WORLD BANK GROUP

Designing Fiscal Instruments for Sustainable Forests

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Rationale for, and Design of, a Feebate for Forest Carbon Sequestration

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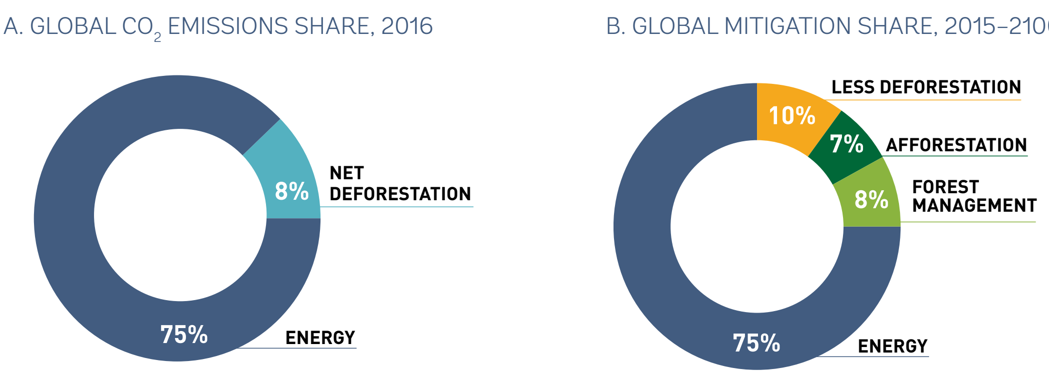
Introduction

Deforestation from (human-induced) activity, net of afforestation, currently accounts for about 12 percent of global carbon dioxide emissions (figure 5.1, panel a), though this share is projected to decline over time. Afforestation offsets roughly half of the current global emissions from deforestation,[1] leaving net emissions of approximately 5 billion tonnes in 2016, compared with industrial CO_2 emissions of about 36 billion tonnes.[2] Under business-as-usual (BAU) conditions (that is, with no mitigating measures), net human-induced emissions from forestry are—albeit with much uncertainty—projected to steadily decline (as deforestation opportunities are progressively exploited) by around 50 percent by 2050 and by 100 percent by 2100, while industrial emissions are projected to roughly double over the century.[3]

FIGURE 5.1
CONTRIBUTION OF FORESTRY TO EMISSIONS AND CLIMATE STABILIZATION



1 For simplicity, here afforestation is taken to include both the establishment of forests or tree stands in areas with no previous tree cover and replanting of trees in a previously deforested area (normally the latter is referred to as reforestation); deforestation is taken to include both clear-cutting of forestland for agricultural uses/timber harvesting and selective harvesting/household use of woody residue (normally the latter is referred to as degradation).

2 There are significant discrepancies in how forestry emissions are currently measured, in part reflecting the difficulty of disentangling human-induced from natural emission releases and sequestration. Global models (like those cited below) suggest significantly higher emissions than the aggregation of inventories reported by individual countries (for example, Grassi et al. 2018). On net, forests act as a carbon sink (capturing some of the industrial CO_2 emissions before they accumulate in the atmosphere) when account is taken of natural (nonhuman-induced) growth, sequestering on net (that is, with human and natural impacts) around 10 billion tonnes of CO_2 a year (Mendelsohn, Sedjo, and Sohngen 2012).

3 See IPCC (2014) and Kriegler et al. (2015), figure 5.1.

In a globally efficient policy to meet climate stabilization goals, studies suggest forestry would account for roughly a quarter of the cumulative CO_2 emission *reductions* out to 2100 (figure 5.1, panel b). Forestry emissions are relatively more responsive to pricing than emissions from energy—that is, there is a relatively greater preponderance of low-cost mitigation opportunities.[4]

However, it is important to promote all the main behavioral responses for reducing emissions. Reducing deforestation, increasing afforestation, and enhanced forest management account for an estimated 42 percent, 27 percent, and 31 percent, respectively, of the efficient accumulation of forest carbon storage over the century under alternative climate stabilization scenarios, with about 70 percent of the combined emission reductions occurring in tropical regions.[5] Enhanced forest management encompasses postponing timber harvesting, planting of larger trees, thinning to increase forest growth, fighting forest fires and other disturbances, and fertilizing.[6] Forests are also a potentially important source (especially for aggressive climate stabilization scenarios) of biomass for burning in power plants with carbon capture and storage to remove CO_2 emissions from the atmosphere—this is a longer-term possibility, however (and is not discussed below), as these technologies are presently unproven at scale and would require high carbon prices.

Nationally Determined Contributions submitted for the 2015 Paris Accord by large forestry emitters often contain nationwide emissions targets but are vague about targets and instruments for the forestry sector. Most of the major, recent contributors to CO_2 emissions from tropical deforestation have made pledges to reduce economy-wide greenhouse gases—typically in the order of 20–40 percent by 2030 relative to GHGs in a baseline year (table 5.1)—though often the more ambitious targets are contingent on external finance. However, NDCs generally lack quantitative emissions targets for the forestry sector, and countries have not specified policy instruments to be used to reduce forestry emissions.

4 See, for example, Gregersen et al. (2010); Houghton et al. (2015); Kindermann et al. (2008); Moulton and Richards (1990); Plantinga Mauldin, and Miller (1999); Richards and Stokes (2004); and Stavins (1999).

5 Figures from Mendelsohn, Sedjo, and Sohngen (2012). See also IPCC (2014), figure 11.18, and Houghton, Byers, and Nassikas (2015).

6 Around 1 billion hectares (25 percent) of global forests are currently in managed production plantations, though only 70–100 million hectares are in fast-growing regions (Mendelsohn, Sedjo, and Sohngen 2012). Converting more forestland to plantations (especially in the tropics) could significantly increase carbon storage.

