DRAFT REPORT

Policy Impacts on Deforestation: Lessons from Past Experiences to Inform New Initiatives

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Introduction

National and international efforts to reduce deforestation in the last few decades, while having some impact, have failed to substantially slow the loss of the world's tropical forests. Tropical deforestation is widespread and accounts for 12%–17% of the world's greenhouse gas (GHG) emissions. New global concern about climate change, together with the realization that reducing emissions from forest deforestation and degradation (REDD) can play a large role in climate change mitigation, makes it critical to learn from previous influences on rates of deforestation.

Within the UN Framework Convention on Climate Change (UNFCCC), negotiators are considering ways to include incentives for REDD and other forest-carbon activities in any post-2012 treaty. In parallel, the U.S. Congress is developing proposals for a long-term GHG cap-and-trade program with incentives for REDD and possibly other international forest-carbon activities.

Such policies may mobilize new funds for forest conservation and for addressing drivers of deforestation in developing countries. Such climate-related incentives for REDD are likely to be performance-based, emphasizing the monitoring, reporting, and verification of results. This emphasis, alongside financial incentives, could increase policy impacts on deforestation rates.

Policy effectiveness, efficiency and equity all can increase if we learn lessons from the past about what drives and what inhibits deforestation and degradation. It is in the interest of any REDD program to understand what has worked in reducing forest loss and degradation and what has not, as well as the reasons for the differences in outcomes. Investments and policies then can more effectively embrace and extend what has worked while reducing the risk of further failures.

This white paper aims to provide such lessons, i.e., to inform both U.S. and international policymakers by analyzing the dominant influences on deforestation and degradation. We study forest-focused and other policies that directly or indirectly influence deforestation, all in light of nonpolicy factors such as trends in commodity prices. We provide examples of previous policies and try to draw lessons from their success and failure, then link those observations about the past to key decisions current policymakers must soon make within their climate policy deliberations.

The rest of this introduction briefly highlights the two sectors that dominate deforestation and degradation, i.e., agriculture and logging, and then distinguishes three categories of policies that could produce REDD. Sections 1–3 then provide evidence about the impacts of a number of policies within each of the three categories and finally we conclude with broader lessons learned.

Two sectors dominate deforestation & degradation[1]

Agriculture

Agricultural expansion is the primary driver of deforestation within the tropics. When tropical forests are cleared, they are almost always converted to agricultural crops or pasture. Thus deforestation is driven by expected benefits of converting forest for production, be that of staple foods for local and national markets or of international commodities including biofuels, timber, and fiber. Incentives to clear forests arise, then, from the local and global demands for commodities that drive prices. Pressures are exacerbated by government policies that support agricultural expansion, from road investment to providing cheap credit and access to land titles when lands are cleared. Only some determinants of demand and prices can be shifted by policymakers, however. For example, global demands for soy may

be outside the purview of REDD policy, while research on soy cultivars for different regions could be an explicit policy choice.

Logging and agriculture

The forest sector clearly also affects forest outcomes. Logging is a part, as is discussed just below, and per se it may cause degradation (often not deforestation however). In addition, though, in the tropics logging often removes just high-value timber and then abandoned forest is more accessible and more likely to be cleared for agriculture than it would otherwise have been.

Logging

The limited profitability of sustainable forest management matters too. Low prices for timber, in part due to unsustainable and often illegal logging practices (e.g., Rhodes et al. 2006), coupled with governments' failures to give credit or tenure security for forest owners, discourage long-term management.[2] Other services provided by forests (species habitat, water quality) often fail to provide any revenue that could affect land-use decisions. Climate policies that fund REDD could change these defaults, leading local actors to value forest services and making it profitable to manage the forests for the many local and global goods they provide, including forest carbon.

Three categories of policies produce REDD

Any effort to conserve forests must be viewed in light of the processes that are driving deforestation and forest degradation. For example, forest conservation policies (e.g., protected areas or payments for ecosystem services) attempt to impose or to induce changes in land usage. The cost of such changes is the loss of what people would have done without the interventions, such as produce and sell crops. Put another way, the fundamental drivers of deforestation are the determinants of the local private and public benefits of clearing forest. Understanding prior plans and thus what is given up if REDD occurs, is critical to predicting land use and inducing REDD.

An important corollary is that whether local conversion decisions are private or public, these decisions often ignore transboundary and global spillovers. Thus, in the absence of an intervention, neither the greenhouse gas emissions nor any other such externalities of forest clearing will affect the local land-use choices leading to deforestation. In principle, then, those local choices might well change if local carbon-based incentives existed.

Putting together all the ideas above, for REDD to be produced any such incentives must overcome the influence of underlying determinants in the sectors that dominate deforestation and degradation, i.e., agricultural and logging. The key determinants include biophysical factors such as soil fertility, forest type, and climate.[3] Those factors cannot easily be shifted, yet understanding how they constrain land use helps in choosing interventions with best impacts.[4] Other determinants can be shifted. For example, various public and private choices which affect the access to forest and the costs of transport to and from forested areas could be shifted. For REDD policy, we will focus on those determinants of land-use choices that can be shifted.

We consider three broad classes of potentially REDD-generating actions. The first two are "conservation" policies or policies that explicitly target forests. We break this group in two: Section 1 examines international policies that are determined by actors outside of the forested countries in question; Section 2 considers domestic forest policy within those countries.

International institutions often attempt to influence and to help implement any changes in domestic forest policy. Here, we draw a distinction between policies and other interventions that can only be implemented

by international actors, such as loan conditionality, donor coordination, and managing demand for imports (discussed in Section 1), and those that are implemented by national or subnational actors in forested countries, even if potentially with international support such as REDD finance (discussed in Section 2). From external macro-scale efforts, such as "forest action plans," to internal micro-scale efforts, such as eco-services contracts, below we review what has and has not worked to date and what is known about why. This provides a number of suggestions about which policies could effectively generate REDD.

Section 3 reviews a third class of actions: shifts in the formulation or implementation of policies that do not explicitly focus on forests but rather on development more generally. The idea is that when there is more than one way to achieve a goal such as increased employment, REDD incentives could lead policymakers to choose the paths that involve lower emissions.

