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Deforestation

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Summary

Deforestation is a major source of global carbon emissions, but efforts to curb deforestation rates have faced significant challenges. In this VoxDevLit, we synthesise recent economic research that attempts to shed light on the path forward. Throughout, we **highlight policy implications and new directions for future research.**

We organise our discussion around four key points. First, **agricultural production is the main driver of deforestation globally**. From cattle ranching and soy in Brazil to palm oil in Indonesia, large producers are clear-cutting forests to convert land into agricultural plantations at industrial scale. This production fuels local economic development, giving rise to a fundamental policy trade-off between economic development and environmental protection. Second, **policy analysis requires careful modelling of firms and firm incentives**. Quantitative evaluation of conservation policies has benefited from new techniques for modelling land use, as well as the growing availability of granular satellite data. Third, **global interactions shape the impacts of forest regulation**. International markets are linked through trade, such that domestic forest regulation has meaningful spillover effects on foreign deforestation activity. Fourth, **regulation faces important political challenges**. Electoral incentives, political capture, and lobbying each undercut the establishment and enforcement of conservation policy.

We highlight several key takeaways for policymakers seeking to reduce deforestation. Such efforts should pair environmental protections with poverty reduction programmes, consider the market incentives and responses of private firms, prioritise both domestic and international policy coordination, and account for political frictions and constraints.

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I Introduction

Tropical deforestation represents one of the most pressing environmental challenges of our time. From 2001 to 2024, over 2.5 million km^2 of tropical forest was lost – an area about the size of France, Spain, Germany, and Italy combined. This forest loss contributes an estimated 14% of total global greenhouse gas emissions (Friedlingstein et al. 2019) and threatens biodiversity hotspots. The environmental consequences extend beyond carbon emissions to include local health impacts from air pollution, disrupted precipitation patterns, and the loss of critical ecosystem services that millions of people depend on for their livelihoods.

The vast majority of this deforestation occurs in low- and middle-income countries, where tropical forests face intense pressure from agricultural expansion, infrastructure development, and resource extraction. Unlike historical deforestation in temperate regions, driven primarily by timber harvesting, contemporary tropical deforestation is overwhelmingly motivated by converting forest land to agricultural use. This creates a fundamental tension between local economic development needs and global environmental protection, as the benefits of forest conversion accrue locally while the costs are borne globally. Understanding the economics of tropical deforestation is therefore crucial for designing policies that can balance development goals with environmental conservation.

Given the critical role of forests in climate change and the implications for economic development, deforestation and land use have been the focus of extensive research across disciplines, including climate science, land economics, and economics more broadly. The proliferation of satellite data, along with keen policy interest, has fuelled the rapid growth of work in this space.

This VoxDevLit synthesises recent economic research on deforestation, mainly in lower-income countries. We highlight recent developments within the economics literature, with an emphasis on the integration of satellite-based data – which provides spatially detailed information – and causal inference methods and quantitative economic modelling.

In **Section 2**, we present some background information on the two main hotspots of tropical deforestation, the Brazilian Amazon and Indonesia. Combined, they were responsible for about half of the global tropical deforestation over the last two decades (Hansen et al. 2013).

In **Section 3**, we examine development as the primary driver of deforestation, focusing on agricultural expansion and the complex relationship between productivity improvements and forest loss. We review the contentious debate over whether agricultural productivity gains lead to reduced or increased deforestation. The section also evaluates policy interventions designed to reduce agricultural expansion, including satellite monitoring systems, credit restrictions, and protected areas, while examining how poverty alleviation and conservation goals can be aligned through careful programme design.

In **Section 4**, we review the application of structural economic models to understand deforestation patterns and evaluate policy effectiveness. These sophisticated quantitative models enable policymakers to assess the cost-effectiveness of various policy instruments. The evidence discussed here suggests that market-based approaches, such as payments for conservation, have great potential to preserve forests and can be cost-effective.

In **Section 5**, we analyse how international trade and spatial economic linkages shape deforestation outcomes. The literature reveals that trade policies generate both direct effects in targeted regions and indirect impacts that propagate across space through trade networks, making comprehensive spatial modelling essential for accurate policy evaluation. We examine evidence on how transportation infrastructure, supply chain governance, and regional trade agreements influence forest outcomes, while highlighting the importance of international coordination for effective environmental policies.