TABLE 5.1
MITIGATION COMMITMENTS FOR LARGE DEFORESTATION EMITTERS

COUNTRY	PARIS MITIGATION PLEDGE[A]	OBJECTIVES AND MEASURES FOR FORESTRY	PERCENT OF GLOBAL CO_2 FROM DEFORESTATION, 2001–2013
Brazil	Reduce GHGs 37% below 2005 by 2025.	Zero illegal deforestation by 2030; restoring and reforesting 12 million hectares of forests by 2030.	45.5
Indonesia	Reduce GHGs 29% (41%) below BAU in 2030 by 2030.	Ban on primary forest clearance; reduce deforestation; restore ecosystem functions; sustainable forest management.	9.0
Colombia	Reduce GHGs 20% (30%) below BAU by 2030.	Reduce deforestation; preserve important ecosystems.	3.4
Bolivia	Increase renewable energy share to 79% in 2030 (relative to 29% in 2010).	Zero illegal deforestation by 2020; increase forest coverage to 4.5 million hectares by 2030; increase sustainable forestry management.	3.1
Madagascar	Reduce GHGs (3.2%) below BAU by 2030 with over half of reduction from forestry.	Reforestation for sustainable timber production and species conservation; reduction of forest timber extraction; agroforestry.	2.3
Peru	Reduce GHGs 20% (30%) below BAU in 2030 by 2030.	Measures to promote forest carbon storage not specified.	2.1
Mexico	Reduce GHGs 25% (40%) below BAU in 2030 by 2030.	Measures to promote forest carbon storage not specified.	2.0
Malaysia	Reduce GHG/GDP intensity 35% (45%) by 2030 relative to 2005.	Measures to promote forest carbon storage not specified.	1.9
Paraguay	Reduce GHGs 10% (20%) below BAU in 2030 by 2030.	Measures to promote forest carbon storage not specified.	1.7
Myanmar	Targets for renewables and energy efficiency.	Increase protected/reserved forest cover to 30% of land area through REDD+ related actions.	1.7
Ecuador	Reduce energy GHGs 20.4%-25% (37.5%-45.8%) below BAU in 2025.	Reforest 100,000 hectares per year to 2025.	1.5
Cambodia	Reduce GHGs (10%) below 2010 levels by 2030.	Increase forest coverage to 60% of land area by 2030.	1.5
Lao PDR	Expand renewables; displace residential biomass burning through electrification.	Increase forest cover to 70% of land area by 2020.	1.5

Source: Details on emissions pledges from UNFCCC 2018 and contribution to deforestation from WRI 2018.
Note: BAU = business as usual; GDP = gross domestic product; GHG = greenhouse gas.
a. Where applicable, more ambitious targets conditional on external finance are in parentheses.

Feebates (fee-rebates schemes) are a potentially promising instrument for reducing net emissions from forestry. These policies, which would be administered at the national level, apply a sliding scale of fees on landowners that reduce their carbon storage relative to a baseline level and corresponding rebates to landowners that increase carbon storage.

This chapter discusses feebates and how they might be designed. Section 2 provides more background on pricing carbon forest storage. Section 3 discusses the economic and practical rationales for using feebates to mitigate net forestry emissions. Section 4 looks at some design issues. Section 5 discusses limitations to the application of feebates.[7]

Mitigation Potential and Current Initiatives: A Closer Look

Midpoint estimates from the literature suggest that CO_2 prices of $20, $50, and $100 per tonne by 2030 would reduce net forestry emissions by around 1.5, 2.5, and 3 billion tonnes per year, respectively. These figures are based on the most recent review of the International Panel on Climate Change,[8] though there is a considerable range of estimates in the literature.[9]

TABLE 5.2
CONTRIBUTION BY REGION AND BEHAVIORAL RESPONSE TO MITIGATING FOREST CARBON (FOR $50 CO_2 PRICE IN 2030)

	SHARE OF MITIGATION BY BEHAVIORAL RESPONSE			
	AFFORESTATION	REDUCED DEFORESTATION	FOREST MANAGEMENT	TOTAL
USA	22	0	77	12
Europe	42	3	55	2
OECD Pacific	46	14	40	2
Non-annex 1 East Asia	31	7	62	11
Transition Countries	34	5	61	11
Central/South America	21	62	17	26
Africa	34	60	6	18
Other Asia	30	29	41	18
Middle East	43	25	32	1
Total	29	34	37	100

Source: IPCC 2007, table 9.3.

7 Some of the discussion draws from Mendelsohn et al. (2012).
8 See IPCC (2014), figure 11.13.
9 For example, some studies suggest a $50 carbon tax would reduce global forestry emissions by more than 9 billion tonnes a year in 2030 (that is, changing human-induced emissions from positive to negative); see IPCC (2014), figure 11.14.

The potential scale of mitigation, and the most promising behavioral responses, differ dramatically across regions. Although a little dated (from IPCC 2007), estimates in table 5.2 give a broad sense of the largest sources of mitigation potential across regions and behavioral responses (for a \$50 CO_2 price in 2030). They suggest Central and South America would account for 26 percent of the global carbon forest mitigation, followed by Africa and Other Asia (each 18 percent); the United States, Non-annex 1 East Asia, and Transition countries (each 11–12 percent); and Europe, OECD Pacific, and the Middle East (each 1–2 percent). Reduced deforestation accounts for about 60 percent of mitigation potential in Central and South America and Africa, but it is far less important in other regions—in fact, forest management accounts for 60–80 percent of mitigation potential in the United States, Non-annex 1 East Asia, and Transition countries, while afforestation accounts for 20–47 percent of mitigation potential across regions. Mature tropical forests contain 300–400 tonnes of CO_2 per hectare, so slowing tropical deforestation has a large and immediate impact on emissions.

The REDD+ program provides technical and financial support for developing countries to reduce net CO_2 emissions from forestry.[10] REDD+ refers to reducing emissions from deforestation and forest degradation in developing countries, and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries. Funding for REDD+ is managed by the Forest Carbon Partnership Facility through (i) a Readiness Fund, and (ii) a Carbon Fund, which are underpinned by a multidonor fund of governments and nongovernmental entities, including private companies.[11]

The Readiness Fund helps tropical and subtropical developing countries prepare for a future large-scale system of positive incentives for REDD+, most notably by establishing capacity for measuring forest carbon inventories. Forty-seven developing countries (18 in Africa, 18 in Latin America, and 11 in the Asia-Pacific region) are participating in the Readiness Fund.[12] Among other things (for example, identifying the drivers of deforestation to guide future policy responses), this fund helps countries develop capacity for measuring a forest reference emission level inventory of carbon storage for different parcels of land, and its periodic updating—procedures that are commonly referred to as monitoring, reporting and verification systems.[13] The inventory covers emissions and removals of GHGs resulting from direct human-induced land use, land use change and forestry (LULUCF) activities.[14] Specifically, countries are invited to submit a proposed forest reference emission level, based on IPCC guidelines, and each submission is technically assessed by a team in accordance with United Nations Framework Convention on Climate Change (UNFCCC) procedures and time frames.[15] An update report is then submitted (every two years) for countries

10 Initially REDD referred only to emissions from deforestation and degradation. The "+" was added to also include emission reductions from changes in forest management and afforestation.