1. International Forest Policies

Many international efforts have aimed to reduce deforestation and to increase transparency in the forest sector. With few exceptions, large-scale conservation of tropical forest cannot be attributed to these efforts. Few initiatives effectively influenced underlying drivers of deforestation, such as infrastructural and agricultural policy while others did not even identify them. Substantial or sustained improvements to rural economic conditions and development practices were also not part of many programs. Yet there are cases where targeted, well-managed international efforts catalyzed domestic pressure for reform or realigned political and economic interests to achieve tropical forest conservation. Below we indicate elements, from the suite of past efforts, that may play a role within REDD.

1.1. Conditional loans

The amount of loans and development assistance contingent upon forestry reform has risen in recent decades, with significant sums spent to create and improve management of forest areas. Conditional loans attach specific reforms—improved law enforcement, expanded parks areas, economic policy changes—to lending from governments and multilateral financial institutions.

There has been controversy over whether such lending—imposing benchmarks and requirements as a condition for loans—is the best way to spur environmental reforms. The effectiveness of this approach has been limited by corruption and insufficient coordination with stakeholders from village associations to large timber firms. Transforming local institutions is complex and slow, particularly when the external pressure is not matched with internal support for reform. Many loan covenants thus have overreached, asserting sweeping reforms without connecting the external conditions in question to national or local development priorities.

Between 1971 and 1990, most long-term aid carried little or no effective conditionality (Boone 1995). Only under relatively recent pressure from donor governments and international financial institutions were such conditions designed to enforce accountability. This increased in the 1990s to influence unsustainable forestry practices and promote good governance in countries such as Cambodia, Philippines, and Indonesia. It was, to some extent, an alternative to the binding multilateral treaties that proved hard to establish. Multilateral lending and macroeconomic policies were seen as a new way to address issues such as deforestation (Ross 1996).

In many cases, these loans failed to impose the sweeping policy changes they envisioned. The International Monetary Fund points out in an internal review (referring generally to macroeconomic policy adjustments) that "tightly budgeted conditional assistance programs never bring about reforms" since narrow domestic interests and uneven access to information raise the cost of lending programs and hinder implementation (Mayer 2005).

Yet evidence of more targeted, successful conditional loans exists—particularly around environmental issues.For the most part, successful loans catalyzed domestic appetite for reform when the self-interests of lenders and recipient countries were aligned. These domestic interests were critical in explicitly connecting reforms to national or local development priorities. External pressure advances these reforms as long as there is "commitment to the reform agenda and engagement with stakeholders to communicate [the] strategy" (Ross 1996; Seymour 2000). Several examples are examined below and shared conditions for success are described.

1.1.1. Case evidence

Many instances of ineffective lending programs exist but some programs have produced environmental governance successes that may be replicable elsewhere. Two decades of research and reviews by institutions suggest that there are some common features of successful lending operations and loans in the context of the forestry sector (World Bank 2006; Keohane and Levy 1996):

- political power is not primarily aligned with logging or other extractive industries
- advocate for targeted forest policy changes instead of long-term, comprehensive institutional reform potentially unconnected to the purpose of the loan itself
- maintain and expand domestic support for forestry sector reform among public actors and beyond them, including by communicating policy strategies clearly and explicitly

When some or all of these conditions are not in place, the already challenging task of reform becomes mired in the political process with few advocates in the recipient government. These failures are generally traceable to government resistance to reforms, loan conditions that run counter to government interests, weak ownership of reform proposals, and economic or political pressure (Ross 1996). Evidence also suggests that that reforms focused primarily on "equity or environmental objectives" rarely win full support. Government self-interest is a powerful motivating factor (although lender, recipient, and community interests may overlap) and loan conditions that favor government interests, at least in part, are more likely to be adopted than those which dilute these government interests (Seymour et al. 2000).

Evidence about the results of lending programs is mixed. The poor examples, such as World Bank loans to Indonesia and Cameroon, failed to translate lending into new forest sector management and reform (in this case, concession allocation and management procedures) (Seymour et al 2000). Initial implementation efforts were often rejected outright or rebuffed, government cooperation was minimal, and the logging industry continued to wield strong political influence over public policy. As a result, the World Bank loans were withdrawn, canceled, or modified.

However, success was more likely if domestic constituencies were already advocating reform and loan programs reinforced this agenda. In Africa and Southeast Asia, such loans backed domestic interests that had previously lacked the political capacity to enact changes or overcome industry opposition (Ross 1996). The World Resources Institute (WRI 1999) and others suggest that these conditional loans work far better when trying to "tip the scales in favor of [pre-existing] reformist elements…against vested interests" (Seymour et al. 2000). In the Philippines, World Bank loans allowed the government to raise logging taxes, resist special interests, and enforce neglected forestry laws despite a powerful industry lobby (Ross 1996). A similar case unfolded in Papua New Guinea when adjustment lending allowed advocates for reforms in the government to consolidate and implement policies that curbed illegal logging (Seymour et al. 2000).[5]

A series of problematic World Bank loans in the 1990s confirmed this important role for domestic constituencies (World Bank 2006). According to an internal review, loans offered advocates the

resources, legitimacy, or authority to push through reforms otherwise blocked by entrenched elements of government or industry. While a broad range of changes found domestic allies, measures that tended to strengthen the government's hand in dealing with forest-related issues (e.g., expanding the authority of the Forest Service) were more likely to receive support than those solely diluting its power, such as public participation mandates, privatization of the forest industry, or land tenure changes.[6]

1.1.2. Looking ahead

An independent review by WRI of experiences in Papua New Guinea, Cameroon, Indonesia and Kenya concluded that conditional loans could "catalyze key forest policy changes," given the appropriate circumstances, challenging a widespread belief that conditional loans were generally ineffective in promoting policy changes (Collier et al. 2001). The review suggests even partial government commitment to reform is sufficient if lenders demonstrate commitment to loan terms, avoid promoting long-term reforms through short-term loans, and raise the profile of forest issues with domestic constituencies including nonforestry ministries and key stakeholders outside of government.

These suggest lessons for REDD. Reforms that will reduce deforestation must present a clear and compelling case for their adoption with some level of support among government bodies, civil society, or local communities. Loans can strengthen, legitimize, and enable domestic advocates of change to realize reforms. Economic incentives, while important, are not enough if other drivers of deforestation are not addressed. Finally, loans are partnerships involving investments in understanding the interests and issues, as much as financial arrangements.

