting takes place. Section 9 concludes that the EUDR will be effective in reducing the extent of deforestation embodied in EU imports, albeit at significant cost, but is likely to have only a small effect on deforestation itself unless the United States and China adopt similar measures.

2. The Regulation

The EUDR regulates imports into the EU of seven primary commodities, the production of which is viewed as responsible for deforestation in the producing countries. The seven commodities are cattle (beef), cocoa, coffee, palm oil, natural rubber, soya, and wood (European Union, 2023, Article 2). Annex 1 of the Regulation specifies that regulations extend to products that have been "fed" or "made using" these seven commodities. Hence leather, chocolate and cocoa confectionary, roasted coffee, glycerol, tyres and other products made from natural rubber, manufactured wooden objects, paper and printed books all fall under the regulation. Imports of any of the listed products into the EU must be accompanied by a "due diligence statement" demonstrating that the merchandise is deforestation-free and has been produced in accordance with relevant national legislation (Article 3). In relation to the Regulation, "deforestation-free" is taken as meaning that the land on which the commodities have been produced has not been subject to deforestation since 31 December 2020 (Article 2, definition 13). Forwood *et al*. (2023) provide a good short summary of the regulation.

The Regulation makes importers responsible for ensuring compliance with the EUDR provisions through the submission of due diligence statements although SME importers face more limited obligations. Importers are required to carry out risk assessment exercises to ensure that merchandise is indeed EUDR-compliant (Article 10). These must be based on the collection of detailed information. EU member states are required to carry out annual checks

on importer compliance (Article 16). It is envisaged that compliance checks will be calibrated against the perceived riskiness of the exporting country, with exporters based on a three-tier classification into "low, standard or high risk" countries (paragraph 68). Importers can be fined for non-compliance with the size of the fine being proportional to assessed environmental damage but up to 4% of total EU turnover (Article 25). The EUDR comes into force from 30 December 2024 and applies to all products produced after 29 June 2023.

3. Deforestation

The quantification of deforestation raises conceptual, measurement and information issues. At a national or regional level, we can distinguish between gross and net forest loss and between forest loss and forest degradation. Further, forest loss can be permanent or temporary, as when an area of forest is logged or destroyed by wildfire. Pendrill *et al*. (2022, page 2) define deforestation as a "persistent conversion of natural forest to any other land use". This is a measure of Tree Cover Loss (TCL). Curtis *et al*. (2018) reserve the term deforestation for "*abrupt* transition for land with trees to land without trees" (emphasis added). Their definition focuses attention on land clearing as distinct from gradual evolution. Either definition is possible but, if concern is with climatic impact, the abruptness of any transition is not relevant. Hansen *et al*. (2013) produced high resolution satellite-based maps of world forest cover. These maps derive from satellite-based remote TCL sensing and form the basis for the widely-used Global Forest Change (GFC) dataset.[1] GFC TCL data may not distinguish between permanent and transitory losses and between deforestation and forest degradation (Curtis *et al*., 2018).

The FAO publishes a five yearly Global Forest Resources Assessment (GFRA) primarily based on land use statistics at the national level but complemented by remotely sensed information.[2] The FAO definition of deforestation excludes conversion of natural forest to forest plantation which is included in the GFC definition. That distinction is important for biodiversity concerns but less so in terms of climatic change. FAO (2020) is the most recent report based on the GFRA data and provides a coarse but comprehensive assessment of the state of the world's forests. The report counsels that net forest loss differs from deforestation because of reforestation and natural forest expansion. According to the report (page xi), the rate of net forest loss decreased substantially over

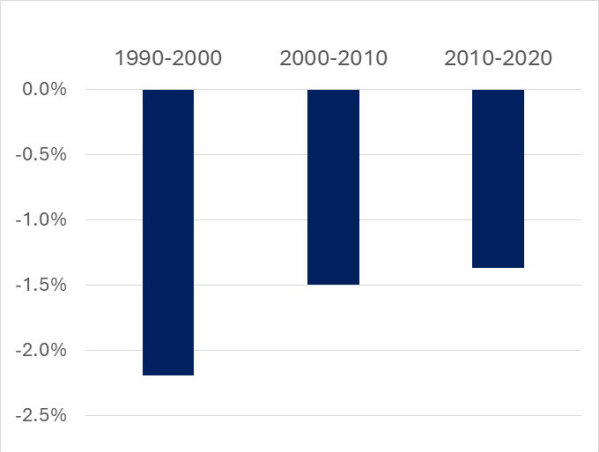

Figure 1: Net forest loss (world), 1990-2020. Source: FAO (2020)

[1] https://data.globalforestwatch.org/documents/941f17325a494ed78c4817f9bb20f33a/explore
[2] https://www.fao.org/forest-resources-assessment/en/

the period 1990–2020. See Figure 1. Net deforestation is some countries has been offset by net forest expansion in others. Over the period analyzed in the report, South America and Africa have seen the most substantial net deforestation while Asia and Europe have seen significant net reforestation. There has only been modest net change in Oceania and North and Central America. On an acreage basis, net forest loss has been greatest in Brazil, the DRC, and Indonesia and net reforestation greatest in China, Australia and India (*ibid*, page 18).

The EUDR refers both to deforestation and forest degradation. It defines "deforestation" as the conversion of forest to agricultural use, whether or not human-induced; and "forest degradation" as changes in forest cover including conversion of natural ("primary") forest into plantation, cultivated forest or other wooded land (European Union, 2023, Article 2). The Regulation makes clear that its concern is with the impacts of deforestation on all of climate change, biodiversity loss and the welfare of indigenous peoples. The objective is that of promoting "deforestation-free supply chains" (paragraph 41). This characterization is closer to the Pendrill *et al*. (2022) deforestation measure than to that underlying the GFRS.

Hosonuma *et al*. (2012) provided the first systematic assessment of the role of agriculture as a driver of deforestation. The importance of the various factors varies both geographically and with regard to the country's level of development, and specifically the extent of pre-existing forest cover. Using GFRA data, they estimate that, overall, agriculture was responsible for 73% of deforestation over the two decades from 1990.[3] This estimate predates the availability of the GFC data. Pendrill *et al*. (2019) arrive at a lower estimate (45%-65%) using a hybrid approach combining GFC data with a land balance model based of the GFRA data. Pendrill *et al*. (2022) comment that the quality of the GFRA land allocation data, which are often imputed or estimated, can be problematic. Using GFC data over the five year period 2011-15, the latter authors report a 60%-83% range for the importance of agriculture as a deforestation driver, commenting that the wide range reflects uncertainty as to what proportion of TCL is permanent as distinct from resulting from shifting agricultural production (prevalent in much of Africa).

In order to assess the likely impact of the EUDR, we need to move to a crop-based analysis. Pendrill *et al*. (2019) and Goldman *et al*. (2020) both provide estimates. Remote sensing is not currently sufficiently developed to give accurate crop identification. This difficulty is accentuated where there is inter-cropping and where planting is extensive (as is often the case in cocoa), and where tree crops are grown under forest cover (again often the case in cocoa but also sometimes in coffee). The Pendrill *et al*. (2019) estimates provide greater detail but derive from the GFRA data and rely on an assumption that crop composition remain unchanged as agricultural land area expands. The estimates in Goldman *et al*. (2020) are based on overlaying information from a number of different datasets. This

[3] This estimate is similar to an earlier estimate given by Geist and Lambin (2002).

gives them very detailed data on oil palm, natural rubber and wood fibre; and for pasture and soybeans in parts of South America. They adopt a coarser approach for cocoa and coffee, where there is a general lack of detailed and comprehensive information on the precise location of production, and also for other commodities in areas not covered by their overlaying data. Their numbers are obtained by overlaying detailed remotely sensed information on forest cover (or its absence) with national information on crop yields.