11 The Readiness and Carbon Funds currently have funds of \$400 and \$900 million, respectively. See "About FCPF," Forest Carbon Partnership Facility, www.forestcarbonpartnership.org/about-fcpf-0.

12 Argentina, Belize, Bolivia, Bhutan, Burkina Faso, Cambodia, Cameroon, the Central African Republic, Chile, Colombia, the Democratic Republic of Congo, the Republic of Congo, Costa Rica, Côte d'Ivoire, the Dominican Republic, El Salvador, Ethiopia, Fiji, Gabon, Ghana, Guatemala, Guyana, Honduras, Indonesia, Kenya, Lao PDR, Liberia, Madagascar, Mexico, Mozambique, Nepal, Nicaragua, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Sudan, Suriname, Tanzania, Thailand, Togo, Uganda, Uruguay, Vanuatu, and Vietnam. See "FCPF Country Participants," Forest Carbon Partnership Facility, www.forestcarbonpartnership.org/redd-countries-1.

13 Or if not immediately practical to measure stored carbon, a reference level of forest coverage can be established instead. Reference levels must eventually have national coverage, but they may reflect various subnational reference levels for the interim.

14 LULUCF refers to a GHG inventory sector that covers emissions and removals of GHGs resulting from direct human-induced land use, land use change and forestry activities.

15 The LULUCF experts undertaking the technical analysis check whether data and information provided in the submitted technical annex are transparent, consistent, complete, and accurate. Reference levels need to maintain consistency with the country's GHG inventory estimates that are regularly reported to the UNFCCC.

seeking payments for results-based actions. These inventories and their updating (perhaps with some adjustments) provide a basis against which the taxes and subsidies in a feebate scheme could be applied, though there are other possibilities for the baseline (see below).

The Carbon Fund provides performance-based payments for jurisdictions reducing emissions below reference levels. The intention of these negotiated contracts is to help recipient countries and their stakeholders (including forest-dependent indigenous peoples, other forest dwellers, and the private sector) implement sustainable forest management strategies over the longer term.[16] Currently, there are REDD+ initiatives in 57 countries,[17] but in the future some of the funds might also be used for capacity development for implementing feebates.

Forest carbon inventories can be established through a combination of satellite monitoring, aerial photography, and tree sampling. Satellite pictures can be used to measure forest coverage and over time reveal visible land use changes like clear-cutting of intact forest. Carbon storage per hectare of forested land is more difficult to verify, however, as it varies with land productivity, tree species, and forest management practices (for example, selective harvesting can reduce stored carbon without visible clear-cuts). Low-level aerial photography along forest boundaries, using technologies like lidar (light detection and ranging), can estimate wood volume (and therefore implicitly account for selective harvesting and changes in forest management) much more cheaply than field sampling.[18] However, field sampling (the most expensive technology) is normally still needed for densities below a certain threshold—administrative costs might be kept down by, for example, limiting sampling to once every several years.[19] Underscoring the practicalities of such systems, remote sensing has already been used for fiscal policy (see box 5.1), although not yet for feebates.

16 To receive results-based finance, countries must have a national strategy or action plan, an assessed forest reference emission level and/or forest reference level, a national forest monitoring system, a system for providing information on how the safeguards are being addressed and respected, and an MRV system to validate results-based actions.

17 See the International Database on REDD+ Projects and Programmes, www.reddprojectsdatabase.org/view/countries.php.

18 Lidar sensors (covering areas from a few centimeters to tens of meters in diameter) fire pulses down from airplanes to collect three-dimensional data on forests and can penetrate the upper forest canopy to reveal the density of vegetation underneath all the way to the ground—along with canopy height, tree cover, and vertical structure, carbon density can then be estimated (for example, Asner et al. 2010).

19 Measuring aboveground carbon only (usually about three-quarters of the total) could also keep costs down.

BOX 5.1 AN EARLY EXAMPLE OF SATELLITE MONITORING FOR FISCAL POLICY: DEFORESTATION-RELATED FINES AND RESULTS-BASED PAYMENTS IN BRAZIL AND PERU

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A feebate scheme would require strong remote sensing systems. Some early experience from other price-based forestry policies sheds light on implementation opportunities and challenges. Forested areas, particularly those that hold the greatest value for climate and sustainable development, are often located far from cities and can be difficult to reach—and thus in many cases difficult to monitor. However, satellite-based systems are changing that. New science, products, and capacity are improving our ability to monitor forest cover from space, and once a system is in place, forest monitoring can be done much more cheaply, efficiently, and systematically than relying on traditional methods of ground sampling.

Satellite monitoring (figure B5.1.1) is already used across the world to determine fines and payments related to deforestation. At a national scale, satellite monitoring has been a key component in determining results-based payments related to REDD+. The government of Norway recently announced its first payment of an estimated $24 million to Indonesia for reducing deforestation in 2016 based on satellite monitoring (Royal Norwegian Embassy in Jakarta 2019). As monitoring and national capabilities improve, national governments are also beginning to use satellite monitoring to enforce fines and payments for ecosystem services programs at a local level.