In conclusion for conditional loans, we repeat from above the brief common features of successful forestry sector lending operations (World Bank 2006; Keohane and Levy 1996), noting that some of the conditions are part of controllable policy design but others are not:

- political power is not primarily aligned with logging or other extractive industries
- advocate for targeted forest policy changes instead of long-term, comprehensive institutional reform potentially unconnected to the purpose of the loan itself
- maintain and expand domestic support for forestry sector reform among public actors, and beyond them, including by communicating policy strategies clearly and explicitly

1.2. Donor coordination

Donor coordination is intended to increase the effectiveness and efficiency of overseas development assistance (ODA) by reducing duplication, inefficiencies, and the administrative burden on recipient countries, as well as strategic targeting of aid. While some assistance trends have improved, in general donor fragmentation as well as overemphasis on technical assistance and poor selection of both policies and institutions persist.[7] This suggests a lack of learning and repetition of past mistakes[8], as well as the influence of entrenched interests who may benefit from such current arrangements, including firms in donor countries and officials in recipient countries.

Donor coordination[9] is expected to maximize overall development impact, even if donors act separately, by directing resources to where they are most needed. This is likely to entail: (a) development of common arrangements for planning, managing, and delivering aid; (b) simplification of procedures and requirements to reduce their burden on partner governments; and (c) sharing information to promote transparency and improved coordination (Balogun 2005).

Donor coordination is meant to address aid-absorption and governance issues that face recipient country policymakers, especially in poorer countries (Easterly 2007). Despite little academic research on donor coordination, rising pressure (as aid programs have shifted from project and conditional aid to multi-donor trust funds) have led donors to commit themselves to "harmonize the operational policies, procedures, and practices of [their] institutions to improve the effectiveness of development assistance" in the 2003 Rome Declaration on Harmonization, which was followed by the Paris Declaration on Aid Effectiveness in 2005[10] (Easterly 2007; OECD 2003). If successful, such coordination could improve upsides of aid (strengthening domestic institutions and salaries for civil service, improve governance, and public participation in government) while reducing possible downsides (waste, inefficiency, corruption and dependency) (Easterly 2007).

The theory or idea behind donor coordination is that donors and recipients benefit if the decision and financing are rationalized among actors (this assumes that to at least some extent similar goals are shared). The inefficiency of disparately managed aid is due to several factors:

- fragmentation of giving causes mixed incentives (from donor country interest groups, budget mandates) that distract donors from maximizing overall development
- incomplete information hampers effective decision-making and administration to influence specific sectors and/or issues (Hallonen-Akatwijuka 2004)[11]
- diffuse interest in reforms (e.g., civil service administration) weakens donor incentive as "assignable" credit is limited and the donors can only claim a small share of the credit
- over-recruitment of administrators for various projects (Knack and Rahman 2004)[12]

However, there are conditions under which these are not the issue. Research suggest that where recipient governments do not share donors' goals and contracts cannot be used effectively (see Conditional Loans above), coordination may not lead to benefits if governments (officials) capture money designated for the poor or for public services (Easterly 2007; Torsvik 2005[13]).

1.2.1. Case evidence

Efforts to coordinate in forestry have fallen short of expectations. The Tropical Forestry Action Program (TFAP), for instance, was founded by UN agencies, the World Bank, and the World Resources Institute in 1985 as an ambitious attempt at donor coordination within the forestry sector. Its effectiveness was limited by declining political support once its reform approach (largely ignoring nonforest sectors) produced few tangible results and major process delays. This approach is compared with the incipient potential of Ghana's Natural Resources and Environmental Governance (NREG) Program, still early in its development, to enact cross-sectoral coordination by donor and recipient governments. We show that what might be called "donor coordination" encompasses a wide range of institutional arrangements, illustrated through programs such as TFAP, the PPG7, and NREG.

Tropical Forestry Action Plan (TFAP)

As an internationally-backed initiative to reverse the tide of deforestation overtaking tropical forests, TFAP may be the closest predecessor of REDD in scope and ambition. TFAP increased forest aid, coordinated spending, and developed national forest management plans. It focused almost exclusively on the forest sector (versus infrastructure, agricultural commodity trade, and development goals that are all relevant). It lost crucial political support in part due to insufficient participation by civil society and forest-dependent communities within the policy's development.

The precise goals and objectives of TFAP are muddied by revisions in its early stages but "The Basic Principles of the TFAP" (FAO 1989) cites an "ultimate objective of conservation and development of tropical forest resources" along with specific objectives of "rural development (food security, alleviation of poverty, equity and self-reliance) and sustainability of development (ecological harmony, renewability of resources, conservation of genetic resources)."[14] To help to meet these, TFAP outlined a planning framework to guide development of national strategies:

1. sustainable forestry use activities (agroforestry, community forestry, etc.)
2. industrial forestry activities (plantations, increasing timber for export)
3. fuelwood and energy activities (increasing supply and reducing demand)
4. forest conservation activities (protected areas, etc.)
5. institution building activities (legal reforms, capacity building, etc.)

TFAP increased donor coordination, aid, and national action plans to direct resources. By 1990, more than 40 government agencies and NGOs had contributed to TFAP with 70 recipient countries that controlled 60% of tropical forest area developing NFAPs.[15] Implementation was well underway by 1994 with 31 countries (in Africa and Asia/Pacific and Latin America and the Caribbean) implementing action plans.[16] TFAP even surpassed its goal of doubling forestry aid by increasing funding from $400 million per year in 1985 to $1.3 billion per year in 1990.[17]

However, this did not effectively slow deforestation. From 1980 and 1990, tropical deforestation increased by 40% to nearly 17 million ha/yr.[18] By 1990 disappointment with TFAP was widespread. A meeting of "civil society" organized by WWF-US concluded that the TFAP was ineffective and, without dramatic reform, should be halted. The World Rainforest Movement, Friends of the Earth, and even a TFAP co-founder, WRI, issued scathing reviews of the program.

Assessments faulted TFAP's institutional structure and implementation for: (a) failing to prevent the rise in tropical deforestation; (b) designing NFAPs without adequate participation of indigenous peoples and other forest-dependent communities; and (c) inadequate attention to issues like land tenure and the presence of indigenous peoples in forests. A TFAP restructuring process was initiated at FAO but the dialogue went on through 1996 and the program never reemerged.

In hindsight, TFAP failed to address differences between national and local concerns, such as local goals for development assistance or community benefits from logging, as well as claims to forest resources by poor communities. Instead it focused narrowly upon the industrial forest sector. This also meant that TFAP was not addressing some root causes of deforestation, such as agriculture, macroeconomic and development policies, and uncertainty of land tenure.