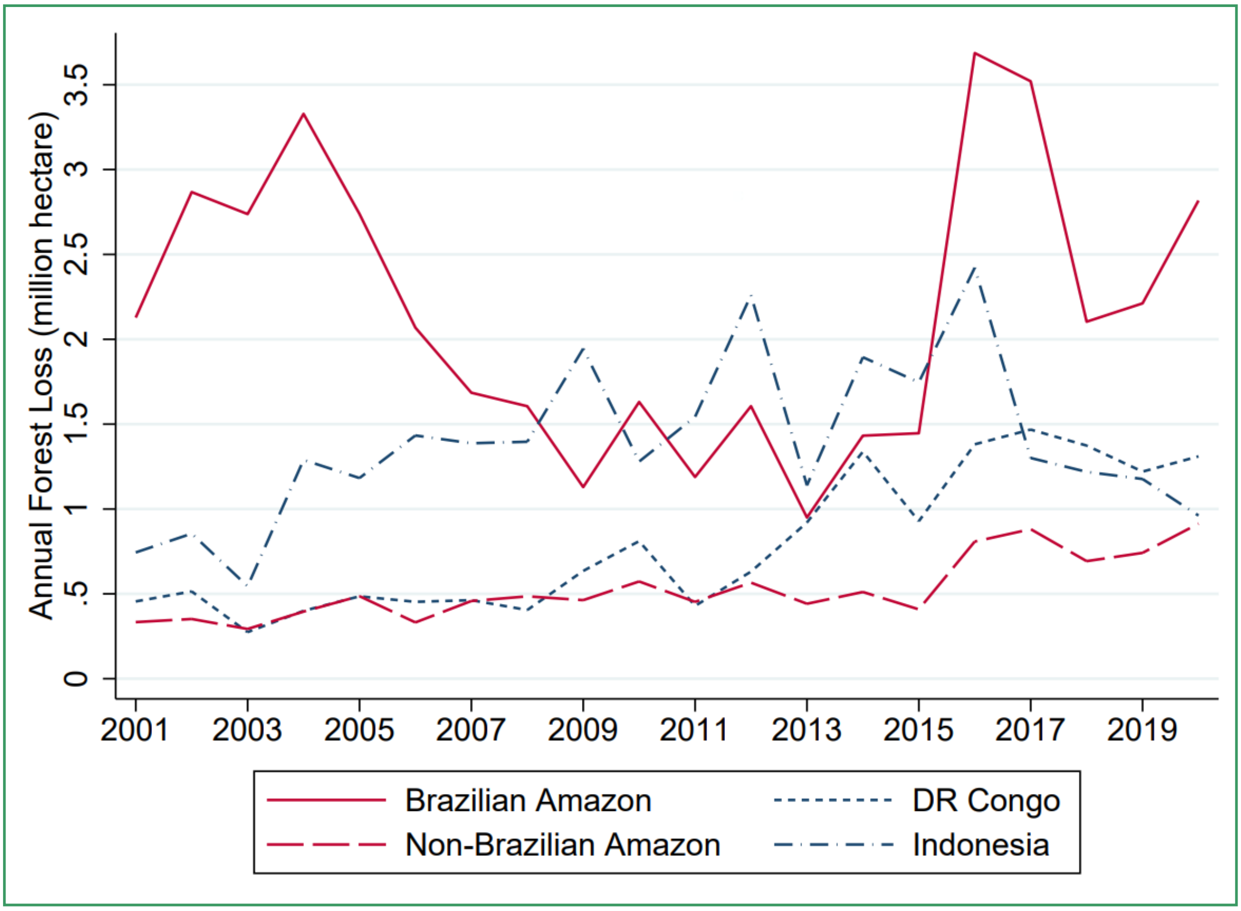
In **Section 6**, we explore the critical role of political economy factors in determining the feasibility and effectiveness of forest conservation policies. The research demonstrates that political concerns – driven by the distributional impacts of regulation – often constrain policy implementation. We review evidence on how electoral cycles, local political capture, and lobbying systematically undermine conservation efforts, suggesting that durable forest protection requires policies designed to navigate political resistance and align local economic interests with conservation goals.

II Background

We highlight two important tropical ecosystems: the Brazilian Amazon and the Indonesian rainforest. Both are under threat from agricultural expansion. As Figure 1 shows, these two countries have consistently ranked as the top two countries for annual forest loss between 2001 and 2024, with deforestation rates that substantially exceed those of other tropical forest countries, including the Democratic Republic of Congo and other Amazon basin countries.

While tropical forests in Africa, particularly in the Democratic Republic of Congo, represent a substantial portion of global forest cover, this review focuses primarily on Brazil and Indonesia for two reasons. First, as Figure 1 demonstrates, deforestation rates in Africa have been substantially lower than in these two countries over most of the past decades. Second, there is remarkably little rigorous economic research on deforestation in the African context.

Figure 1 Forest Change in the Amazon, DR Congo and Indonesia, 2001-2020



This figure (from Burgess et al. 2023) compares annual forest loss in the Brazilian and non-Brazilian Amazon, the Democratic Republic of the Congo, and Indonesia, based on data from Hansen et al. (2013).

IIa The Brazilian Amazon

Brazilian law defines and protects the Legal Amazon (*Amazônia Legal*), a region that covers the majority of the Amazon rainforest, which also extends into neighbouring countries like Colombia and Peru. In particular, the Brazilian Forest Code imposes several restrictions on forest conversion, including no clearing land near rivers and a requirement that landowners must maintain 80% of their property in the Legal Amazon as forested land. However, enforcement of such rules has been weak, leading deforestation rates to rise to alarming levels by the early 2000s.

The Brazilian government responded to these rising levels of deforestation by strengthening regulation. In 2004, the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm) aimed to reduce deforestation rates. Technological innovations like DETER, a satellite-based monitoring system, allowed for real-time detection of forest loss (Assunção et al. 2023b). Deforestation on untitled land was reclassified as a felony punishable by prison, and protected areas were expanded (Soares-Filho et al. 2010, Harding et al. 2021). The deforestation rate fell by roughly half over the period from 2005 to 2012 (Burgess et al. 2023).