The Brazilian Institute of Environment and Renewable Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, or IBAMA) sends fines to private property holders for illegal deforestation based on satellite monitoring. IBAMA analyzes data from a half dozen government and civil society monitoring systems, which all use satellite imagery from various sources to automatically detect deforestation in the Brazilian Amazon between a daily and monthly basis. For deforestation areas that overlap with private property boundaries, analysts compare satellite images from before and after the deforestation event to confirm the change, estimate the total area deforested, and determine whether there was a violation of the forest code (which specifies a proportion of private property that must remain forested and prohibits deforestation in certain sensitive areas, such as along rivers). Much like speed or red-light camera systems are used to monitor and issue traffic violations, with illegal forest clearing, IBAMA will mail a report of the results along with a fine based on the area of deforestation. The program, called Remote Control, has been in operation since 2016 and has resulted in more than 1 billion reais ($260,000) in fines (Pontes 2017). A related program, Operation Panopticon, is intended to prevent future deforestation.

FIGURE B5.1.1
SATELLITE MONITORING FOR FOREST FISCAL POLICY

Source: Global Forest Watch / World Resources Institute.

Using satellite imagery, IBAMA identifies areas with high deforestation rates and issues warnings to nearby rural landowners with details of existing laws and the consequences for noncompliance. More than 25,000 warnings have been sent to property owners in eight states in the Amazon (IBAMA 2018). While the effects of the Operation Panopticon and Remote Control programs have not been specifically estimated, IBAMA's law enforcement efforts based on satellite monitoring, which also include field operations and the establishment of embargoes, are estimated to have avoided nearly 60,000 square kilometers of deforestation between 2007 and 2011 (Assunção et al. 2013).

In Peru, the Ministry of Environment (Ministerio del Ambiente, or MINAM) uses satellite monitoring to monitor compliance for a conditional cash transfer program with indigenous communities. The ministry began operating a satellite-based weekly deforestation monitoring system in 2017 on the basis of its annual REDD+ monitoring. The system and its corresponding web portal, Geobosques, are now the main monitoring mechanism for a conditional cash transfer program in which indigenous communities receive payments (at 10 soles/$3 per hectare per year) in exchange for conserving designated forested areas within their territories. Ministry analysts receive automated notifications whenever new deforestation areas are detected within one of the conservation areas, and then they prepare reports on the deforestation event. Those reports are sent to the communities, which are responsible for visiting the site of the event to verify it and report on the cause. Outside invasions are reported to the appropriate authority, while a community found violating its conservation agreement may be removed from the program. As of writing, around 200 native and rural communities representing 15,000 families throughout Peru participate in the program, conserving a total of 2 million hectares of forest (Peru, Ministerio del Ambiente 2019).

Implementing programs like these are not without challenges:

- **Effectiveness**: In IBAMA's program, payment of fines is low. This is likely due to the remoteness of the landholdings and the lack of resources for IBAMA to collect fines. In this context, the more effective "stick" has been an agreement by financial institutions to blacklist violators and lock them out of credit. In a "carrot" policy like a tax incentive, one would speculate that landholders would be motivated to cash in on their reward for good behavior.
- **Liability**: A risk in both the Remote Control and conditional cash transfer programs is punishing landholders for the deforestation activities of others. The burden of proof lies with the landholder or community to prove they are not responsible for the violation. In Brazil, there are also instances of bad actors registering land in the names of others to avoid the consequences of the program.
- **Capacity**: Both types of programs require capacity, both in expertise in the interpretation of satellite imagery and in resources to do ground investigations in the case of disputes, which are costly and time-consuming.
- **Contextual data**: For such systems to work, accurate land tenure boundaries and ownership data must also be available and used in conjunction with satellite information.

Despite these limitations, advances in satellite monitoring systems have made it possible to monitor huge areas on a frequent basis at a relatively low cost. These early examples are just beginning to scratch the surface of potential applications for the monitoring of eligibility for results-based payments and compliance with fiscal policy. More opportunities will continue to arise with further improvements in monitoring systems, new satellites, additional remote sensing capacity in the governments of forested countries, and more accurate, digitized contextual data on land ownership.

Rationales for Feebates

A feebate would involve a system of fees and rebates applied to landowners according to a basic formula:

$$\tau_t^{CS} \cdot \left(CS_t^i - CS_{t,BASE}^i\right) = Y_t \quad (5.1)$$

Here, CS_t^i is tonnes of stored carbon on the property for an individual landowner i at time t; $CS_{t,BASE}^i$ is a baseline level of carbon storage attributed to that landowner at time t;$\tau\tau_t^{cs}$ is a payment per tonne of stored carbon (see below); and Y_t is the landowners' total payment at time t (or subsidy if Y_t<0). Landowners therefore pay fees, or receive rebates, in a future year depending on whether stored carbon is lower or higher than the baseline level.

Feebates have several economic attractions

First, feebates are potentially *effective* at exploiting all potential opportunities for promoting forest carbon storage within national boundaries, at least on privately owned land and possibly on public land subject to private harvesting. With landowners penalized or rewarded according to any change in behavior affecting their observed level of carbon storage on their property, they have incentives to increase storage through all three channels noted above. And, with the feebate applied nationwide, landowners in all regions of the country face these incentives. If instead, for example, feebates were applied to changes in forest coverage rather than stored carbon, this would not promote changes in forest management to increase carbon stored per hectare. In principle, feebates can also be built into concessions granted to private entities harvesting timber on public lands (see below).

Second, feebates promote *cost-effectiveness.* Feebates provide the same reward for an extra tonne of stored carbon across the three mitigation channels and across all landowners (and potentially timber harvesters on public lands)—this encourages equalization of incremental mitigation costs across all mitigation opportunities and regions, which promotes mitigation at least cost (leaving aside domestic environmental co-benefits discussed below). And since the feebate price (see below) is explicitly set, it could be harmonized with carbon prices elsewhere in the economy, particularly those for fossil fuel emissions, thereby striking the cost-effective balance of mitigation across the forestry and energy sectors.

Third, feebates can *eliminate the risk of carbon leakage* among landowners within national borders and any leakage at the international level undermines efforts by other countries to meet their Paris commitments. Carbon leakage refers to (partially) offsetting increases in carbon emissions elsewhere, indirectly caused by a carbon mitigation measure. For example, reduced deforestation for agriculture or timber harvesting may put upward pressure on farmland or timber prices, thereby encouraging more deforestation in other regions, though the empirical importance of leakage effects will be highly site-specific and perhaps difficult to gauge ex-ante. Leakage within national borders across private land is addressed under a comprehensive, nationwide-feebate program because any reduction in carbon storage in one region will automatically result in extra fees. And although potential leakage at the international level may be substantial,[20] the resulting extra emissions in other countries would be reported to the UNFCCC, undermining efforts of those countries to demonstrate progress on meeting their Paris mitigation pledges[21] (international leakage is discussed further below).