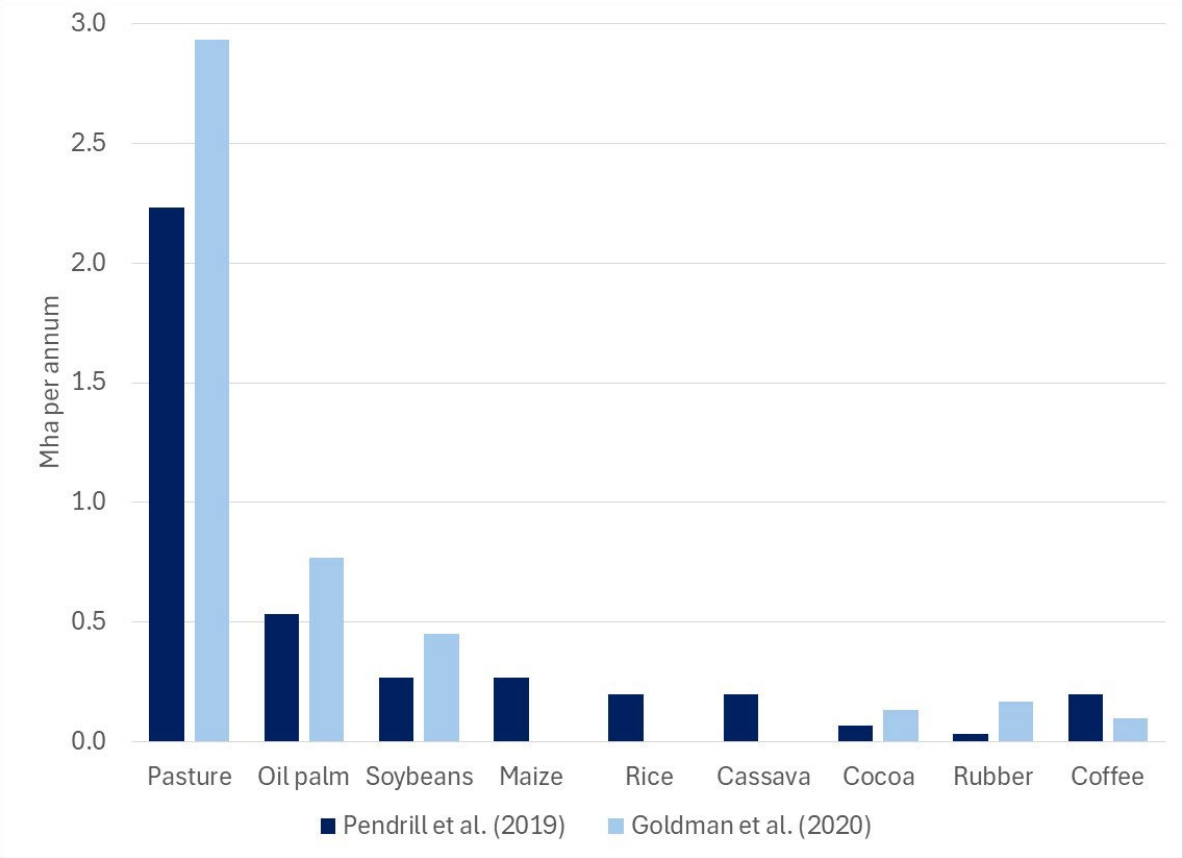

Figure 2: Estimated forest loss by commodity (Pendrill *et al*. (2022)

Figure 2, which derives from the information in Pendrill *et al*. (2020, Table S6), compares the Pendrill *et al*. (2019) and Goldman *et al*. (2020) estimates. There are two points to be noted. First, Pendrill *et al*. (2019) estimate overall deforestation over their analysis period (2005-13) as 5.5 million hectares per annum (Mha pa) while Goldman *et al*. (2020), who analyze the longer period 2001-15, imply a figure of 8.2 Mha pa. As noted above, Pendrill *et al*. (2020) regard the Pendrill *et al*. (2019) estimate as "conservative". This, together with the different analysis periods, may go some way to explain the higher estimates given by Goldman *et al*. (2020). Second, Goldman *et al*. (2020) do not give figures for forest loss to maize, rice or cassava, which are included in an unattributed category (not charted) along with wood products and subsistence agriculture.

- The two sets of estimates are in agreement that increases in pasture for the production of cattle meat production has been the single most important driver of deforestation. The Pendrill *et al*. (2019) estimates see increases in pasture as

responsible for over 40% of the total. It has been particularly important in Latin America where it accounted for 60% of the net forest loss (72% in Brazil).

- The two studies also agree in seeing palm oil production as the second most important driver with losses concentrated in South-East Asia. Pendrill *et al*. (2019) report that it accounted for 46% of deforestation in Indonesia and 69% in Malaysia. World Resources Institute (WRI) time series data on deforestation show a clear link to palm oil prices in the previous year.[4]
- The production of soybeans is seen as accounting for a similar degree of net forest loss, again in Latin America, in particular in Brazil, but also in Argentina, Bolivia and Paraguay.
- Forestry products (not charted in Figure 2) were also an important contributor to net forest loss. WRI figures show 90% of the loss of primary forest in Indonesia as attributable to this category, mainly to forest plantations.
- Tropical export crops (cocoa, coffee and natural rubber) were seen as relatively unimportant drivers of net deforestation accounting around 5% of the total loss.

In summary, of the seven commodities specified in the EUDR, four (cattle meat, oil palm, soya and wood products) are seen as having been important drivers of deforestation and three (cocoa, coffee and natural rubber) as relatively unimportant drivers. Nevertheless, these three commodities may have played in important role in deforestation in specific countries.

4. Imported deforestation

This section addresses the question of the extent to which deforestation is embodied in EU imports of the seven commodities specified in the EUDR. Pendrill *et al.* (2019) distinguish between deforestation attributable to commodities destined for consumption in the producing country and that embodied in exported commodities. They state that cattle meat is primarily consumed locally with only 11% in their dataset exported. On the other hand, cocoa, coffee, natural rubber, and palm oil are primarily export crops. Even though they are responsible for a smaller overall share of deforestation, they may potentially account for a high proportion of deforestation embodied in European imports.

Table 1 shows EU shares of six of the seven EUDR commodities in world production of the commodity.[5] (I omit timber since most wood is imported in manufactured wood products making it difficult to estimate the commodity share). The EU shares include semi-processed commodity products converted into commodity equivalents.[6] The table shows

[4] https://research.wri.org/gfr/forest-extent-indicators/deforestation-agriculture#how-much-forest-has-been-replaced-by-specific-agricultural-commodities

[5] Data sources: World production – FAOSTAT. EU-27 imports – Eurostat. All figures are 2017-2021 averages.

[6] Beef: boneless beef, 1.16; leather 0.65. Coffee: roast, 1.19. Cocoa: powder 0.59; paste, 1.25; butter, 0.67; chocolate, 1.20 (powder and butter are treated as joint products). Oil palm: palm kernel oil,

substantial import shares for cocoa and coffee, a negligibly small share for beef, and intermediate shares for palm oil, soybeans and natural rubber.

Table 1
European import share of world production

	Beef	Cocoa	Coffee	Natural rubber	Palm oil	Soybeans
EU-27	0.7%	39.4%	40.6%	11.0%	18.5%	9.3%
CH+N+UK	<0.1%	2.8%	3.8%	0.2%	0.8%	0.6%
EU+3	0.7%	42.2%	44.3%	11.1%	19.3%	10.0%

Source and definitions: see text. Column totals may not sum because of rounding.

Bradford (2020) argues that, in certain industrial contexts, there is a regulatory "race to the top" since firms are forced to choose between compliance with the most exacting set of regulations or alternatively retreating from the highly regulated markets. Since the EU has tended to be the most stringent regulator, she argues that the EU has become the global regulator in those industries. This is the "Brussels effect", named after the "California effect" (Vogel, 1995) in the United States automobile market. Perkins and Neumayer (2012) examined whether the California effects extends across national borders. The mechanism is that global companies will wish to sell products manufactured to the same specification in all the countries in which they operate.

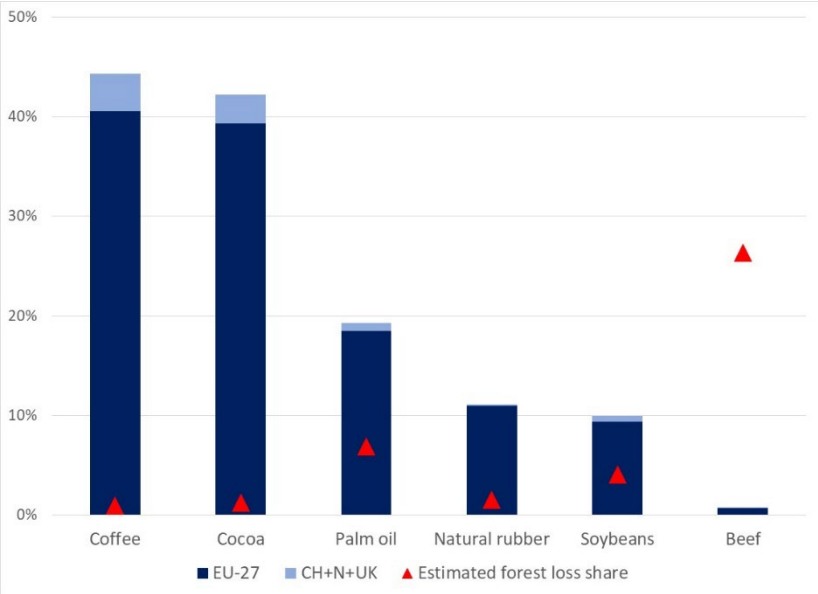

Figure 3: EU import shares compared with shares of forest loss

This argument appears weak in relation to products manufactured from the EUDR commodities, with the possible exception of rubber goods, but we should nevertheless

5.71; oilcake from palm, 0.30. Natural rubber: rubber manufactures, 0.15. Soybeans: soybean oil, 2.81; soy sauce, 0.50; soy oil cake (meal), 0.6 (soybean oil and meal are treated as joint products).

expect a Brussels effect for the broader European market where Switzerland and the UK are the two most important extra-EU countries. Indeed, the UK government has announced similar regulations but on a more restricted list of commodities UK Parliament, 2023).[7] Table 1 therefore also reports the share of imports into three EU neighbours (Norway, Switzerland and the UK) , netting out EU-27 exports to these countries, in recognition that importers into these countries are likely to insist on EUDR-compliance.

Figure 3 charts this information and adds the Goldman *et al*. (2020) forest loss percentages previously charted in Figure 2. Cocoa and coffee, in which Europe imports a large proportion of world production, are relatively unimportant in accounting for deforestation at the global level; the opposite is true of cattle production, which is a major driver of deforestation. The correlation of the Goldman *et al*. (2020) forest loss percentages with the EU import shares is -0.65.