However, the enforcement of these regulations was weakened in the decade that followed. In 2012, the New Forest Code granted amnesty to lands that were illegally deforested before 2008 (Soares-Filho et al. 2014, Freitas et al. 2018). From 2013 to 2016, there were large cuts to the budget of Brazil's environmental agency (IBAMA) (CGU 2016), and Brazil experienced broad political realignment toward candidates that supported agricultural expansion. The result was a resurgence in deforestation and the reversal of prior gains (Rochedo et al. 2018, Burgess et al. 2023).

IIb The Indonesian Rainforest

The Indonesian forest estate (*kawasan hutan*), which covers roughly 70% of Indonesia's land area, is officially owned by the central government. The forest estate includes protected areas, which are conserved, and production forests, which can be leased for commercial activity that includes agriculture, logging, and mining. Agricultural use typically involves clear-cutting, often by palm oil producers and often with fire (Balboni et al. 2024). Palm oil plantations now occupy 15% of total land area in Indonesia and Malaysia (Hsiao 2025). The palm oil industry accounts for a large share of agricultural production in Indonesia, which supplies over half of the world's palm oil. Palm oil is then used as a key ingredient in a wide range of goods that include food products, consumer goods, and biofuels.

A distinct feature of Indonesian deforestation is the destruction of peatland forests. Peatland forests are wetlands that are major carbon stores, housing swampy layers of decomposing organic matter – peat – that is often several metres deep. The draining and clearing of this peat layer has severe carbon consequences that greatly exceed those from the clearing of non-peatland forest. The establishment of the Peatland Restoration Agency (*Badan Restorasi Gambut*) recognises the importance of peatlands, but domestic efforts to regulate have faced broad challenges in curbing deforestation, including in protected areas (Busch et al. 2015).

III Economic Development and Agriculture

Agricultural expansion is the dominant driver of tropical deforestation worldwide: cattle ranching and soy cultivation in Brazil, oil palm plantations in Indonesia, and subsistence farming across the tropics (Balboni et al. 2023). On one hand, agricultural growth provides food security and rural incomes, often serving as the foundation for structural transformation in developing economies. On the other hand, agricultural expansion imposes significant environmental costs through greenhouse gas emissions and biodiversity loss. Policymakers must navigate this trade-off, as efforts to boost rural productivity and incomes can inadvertently accelerate forest loss unless accompanied by effective conservation measures.

IIIa Agricultural Productivity

One of the most contentious debates in the economics of deforestation centres on whether making farmers more productive helps or hurts forests. This debate centres on two competing hypotheses with radically different policy implications.

Theory

The *Borlaug Hypothesis*, named after Nobel laureate Norman Borlaug, suggests that productivity improvements allow farmers to produce more food on existing land, reducing pressure to clear additional forests. This ‘land-sparing’ view holds that agricultural intensification can satisfy growing food demand without expanding cultivated area.

The *Jevons Paradox* offers the opposite prediction: productivity improvements make agriculture more profitable, raising the opportunity cost of leaving land forested and incentivising farmers to convert more forest to farmland.

Farrokhi et al. (2025) help reconcile these competing views by showing that outcomes depend on demand elasticity. When demand is highly responsive to price changes (i.e. elastic), productivity gains lead to large increases in area cultivated, supporting Jevons. When demand is less responsive (i.e. inelastic), productivity gains mainly reduce prices without expanding area, supporting Borlaug.

Evidence

Research has shown that productivity improvements can spare land and reduce deforestation, particularly in smallholder settings. Abman et al. (2020) studied Uganda’s agricultural training programme using spatial discontinuity in village eligibility. The programme reduced deforestation by 14% in the short run by helping farmers intensify production through improved techniques rather than expanding to new areas. Abman and Carney (2020) found that input subsidies for small-scale agriculture in Malawi reduced deforestation in the short run. Assunção et al. (2016) showed that rural electrification in Brazil improved crop farming productivity relative to cattle ranching and reduced forest loss.

On the other hand, research has also found that productivity improvements can accelerate deforestation. Carreira et al. (2024) studied Brazil’s adoption of genetically engineered soy seeds introduced in 2003. Municipalities with greater potential gains from adopting the new technology experienced faster deforestation as farmers expanded soy cultivation into previously forested areas. The key difference is economic context: Brazil’s soy expansion occurred in large-scale commercial agriculture with substantial government-subsidised credit and strong international demand, enabling agricultural frontier expansion into forests.

These seemingly contradictory findings make sense when viewed through economic conditions and institutional context. Small-scale agriculture with limited access to credit and capital markets tends to support Borlaug, as productivity improvements lead to intensification on existing land. Large-scale agriculture with mobile capital supports Jevons, as improvements attract resources and enable frontier expansion. Crops destined for elastic international markets are more likely to generate expansion, while crops for inelastic local markets promote intensification (Farrokhi et al. 2025).

IIIb Policy Interventions

Policymakers have experimented with various interventions to limit agricultural expansion into forests while preserving rural development opportunities. Most rigorous evidence comes from Brazil’s Action Plan for the Prevention and Control of Deforestation in the Legal Amazon, which implemented multiple policies simultaneously in the 2000s.

Monitoring and Enforcement

Brazil developed sophisticated satellite-based monitoring that revolutionised deforestation detection. The Real-Time System for Detection of Deforestation (DETER) processes satellite imagery to issue near-real-time alerts, enabling quick environmental authority response. Assunção et al. (2023) exploited cloud coverage blocking satellite visibility as natural variation and found that increasing enforcement by half decreases municipal deforestation by 25%. Ferreira (2023) documented the complete chain from satellite detection to deforestation reduction, finding that real-time alerts increased inspection probability by two percentage points. Gandour et al. (2019) found that this monitoring system, which focused on detecting the clearing of primary forests, had the unanticipated consequence of increasing forest regeneration as well.