Brazil's pilot program to conserve the Brazilian Rain Forest with the G-7 (PPG7)

The Pilot Program to Conserve the Brazilian Rain Forest (PPG7) was launched in 1990 by the G-7 countries (Canada, France, Germany, Italy, Japan, the UK, and the U.S.) in response to growing global concern over deforestation in the Amazon.[19] Administered by the World Bank and the Brazilian government, the objective of its numerous elements was "…to maximize the environmental benefits of Brazil's rain forests consistent with Brazil's development goals."[20]

The PPG7 program suggests that local engagement and stakeholder support improve the impacts of coordination efforts. For instance, extractive reserves and indigenous lands were created using processes

that not only delimited boundaries but also, crucially, created a network of invested local stakeholders. Local involvement appears to yield effective management and with low amounts of external funding. PPG7 also modernized scientific research centers, trained thousands of people in fire prevention and control, and built capacity for environmental monitoring such as that used in Mato Grosso's state environmental agency to track land use on large properties. Yet per enforcement this example also illustrates that high capacity may not have a large impact, absent local political will and an effective coordination across the relevant agencies at multiple levels of government.

PPG7's 2000 review stated: ". . . it was impossible to measure [if it] has reached its objectives… contributions [have been] indefinite and non-measurable. . . the definition of objectives. . . caused conceptual problems, particularly the concept of sustainable development . "). Yet in scope and financing the PPG7 was the largest conservation program in the Amazon at the time.[21]

PPG7 did establish extractive reserves, demarcate indigenous lands, and build capacity in Brazilian civil society to engage in environmental issues. Recent satellite evidence shows that the indigenous territories (PPTAL sub-program) and extractive reserves (RESEX sub-program) have served as partial bulwarks against deforestation and fire. RESEX established four reserves, covering 2.1 million hectares, which are community-managed and allow forest-friendly economic activities, such as the sustainable harvesting of rubber and nontimber forest products. RESEX helped also with product development, marketing, social services, and monitoring of illegal activity. Costs per hectare managed were reported to be less than $1 per hectare and incomes may have risen.[22]

PPTAL demarcated 59 indigenous territories covering 45.5 million hectares or more than 10% of the Amazon forest. It is credited with innovative participatory methodology that allows more timely, accurate, and cost-effective demarcation. Both the World Bank and the 2000review highlight creation of the Amazon Working Group and a civil society network of over 700 NGOs, suggesting that the social capital that this created was an important achievement of the program, in light of the abilities of such networks to monitor and to challenge anti-environmental policies.

While the PPG7 had many other direct outputs, such as the creation and modernization of scientific research centers and training thousands in fire prevention and control, it is difficult to say what impact these efforts had on deforestation. That said, while not empirical evaluations of most of the elements of the PPG7, some recent scientific studies of both indigenous lands and extractive reserves on deforestation have found them to have a significant conservation effect.[23]

Ghana's Natural Resources and Environmental Governance Program (NREG)

Donor coordination is at the core of the five-year Natural Resources and Environmental Governance (NREG) Program designed by the Government of Ghana for sectoral budget support and reforms between 2008 and 2012. It includes three sectors—Forestry and Wildlife, Mining, and Environmental Protection. Funders such as the European Commission, World Bank, British aid agency DFID, French Development Agency, Swiss Aid, and Netherlands Embassy are called Development Partners and provide sectoral support for the design, implementation, monitoring, and evaluation of NREG. A Progress Assessment Framework tracks performance measures for each subsector. Program Matrices and Outcome Indicators were jointly defined and agreed upon in March 2009 and this Voluntary Partnership Agreement process may suggest successful consultation process.

In Forestry and Wildlife, NREG's stated purview spans management and governance and involves coordination of implementation including linkages between sectors and aligning donor assistance with the Ministry's Expenditure Framework. Coordination is emphasized among not only ministries but also civil society and development partners, consistent with a performance focus. Cross-sectoral coordination and a performance focus are likely to be relevant in REDD.

As NREG was created only recently, evaluating its performance is premature. Yet early indications suggest the NREG platform at least has several advantages: (a) it may give donors more confidence in providing non-earmarked financial support, due to the 3-year monitoring and reporting assessments; and (b) coordination of all the donors via a single platform is expected to reduce transaction costs and improve predictability of funds. However, NREG still falls short of the most comprehensive view of forest protection since the Agriculture Ministry is not part of NREG though agriculture clearly affects deforestation. Other government agencies that influence key drivers, such as transport and infrastructure, also are not fully engaged. This may change as NREG is building an inter-ministerial body to which the REDD Steering Committee will report. Such coordination will likely be critical to its success.

1.2.2. Looking ahead

The most effective REDD framework will require coordination of support for many quite distinct sectors. The benefits of harmonizing of their actions and of the provision of resources to support such actions may mean that donor coordination plays a central role in REDD's effectiveness and efficiency.

A critical lesson from the past is to avoid purely forest-sector or donor-driven strategies. Any actions that affect deforestation should be productively harmonized within REDD strategy. Effective and efficient REDD is likely to involve including infrastructural and agricultural and other policies in a strategy while providing a way for donors to align objectives with all of them.

A second key point is that donor coordination is not enough for broad stakeholder buy-in. The latter involves consultation concerning the needs of all critical local groups, raising the need to reconcile local and national as well with external goals. For equity and efficiency reasons, this brings in forest-dependent communities. In TFAP, civil society demanded consultative processes and to a certain degree a battle over broad consultation outside of government sunk the initiative. Within PPG7, local civil society was consulted usefully about land demarcation and protections. As is attempted in NREG, creative platforms for coordination and consultation could be critical.

In sum, the lessons from TFAP and PPG7 and early NREG evidence suggest that future success will be:

- collaborative between domestic governments and donors;
- accountable to all the parties through transparent reporting;
- encompassing many sectors' concerns; and
- seeking out donors' common interests with all local stakeholders

1. 3. Debt relief

Given the significance for the approaches above of forested countries' domestic politics, debt relief has an advantage: it is external actors who are the lenders and can forgive a debt. [24] Yet how, or whether, relief effectively targets deforestation is a question that needs addressing.