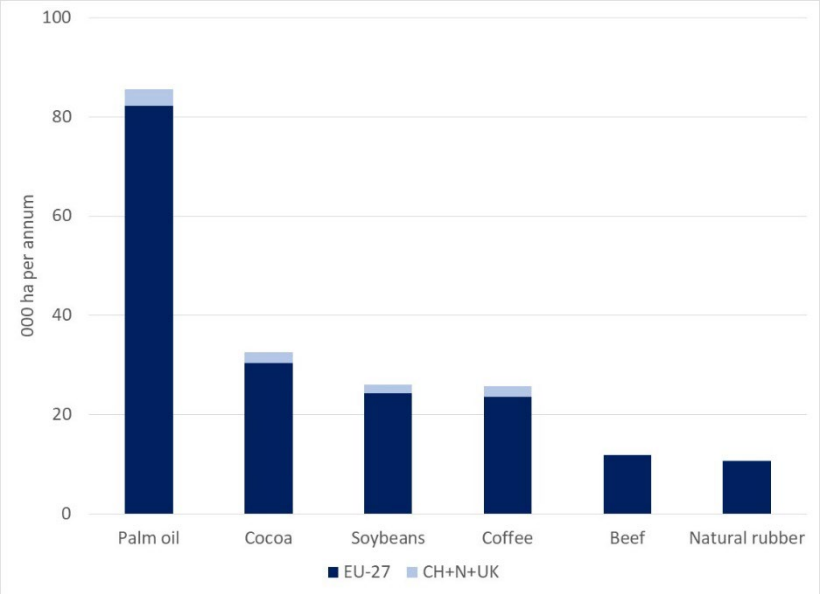

Figure 4: Estimated European imported deforestation (000ha pa)

By interacting the Goldman *et al*. (2020) forest loss estimates over 2001-15 and the European import shares charted in Figure 3, I can obtain an estimate of the approximate extent of deforestation embodied in European imports. The results are charted in Figure 4. These figures indicate that EU palm oil imports embody the largest quantum of deforestation, estimated at 82,000 ha p.a., followed by cocoa estimated at 30,000 ha p.a. and coffee and soybeans each at 24,000 ha p.a. These estimates are based on the strong assumption that the extent of deforestation within each country is independent of the crop grown. It is, for example, possible that in a cocoa-exporting country with high recorded deforestation, that deforestation is due entirely to forest loss for timber production.

[7] Only preliminary details are available at the time of writing. Four commodities are provisionally specified: cattle products (excluding dairy), cocoa, palm oil, and soy. There is no mention of coffee, natural rubber or timber.

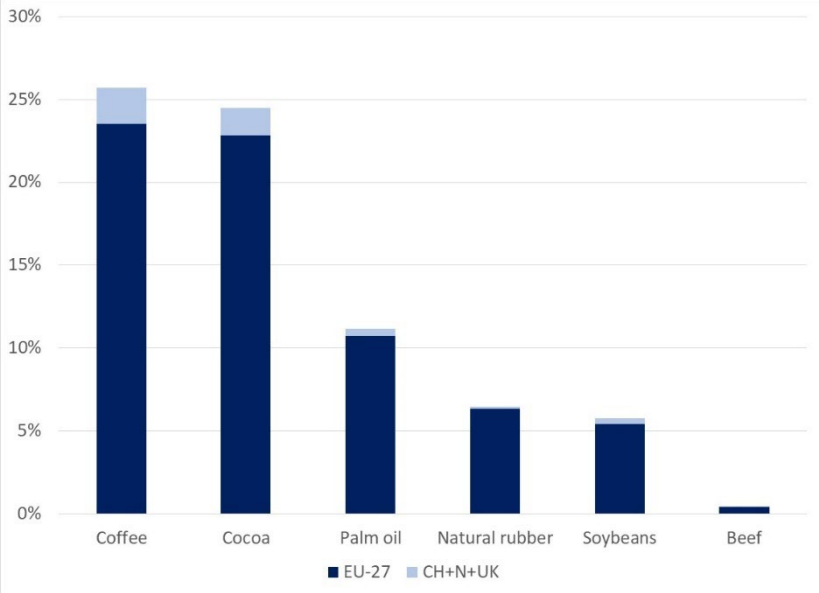

Figure 5: Estimated European imported deforestation as a share of world total deforestation

The rankings shown in Figure 4 change dramatically if imported deforestation is expressed as a share of the Goldman *et al*. (2000) estimates of total deforestation driven by each ERUDR commodity – see Figure 5. EU imports are estimated as embodying 4.0% of total world deforestation resulting from agriculture and 2.8% of total world deforestation. 23.5% if coffee and 22.8% in cocoa. Although coffee and cocoa are not major drivers of deforestation, EU imports embody a high proportion of the deforestation arising from these activities

5. Commodity supply chains

Commodity supply chains are complicated, and possibly more complicated than the European Parliament realized when it enacted the EUDR. This complexity makes implementation of the required due diligence controls difficult and possibly costly. It may result in unintended collateral effects favouring one group of supply chain participants over another.

There are two points in the commodity supply chain issues at which EUDR-compliance issues may arise. The “first purchaser” (a company exporting to Europe or a supply chain intermediary) of the commodity will need to provide evidence that the land on which the commodity was produced has not suffered from deforestation since the cut-off date at the end of 2020. It is envisaged that this will require precise geophysical location of the farm or plot on which production has taken place. Absence of deforestation can than be established by comparing satellite images showing the current forest cover at that location with that at or before the 2020 cut-off date. Governments and a number of commercial organizations produce interactive maps which permit identification of the first cover in the small polygonal region in which the producing farm is located. Figure 6 reproduces a forest cover map for

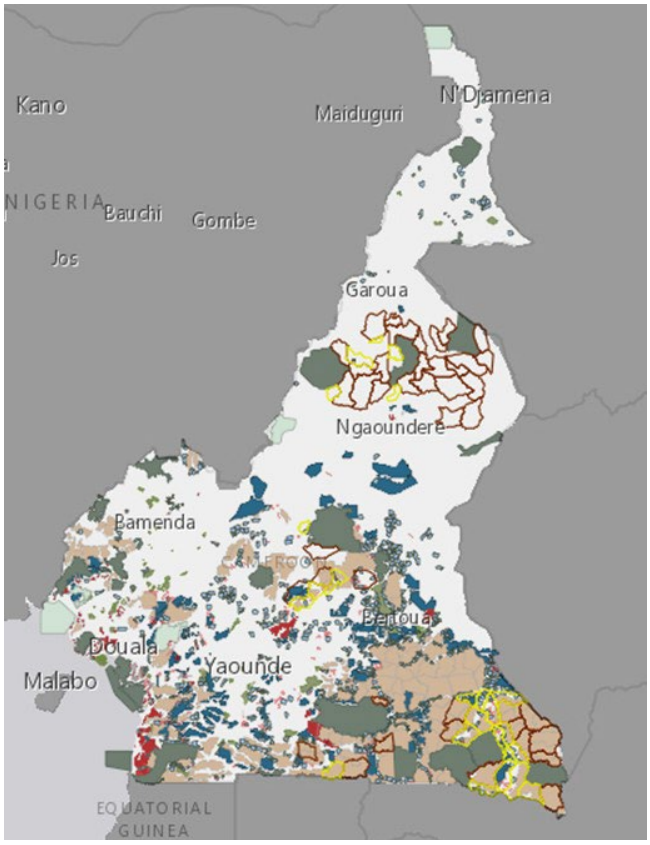

Figure 6: Forest cover map, Cameroon, 2020

Cameroon in 2020.[8] It will only be possible to demonstrate EUDR-compliance by reference to a map of this sort. It is currently unclear what proportion of the EUDR commodities are produced in unmapped areas.

The second compliance issue relates to aggregation. The EU importer will need to report due diligence that shows the entire quantity imported satisfies this requirement. In a small proportion of instances, a European importing company purchasing at origin will be the first purchaser. This may be the case with some soybean, palm oil and natural rubber purchases from large farms or plantations. However, in the majority of instances, EU imports will be intermediated by traders, cooperatives, export companies, or all of these. zu Ermgassen *et al*. (2022), who discuss the cattle, cocoa, palm oil and soybeans, show that "indirect sourcing" is prevalent in all four supply chains and is universal in the Ivorian cocoa and Brazilian live cattle chains. This will always be the case with smallholder production where intermediation will involved aggregation of the products of a large number of farmers. For example, West African cocoa beans are invariably bulked and exported either in containers or bulk carriers. A 40 foot (12.2 m) container carries around 25 tons of cocoa beans which may have been produced on around 400 farms. A bulk carrier will take around 5,000 tons of beans may have been grown on around 80,000 farms.[9] EUDR-compliance requires that EU importers need to maintain no-deforestation records of the entirety of their imports. Under pre-EUDR arrangements, European importers had no interest in knowing the detail of where crop was produced, and in any case, traceability would have been lost whenever aggregation took place.

The extent of aggregation differs both across the EUDR commodities and across origins:

- Prevalence of smallholder production will increase the need for aggregation.

[8] *Forêts communautaires* and *communales* are shown in blue ; managed forests (*forêts UFA*) are in brown). Source: Ministère de Forêts et de la Faune, Cameroon; and World Resources Institute, https://cmr.forest-atlas.org/

[9] Federation of Cocoa Commerce, private communication.