Fourth, feebates *avoid large fiscal costs* for the implementing country since they can be designed to be approximately revenue neutral. Baseline inventories for carbon storage can be chosen such that the expected revenues from landowners paying fees equals expected outlays to landowners receiving subsidies (see below). Alternatively, if baselines are simply set relative to historical carbon storage—as recorded in the REDD+ inventories—a feebate is likely to generate net future revenues if deforestation significantly outweighs afforestation/enhanced management in the BAU and involve net fiscal costs if the converse applies in the BAU. To the extent any net fiscal cost is anticipated, there might be possibilities for sharing some of this burden with external donors (for example, if donors are anxious to establish a poster child for forest carbon pricing schemes).

Fifth, feebates are *straightforward to scale up,* at least from a technical perspective. The carbon storage price in the feebate can be ramped up over time in line with emission objectives for the forestry sector with approximately (if baselines are set accordingly) no fiscal costs.

Sixth, expanding forest coverage (through feebates or other policies) can *generate a range of other environmental co-benefits* beyond carbon storage. These co-benefits include, for example, reduced risks of water loss, flood risk, soil erosion, and river siltation, and greater preservation of biodiversity and local cultures and traditions. In principle, these benefits should be netted out from estimated mitigation costs for forest carbon storage (to the extent they are not internalized through other policies), though in practice this is challenging because benefits are site-specific and there may be scant regional-level data for quantifying them. The co-benefits (for example, biodiversity preservation) may be greater for reduced deforestation than other behavioral responses—for example, it is difficult to rebuild complex intact ecosystems artificially—perhaps warranting a higher tax rate on CO_2 emissions from deforestation than the corresponding reward per tonne of CO_2 reduced from afforestation or changes in forest management,[22] though this issue is not taken up here.[23]

Seventh, feebates are complementary with other mitigation efforts. If other efforts to reduce forestry emissions (for example, project-based approaches) continue, their effectiveness is not directly affected by the feebate. In contrast, if forestry emissions were covered by an emissions trading system, other measures, by definition, would have no emissions impact since emissions are fixed by the cap—instead, their impact would be to lower the emissions price (to maintain equilibrium in the market for emissions allowances).

Feebates also have some practical attractions

First, their *administration should be manageable* where landowners are clearly identified taxpayers. Following the establishment of an MRV system, fees and rebates could then be

20 A study for China by Hu and Hodges (2014), for example, estimates leakage rates at 80–90 percent, with most of the extra offsetting forestry emissions occurring in the Russian Federation, Southeast Asia, and the European Union. For the United States, Murray, McCarl, and Lee (2004) estimated the international leakage rate could be anywhere from less than 10 percent to more than 90 percent depending on the type of activity and location.

21 Though not all countries may have the institutional capacity to control the additional pressures put on their forest resources.

22 Moreover, primary forests are denser in carbon than planted forests because logging disturbs carbon stored in soil and peatlands.

23 And more generally, there may be other factors to consider in setting incentives. For example, greater carbon storage might increase risks of forest fires and longer rotations can diminish resilience to storms (as high trees are more sensitive to winds).

routinely assessed (see below), and applied by finance ministries, after completion of a registry of landowners.[24] The main administrative issues are (i) establishing the initial assignment of land parcels (specifically, existing forestland potentially subject to deforestation/degradation and land potentially convertible to forestland) to identifiable landowners, and (ii) the capacity for collecting fees from them, or disbursing rebates to them. It would be natural to delegate collection to the government ministry that currently administers agricultural and forestry taxes, usually the finance ministry, to integrate (rather than risk duplicating) administrative procedures.

Second, use of a REDD+ MRV system *circumvents the need to assess additionality* under a feebate (though this also applies to project-based approaches). In the past, a challenge for project-based approaches to reducing forestry emissions has been the need for projects to demonstrate "additionality," that is, that the project would not have gone ahead anyway in the absence of the contracted payment. With a periodically updated MRV system in place, there is no need to assess additionality under a feebate (or the project-based approach) because the baseline against which changes in emissions are calculated is already available.[25]

Third, there might be *political support for the program.* This might come from landowners who anticipate receiving rebates. These landowners may also have strong incentives to help program administrators with the MRV process.

Feebates have not previously been used in the forestry sector, but there are precedents of sort. Feebates are becoming common in the transport sector as a component of vehicle tax systems designed to promote penetration of low-emission vehicles.[26] And they bear some resemblance to the payments for environmental services program pioneered in Costa Rica (see box 5.2), although (i) this system mirrors only the rebate side of the feebate, (ii) payments are related to not only carbon storage but also other environmental impacts, and (iii) not all landowners are covered by the system.

24 However, many countries, including richer countries like Brazil or Indonesia, are still struggling with creating a unified registry of landownership. In Brazil, for instance, violent conflicts over land ownership are still a problem (see Damasceno Costa, Chiavari, and Leme Lopes 2017).

25 It is quite possible that rebates will be provided to some landowners for afforestation or forest management projects that would have gone ahead anyway without the rebate, though this is inherent in any subsidy program.

26 That is, a sliding scale of fees are applied to vehicles with emission rates above a benchmark rate and rebates for vehicles with emission rates below the benchmark. Variants of these schemes have been used in Denmark, France, Mauritius, the Netherlands, Norway, Sweden, and the United Kingdom (Bunch et al. 2011; Cambridge Econometrics 2014).