Debt relief towards conservation agreements, or "debt-for-nature swaps," are "transaction(s) between two or more parties to enable conservation or the provision of environmental services" (Deacon 1997).[25] These may be three-party swaps, usually with a conservation group purchasing debt to commercial banks or creditor government that was renegotiated then selling it to the debtor country for more than the NGO paid but less than the secondary market value. The difference can be used to fund conservation. Swaps may also be bilateral (government-to-government).

This approach gained popularity in the last two decades with such transactions generating over $117 million in local currency for conservation projects, including through the purchase of about $168 million

in debt (face value) for $49 million between 1987 and 2006 (CRS 2006).[26] It relies on external institutions willing to forgo funds in return for protection of the forest.

Even without direct contributions labeled for conservation, though, debt relief may lead to increased forest conservation since debt may encourage deforestation. Large government debts to foreign countries and international banks may encourage tropical countries to raise revenues to cover debt service through timber royalties or taxes on agricultural exports. Looking globally, for instance, Kahn and McDonald 1995 finds a relationship between debt levels and rates of deforestation.

Since many factors drive forest loss, especially at the scale of a country, clear causal links are difficult to establish between debt reduction and lower resource extraction[27] (CRS 2006). For example, during the 1990s, Indonesia may have been pressured by international financial institutions to increase its exports of timber, paper pulp, and palm oil in order to, among other things, service debt payments. A handful of studies in the last decade that suggest government debt or budget constraints create incentive for government to designate greater harvesting area and permit more deforestation to raise revenue (Kahn and McDonald 1995 and Amacher 1999).

These analyses also consider that debt may have other consequences for forest. Binding government revenue constraints make efficient or even adequate enforcement effort impossible for central governments located up to many hundreds of miles away from these forest resources (Amacher 2008). As Amacher et al. (2008b) find, this would exacerbate both illegal logging and the influence of bribes upon operation of concession and design of policy. In this setting, "REDD transfers" in principle could reduce incentives for governments to increase harvest concessions.

1.3.1. Case evidence

We distinguish two avenues by which debt relief may affect deforestation. The indirect approach would reduce debt burdens in order to relieve financial pressure to increase exports and repay loans, which might or might not affect deforestation. The direct approach would involve a form of earmarking the monies forgiven explicitly for conservation by developing countries (an option that then takes on some of the characteristics of conditioning loans on less forest loss).

Currently debt relief often is being used directly as a tool for conservation, i.e., the second approach, especially as implemented by the United States and Germany. Most early transactions that involved country debt that was owed to commercial banks, in addition, were administered by nongovernmental conservation organizations. Other debt-for-nature initiatives involved official (public) debt and were administered by creditor governments directly with debtor governments.

The 1998 Tropical Forest Conservation Act (TFCA) authorized exchanges of developing country debt for deposits to tropical forest funds. The interest earned (and perhaps the principal) supports grants for tropical forest conservation projects. Eligible conservation projects include (1) establishing, maintaining, and restoring forest parks and protected reserves; (2) increasing the capacity of personnel to manage reserves; (3) developing and supporting communities near or in tropical forests; (4) developing sustainable ecosystem and land management; and (5) identifying the medicinal uses of tropical forest plants and their products. If the activities supported were not going to occur in the absence of these deposits of funds, this direct approach can have impacts.

By 2006, 11 countries had established agreements to reduce their debts to the U.S. and generate $136.5 million in local currency over 12–26 years for tropical forest conservation. By 2009, the U.S. had used the TFCA to reduce debts of nine Latin American countries in addition to Bangladesh, Botswana, and the Philippines, often with contributions from major environmental organizations. For example, in 2002 the U.S. government forgave $6.6 million of Peru's debt with contributions from the Nature Conservancy, the

World Wildlife Fund, and Conservation International after Peru agreed to commit about $10.6 million of debt savings to conservation over 12 years. The U.S. funds alone ostensibly enabled preservation of more than 27.5 million acres of rainforest.[28] Working with the Club of Paris, Peru has also substantially reduced its debt with Germany, Canada, Finland, Holland, and Switzerland, putting part of those funds (~US$57 million) in environmental programs with involvement of NGOs like Profonanpe.

Debt relief terms can appeal to tropical forested countries' economic self interests as well as their goals for conservation. Indonesia rejected earlier international proposals for debt relief in favor of a deal that was distinguished by its clear incentive structures, feasible objectives, and discretion about spending on forest conservation. To be eligible for this debt swap, a country was only required to have the Ministry of Forestry submit a forest conservation proposal with budget support from the Ministry of Finance plus an independent audit of the Ministry of Forestry's management of the project. The most recent swap under TFCA is expected to reduce Indonesia's debt payments to the U.S. by US$30 million. It involves international and national environmental organizations (Conservation International and Yayasan Keanekaragaman Hayati Indonesia). The German government also agreed to swap about EUR 12.5 million in loans for EUR 6.25 million of forest conservation programs in Indonesia, along with a second program (EUR 106 million) also financing forestry programs.[29] Yet for this and many other examples cited above, impacts on forest have not yet been shown.

1.3.2. Looking ahead

As the lack of specific rigorous conditionality in the debt relief conditions might suggest, currently drawing any causal linkages between debt and deforestation is difficult. Evaluations of the impact of debt swaps are few: a 2007 U.S. evaluation of an initiative in El Salvador did not quantify forest impact but suggested that results fell short of its ambitious targets. However, debt swaps continue to attract donor and host country support, labeling millions of dollars for long-term forest-conservation projects. Generally, this has been viewed as a success by conservation organizations and debtor governments because of the funds generated for conservation efforts.

While secondary market and other conditions affect the appeal of debt-for-nature swaps looking forward, for conservation purposes it is attractive to invest over a long time horizon. [30] Ultimately, though, successes depend on "the viability of the programmes [and] strength of the organizations and communities implementing the programmes [with] swap proceeds."[31]

1.4. Demand management

Demand management shares with debt relief the advantage of significant external control. Thus if the world wants less deforestation, in principle we can just stop demanding destructive output. Global demand for pulp, paper, food, biofuel and other agricultural products drives deforestation and destructive (and often illegal) logging. The volume and the value of all these commodities is extremely large including the annual trade of timber ($224.3 billion), soy ($22 billion) and palm oil ($12.7 billion) (FAO 2006; WRI 2007). The trade links suggest a role for global demand-side interventions to reduce economic incentives for production of commodities on the forest frontier.