- This need will be further increased where crops are grown extensively and are inter-cropped, as is often the case with cocoa, and so individual farmers only produce small quantities
- … and where the commodity is homogeneous (cocoa and robusta coffee but not arabica coffee).

The FAO defines smallholder producers as "farmers … who manage areas varying from less than one hectare to 10 hectares". Lowder *et al*. (2016) provide estimates of the global distribution of smallholder farms at the national level. I am not aware of comparable information at the commodity level. Table 2 reports the results of interacting the Lowder *et al*. estimates with shares of commodity production averaged over the years 2017-21.[10] The estimates should be treated as approximate – the estimates assume that the farm distribution within each country is independent of the crop produced and the Lowder *et al.* data are not comprehensive and derive from surveys undertaken at different dates. Nevertheless, the rankings are the same irrespective of the farm size taken as identifying a smallholding: smallholdings are seen as the dominant production mode for palm oil and natural rubber, followed by cocoa.[11] Smallholdings are less prevalent in beef and soybeans production. Coffee is intermediate.

Table 2
Estimated farm size distributions

	0-1 ha	0-2 ha	0-5 ha	0-10 ha
Beef	31.2%	40.1%	52.7%	59.6%
Cocoa	49.6%	64.8%	82.3%	90.6%
Coffee	42.9%	55.6%	71.8%	79.3%
Natural rubber	63.6%	79.5%	93.9%	97.5%
Palm oil	64.9%	81.3%	95.1%	97.8%
Soybeans	17.6%	25.1%	39.0%	48.3%

Author's calculations weighting data in Lowther *et al*. (2016), WEB Table 3, by country production shares (averaged over 2017-21).

Textbook descriptions of market interactions typically see concentration as being located either with producers (monopolistic market structures) or purchasers (monopsonistic structures). Many supply chains in the primary commodity sector are more complicated since the concentration is at an intermediate point in the chain. The commodity

[10] Source for farm size distribution (111 countries): https://www.fao.org/family-farming/detail/en/c/273864/. The estimates derive from survey undertaken at differing dates. Source for production statistics (193 countries): FAOSTAT. Numbers for the 82 countries not included in the Lowder *et al*. (2016) dataset are extrapolated from regional averages.

[11] According to the International Institute for Sustainable Development (IISD), around 90% of cocoa farmers produce on less than five hectares. https://www.iisd.org/ssi/commodities/cocoa-coverage/#:~:text=About%2090%25%20of%20growers%20are,lands%20less%20than%205%20hectares.

is produced by a large number of farmers (a very large number in the case of smallholder production) and is processed by a large number of users. A much smaller number of commodity trading companies sit between these two groups.

In the remainder of this section, I focus on cocoa, coffee, and palm oil. Over 98% of EU imports of cocoa beans originate from West Africa where production is almost entirely by smallholders and where production is often extensive involving intercropping. Fold (2002) characterizes the cocoa market as bipolar – the structure resembles an egg-timer with a broad base and top but very narrow in the middle. See also Carodenuto and Buluran (2021) and Gilbert (2024). Cocoa market concentration at the processing stage is attributable to economies of scale in both bulk transport and in processing itself. See also Fold (2001), Gilbert (2009) and Araujo Bonjean and Brun (2016). See van Duijn (2013) on palm oil. Lyons-White and Knight (2018, page 306) report market participants as describing the palm oil supply chain as being "hourglass-shaped, with many different stakeholders at the supply and demand ends and a small number of trading companies in the middle".

The hourglass structure is illustrated for palm oil in Figure 7, reproduced from Lyons-White and Knight (2018, Figure 2). The large number of oil palm farmers, signified by small palm trees, are at the top of the hourglass. Local traders convey the palm oil and kernels to a smaller number of millers and processors who sell to a small number of trading companies, many of which will be multinationals. This involves aggregation of the products of large numbers of farmers. The traders in turn sell to refiners and manufacturers who use the palm oil in the production of multiple "fast moving consumer goods" (FMCGs) which are then retailed to very large numbers of final consumers. The diagram allows either for complete specialization at each stage of the supply chain (solid red line) or for a degree of vertical integration (broken line).

The EUDR imposes compliance obligations at the import stage, i.e. on the commodity processors, refiners and manufacturers in the lower bulb of the Figure 7 hourglass. These obligations require full traceability of the products they purchase back to the farmers at the top of the Figure. Traceability needs to be maintained through the lower part of the bulb in which often small quantities of the commodity are used in the manufacture of the FMCGs.

Indonesia and Malaysia are the most important producers of palm oil. Averaging over the five years 2017-2021, Indonesia accounted for 60.3% of world palm oil production,[12] mostly grown intensively. Smallholders predominate in Sumatra, which is the most important producing region, but larger scale industrial plantations have dominated the expansion in Kalimantan and Papua over the two most recent decades (Santika *et al*., 2021). Zhunusova *et al*. (2022) report 42% of Indonesian palm oil and 28% of Malaysian palm oil was produced on plantations. Lyons-White and Knight (2018, page 306) discuss the practical difficulties of ascertaining deforestation commitments in the palm oil supply chain. Supply

[12] Source: FAOSTAT.

chain intermediaries stated that fruit bunches “were often traded between multiple smallholders … before arriving at a mill” making traceability “difficult or impossible”. They state (page 310) that “complexity of the palm oil supply chain was the major barrier to the implementation of no-deforestation commitments”.

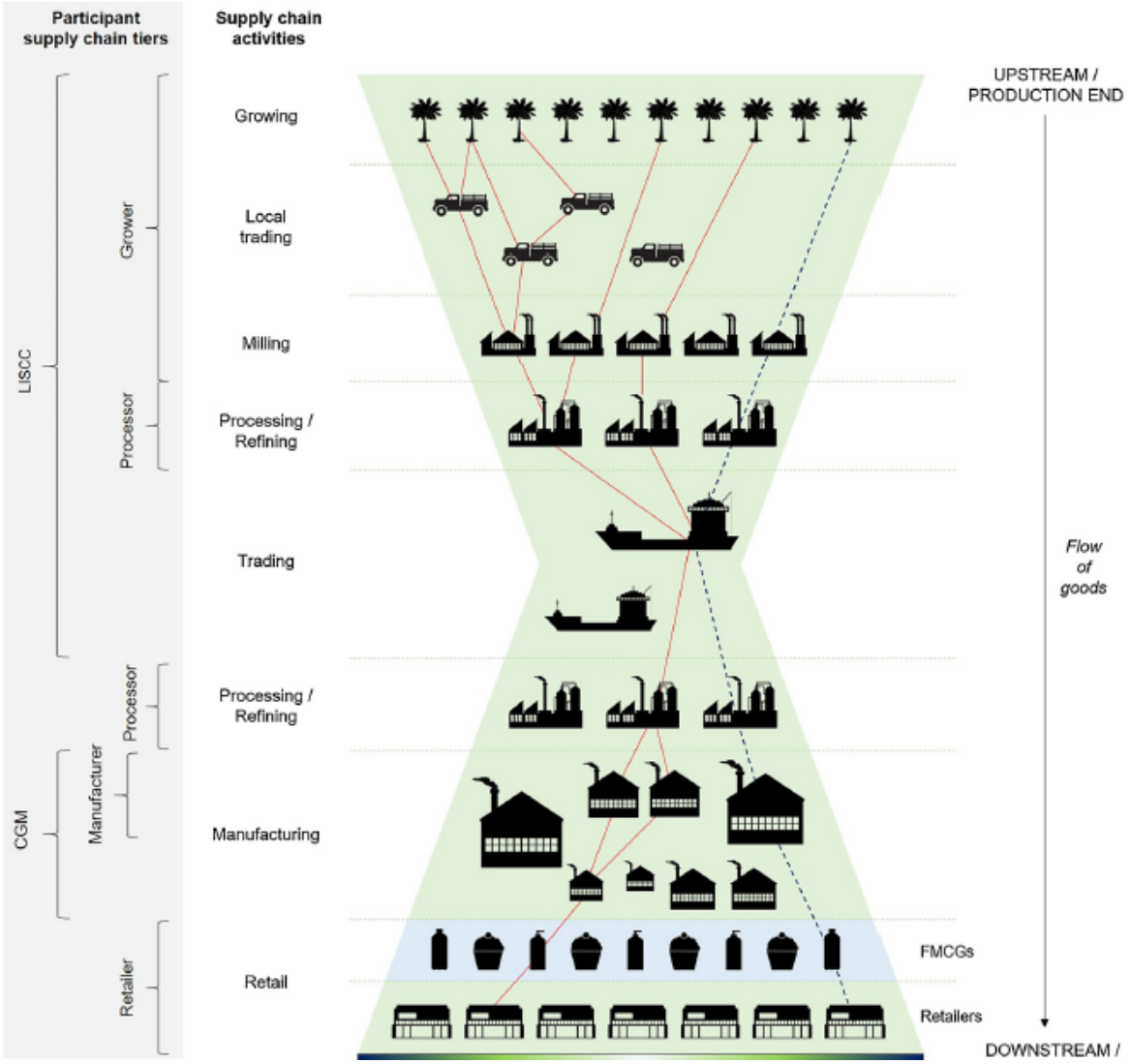

Figure 7: The palm oil supply chain (from Lyons-White and Knight, 2019)

The coffee and natural rubber supply chains combine smallholder production and larger plantations. The website Coffee Intelligence states that “the EU has failed to recognise a difference [in relation to EUDR compliance] between smallholders and larger estates”.[13] In other respects, the coffee supply chain is similar to that of cocoa. Coffee Intelligence argues that “The coffee supply chain is complex and involves many intermediaries. … Traceability has long been an issue for the industry, and it’s another factor why this may be so difficult to implement” (*ibid*). However, unlike cocoa, coffee is typically grown intensively and the prices paid for arabica beans can vary in relation to perceived quality. Moreover, processing is less

[13] https://intelligence.coffee/2023/08/eu-deforestation-laws/

concentrated than in cocoa and independent exporters play a greater role. The natural rubber chain has similarities with palm oil with a significant proportion of direct links between growers and processors and manufacturers at origin, in particular in the manufacture of condoms and surgical and other latex gloves. By contrast, the soybeans supply chain is simpler with a large proportion of beans produced on large farms and sold directly for export – see Weerdenburg (2023) for discussion.