Financial Restrictions

Brazil pioneered using agricultural credit policy as an environmental tool. Through Resolution 3545 in 2008, Brazil made rural credit in the Amazon conditional on environmental compliance and legal land titling. Assunção et al. (2022) found that the policy led to 60% less deforestation than would have occurred otherwise. The mechanism was straightforward: reduced credit disbursements, with 75% of the effect driven by a reduction in cattle ranching loans – the primary driver of deforestation in the Amazon.

Place-Based Policies

One extremely popular policy tool to preserve forests is protected areas. A comprehensive review by Reynaert et al. (2024) found that protection had modest impacts on forest cover in most cases, with stronger effects only in areas facing genuine development pressure rather than “paper parks” with little economic potential. Many protected areas may be established in locations with low economic value, limiting their conservation additionality. Furthermore, enforcement capacity and political commitment vary substantially across contexts, affecting their effectiveness.

In contrast to traditional protected areas, Brazil developed a more targeted approach through its “Priority List” of municipalities subject to intensified monitoring starting in 2008. Assunção et al. (2023a) found the Priority List reduced deforestation by 43% in targeted municipalities. More importantly, they developed optimisation methods showing that a perfectly targeted list would have achieved 10% lower carbon emissions.

Heterogeneous and Dynamic Policy Effects

Policy effectiveness varies across locations and time. Harding et al. (2021) documented that different conservation policies implemented in the Amazon had varying effectiveness depending on commodity prices, which influence the underlying deforestation pressure. Burgess et al. (2023) used Brazil’s international borders to track policy effectiveness over time. They documented three periods: 2001-2005 when Brazilian deforestation rates were three times higher than across borders; 2006-2013 when differences disappeared as Brazil implemented strong policies; and 2014-2020 when differences re-emerged as regulations weakened. This reveals that even effective policies can lose impact when political support erodes.

IIIc Poverty Reduction

A critical challenge is ensuring that environmental policies do not undermine poverty reduction goals - an issue which is particularly acute in tropical forest regions with high poverty and limited non-agricultural opportunities.

Cash Transfers

Programme design critically affects environmental outcomes. Alix-Garcia et al. (2013) studied Mexico's (means-tested) conditional cash transfer programme and found that additional income increased deforestation through higher consumption of land-intensive goods. In contrast, Brazil's *Bolsa Verde* programme demonstrates that transfers can achieve both poverty reduction and forest conservation when designed with explicit environmental goals. The programme paid extremely poor households in forested areas with payments that were associated with regional forest cover, creating collective incentives for conservation. Wong et al. (2025) found Bolsa Verde reduced annual deforestation. Evaluating *Bolsa Floresta*, direct conditional payments in preservation areas, Cisneros et al. (2022) find small conservation effects from the programme. Simonet et al. (2018) estimate significant reductions in deforestation from a pilot project to Reduce Emissions from Deforestation and forest Degradation (REDD+) in the Brazilian Amazon that targeted smallholders. Cash transfers can also be administered in the form of employment. Pagel and Sileci (2025) find that a large-scale tree-planting programme in the Philippines achieved poverty reduction through job creation.

Direct compensation for conservation can align incentives effectively (Alix-Garcia and Wolff 2014). Jayachandran et al. (2017) conducted a randomised trial in Uganda offering forest-owning households annual payments for conservation. Tree cover declined by only 4.2% in treatment villages versus 9.1% in controls, with social benefits 2.4 times larger than costs. But, implementation challenges often undermine effectiveness. Jack et al. (2025) found that standard contracts paying after verification did not affect crop residue burning in India. However, incorporating partial upfront payment increased compliance by 10 percentage points, highlighting the importance of addressing liquidity constraints and farmer distrust. Jack and Jayachandran (2019) argue that enrolment costs can improve programme effectiveness by deterring participation from those who would have conserved regardless of payment. This suggests that some friction in programme access may be beneficial for targeting.

One challenge of implementing transfers conditional on conservation is that in some countries deforestation is already illegal, subject to high penalties (like in Brazil). Thus, it is difficult to design an institutional framework that pays farmers not to do what they are already prohibited from doing.

Alternative Development Pathways

Tourism provides forest-friendly development opportunities. Saavedra (2025) conducted the first randomised trial of ecotourism promotion in Colombia, finding significant decreases in deforestation around ecotourism sites alongside increased tourism and employment. Linsenmeier (2025) used economic modelling to show that tourism in Brazil helped preserve natural land equivalent to the total deforested area over the past 20 years by providing alternative rural employment. McGahan and Pongeluppe (2023) show how private companies can invest in sustainable conservation activities and in protecting natural habitats as a product differentiation strategy, enabling them to signal environmental responsibility and charge premium prices while generating conservation benefits.

IIId Policy Takeaways

We highlight several key insights for balancing economic growth with forest conservation.

- **Agricultural productivity**. Productivity programmes should explicitly promote intensification over expansion. We note that the impact of these programmes will depend on the context: we would expect higher deforestation in commercial agriculture with mobile capital and elastic international demand, but reduced deforestation in smallholder settings with factor constraints and inelastic local demand.