BOX 5.2 COSTA RICA'S ENVIRONMENTAL SERVICES PAYMENT PROGRAM

Over the last 20 years, Costa Rica has pioneered the Pago por Servicios Ambientales (PSA) program, administered by the National Forestry Financing Fund (FONAFIFO). The program has been predominantly financed by a 3.5 percent sales tax on fuel use, though the objective is that all beneficiaries of environmental services eventually pay for the services they receive. For example, water users are charged for upstream watershed management services, though there has been more limited success charging for biodiversity and carbon. The program provides, on a project-by-project basis, payments to a limited number of landowners to compensate them for the following services:

- Carbon sequestration
- Protection of water catchment areas for urban, rural, and hydroelectric plant use
- Protection of biodiversity (for ecosystem preservation, scientific research, the pharmaceutical industry)
- Protection of natural landscapes (for tourism and scientific purposes)

Payments are given per hectare, depending on land classification, and provide compensation for complementary regulations preventing conversion of land for commercial purposes. Implicit CO_2 prices in the program have been around $8 per tonne (Porras et al. 2013, 14). Approximately 11 percent of Costa Rica's national territory is protected by the plan, which pays out roughly $15 million a year to around 8,000 property owners. Many small and medium farmers are precluded from the program, however, because of limited funding for the program or legal restrictions on their land.

Although forest coverage in Costa Rica has increased dramatically from well below 30 percent of Costa Rica's total land area in the early 1980s to 54 percent in 2014 (Porras et al. 2013; World Bank 2018), most of the increase occurred prior to the establishment of the PSA program—the program was in part compensating for preexisting regulations.

Source: "Payment Program of Environmental Services (PPES)," FONAFIFO, www.fonafifo.go.cr/en.

Bottom-up, project-based approaches, on the other hand, may face severe limitations

Their effectiveness, cost-effectiveness, and scaling up may be constrained by three key obstacles. One is the high administrative costs associated with contracting for projects on a landowner-by-landowner basis, which requires experts trained in forestry to evaluate projects and national governmental organizations supporting the project. Besides significantly increasing overall program costs, high transaction costs likely preclude smaller-scale landowners and perhaps also some larger ones (depending on budget constraints). A second obstacle is the lack of an automatic mechanism—the same explicit or implicit price on CO_2 across landowners—for guaranteeing that the most cost-effective projects are prioritized. Third, and especially important from the perspective of scaling up, is the need to finance each carbon storage project from domestic/external sources (this finance is automatically provided from the fees paid by landowners reducing carbon storage under the feebate approach).

The potential for emissions leakage within national borders may be greater under project-by-project approaches. This is because there would be no penalties for landowners who are outside of the contracting process for reducing carbon storage in response to program-induced changes in agricultural or timber prices.

Design Issues

Baselines

If the REDD+ reference is used for the baseline in the feebate, the feebate will likely lose some revenue, at least if, at the aggregate level, business-as-usual emissions are constant. For the feebate to be revenue neutral, the reduction in carbon storage aggregated over landowners paying fees must equal the increase in carbon storage aggregated over landowners receiving rebates. In other words, baseline carbon storage aggregated over landowners, in equation (5.1), must equal carbon storage with the feebate aggregated across landowners, that is, from equation $\Sigma_i CS^i_{t,BASE}$ should equal $\Sigma_i CS^i_t$—if the aggregate baseline falls short of this level, the feebate will lose revenue, and vice versa if the baseline exceeds aggregate storage with the feebate. Therefore, if the baseline level is set equal to the BAU with no mitigation policies, it will lose revenue for the implementing government (as the policy itself causes storage to increase above the BAU), and similarly if the baseline is set equal to the initial REDD+ reference level—the current BAU—and there is no expected change in the BAU. Any net fiscal loss is likely modest, however, because the feebate price applies to the difference between emissions and baseline emissions, which is likely a modest fraction of total emissions.

For revenue neutrality, baseline carbon storage could be set to the initial REDD+ reference level with (national-level) adjustments for future changes in (i) BAU storage and (ii) policy-induced changes in storage. That is, the following formula could be used for setting future baselines such that, in expected terms, the feebate is revenue neutral:

$$CS^i_{t,BASE} = (1 + \Delta^{BAU}_t) \cdot (1 + \Delta^{FEEB}_t) \cdot CS^i_{REDD+REF} \tag{5.2}$$

$CS^i_{REDD+REF}$ is the initial carbon storage for landowner i, as inferred from the REDD+ reference level; Δ^{BAU}_t is any expected proportionate change in aggregate carbon storage in the BAU between a future period t and the current period; and Δ^{FEEB}_t is the proportionate increase in aggregate carbon storage, relative to the REDD+ reference, that would be induced by the feebate in period t. If the feebate price is rising over time, Δ^{FEEB}_t will be increasing over time, requiring updating of baselines to preserve revenue neutrality. Ideally, country-level analysis would be conducted to provide initial estimates of Δ^{BAU}_t and Δ^{FEEB}_t, or in their absence, extrapolations from regional or comparator country studies, and estimates might be updated over time with future experience.

Individual landowners should not be able to affect their future baselines through near-term actions, as this might provide perverse incentives for reducing carbon storage. That is, future changes in baselines at the level of the individual landowner should not be linked to future measures of carbon storage attributed to that landowner from inventory updates under the REDD+ MRV system. Instead, those inventories should be used in the calculation of changes in storage relative to a baseline that is exogenous to future actions of the individual landowner.

Payment formulas

Feebates should involve annual tax/subsidy, or "rental," payments rather than large up-front payments,[27] given that changes in carbon storage may not be permanent. The problem with

27 In the present context, the rental payment for CO_2 refers to an annual payment for carbon sequestered in forests.

one-off, up-front payments is that changes in land use may not be permanent (for example, a new tree farm receiving an up-front rebate may be subsequently harvested or destroyed by fires, pests, or windstorms), requiring complex, ex-post repayment procedures to provide adequate incentives to maintain the land use change.

Annual payments should equal the carbon price times the interest rate.[28] That is, the price per tonne of stored carbon should be:

$$\tau_t^{CS} = r \cdot \alpha_t^{CO2} \cdot \beta \tag{5.3}$$

Where r is the real interest rate, α_t^{CO2} is the price per tonne on CO_2 emissions (see below), and β converts a price per tonne of CO_2 into a price per tonne of carbon—given there are 3.67 tonnes of CO_2 per tonne of carbon, $\beta=3/11$. For illustration, a $50 per tonne price on CO_2 translates into a feebate price (τ_t^{CS}) of $0.7 per tonne of stored carbon per year, with a 5 percent interest rate. Fees/rebates could either be administered on an annual basis (to coincide with the collection of other taxes) or every two years (to coincide with the prospective updating of REDD+ inventories).