EUDR compliance will involve less aggregation and hence be simpler and less costly when imports into the EU are sourced from larger producers and not smallholders. This has led to the charge that the EUDR will favour plantations over smallholders. Reuters reported that EU coffee importers are turning away from African beans, predominantly produced by smallholders and quoted one trader as stating "Roasters are moving to big rich Brazilian farmers".[14] Similarly, the East Asia Forum reported that smallholders "may be disproportionately affected by the EUDR" leading the authors to argue that "In the long run, this may further reduce their ability to participate in the palm oil market, further increasing the dominance of large corporations".[15] Zhunusova *et al*. (2022) make similar arguments.

This issue does not arise in cocoa where smallholders account for almost the entirety of production. However, a different collateral impact of the EUDR may arise in Côte d'Ivoire, the most important producing country, accounting for 63% of West African and 39% of world production.[16] Six multinational trading companies[17] dominate Ivorian cocoa exports, benefiting from economies of scale in transportation and superior access to credit, at the expense of national exporters. The Ivorian *Conseil du Café-Cacao* (CCC), which regulates the Ivorian sector, regards this concentration as against the Ivorian national interest[18] and has moved to guarantee a share of the export trade to the local exporters, some of which are politically powerful. The multinational exporters are better placed to ensure EUDR-compliance than national exporters with the consequence that the EUDR may strengthen the position of the former group. The national authorities will not welcome such a development.

---

[14] M. Angel and D. Kurniawati, "Coffee firms turning away from Africa as EU deforestation law looms". Reuters, 19 December 2023. https://www.reuters.com/markets/commodities/coffee-firms-turning-away-africa-eu-deforestation-law-looms-2023-12-19/

[15] M.A. Iswara, D.S. Nurshadrina, and A. Suryaahadi, "European Union palming off deforestation regulation to smallholders in Indonesia", East Asia Forum, 10 October 2023. https://eastasiaforum.org/2023/10/10/european-union-palming-off-deforestation-regulation-to-smallholders-in-indonesia/

[16] 2017-21 average. Source: FAOSTAT.

[17] Barry Callebaut, Cargill, Ecom Trading, Olam, Sucden, and Touton. The first four of these companies accounted for 75% of global cocoa trading and processing in 2016-17 (Startiz *et al*., 2022).

[18] " «Le cartel de ces six multinationales constitue un danger pour notre secteur cacao», a déclaré à Reuters un responsable du Conseil du café-cacao (CCC) sous le sceau de l'anonymat. «Nous devons réduire leur influence et assurer que tous les acteurs ont une place pour travailler.» ". CommodAfrica, 29 April 2021. https://www.commodafrica.com/29-04-2021-la-cote-divoire-attribuerait-20-des-exportations-de-cacao-aux-operateurs-nationaux/

At the same time, there may also be positive collateral impacts in terms of improved supply management. Cocoa in Côte d'Ivoire provides a case in point. Côte d'Ivoire experienced civil war over the periods 2002-07 and 2010-11. The ending of each of the two phases of war was associated with a large increase in production in the years that followed.[19] These dramatic increases in supply resulted in nominal cocoa prices at the world level falling by 10.2% in deflated terms comparing the five years 2015/16 to 2020/21 with the period 2005/06 to 2010/11.[20] The phases of rapid cocoa expansion took place around four years after the end of each war episode, consistent with the time cocoa trees reach production, and was associated with large scale internal migration from the north of the country, and possibly also beyond, by families seeking land in the aftermath of the war disruption. The absence of accurate crop maps and clearly defined property rights were instrumental in the inability of the Ivorian government to control this new planting, some of which may have been illegal. The need to comply with EUDR due diligence procedures should assist in improving domestic supply management in commodity-producing countries.

6. Extra-territoriality

The EUDR is explicitly extra-territorial. Net deforestation in the EU is negative (see section 3) and of the seven commodities specified in the Regulation, only timber and a small quantity of soybeans are produced within the EU. Although the EUDR does not attempt to regulate either the location or manner of commodity production in the producing countries, it has this effect indirectly since, by prohibiting the import of non-compliant supplies into the EU, it also restricts the export possibilities for these commodities. Furthermore, the EUDR prohibits import into the EU of commodities produced on deforested land even where deforestation is legal in the producing country (European Union, 2023, paragraphs 33-34).

The perception of extra-territoriality was articulated by the Indonesian Minister for Economic Affairs Airlangaa Hartarto, with specific reference to palm oil where Indonesia is the leading exporter. He stated "A key feature of the EUDR regulation forcing other people and countries to submit to internal EU regulations … is the regulatory imperialism that the Global South must now confront".[21] Again discussing the Indonesian palm oil sector, Iswara *et al*. (2023) suggest that the EUDR might be seen as "a veiled protectionist measure" encouraging European consumers to substitute domestically produced sunflower for palm oil. Almeida *et al*. (2023, page 5), who discuss EU environmental policy more generally, see

[19] Production rose by 44.6% from crop year 2009/10 (1.24 Mt) to 2014/15 (1.80 Mt) and by a further 17.2% to 2019/20 (2.10 Mt). Source: ICCO, *Quarterly Bulletin of Cocoa Statistics* (various issues).
[20] Deflation by the US Producer Price Index. Averages of the ICCO Indicator Price. 2005/06 – 2010/11: $2354/t ($2410/t at 2010 values); 2016/17 – 2020/21: $2453/t ($2165/t at 2010 values). Source for ICCO Indicator Price: ICCO, *Quarterly Bulletin of Cocoa Statistics* (various issues). Source for US PPI: IMF, *International Financial Statistics*.
[21] "EUDR: Hartarto *versus* Timmerman's tin ear". *Palm Oil Monitor*, 19 June 2023. https://palmoilmonitor.org/2023/06/19/

the EU as a "moral intervener" with the aim of "influencing decisions of foreign governments … [and] creating mechanisms of soft regulatory power for climate response".

Voluntary certification provides an alternative approach to environmental sustainability. The Roundtable on Sustainable Palm Oil (RSPO),[22] founded in 2004, is the best known and most studied of such schemes. The Round Table on Responsible Soy Association (RTRS),[23] founded in 2006, has similar objectives but has attracted less academic interest. Evidence on the effectiveness of the RSPO remains mixed. Brandi *et al*. (2015) find evidence that smallholders often lack both the information and the degree of organization required for RSPO-certification. Cattau *et al*. (2016) show that fire loss is less likely on RSPO-certified plantations relative to non-certified plantations in periods of low fire risk but not in periods of high fire risk. Carlson *et al*. (2018) show that RSPO-compliance reduces deforestation. Using village-level data, Santika *et al*. (2021) find mixed impacts from RSPO certification on farmer welfare in villages with a history of market integration but negative impacts in villages which have previously depended on subsistence agriculture. Ruysschaert and Salles (2024, page 440) see the RSPO as a bargain in which growers "preserve areas of forest of high biodiversity value, to the benefit of … palm oil processors [and] consumer goods manufacturers". They remark that farmer participation requires that they receive a sufficient premium over non-certified palm oil. They find that certification proves too costly for many smallholders in relation to the realized premium.

The major difference between voluntary certification schemes, like the RSPO, and the EUDR, is that farmers opt into voluntary schemes while, under the EUDR, they opt into supplying EU customers. A proportion of pre-EUDR suppliers of palm oil to the EU will not have been certified so the EUDR's coverage should be larger, or at least, not smaller. It was open to the Indonesian government to obligate RSPO certification for palm oil exports but they elected not to do this. EUDR due diligence controls take that decision out of Indonesian hands in relation to exports to Europe.

Overall, the evidence indicates that the RSPO has at best been only moderately effective in limiting deforestation and that consumers have been unwilling to pay sufficiently high premium to make the scheme attractive to smallholder producers. By requiring due diligence, which is analogous to certification, the EUDR aims for complete producer coverage with regard to supplies imported into Europe and may therefore hope for a larger impact on deforestation but at the expense of over-riding elements of the sovereignty of producer country governments.

7. Gainers and losers

The EUDR will cause a combination of higher intermediation costs, substitution between EUDR-compliant and non-compliant producers, likely higher prices paid by European

[22] https://rspo.org/
[23] https://responsiblesoy.org/

consumers, and possibly higher prices to some EUDR-compliant producers. In Figure 8, I set out a simple model that allows analysis of these impacts.