Demand-side efforts may take many forms, from loosely organized consumer campaigns and related (but increasingly more influential) voluntary certification systems through to treaties and government policies. All of these must involve coordinating or influencing a large number of international actors using coercive enforcement (if by a state) or simply information or publicity, from civil society or from the government. Examples include the harmonization of trade policy, such as trade controls for CITES-listed species; the European Union's 2003 FLEGT Action Plan to prevent illegal imports into the EU; the 2008 amendments to the U.S.'s Lacey Act expanding import restrictions on plants and plant products, as well

as disclosure and information campaigns that influence public opinion or reveal the actual environmental impacts of commercial products.

Demand-side measures may be critical to the success of REDD. Experience in tropical countries has shown that measures to slow or stop deforestation that do not address demand face serious complications; the implications of high demand may hinder law enforcement and thwart the formation of policies regulating forest assets. Yet demand-side measures themselves must be robust enough to stand up to market forces. Demand measures such as wood processing fees or log export bans may not matter if demand is sufficiently high (or other distortions such as corruption are present). Ghana's experience with such measures from 1979 to the 1990s shows inadequate policies will fail to dampen market demand and must be complemented by supply-side control (Richards 1995).[32] This has already been recognized in the climate debate, and direct support for countries seeking to address illegal logging are included in the U.S. American Climate and Energy Security bill (H.R. 2545), passed by the House in June 2009 (WRI 2009[33]).

1.4.1. Case evidence

Private sector initiatives (campaigns–certification)

Famous campaigns to date highlighted "the hamburger connection" to clearing in Central America from beef consumption in the U.S. and identified "forest-friendly" commodities such as certified timber, nontimber forest products, and "bird-friendly" coffee or cacao. These were all attempts to shift demand away from production that causes deforestation or towards production that maintains forest cover. While such campaigns have rarely shifted global prices significantly due to the size of markets and number of buyers unwilling to adjust their purchasing habits, they have created market niches for certified producers by changing the procurement practices of some major consumers, especially those with brand names to protect.

Both governments and NGOs have emphasized the importance of full information and disclosure of where and how products are supplied. For example, the Forest Footprint Disclosure Project recently launched by the UK government reveals how companies' "operations and supply chains are impacting forests worldwide, and what is being done to manage those impacts responsibly" (Mongabay.com 2009).[34] NGOs have pursued a similar approach, providing information to consumers as part of their strategy for persuading companies to adopt certification.

In Brazil, NGOs appear to be having some success influencing demand for beef and soybeans from the Amazon. For example, in 2006 agricultural giants like Cargill, Archer Daniels Midland Co. and Bunge Ltd., as well as France's Dreyfus and Brazilian-owned Amaggi, agreed to a moratorium on clearing forest for soybeans after pressure and publicity from groups like Greenpeace (halting clearing in high-deforestation areas by 2008, according to Greenpeace and the Brazilian Vegetable Oils Industry Association (AP 2008[35]). Nepstad et al. (2009) suggest that such "market exclusion of deforesters could be strengthened through government measures that penalize companies and banks that indiscriminately do business with Amazon farmers and cattle ranchers."

Boycotts by themselves have some fundamental weaknesses: freeriding and coordination failures clearly are endemic with such decentralized private choices with spillovers, given the inherent tradeoff between opportunity cost of participating and the potential to hurt the targeted firm (Delacote 2009). It is usually difficult to scale up boycotts to national policy because of WTO rules.

Nonetheless, such campaigns can have effects and may work in tandem with other policy approaches. For instance, calls for tropical timber boycotts in late 1980s are widely believed to have been an impetus for the development of sustainable forest certification systems. Supporters of certification continue to use negative publicity and boycotts targeted at companies (and their supply chains) to encourage

commitments to purchase certified products. Sasser et al. (2006) point out that firms may respond "strategically to NGO demands in order to maintain control over their institutional environment." In particular, in the US, forest product firms created their own certification standard rather than join the Forest Stewardship Council (FSC).

FSC and competing forest certification systems appear to modestly boost relative profitability through reduced marketing costs, lower risks associated with forest-friendly goods, preferential access to buyers and, sometimes, price premia. Other commodities such as coffee and cacao are being certified too and another increasingly well-known example is the Roundtable on Sustainable Palm Oil (RSPO). Bitzer et al. 2009 notes: "Over recent years, the use of standards and voluntary codes of conduct in combination with certifications schemes has spread significantly in many agro-commodities. Observers even speak of the emergence of a global audit culture originating in Northern industrialized countries and stressing inspection, measurement and certification (cf. Strathern 2000, in Lyon 2006; Hughes 2001)." Such a dissemination of like efforts creates new dialogues and demand for participating producers.

Certification too has its weaknesses. To the extent it is being applied mostly to "parallel production systems" that affect only small fraction of area used for a crop, its impacts could be limited. Few countries targeted for REDD have large areas of certified forests: only 15% of FSC-certified forests are located in the tropics and sub-tropics (FSC 2009), with 217 certificates issued by October 2009.[36] Thus the costs of certification may be outweighing the benefits, which have remained limited to rewards in markets versus for instance any public "push" (forest sector governance) that would support adoption (Ebeling and Yasue 2009).[37]

Further, to the extent that multiple certification systems exist and compete for the minds of the world's consumers, they may undermine the effectiveness of the most stringent, at least. It is even possible this could yield a "race to the bottom" (Bitzer et al. 2009; Raynolds et al. 2007).). On the other hand, Sasser et al. (2006) and Overdest (2009) suggest that competition among forest certification systems has actually led to a general ratcheting up of forest management standards, all with third-party oversight.

Another weakness of certification is that many initiatives fail to engage with stakeholders in producer countries (Partzsch 2009, Bitzer et al. 2009) Some consider FSC, e.g., to have been effective in engaging stakeholders through national working groups: " . . . when certification does not itself prove to be the answer to these questions, the debate has been effective. There are cases of working group deliberations being taken into other policy arenas. At the very least, the work of such groups has had an excellent capacity development effect" (Bass and Guéneau 2005). In short, if certification goes beyond campaigns because of local producer buy-in, buy-in is critical.