- **Policy Interventions.** Satellite monitoring represents a breakthrough in enforcement capability but requires sustained political commitment. Financial policy is powerful – making credit conditional on environmental compliance effectively limits agricultural expansion. Data-driven targeting can substantially improve the cost-effectiveness of place-based policy.
- **Poverty and Conservation.** Cash and asset transfer programmes can increase or decrease deforestation depending on design. Addressing liquidity constraints and trust issues dramatically improves conservation programme effectiveness. Well-designed programmes can achieve both poverty reduction and environmental protection simultaneously.
- **Sustained Commitment.** Even highly effective policies lose impact when political support erodes. Building durable coalitions and designing robust institutions are crucial for long-term conservation success.

IV Modelling Firms and Policy

During the 1990s, empirical studies of deforestation increasingly drew on economic models which assumed that land is allocated across alternative uses to maximise economic returns, with a predominant focus on tropical regions (e.g. Reis and Guzman 1992, Nelson and Hellerstein 1997, Pfaff 1999, Cropper et al. 1999). Researchers commonly used static multinomial logit models to estimate probabilities of various land-use choices – retaining forest cover, converting to pasture, or cultivating crops – as functions of factors influencing agricultural profitability. This early research highlighted the importance of land characteristics (such as soil quality) and transportation costs in explaining deforestation.

Agricultural and Land-Use Policies

Building on this literature, Souza-Rodrigues (2019) developed a static structural model to assess the cost-effectiveness of alternative policies in the Brazilian Amazon in 2006. By exploiting regional variation in transportation costs to recover farmers' responses to permanent changes in land-use returns, he finds that counterfactual payment programmes to avoid deforestation and land-use taxes on agricultural land can be highly effective in preserving the rainforest and substantially less costly than existing command-and-control policies that restrict agricultural area on private properties. This finding has important implications for conservation finance: market-based instruments can promote forest protection.

Yet, land-use change is inherently dynamic, with landowners making decisions that depend on current prices, expectations of future prices, and switching costs, such as forest clearing (Stavins and Jaffee 1990, Stavins 1999). These dynamic elements create differences between short- and long-run land-use elasticities, as permanent price increases can justify fixed costs of land conversion. In contrast, temporary price fluctuations may not (Scott 2013). This creates an external validity problem for static models: estimates based on short-term variation may not accurately predict the long-run effects of lasting policy changes.

Recent dynamic models address these issues by accounting for dynamic elements that influence land-use choice, allowing policy analysis to distinguish between transitional and long-term dynamics. Araujo et al. (2025b) examined deforestation dynamics and conservation policies in the Brazilian Amazon between 2008 and 2017, estimating the carbon-efficient level of forest cover – the amount preserved if farmers internalised the social cost of carbon. Compared to this efficient benchmark, business-as-usual results in massive deforestation, releasing 42 billion tonnes of CO_2 due to an inefficient loss of 1.2 million km^2 of forest cover – clearing equivalent to twice the size of France. A carbon tax aligned with the social cost of carbon would prevent this loss and generate over $1.6 trillion in social welfare gains. Importantly, a second-best policy, such as a tax on cattle ranching, captures up to 87% of the welfare gains from the carbon tax. This highlights that targeted sectoral policies, although second-best, may deliver significant environmental benefits.

Assunção et al. (2025) also developed a dynamic spatial model, focusing on ambiguity in location-specific agricultural productivity and carbon absorption capacity, to evaluate carbon pricing policies in the Brazilian Amazon. They also find that modest carbon prices could generate significant reductions in greenhouse gas emissions.

Scott et al. (2025) study cattle management dynamics, emphasising cattle's dual role as both a consumption and a capital good. Temporary price spikes encourage ranchers to cull more cattle immediately, thereby shrinking future herd size and reducing incentives for deforestation. Persistent price increases lead ranchers to retain breeding cattle and expand herds. They show deforestation is largely unresponsive to temporary price shocks but highly elastic to persistent price changes. They also find that deforestation taxes can benefit farmers in the long run by raising beef prices and increasing profits per hectare.

Deforestation and Precipitation

Araujo (2024b) provides the first integration of climate feedback effects into structural land-use models. The Brazilian Amazon sustains rainfall by recycling moisture through evapotranspiration – the "flying rivers" mechanism (Nobre et al. 1991, Marengo et al. 2004). Deforestation can disrupt this cycle, reducing rainfall and agricultural productivity downwind (Spracklen et al. 2012). Araujo (2024b) develops a framework integrating climate and economic land-use models and finds that having more forest upwind is associated with more rainfall. As an application, he simulates the rollback of protections for the Xingu Indigenous Territories in Mato Grosso. If unprotected, 47% of Xingu would be deforested, generating a climate externality by reducing rainfall by 20% in downwind regions, thus reducing crop yields and leading to the conversion of 60,000 km² of agricultural land to forest due to abandonment. This climate externality offsets 40% of the gains from expanding agricultural land into protected areas. This suggests traditional cost-benefit analyses may significantly underestimate the benefits of conservation by neglecting climate feedback.

Energy and Deforestation

Sant'Anna (2024) examines the deforestation footprint of biofuels by studying sugarcane ethanol supply in Brazil. He notes that sugarcane is a crop with declining yields over time until fields are replanted, motivating a dynamic model that disentangles the roles of acreage (extensive margin) and yields (intensive margin) on ethanol supply. He finds that 92% of new ethanol production comes from increases in planted area, 19% of which is direct deforestation. This highlights how biofuel policies intended to reduce carbon emissions may inadvertently increase them through land-use change effects.