I consider a specific EUDR commodity. The model makes the simplifying assumption that world production, European consumption and non-European consumption are all unaffected by the EUDR. This allows me to suppose that the world, i.e. extra-European, price of the commodity is unaffected. I also assume that, prior to the EUDR, producers self-sorted into supplying the European and non-European markets on the basis of relative intermediation costs. The model therefore focuses on the costs of EU-compliance and of diversion of supplies to and from the European market.

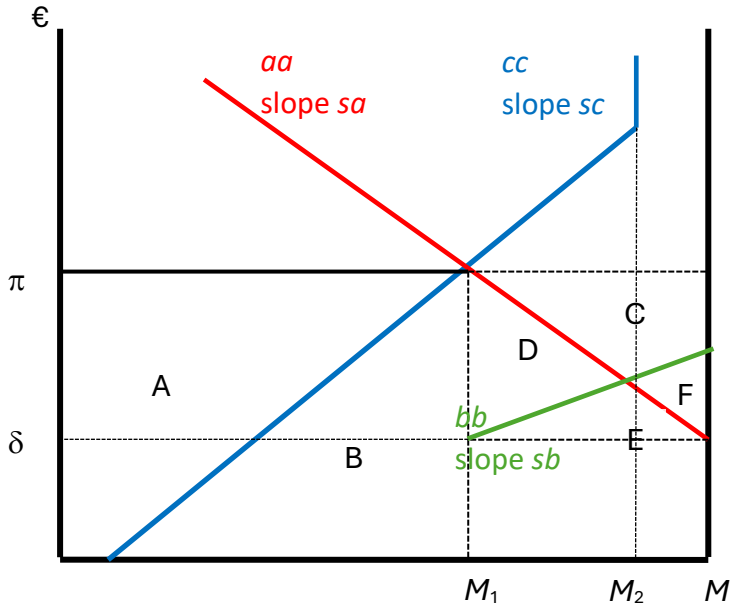

Figure 8: Simple analytical model

European imports, *M*, are measured along the horizontal axis. The vertical axis measures the price paid by European consumers net of the world price. The compliance cost for pre-EUDR suppliers is the line *cc* which is drawn as upward-sloping since costs will vary depending on the origin country, farm location and other factors. The final section of *cc* is drawn as vertical reflecting the possibility that a quantity M-M_2 might have been produced on deforested land and therefore could not be made compliant at any cost.

The line *aa* represents the supply curve of compliant commodity from producers who were not supplying European markets prior to the EUDR. This line is again seen as upward sloping, but reading from right to left. The line *aa* intersects the vertical axis at δ (> 0), representing the additional costs that these producers bear in supplying the European market. The lines *aa* and *cc* intersect at the quantity M_1 and premium π which equates marginal compliance costs to marginal diversion costs. The quantity M_1 is supplied by the "traditional" (pre-EUDR) suppliers and the quantity M-M_1 is diverted from the non-European market. (So long as marginal compliance costs are lower than π, these suppliers have no incentive to divert to the non-European market). The line *bb* represents the supply curve of

the non-compliant commodity diverted from the European market. For simplicity, I suppose that these quantities incur the same diversion costs δ.[24]

We can use Figure 8 to identify welfare gains and losses from the EUDR:

- European consumers pay the premium π on the entire quantity *M* imported. This implies a welfare loss of *A*+*B*+*C*+*D*+*E*+*F*.
- EUDR-compliant traditional suppliers supply the quantity M_1. They obtain the EUDR premium π and so obtain increased revenue *A*+*B* but bear the compliance costs given by triangle B. Their net gain is triangle *A*.
- Non-EUDR-compliant traditional suppliers divert quantity M-M_1 to the non-European market. Their additional costs are *E*+*F*.
- Non-traditional suppliers who divert the quantity M-M_1 to the European market obtain additional revenue *C*+*D*+*E*+*F* but incur additional costs of *D*+*E*. Their net gain is *C*+*F*.
- Summing, the net producer gain is *A*+*C*-*E* which is drawn as positive in Figure 8 but which would be negative if area *E* is sufficiently large.
- The overall welfare loss is *B*+*D*+2*E*+*F*. (The diversion costs *E* are borne both by the non-compliant traditional suppliers and by the non-traditional suppliers that replace them and hence enter this expression twice).

Overall, therefore, consumers lose from the EUDR by paying the EUDR premium. Compliant producers benefit from the premium but also pay higher intermediation costs. Non-compliant producers lose and bear additional costs in supplying non-European markets.

The premium and the size of the welfare costs and benefits will become clear once the Regulation becomes operative in 2025. However, we can use the Figure 8 model to advance some general considerations. I consider two latent factors:

- the European share σ of total import of the commodity, displayed in Table 1; and
- the smallholder share τ of smallholders in domestic production displayed in Table 2.

I hypothesize that marginal compliance costs, measured by the slope *sa*, will rise with the quantity of the commodity for which due diligence is required, so $dsc/d\sigma > 0$, and also with the proportion of producers that are smallholders, so $dsc/d\tau > 0$. Similarly, I hypothesize that marginal diversion costs, measured by the slope *sc*, will rise with the extent of diversion required, so $dsa/d\sigma > 0$ but I would not expect any clear relationship with τ. The diversion cost intercept δ will depend on commodity characteristics and production locations. It is unclear why δ would be related to the consumption or smallholder shares.

[24] The diagram implicitly assumes that the quantities M-M_1 both diverted by traditional suppliers onto the non-European market and diverted by non-traditional suppliers onto the European market are intra-marginal since otherwise there would be an impact on the non-European price.

Table 3 Possible premium levels				
	European share σ	Smallholder share τ	EUDR premium π (score/10)	
Beef	very low	low	3	low
Cocoa	very high	high	9	high
Coffee	very high	medium	8	high
Palm oil	medium	very high	8	high
Natural rubber	low	very high	7	medium
Soybeans	low	low	4	low
European shares (σ) from Table 1 (row 3): Under 3% = "very low", 4%-15% low; 16-30% = "medium", 30-40% = "high"; >40% ="very high". Smallholder share (τ) from Table 2, (column 3): Over 90%, "very high"; 80-90%, "high"; 60-70%, "medium"; under 60%, "low". Score: "very high" 5, "high", 4; "medium", 3; "low", 2; "very low", 1.				

We can use these hypotheses to obtain qualitative predictions of the likely premium levels arsing from the EUDR and hence the welfare costs and benefits. The calculations and results are displayed in Table 2 where I use a five-way classification for each of the European share, reported in Table 1, and for the smallholder shares estimated in Table 2. This allows me to obtain a score out of ten for the likely premium level by summing the scores in the two columns. On this, very crude, basis, the premium is seen as likely to be relatively high in the cocoa, coffee, and palm oil markets, but somewhat lower in the natural rubber market. I expect low premiums in the beef and soybean markets.

The analysis is crude and relates only to relative magnitudes. Ot says nothing about the absolute size of any premium and hence nothing on the absolute size of the welfare costs and benefits sketched in Figure 8. The discussion is premised on a lack of comparable regulations in other major consuming countries, in particular the United States and China. Such developments would raise diversion costs by eliminating alternative sales locations and hence would raise premiums and welfare costs and benefits.

8. Impact on deforestation

It is, of course, inevitable that, by moving away from the competitive allocation, the EUDR will impose net pecuniary costs. The substantive issue is whether these costs are offset by the benefits from reduced deforestation. The Regulation states as objective minimization of the EU's contribution to deforestation and forest degradation worldwide, thereby contributing to a reduction in global deforestation – see section 1. The Regulation will ensure a reduction in European imported deforestation but, to the extent that non-compliant supplies are diverted to other jurisdictions, it may have only a small effect on global deforestation.

As stated in section 7, a crucial consideration in this regard is whether similar regulations are introduced in other consuming countries. So long as there is large

unregulated market, diversion costs will be low and incentives to expand production will remain despite the EUDR. Diversion costs will be higher the smaller is the unregulated share of the world market.

China is a major consumer of natural rubber, palm oil and soybeans but accounts for only a small share of world cocoa and coffee consumption.[25] There is no reason to expect market-based pressure on non-European commodity processors to line up with the EUDR (a "Brussels effect") since processed products are largely sold on regional and not world markets – see section 4. Extension of deforestation controls to the North American market would make diversion very costly in cocoa and coffee but China will need to be involved for this to result in the other five EUDR commodities. Absent such an extension, the EUDR is likely to do more go calm the consciences of European voters with regard to deforestation arising from natural rubber, palm oil and soybeans production than to have a significant effect on deforestation itself. To quote Iswara er al. (2023), the EUDR will have "palmed off" responsibility for deforestation onto other consuming countries without significantly reducing its overall level.