While such private-sector initiatives may not yet have had conservation and stewardship effects as large as initially imagined, policies to complement such schemes—both on the demand and on the supply side—may dramatically change this picture. Contrasting Bolivia and Ecuador suggests this "can be successful … where governments have limited governance capacity" but this relies on considerable government contributions, such as to enforce forestry laws, to offer financial incentives for certified forestry, to impose land tenure security, and to encourage large-scale, vertically integrated commercial forest operations (Ebeling and Yasue 2009).[38]

Reciprocal trade controls

Reciprocal and unilateral trade controls—laws in importing nations that provide a legal basis for the monitoring and seizure of illicit trade—are increasingly used to complement both exporting nations' domestic laws and international rules such as those under the Convention on International Trade in Endangered Species (CITES). States can establish regional enforcement protocols by harmonizing major

importing and exporting customs policies, giving governments better tools to control the commerce in wildlife, especially in timber, across their borders.[39]

Indonesia's listing of ramin under the Convention on International Trade in Endangered Species (CITES) complemented domestic law and gave foreign governments the ability to police trade. This is believed to have significantly reduced illegal trade in the species from Indonesia (Lawson 2005). A second well-documented example is Indonesia's ban on exports of round and squared logs in 2001. This was complemented by a prohibition against imports of such logs in Malaysia. Reports of illegal log smuggling dropped dramatically (Lawson 2005). The Environmental Investigation Agency cites it as one of a "few cases where any of the commitments on this topic made by governments in the region over the past few years has been shown to have had any real impact on the ground."[40]

Yet the ban does not cover wood products or sawn timber, i.e., other products may still be smuggled unimpeded. Harmonized paperwork requirements would help, as border officials from two sides can then compare import/export records. Without more complete reciprocal controls, there is no legal basis by which to seize them that could provide the crucial formal justification.

Further, most economic studies suggest high efficiency costs and limited environmental impact of log export bans, for instance, although the conservation gains may rise with insecure land tenure and when informal logging roads are more central in the process of forest clearing.[41] At the least, then, identifying the conditions under which these policies will help seems critical.

EU's FLEGT Action Plan

The EU has taken a bilateral, voluntary approach to such trade measures in the Forest Law Enforcement, Governance, and Trade Action (FLEGT) begun in 2003. The initiative relies on national law in the country of origin to define illegality of timber and wood products. The FLEGT program calls for agreements between exporting and EU countries to help exporting nations to regulate and track forest practices and to ensure only licensed timber is imported into EU markets. While Ghana is the first country to conclude a trade agreement under the program, Indonesia, Malaysia, Cameroon, Liberia and Congo are engaged in formal negotiations, and Vietnam, Gabon and Central African Republic have expressed interest in the program.[42]

These agreements are designed to ultimately "eliminate illegally-produced timber from partner countries' international and domestic trade."[43] Producer countries adopt administrative legal and technical systems to verify that timber is produced in accordance with national laws. The EU provides financing to meet these goals through improved enforcement and institution building. These Voluntary Partnership Agreements originally cover solid wood products (logs, plywood, veneers, etc.) and may be extended to manufactured goods at the export-country's discretion. This program is intended to reinforce producer-country government reforms that aim to improve forest governance in order to improve access to EU markets, raise revenue from taxes or duties, and, thus, be able to finance poverty-reduction and community-development programs.

FLEGT's effectiveness is not yet known since its implementation is still in its early stage. Criticisms from civil society assert that voluntary bilateral agreements are less effective than are legally binding controls upon timber imports, or region-wide enforcement protocols. However FLEGT—especially in its focus upon deforestation drivers, data collection and law enforcement—may inform the development of REDD approaches with voluntary and legally binding systems, including for the building of infrastructure and political intuitions for a REDD framework.[44]

U.S.'s Lacey Act and amendments

Monitoring trade and imposing liability for illegal wood products in the supply chain may well effectively guide demand. Designed properly, such restrictions could empower governments to stop illegal timber from slipping into legal commerce and thereby dissuade the private sector from indiscriminately sourcing its raw materials. The Lacey Act, which is among the oldest and most sweeping of U.S. conservation laws, is a domestic trade provision with precisely such aims. Originally targeting trade in endangered species, now it may diminish demand for illegal timber.

The Lacey Act was amended in 2008 to extend its reach to products derived from plants illegally harvested within or outside the United States (including timber) and those manufactured outside of their country of origin (consider for example growing production of furniture in China based, it is believed, on illegal timber supplies). This ban applies to most goods containing wood products, such as furniture. Importers are now required to declare country of origin, quantity, and plant species of their products. Violations carry civil or criminal penalties based on a defendant's knowledge of the law.[45] This casts an unprecedented wide net over illegal sourcing of timber and plants and while one can imagine it being hampered by forgery and a lack of documentation, cases are being brought. Though it was initially intended to be fully enacted by 2008, the Lacey Act permitted extensions to give private firms—manufacturers, importers and resellers—time to adjust procurement practices and examine supply chains to screen out illegal wood products.

Criticisms have focused on the cost and complications of screening such supply chains. Yet that focus suggests the potential for binding impact. The law's mandates gives government the power to truly restrict imports of illegal timber (as defined at source) and imposes a duty on the importer to undertake a reasonable level of due diligence. This achieves several things:[46]

- it injects transparency into the supply chain by transferring the initial effort of eliminating illegal wood and plant products from overburdened government agencies to purchasers;
- it enables enforcement to be monitored and thereby safeguarded by civil society groups; and
- it provides customs with a mechanism to seize plant products harvested illegally in other countries, removing protection once provided by the norms of international commerce.

While effects of this law are not yet known, it is believed to be increasing transparency of the supply chain for wood products in the private sector. Such standards need to be adopted consistently by both exporters and importers if any such policy's full potential is to be realized.

1.4.2. Looking ahead

Market-mediated mechanisms to guide demand can limit trade in illegal goods but impacts will depend heavily on their scope and on enforceable mechanisms against illegal or undesired goods. When all of a large buyer's purchases meet such standards, not just small lots for differentiated markets, and when all timber is labeled with its origin by mandate, impacts could be significant.

Bilateral and unilateral instruments can complement one another but enforcement in is key to any success. FLEGT illustrates disadvantages of bilateral instruments: the slow pace of negotiations, questionable legal standards in certain nations, and inability to address illegal trade in countries that do not agree to partner. However, properly designed, FLEGT could help reform forest industries. The Lacey Act demonstrates the strength of laws in importing nations to place the onus on private entities to manage supply chains. Using national law allows border agencies to seize and enforce bans against illegal imports, creating a powerful disincentive for producers.