Araujo (2024a) shows that deforestation, by reducing precipitation downwind, has sizeable implications for hydroelectric generation. Using an econometric climate model that connects deforestation with rainfall patterns, he finds that Amazon deforestation since the 1980s has reduced rainfall by 8-13% in Mato Grosso, Brazil. For the Teles Pires hydropower plant – one of Brazil's ten largest – this translates to 2.5-10% reduction in energy generation capacity, representing an annual loss of approximately 10% of the plant's revenue.

Market Design

The role of market design in achieving environmental goals is an important topic of growing empirical interest. Aronoff and Rafey (2025) study wetland conservation and offset markets in Florida, finding that offset markets generated substantial private gains from trade relative to direct conservation. At the same time, offset trading also produced unintended hydrological externalities by affecting flood risk. Aspelund and Russo (2025) investigated market design for the US Conservation Reserve Programme, linking auction bids to satellite-based land-use data. They find the programme generates $126 million per auction in welfare gains but captures only 15% of potential efficiency, partly because 75% of marginal winners would have conserved anyway. They propose alternative scoring rules accounting for expected additionality, closing 41% of the efficiency gap. Heilmayr et al. (2020) studied the carbon impacts of forest subsidies in Chile between 1986 and 2011. They find that while payments for afforestation increased tree cover, they also incentivised the plantation of exotic species at the expense of native ones. This illustrates that conservation programmes must be carefully designed to achieve intended environmental outcomes rather than simply maximising tree cover.

Future Work

The empirical literature on deforestation has progressed from documenting its key determinants to developing structural models that enable policy simulations and discussion of optimal policy design. Early studies relied on static, spatially explicit models, while more recent work incorporates dynamic frameworks and climate feedback loops. Future work can go further by developing new analytical tools for modelling and estimating dynamics, integrating scientific modelling of climate phenomena. Complementary advances in market design emphasise the role of carefully structured mechanisms, such as offsets and auctions, in improving conservation outcomes. Future work in this vein will inform ongoing efforts to establish voluntary and mandatory carbon markets, including on an international scale.

IVa Policy Takeaways

Structural models of firms and firm incentives provide crucial insights for policy.

- **Market Incentives.** Market-based instruments like payments for conservation and land-use taxes can be very cost-effective and generate enormous welfare gains. Second-best sectoral policies targeting the major drivers of deforestation, such as cattle ranching, can capture most of the benefits.
- **Dynamic Responses.** Policy effectiveness depends critically on whether changes are perceived as temporary or permanent. Policies should account for these dynamic responses in their design.
- **Programme Design.** Conservation programmes must be carefully designed to achieve intended outcomes and additionality. Simple metrics like tree cover may miss important environmental goals like biodiversity preservation.
- **Climate Feedbacks.** Traditional cost-benefit analyses may underestimate conservation benefits by ignoring climate feedback. Protected areas may be more economically justified than previously recognised, particularly where forests provide crucial rainfall for agriculture.

V Trade and Migration

A growing body of research employs quantitative spatial economy models to examine how trade influences deforestation (for wider reviews on the environmental implications of trade, see Copeland et al. 2022, Cherniwchan and Taylor 2022). At the core of this literature is the idea that the spatial distribution of consumers and producers – and the trade linkages connecting them – matters for understanding the aggregate effects of policy. Trade policies, such as improved transportation or tariff changes, generate both direct effects in targeted regions and indirect effects that propagate across space through trade and migration. Capturing the full impact of such policies on forest loss, therefore, requires methods that can quantify both these direct and indirect effects.

Spatial Linkages

We start with a series of recent papers that examine the impact of various deforestation policies on Brazil's forests. First, Asher et al. (2020) studied the deforestation impact of transportation infrastructure, finding that upgrading national highways has sizable effects on deforestation. Madhok (2025) documents that forest encroachment by transport and other infrastructure accounts for 20% of species loss in India. Araujo et al. (2025a) adapts the market access approach designed by Donaldson and Hornbeck (2016) to assess the general equilibrium effects of transportation infrastructure using detailed data on transportation networks. They find that failing to account for the indirect effects of locally targeted infrastructure projects would underestimate their total deforestation impact by about a quarter.

Second, using the trade and land-use framework of Sotelo (2020) and Farrokhi et al. (2025), Gollin and Wolfersberger (2024) show that road expansion since the 1990s accounts for roughly one-tenth of total deforestation in Brazil. Third, Leite-Mariante and Restrepo (2024) develop a dynamic spatial economy model and finds that anti-deforestation policies trigger spatial leakages that unfold gradually over several years. Fourth, using a longer time series dataset, Akerman (2025) examines how Brazil's demographic transition influenced deforestation across regions and finds that the slowdown in population growth significantly contributed to curbing deforestation.

Beyond Brazil, Balboni et al. (2024) study forest fires in Indonesia and highlight the role of spatial externalities. Forest fires set for land-clearing purposes often spread to neighbouring plots of land, giving rise to potential uninternalised externalities.