This is a harsh judgment and may not apply to cocoa and coffee where Europe has large import shares – see Tables 1 and 2. In cocoa, where the expansion of cocoa production in Côte d'Ivoire is often seen as the driver of deforestation, the EU accounted for an average of 54.3% of Ivorian cocoa exports over the five crop year 2017/18 to 2021/22.[26] Renier *et al*. (2023) report a detailed analysis of deforestation in Côte d'Ivoire over the period 2000-15. The authors report that, over that period, 77% of the initial 6.8 Mha of tropical moist forest was deforested or degraded. 18% of this total (1.25 Mha, approximately 83,300 ha pa) was attributable to cocoa with the remainder to palm oil, natural rubber, food crops, logging and mining.[27] This is an estimate of the quantity $M\text{-}M_2$ in Figure 8. Cocoa yields vary enormously across farms depending in part on farm size, rainfall and the extent of inter-cropping. Taking a yield of 485 kg/ha[28] and supposing a constant rate of deforestation, I obtain an order of magnitude estimate that approximately 121 million metric tons (Mt) of Ivorian cocoa may currently (2023/24) be produced on land that has suffered deforestation or degradation over the three years since the EUDR cut-off date of end 2020. Annual Ivorian production averaged 2,094 Mt over the five crop years 2016/17 to 2020/21 so this gives an order of magnitude

[25] Average (mainland) China imports as shares of world production 2017-21: cocoa 1.6%, coffee 0.9%, palm oil 13.7%, natural rubber 17.5%,, soybeans 27.2%. (Bean equivalents in cocoa, coffee, and soybeans; oil equivalent in palm oil). Source: FAOSTAT.

[26] Bean equivalents. Source: ICCO, *Quarterly Bulletin of Cocoa Statistics*, various issues.

[27] The authors imply (*ibid*, page 7) that this may be an under-estimate since cocoa if often planted under forest cover with deforestation or forest degradation only becoming clear after three to five years once the new trees become productive and the cover is cleared.

[28] This figure is based on a study undertaken by Barry-Callebaut and Agri-Logic that reported a range of 350-620 kg/ha. Green, E, "Côte d'Ivoire cacao production: Barry Callebaut and Agri-Logic target yield, farm size and price", *Food Ingredients 1st* (5 May 2023). https://www.foodingredientsfirst.com/news/cote-divoire-cacao-production-barry-callebaut-and-agri-logic-target-yield-farm-size-and-price.html

estimate of 6% of the Ivorian crop (121,250 tons) that would fail to meet the EUDR import criteria. (There will be a further quantity, possibly larger, for which compliance costs will exceed the value of selling in Europe). This tonnage would need to be sold into non-European markets. It is possible that some of all of this quantity of cocoa would not have been produced if the EUDR had been effective in the past, but, once planted, trees are seldom grubbed up. The relevant issue is therefore how the Regulation will affect future forest clearing.

An implication of the EUDR is that future increases in production should come by raising yields from trees on existing cultivated land and on replanting on the same land when trees reach the end of their productive life. Yields of tropical commodity crops vary substantially across farms in the same country resulting in a large gap between potential yields. Research in cocoa shows that yield differences have many drivers, but the quality of farm management and fertilizer application are among the most important (Uribe *et al*., 2001; Hoffman *et al*., 2020). Coffee and palm oil yields can also be increased by fertilizer application (Cannell, 1973; Sanputawong *et al*., 2017). However, increasing fertilizer application is not straightforward. Fertilizers need to be purchased early in the crop year and hence financed out of the previous year's revenue or on credit. Development economists have stressed that, absent government schemes to provide fertilizer, poorer farmers are likely to be either limited by lack of collateral or will face high interest rates (Binswanger and Sillers, 1983). In these circumstances, some farmers may find it more attractive to expand planting, perhaps into currently forested area.

In cocoa, replanting on the same land is not always an attractive proposition. An old literature in economic geography sees cocoa as a "frontier crop" (Mikesell, 1960; Hill, 1963). Ruf *et al*. (2015, page 102) explain that "cocoa famers, often migrants, took advantage of the 'forest rent' of more fertile soil" when establishing new farms on cleared land, while ageing farms, on which this rent has been extracted, are seldom replanted with cocoa. Knudsen and Agergaard (2015, page 325) document how "The movement of the production of cocoa in Ghana from one region to another in search of fertile land and continued high outputs and revenues has resulted in successive openings of frontier land for cocoa production".

Ruf and Varlet (2017) suggest that the potential for further deforestation in Côte d'Ivoire may be small as most of the previously existing forest has been lost. The implication is that the EUDR is likely to have only a small impact on deforestation even over the longer term. The more important EUDR impact may come from discouraging deforestation in countries where production is increasing, in particular Brazil and Colombia, but also the DRC, Guinea, Liberia, and Madagascar which are currently only minor producers. If Ruf *et al*. (2015) are correct in arguing that cocoa only grows well under tropical cover, there is a danger that the EUDR, in conjunction with similar schemes in other consuming countries, may severely limit future supplies of cocoa by making planting of cocoa impossible in areas to tropical forest. From this perspective, the sustainability focus in cocoa should be on

managed planting and reforestation at the end of the (approximately) forty years of productive tree lifetime rather than on deforestation *per se*.[29]

9. Concluding comments

The EUDR imposes stringent due diligence requirements on importers of a group of seven agricultural commodities into the European Union with the objective of reducing deforestation in the producing countries. These requirements will not be limited to imports into the EU since the majority of importers in extra-EU European countries, in particular Switzerland and the UK, will also choose to comply in order to be able to export processed products into the EU.

EUDR due diligence will require importers to maintain and provide information on the deforestation status on the entire quantity of the commodity imported. This will often require information on a very large number of farms, particularly where the commodity is produced by smallholders. Supply chain intermediaries had no incentive to collect this information prior to the introduction of the EUDR. Furthermore, such information, if complied, would have been lost as the commodity moved through the supply chain. The EUDR therefore requires a complex and costly revolution in supply chain information keeping. It may also result in significant and costly restructuring of tropical commodity supply chains to the likely detriment of smallholders relative to larger producers, and to nationally-based supply chain intermediaries relative international trading companies.

Governments of the commodity-producing countries see the EUDR as unwarranted, and even imperialistic, intervention in their economies. These governments might be happier with a voluntary system of controls based on certification. The Roundtable on Sustainable Palm Oil provides a possible model but the evidence suggests that this scheme has had only a limited impact on deforestation and that certification costs leave many smallholder farmers outside the scheme. There is therefore a potential conflict between deforestation, supposing that the EUDR can deliver this, and respect for the sovereignty of producing country governments.

EUDR compliance will impose costs which will be compensated by the emergence of a premium for compliant supplies. European consumers will be obliged to pay this higher premium and will hence suffer a welfare loss. It is difficult to predict the likely scale of this premium prior to the Regulation becoming effective at the start of 2025. Nevertheless, it seems likely that the premium will be highest in the cocoa and palm oil markets. Traditional suppliers to the European markets who are able to comply with the EUDR will benefit from the premium but will bear compliance costs. Producers that are unable to comply will need to divert supplies to the non-European market thereby incurring diversion costs. It is not possible to state *a priori* whether or not producers, as a group, will benefit or lose but any

[29] Managed to ensure continuity of partial tree cover. Ruf and Varlet (2017) argue for certification of forest, and not cocoa, trees.

benefit will be lower than the costs to consumers. Given this net loss, European voters and governments must be persuaded that this will be offset by the gains arising from limiting deforestation.

The EUDR will reduce the extent to which deforestation is embodied in commodities and products imported into the EU, and Europe more widely but, unless similar regulations are adopted by other importing countries, the main impact is likely to be the diversion of non-compliant material to non-European markets. Only in cocoa and coffee, is the European share of global sufficiently large for there to be the potential of a significant impact on deforestation. Any such impact will materialize over time as new planting takes place. Coffee land can be replanted as trees age and yields decline and this may be sufficient to meet demand growth. Replanting cocoa land is less successful, and it is likely that new planting is more likely to take place away from the traditional producing areas.

In summary, the EUDR should result in a substantial reduction in the quantum of deforestation embodied in European commodity imports ("imported deforestation"). It will do this at substantial cost to European consumers without commensurate benefits to commodity producers, in particular smallholder farmers. Unless other consuming countries (particularly China and the United States) enact similar regulations, it will have little effect on deforestation in the beef, natural rubber, palm oil and soybean sectors. There may be some reduction in deforestation resulting from cocoa and coffee production but this will only happen as new planting takes place.

References

Almeida, D.V., V. Kolinjivadi, T. Ferrando, B. Roy, H.Herrera, M. Vecchione Gonçalves, and G. Van Hecken (2023). "The 'greening' of empire: The European Green Deal as the EU first agenda". *Political Geography*, 105, 102925.

Araujo Bonjean, C., and J-F. Brun (2016). "Concentration and price transmission in the cocoa-chocolate chain". Chapter 17 of M.P. Squicciarini and J. Swinnen (eds.), *The Economics of Chocolate*. Oxford: Oxford University Press.

Binswanger, H.P., and D.A. Sillars (1983). "Risk aversion and credit constraints in farmers' decision-making: A reinterpretation". *Journal of Development Studies*, 20, 5-21.

Bradford, A. (2020). *The Brussels Effect*. Oxford: Oxford University Press.

Brandi, C., T. Cabani, C. Hosang, S. Schirmbeck, L. Westermann, and H. Wiese (2015). "Sustainability standards for palm oil: Challenges for smallholder certification under the RSPO". Journal of Environment and Development, 24, 292–314.

Cannell, M.G.R. (1973). "Effects of irrigation, mulch and N-fertilizers on yield components of arabica coffee in Kenya". *Experimental Agriculture*, 9, 225-232.