Setting the CO_2 price

There are different possibilities for setting carbon prices in feebates, but the most logical would be to equate them with national carbon prices for the energy sector, which in turn could be aligned with countries' Paris mitigation pledges. One approach to carbon pricing in the literature looks at price trajectories applied to global GHGs needed to cost-effectively meet climate stabilization goals—a recent review suggests prices of $40–$80 per tonne are needed by 2020 and $50–$100 by 2030 to contain mean projected warming to 2°C (Stiglitz and Stern 2017). Another global approach is to price GHGs at the "social cost of carbon"[29]—one study puts this at $35 per tonne for 2015, rising to $55 per tonne by 2030 (in 2015 U.S. dollars), though estimates are inherently contentious.[30] Within the Paris process, however, the most immediate concern for national policy makers is to align their emissions prices with emissions objectives in their NDCs. Given that solid evidence on the price responsiveness of forestry emissions at the country level is lacking (and likely will be for some time), a period of trying an initial price trajectory and adjusting it based on the observed future response may be needed in the early years of a feebate program. Generally, phasing in prices gradually according to a preannounced schedule is recommended to promote certainty and minimize disruption costs.

Prices, however, may be constrained by prices elsewhere. Most likely (given political or competitiveness constraints), emissions prices for forestry cannot be too far out of line with prices in carbon tax and emissions trading schemes elsewhere. As of 2018, prices are $5–$25 per tonne of CO_2 for ETS and $5–$35 per tonne for carbon taxes (table 5.3), though carbon taxes are much higher in a few cases (for example, Scandinavia), and prices are likely to rise over time as countries strengthen mitigation efforts.

28 For example, Marland, Fruit, and Sedjo (2001) and Sedjo and Marland (2003).

29 This refers to the discounted damages (for example, to agriculture, from rising sea levels, ecological disruption, more extreme climate risks) from the future climate change induced by an extra tonne of current CO_2 emissions.

30 See Nordhaus (2017). Estimates vary widely with differing perspectives on intergenerational discounting and modeling of extreme climate risks.

TABLE 5.3
CARBON PRICES AROUND THE WORLD, 2018

COUNTRY/REGION	YEAR INTRODUCED	PRICE 2019, US$/TONNE CO_2	COVERAGE OF GHGs 2108	
			MILLION TONNES	%
CARBON TAXES				
Chile	2017	5	47	39
Colombia	2017	5	42	40
Denmark	1992	26	22	40
Finland	1990	65	25	38
France	2014	50	176	37
Ireland	2010	22	31	48
Japan	2012	3	999	68
Mexico	2014	1-3	307	47
Norway	1991	59	40	63
Portugal	2015	14	21	29
South Africa	2019	10	360	10
Sweden	1991	127	26	40
Switzerland	2008	96	18	35
ETSs				
California	2012	16	378	85
China	2020	na	3,232	
EU	2005	25	2,132	45
South Korea	2015	22	453	68
New Zealand	2008	17	40	52
RGGI	2009	5	94	21
CARBON PRICE FLOORS				
Canada	2016	15	na	70
UK	2013	24	136	24

Source: Original calculations based on World Bank 2019 and Stavins 2019.
Note: Coverage rates for fossil fuel CO_2 emissions are significantly higher than for total GHGs. ETS = emissions trading scheme; EU = European Union; GHG = greenhouse gas; na = not available; RGGI = Regional Greenhouse Gas Initiatives; UK = United Kingdom.

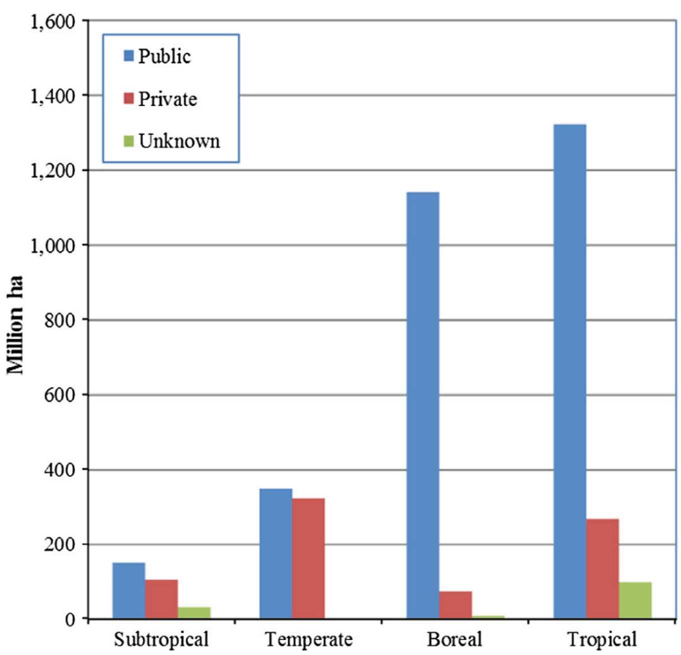
Exemptions

Partial exemptions from fees may be warranted for processed wood. Timber harvested for wood products (for example, furniture and houses) potentially warrants some exemption from fees because the carbon emissions (released at the end of the product life) will be delayed, perhaps by several decades or more. These exemptions might be integrated into existing tax regimes for wood processors and based on analytical analysis of changes in global warming potentials when emissions releases are delayed.

Limitations

The most immediate practical obstacle to feebates is that tropical forests, for the most part, are currently owned and managed by national or subnational governments, whereas feebates are most effectively applied to private landowners. In fact, only about 15 percent of forest area in tropical areas is privately owned, while about 80 percent is publicly owned (figure 5.2). Nonetheless, it is mostly land at the fringe between forests and cropland that is potentially subject to deforestation and afforestation rather than the entire forested area, and this fringe land is largely privately owned. Moreover, future reliance on property rights may expand when, for example, governments attempt to clamp down on illegal logging, or introduce emissions pricing schemes, to demonstrate progress on forestry commitments.