Supply Chains

Market incentives and policies can affect deforestation through supply chain linkages (for a review on deforestation supply-chain initiatives, see Lambin et al. 2018). Dominguez-Iino (2025) examines how tariffs influence deforestation using a spatial economy model in which farmers sell their output to multinational firms in imperfectly competitive markets in South America. The key insight is that these firms exert monopsony power, setting a wedge between producer and consumer prices. As a result, the impact of tariffs depends on the local degree of competition among multinational firms. Since international firms are often less present in remote areas – where carbon density is greatest – tariff increases have lower pass-through to local farmers, weakening the intended policy effect precisely where potential carbon emissions from deforestation are highest.

Barrozo (2025) shows that carbon emissions in the Amazon beef supply chains are highest among small, informal domestic players and intermediaries – not exporters. Because exporters face external pressure to meet standards, they tend to be more efficient and cleaner. As a result, policies focused only on exporters risk ignoring major domestic contributors to emissions.

Global Perspectives

Another paper examining deforestation across a broader set of countries is Hsiao (2025), which focuses on Indonesia and Malaysia. These countries account for 84% of global palm oil production, which is a major driver of forest loss and carbon emissions. The study considers multiple destination countries for palm oil exports and highlights a key coordination problem: if only a subset of countries imposes tariffs on palm products from Indonesia and Malaysia, then global prices decline and prompt unregulated markets to increase their imports. Unilateral tariffs are therefore less effective than coordinated tariffs in mitigating deforestation. The study also quantifies the benefits of committing to long-run regulation, noting that deforestation responds only weakly to short-run regulation. Harstad (2012) offers a contrasting view for fossil fuels, arguing in a theoretical setting that a conservation coalition can avoid issues of leakage and commitment by directly purchasing foreign deposits and choosing to conserve them. In practice, this approach relies on enforcement by local authorities.

Complementing the papers above, which focus on particular regions or countries, Farrokhi et al. (2025) examine deforestation from a global perspective. Their analysis develops new analytical results showing how reductions in trade costs shape global deforestation. Two key insights emerge. First, global trade cost reductions can lead to an increase in total forest area – provided that demand for agricultural goods is sufficiently inelastic. In this case, lower trade costs enable countries to source their food more efficiently across borders, producing the same amount of agricultural output with less agricultural land. Second, the correlation between comparative advantage and absolute advantage plays an important role in determining global forest area. While comparative advantage determines which countries specialise in agriculture, absolute advantage governs how much land is required in production. If countries with a comparative advantage in agriculture also have a higher absolute advantage, free trade can lead to lower global land use for agriculture. The authors develop and calibrate a dynamic spatial economy model that captures these insights and find that global reductions in trade costs can increase global forest area. However, they may simultaneously drive deforestation in specific regions with comparative advantage in agriculture, including Brazil and Canada.

Another recent paper that adopts a global perspective on deforestation is Mishra (2025). The paper applies the discrete choice framework used by Araujo et al. (2025b) and Souza Rodrigues (2019) to grid-level data on global deforestation, comparing private profits from deforestation since the 1980s with estimates of the social cost of carbon. The author then argues that a global Pigouvian tax on deforestation would be more efficient under free trade.

Regional Trade Agreements

Trade agreements often increase pressure on forests. A global panel study reveals that regional trade agreements (RTAs) have led to significant post-enactment deforestation in developing countries, primarily driven by agricultural expansion (Abman and Lundberg 2020). However, new evidence shows that environmental provisions in RTAs can offset these effects. When RTAs include clauses on forest protection or biodiversity, they mitigate the increase in deforestation observed in agreements without such provisions (Abman et al. 2024).

Future Work

Looking ahead, we see three directions for future research within this literature. First, incorporating more institutional dimensions of deforestation – such as enforcement capacity, land tenure, and governance – and studying how these interact with the spatial organisation of the economy. Second, improving the design of optimal trade agreements using quantitative models. While there has been theoretical progress in this area, including Harstad (2024), there remains a need for more quantitative work. Third, most existing studies assume representative agricultural producers. Future work could benefit from explicitly modelling farm-size heterogeneity and scale, which are important in shaping agricultural productivity.

Va Policy Takeaways

We emphasise several implications for trade and migration policy.

- **Policy interactions**. Trade and migration linkages have important interactions with trade policies, shaping their ultimate impact on forest outcomes.
- **Unintended consequences.** Infrastructure investments can have unintended deforestation consequences that are significantly larger when indirect spatial effects are considered.
- **Market structure.** Supply chain policies must account for the structure of markets. Targeting exporters may miss informal domestic actors responsible for the highest emissions.
- **International coordination**. International coordination is crucial for effective trade-based environmental policies, as unilateral actions can create leakage effects that undermine policy goals.

VI Politics and Lobbying

Political concerns constrain the feasibility and impact of forest regulation. These political concerns are driven by the distributional impacts of regulation, which create gains for some and losses for others. In curbing deforestation, countries like Brazil and Indonesia forgo local economic gains for global climate benefits. Importantly, local agents are typically aligned in favouring continued deforestation activity, which creates jobs for local voters, generates profits for local firms, and produces tax revenue for local governments.

Political Incentives

Political incentives shape the enforcement of environmental regulation. In Indonesia, Burgess et al. (2012) highlight the role of local officials' incentives in driving deforestation for illegal logging. Balboni et al. (2021) show that forest fires follow electoral cycles, perhaps as politicians avoid regulating during politically sensitive times. Cisneros et al. (2021) find that deforestation rises in the year before local mayoral elections and that palm oil prices amplify pre-election deforestation. More broadly, Hsiao and Kuipers (2025) document persistent inaction among politicians on environmental issues, including forest regulation.