Carlson, K.M., R. Heilmayra, H.K. Gibbs, P. Noojipady, D.N. Burns, D.C. Morton, N.F. Walker, G.D. Paoli, and C. Kremen (2018). "Effect of oil palm sustainability certification on deforestation and fire in Indonesia". *Proceedings of the National Academy of Sciences*, 115, 121-126.

Carodenuto, S., and M.M. Buluran (2021). "The effect of supply chain position on zero-deforestation commitments: evidence from the cocoa industry". *Journal of Environmental Policy and Planning*, 23, 1-16.

Cattau, M.E., M.E. Marlier, and R. DeFries (2016). "Effectiveness of Roundtable on Sustainable Palm Oil (RSPO) for reducing fires on oil palm concessions in Indonesia from 2012 to 2015". *Environmental Research Letters*, 11, 105007.

Cuny, C.J. (1993). "The role of liquidity in futures market innovations". *Review of Financial Studies*, 6, 57-78.

Curtis, P.G., C.M. Slay, N.L. Harris, A. Tyukavina, and M.C. Hansen (2018). "Classifying drivers of global forest loss" *Science*, 361 (6407), 1108–1111. https://science.sciencemag.org/content/361/6407/1108

European Union (2023). "Regulation (EU) 2023/1115 of the European Parliament and of the Council of 31 May 2023 on the making available on the Union market and the export from the Union of certain commodities and products associated with deforestation and forest degradation and repealing Regulation (EU) No 9". *Official Journal of the European Union*, L.150/206.

FAO (2020). *Global Forest Resources Assessment 2020. Main Report*. Rome: FAO.

Fold, N. (2001). "Restructuring of the European chocolate industry and its impact on cocoa production in West Africa". *Journal of Economic Geography*, 1, 405–420.

Fold, N. (2002). "Lead firms and competition in 'bi-polar' commodity chains: grinders and branders in the global cocoa-chocolate industry". *Journal of Agrarian Change,* 2, 228-247.

Forwood, G., C. Connellan, J. Killick and S. Nordin (2023). “10 key things to know about the new EU Deforestation Regulation”. London: White & Case. https://www.whitecase.com/insight-alert/10-key-things-know-about-new-eu-deforestation-regulation

Geist, H. and E. Lambin (2002). “Proximate causes and underlying driving forces of tropical deforestation”. *BioScience*, 52, 143–150.

Gilbert, C.L. (2009). “Cocoa market liberalization in retrospect”. *Review of Business and Economics*, 54, 294-312.

Gilbert, C.L. (2024). “Cocoa: origin differentials and the Living Income Differential”. *European Journal of Development Research*. https://doi.org/10.1057/s41287-023-00612-x

Goldman, E.D., M. Weisse, N. Harris, and M. Schneider (2020). “Estimating the role of seven commodities in agriculture-linked deforestation: Oil palm, soy, cattle, wood fiber, cocoa, coffee, and rubber”. Washington DC: World Resources Institute. https://www.wri.org/research/estimating-role-seven-commoditie-sagriculture-linked-deforestation-oil-palm-soy-cattle

Hansen, M.C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S.V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C.O. Justice, J.R.G. Townshend (2013). “High-resolution global maps of 21st-century forest cover change”. *Science*, 342, 6160, 850-853.

Hill, P. (1963). *The migrant cocoa-farmers of southern Ghana: a study in rural capitalism*. Cambridge: Cambridge University Press.

Hoffmann, M.P., J. Cock, M. Samson , N. Janetski , K. Janetski, R.P. Rötter , M. Fisher, and T. Oberthür (2020). “Fertilizer management in smallholder cocoa farms of Indonesia under variable climate and market prices”. *Agricultural Systems*, 178, 102759.

Hosonuma, N., M. Herold, V. De Sy, R.S. De Fries, M. Brockhaus, L. Verchot, A. Angelsen, and E. Romijn (2012). “An assessment of deforestation and forest degradation drivers in developing countries”. *Environmental Research Letters*, 7, 044009.

Hull, J.C. (2017). *Fundamentals of Futures and Options Markets* (8th edition). Boston: Pearson.

Iswara, M.A., D.S. Nurshadrina, and A. Suryahadi (2023). “European Union palming off deforestation regulation to smallholders in Indonesia”. *East Asia Forum*, 10 October 2023. https://doi.org/10.59425/eabc.1696975216

Knudsen, M.H., and J. Agergaard (2015). “Ghana’s cocoa frontier in transition: The role of migration and livelihood diversification”. *Geografiska Annaler. B, Human Geography*, 97, 325-342.

Lowder, S.K., J. Skoet, and T. Raney (2016). “The number, size, and distribution of farms, smallholder farms, and family farms worldwide”. *World Development*, 87, 16-29.

Lyons-White, J., and A.T. Knight (2018). “Palm oil supply chain complexity impedes implementation of corporate no-deforestation commitments”. *Global Environmental Change*, 50, 303-313.

Mikesell, M. W. (1960). “Comparative studies in frontier history”, *Annals of the Association of American Geographers*, 50, 62-74.

Pendrill, F., U.M. Persson, J. Godar and T. Kastner (2019). “Deforestation displaced: trade in forest-risk commodities and the prospects for a global forest transition”, *Environmental Research Letters*, 14, 055003.

Pendrill, F., T.A. Gardner, P. Meyfroidt, U.M. Persson, J. Adams, T. Azevedo, M.G. Bastos Lima, M. Baumann, P.G. Curtis, V. De Sy, R. Garrett, J. Godar, E.D. Goldman, M.C. Hansen, R. Heilmayr, M. Herold, T. Kuemmerle, M.J. Lathuillière, V. Ribeiro, A. Tyukavina, M.J. Weisse, and C. West (2022). “Disentangling the numbers behind agriculture-driven tropical deforestation”. *Science*, 377, 1168.

Perkins, R., and E. Neumayer (2011). “Does the ‘California effect’ operate across borders? Trading- and investing-up in automobile emission standards”. *Journal of European Public Policy*, 19, 217-237.

Renier, C. , M. Vandromme, P. Meyfroidt, V. Ribeiro, N. Kalischek, and E.K.H.J zu Ermgassen (2023). “Transparency, traceability and deforestation in the Ivorian cocoa supply chain”, *Environmental Research Letters*, 18, 024030.

Ruf, F., G. Schroth, and K. Diffangui (2015). “Climate change, cocoa migrations and deforestation in West Africa: What does the past tell us about the future?” *Sustainability Science*, 10, 101-111.

Ruf, F., and F. Varlet (2017). “The myth of zero-deforestation cocoa in Côte d’Ivoire”. *ETFRN News*, 58, 86-92. https://agritrop.cirad.fr/586983/

Ruysschaert, D., and D. Salles (2014). “Towards global voluntary standards: Questioning the effectiveness in attaining conservation goals. The case of the Roundtable on Sustainable Palm Oil (RSPO)”. *Ecological Economics*, 107, 438-446.

Sanputawong, S., K. Chansathean, N. Peakchantuk, and C. Chuiruy (2017). “Study of proper fertilizer management on growth and yield of oil palm (*Eleais guineensis* Jacq.)”. *International Journal of Agricultural Technology*, 13, 2631-2639

Santika, T., K.A. Wilson, E.A. Law, F.A.V. St John, K.M. Carlson, H. Gibbs, C.L. Morgans, M. Ancrenaz, E. Meijaard, and M.J. Struebig (2021). “Impact of palm oil sustainability certification on village well-being and poverty in Indonesia”. *Nature Sustainability*, 4, 109-119.

Staritz, C., B. Tröster, J. Grumiller and F. Maile (2022). “Price-setting power in global value chains: the cases of price stabilization in the cocoa sectors in Côte d’Ivoire and Ghana”. *European Journal of Development Research*, 35, 840-868.

UK Parliament (2023). “Introduction of forest risk commodities regulations”. *Statemen*t UIN HCWS117 (12 December 2023). https://questions-statements.parliament.uk/written-statements/detail/2023-12-12/hcws117

Uribe, A., H. Méndez, and J. Mantilla (2001). “Effect of balanced fertilization on cocoa yield”. *Better Crops International*, 15(2), 1-5. https://cadenacacaoca.info/CDOC-Deployment/documentos/Effect_of_Balanced_Fertilization_on_cocoa_yield.pdf

van Duijn, G. (2013). “Traceability of the palm oil supply chain”. *Lipid Technology*, 25, 15-18.

Vogel, D. (1995). *Trading Up: Consumer and Environmental Regulation in a Global Economy*. Cambridge (Mass.): Harvard University Press.

Weerdenburg, F. (2023). “From bean to green: EU Deforestation Regulation and the soy supply chain”. M.Sc. thesis, Wageningen University. https://edepot.wur.nl/642972

Zhunusova, E., V. Ahimbisibwe, L.T.H Sen, A. Sadeghi, A., T. Toledo-Aceves, G. Kabwe, and S. Günter (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 Economics*, 143, 102817.

zu Ermgassen, E.K.H.J, M.G. Bastos Lima, H. Bellfield, A. Dontenville, T. Gardner, J. Godar, R. Heilmayr, R. Indenbaum, T.N.P. dos Reis, V. Ribeiro, I. Abu, Z. Szantoi, and P. Meyfroidt (2022). “Addressing indirect sourcing in zero deforestation commodity supply chains”. *Science Advances*, 8, eabn3132.