FIGURE 5.2
FOREST AREA BY OWNERSHIP CATEGORY, 2010



Source: Whiteman, Wickramasinghe, and Piña 2015.

A longer-term obstacle is the potential for wide cross-country dispersion in forest carbon prices. Given significant cross-country differences in the stringency of mitigation commitments (table 5.1) and in the price responsiveness of forestry emissions (which vary, for example, with national deforestation rates and the availability of potentially convertible farmland), there will be considerable disparity in the carbon emissions prices consistent with countries' mitigation objectives for forestry, implying potentially significant gains from international price coordination.

One promising form of coordination would be a price floor among large forest emitters. Under a price floor arrangement, each participating country would agree to meet or exceed a mutually agreed emissions price (through feebates or other pricing schemes). This arrangement would provide some protection against international leakage and losses in international competitiveness from pricing, for both participating and nonparticipating countries. Parties need to agree on one main parameter—the common price. And coordination over price floors rather than price levels provides the needed flexibility, given the potentially large dispersion in prices consistent with countries' mitigation pledges.

Provisions in Article 6.2 of the Paris Agreement might encourage broad participation in price floor arrangements and help with enforcement. By recognizing internationally transferred mitigation outcomes (ITMOs)[31] across national governments, Article 6.2.[32] means that countries meeting their mitigation pledges with prices below the price floor can (up to a point) benefit from exceeding their pledges by selling ITMOs at the floor price to other countries (for whom the floor price would be insufficient to meet their pledge). In fact, the threat of suspension of ITMO privileges by compliant participants to any participant not meeting the price floor might be used to provide some compliance incentives.

Focusing the arrangement on "effective" carbon prices would provide flexibility and encourages greater coverage of forestland. Effective carbon prices would average over forestland subject to pricing and other forestland that could potentially be priced but is not (for example, because the land is not under private ownership). Focusing the arrangement on these prices allows flexibility in meeting the requirement, for example, through setting higher carbon prices for covered sectors to compensate for noncovered sectors.

Conclusion

Potentially promising candidates for feebates are countries in existing forestry programs with high capacity readiness and land tenure security. Table 5.4 provides some broad assessment of these criteria for selected countries where existing programs include the CIF's Forest Investment Program (FIP) and the Forest Carbon Partnership Facility,[33] capacity is a qualitative measure of progress on developing REDD+ MRV systems, and land tenure security is measured by an index on ease of registering property. Based on these criteria, potentially promising pilots for feebates might include Costa Rica, Indonesia, Panama, and Vietnam, followed by Argentina, Chile, the Dominican Republic, El Salvador, Fiji, Guatemala, Mexico, Paraguay, Peru, and Vanuatu.

31 Under Article 6.2 of the Paris Agreement, countries exceeding their NDC mitigation pledges can sell excess mitigation credits—ITMOs—to other countries, enabling the latter to meet part of their mitigation pledge through ITMOs rather than domestic actions.
32 See UNFCCC (2016).
33 See www.climateinvestmentfunds.org/topics/sustainable-forests and www.forestcarbonpartnership.org/redd-countries-1.

TABLE 5.4
READINESS FOR FEEBATES

Country	Member FIP[a]	Member FCPF[b]	Current REDD+ MRV capacity[a]	Ease of registering property[b]	Country	Member FIP[a]	Member FCPF[b]	Current REDD+ MRV capacity[a]	Ease of registering property[b]
Argentina	no	yes	medium	57	Liberia	no	yes	low	31
Bangladesh	yes	no	na	29	Madagascar	no	yes	medium	45
Bolivia	no	yes	medium	50	Malaysia	no	no	low/medium	80
Belize	no	yes	low	52	Malawi	no	no	low	65
Bhutan	no	yes	low/medium	73	Mexico	yes	yes	medium	60
Brazil	yes	no	very high	52	Mozambique	yes	yes	low	53
Burkina Faso	yes	yes	low	50	Myanmar	no	no	na	52
Cambodia	yes	yes	low	55	Nepal	yes	yes	low	65
Cameroon	yes	yes	medium	38	Nicaragua	no	yes	medium	47
Cent. Af. Rep.	no	yes	low/medium	42	Nigeria	no	yes	low/medium	29
Chile	no	yes	medium	71	Pakistan	no	yes	medium	46
Colombia	no	yes	low	71	Panama	no	yes	medium/high	65
DRC	yes	yes	high	47	Papua New Guin.	no	yes	low	56
Congo Republic	yes	yes	low	38	Paraguay	no	yes	medium	66
Costa Rica	no	yes	high	74	Peru	yes	yes	medium	75
Côte d'Ivoire	yes	yes	medium	58	Rwanda	yes	no	na	94
Dominican Rep.	no	yes	medium	66	Solomon Is.	no	no	low/medium	47
Ecuador	yes	no	low	66	Sudan	no	yes	medium/high	64
El Salvador	no	yes	medium/high	66	Suriname	no	yes	medium/high	46
Ethiopia	no	yes	low	51	Tanzania	no	yes	medium	50
Fiji	no	yes	medium	72	Thailand	no	yes	low/medium	69
Gabon	no	yes	medium	37	Togo	no	yes	low/medium	55
Ghana	yes	yes	high	56	Tunisia	yes	no	na	65
Guatemala	yes	yes	medium	65	Uganda	yes	yes	medium	55
Guyana	yes	yes	low/medium	57	Uruguay	no	yes	low/medium	58
Honduras	yes	yes	medium	63	Vanuatu	no	yes	medium	66
Indonesia	yes	yes	high	62	Vietnam	no	yes	high	71
Kenya	no	yes	low/medium	56	Zambia	yes	no	low/medium	49
Lao PDR	yes	yes	low	65					

Note: FCPF = Forest Carbon Partnership Facility; FIP = CIF's Forest Investment Program; MRV = monitoring, reporting, and verification.
a. From Ochieng et al. (2016), table 6, and author's informal categorization based on information from the REDD Desk (https://theredddesk.org/theme/mrv) and as noted in country footnotes.
b. From World Bank Doing Business database, www.doingbusiness.org/en/data/doing-business-score?topic=registering-property.

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