In Brazil, Pailler (2018) shows deforestation increases in the years when mayors run for re-election. Braganca and Dahis (2022) document that forest reforms shifted political incentives, leading to larger declines in deforestation in municipalities governed by farmer politicians, and Cisneros and Kis-Katos (2024) document that randomised fiscal audits increased deforestation in election years. Araujo et al. (2024) highlight the supporting role of public scrutiny following increased media coverage of forest fires. Katovich and Moffette (2024) show that large landowners exert local political influence to weaken forest regulation.

Political incentives also affect deforestation in other settings. Harding et al. (2024) show that campaign contributions buy reductions in regulatory enforcement in Colombia. Sanford (2021) shows at global scale that deforestation rises during competitive elections. Harstad and Mideksa (2017) demonstrate in a theoretical setting that the optimal design of conservation contracts depends on the spillover effects of conservation across local governments. If these spillovers are such that conservation in one district facilitates conservation in other districts – including through positive spillovers in enforcement – then it is more cost-efficient to establish conservation contracts with districts rather than with the central government.

Lobbying

Burgess et al. (2023) show that the gradual dismantling of environmental regulation and enforcement capacity led to the rise in deforestation in the Amazon in the 2010s. The authors highlight that a pro-conservation equilibrium is fragile to shifts in national political priorities. Costa et al. (2025) show how political interference can be used to bypass environmental licensing of hydroelectric power plants. The implication is that first-best regulation is often politically infeasible, as issues like corruption and electoral incentives interact with the enforcement of forest regulation. Burgess et al. (2025) emphasise that first-best regulation often imposes large profit losses on producers, who may respond by lobbying against this regulation. In such settings, optimal policy might instead seek to navigate political resistance by minimising producer losses.

Dynamic Inefficiencies

One challenge with conservation policy is that the incentives to regulate may change over time. Hsiao (2025) highlights a commitment problem. After the forest has been cleared, the government has a temptation to stop taxing deforestation-related goods. The reason is that taxation cannot reduce emissions once the forest is gone and emissions have been sunk. The problem, however, is that taxation becomes ineffective if deforesters do not expect the government to uphold the tax over the long run. Harstad (2023) studies resource exploitation with dynamic political incentives, highlighting that politics further complicate the government's ability to establish and enforce conservation policies over time. Harstad (2016) shows that similar dynamic frictions arise in a theoretical model of markets for conservation.

Future Work

The path forward involves more work on understanding political incentives and the political feasibility of regulation. Attempts to regulate encounter resistance in the form of votes for the opposition, lobbying by targeted industries, and bribes aimed at softening enforcement. Political rotation and electoral cycles create dynamic considerations that complicate long-run planning. Regulation also has important distributional implications that reshape political incentives, both nationally and locally. Conservation policy must navigate this complex political landscape.

VIa Policy Takeaways

We highlight insights for designing politically feasible and sustainable conservation policies.

- **Electoral incentives.** Electoral cycles and political competition systematically undermine conservation efforts, indicating that policies should be designed to be robust to political turnover or insulated from short-term political pressures.
- **Elite capture**. Local political capture by economic interests is pervasive, highlighting the importance of federal oversight and external monitoring in forest governance.
- **Strategic behaviour**. Conservation markets face fundamental efficiency problems due to strategic behaviour, requiring careful design of payment mechanisms and contracts.
- **Second-best policies.** First-best environmental regulation is often politically infeasible due to concentrated local costs and diffuse global benefits, suggesting that second-best policies that minimise producer losses may be more sustainable.
- **Distributional concerns**. Building durable pro-conservation coalitions necessitates addressing the distributional implications of environmental policies and establishing economic incentives that align local interests with conservation objectives.

VII Conclusion and Evidence Gaps

Curbing deforestation rates will be crucial for meeting our climate targets. Tropical deforestation rates have reached particularly alarming rates, although important progress has been made in recent years. This literature review discusses the body of evidence on the agricultural, industrial, international, and political drivers of deforestation. For policymakers, we offer policy takeaways for protecting our vital forest resources.

For researchers, we highlight new directions for inquiry. There remain opportunities to build on the existing evidence. We can interrogate and seek to lessen the potential trade-off between economic development and environmental protection. We can leverage new data to study firm choices and outcomes at scale. We can develop new policy tools to ensure green trade and international coordination. And we can emphasise and evaluate politically feasible regulation.

We also highlight areas where the evidence in economics is more limited. First, we note a gap in geographic focus. The Congo rainforest is the second-largest tropical rainforest in the world, and yet the vast majority of work in this space focuses on Brazil and Indonesia, where the data landscape is somewhat richer. Second, conservation has important benefits for biodiversity, even as current work typically focuses on carbon emissions. The difficulty lies in quantifying the economic gains from biodiversity, but the first step is to quantify impacts on biodiversity itself. Third, more research is needed on active and passive forest regeneration. Regenerating natural vegetation on degraded land would help to restore ecosystems and protect biodiversity, while also capturing atmospheric carbon. We hope that future work in this growing space will make progress on all fronts. We hope that future work in this growing space will make progress on both fronts.

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