These tools do not, however, directly address failings along these dimensions of interest within exporting countries' wood and forestry industries. Thus private-sector and civil-society information-based campaigns can provide complementary pressures that tip economic incentives toward sustainable management of forests. Other trade policies proposed by civil society could further diminish illegal timber trade and, presumably, illegal deforestation: mandatory licensing of all timber exports; listing of unverified wood as "unknown source"; preventing endorsement of ineffective certification; third-party verification of FLEG-like systems; and licensing to cover the whole chain of wood processing. Yet despite recent progress including agreements between tropical forest nations and the U.S., Japan and Australia, where most such wood products are sold, one systematic leading approach to deal with these markets-&-incentives issues has not emerged.

Many approaches in concert may work, as coercion (law) and persuasion (campaigns) appear to be complementary. In forested countries with large enough domestic demand (e.g., in Brazil consider southern states' purchases of beef from the Amazon), such ideas even could be applied purely internally. Extensive analysis of their effectiveness is not yet available. However, assessments suggest significant effects and potential for broader impact if applied among more trading partners and markets. REDD presents another case for coordinated action (WRI 2009).

2. Domestic Forest Policies

Various national and subnational initiatives have aimed to conserve forests. Their primary aim—reducing deforestation—has typically been only partially achieved, however, due to limitations in how key deforestation drivers were addressed. For protected areas and ecoservices payments, being located in areas of relatively lower deforestation threat limits impact by failing to take on key land-use drivers. Concessions manage clearing pressures yet many details of policy designs (of ecopayment contracts or concession royalty structure) are critical to local land-use incentives. Finally, while decentralization does not per se address any of those issues, if all of the incentives can be aligned then local decision control can generate REDD and, in some situations, do better.

2.1. Protection

Protected areas are the most common explicit forest conservation policy. Yet they tend to be on land with relatively low threat of deforestation. Thus, protection may change little relative to the outcome without policy. In other words, less deforestation is avoided than is typically assumed (going off recent studies of global data and of Costa Rica, the Brazilian Amazon, and Mexico). On the other hand, analyses also indicate that impacts on deforestation vary considerably across the landscape. Where deforestation threats are relatively high and yet enforcement is relatively strong, such as within the Chico Mendes Extractive Reserve in the Brazilian Amazon near the Interoceanic Highway, then there can be significant benefits in terms of avoided deforestation.

As protected areas cover ~12% of the Earth's land surface and cost money, resources and political capital to establish and maintain, an important REDD question is whether they "work." Protection is established for many reasons and with a range of land-use strictures. Many focus on where specific ecological services like species or carbon are most intensely provided while other analyses have completely different foci, e.g., economic opportunities afforded to or taken from people in and around protection (Emans 2008 e.g.). The latter foci, i.e. impacts on local people including access to non-timber forest products, are likely to be critical for political acceptance and distributional impacts of REDD. We focus on deforestation.[47]

As it seems to be essentially common knowledge why protection might work, i.e., prevent deforestation, we focus here on why it might not. Consider a completely forested protected area. It may not be achieving

anything at all. It would not be if those lands would be forested without protection, e.g., simply because characteristics such as steep slopes do not facilitate deforestation.

Further, national protected-area networks are in fact often decidedly unrepresentative in terms of the lands they occupy (Joppa and Pfaff 2009b). On various dimensions relevant for the deforestation decision, their sites differ from all unprotected lands—even, perhaps surprisingly, from spatial buffers or lands around protected areas. The former may not be surprising. Many models of household and agency choices suggest reasons why pressures and constraints would lead to nonrandom locations for protection. The latter comparison is relevant as it is common in initial efforts to evaluate impacts of protection (Joppa and Pfaff 2009a) which we can now see provide overestimates of avoided deforestation (Joppa and Pfaff 2009c).[48] Thus for REDD there is payoff in evaluating the specific conditions being considered for new protection.

2.1.1. Case evidence

Initial Efforts

Protection's impacts have long been evaluated but the methods for doing so have varied. Some informal evaluations appear to involve only observation of forest, e.g., common statements that Costa Rica's protected areas are a success as they are essentially fully forested. In this vein, Fuller et al. 2003 suggest protection is not viable in Kalimantan given considerable deforestation during 1996–2002. Yet conclusions based solely upon observing forest, or not, are problematic. To learn impact, one must compare what happened in an area to what would have happened had that area not been protected. The latter must be inferred and several approaches have been tried.

One might compare protected-area outcomes with outcomes in all the unprotected areas. Gaveau et al. (2007) compare thirty-year clearing of unprotected areas with lower rates under protection. Similar comparisons are in Messina et al. 2006 on the Ecuadorian Amazon, Sanchez-Azofeifa et al. about the Sarapiqui region of Costa Rica, and DeFries et al. 2005 for the globe.

More commonly, analysts compared protected-area outcomes to outcomes in the areas immediately surrounding protection, or buffers, in an effort to compare more similar situations. Bruner et al. analyzed deforestation in and around 93 protected areas across 22 tropical countries using survey data. Vina et al. 2007, updated to 2001 a Woolong study from Liu et al. and across the entire period (from 1965) found habitat loss ~17% lower inside the reserve than in the buffer zone. Sader et al. 2001 compare the northern Guatemalan Maya Biosphere reserve (GMBR) with a buffer in four different time periods, always finding higher clearing in the buffer zone. Kinnaird et al. assessed deforestation around Bukit Barisan Selatan National Park on the Indonesian island of Sumatra (see Gaveau et al. [2007] above). From 1985 to 1999, forest cover fell from 80% to 52% inside the park, and from 15% to 1.6% in a 10km buffer around the park. Many comparisons like this find less deforestation within protected areas and thus claim impacts.

Apples-to-Apples

As noted above, the land characteristics of protected areas often differ not only from the entire set of unprotected areas but also from the spatial buffers commonly assumed to be similar. Thus "matching" aims to address this in explicitly constructing an "apples to apples" comparison group by using measurements of land characteristics to select the most similar possible locations.[49] Only recently has matching been applied to protected areas. This started with Costa Rica (see below) and new efforts are ongoing for the entire Brazilian Amazon (Pfaff and Robalino et al. 2008), the region around the InterOceanic Highway including Chico Mendes Extractive Reserve (Delgado et al. 2008), all of Mexico (Zepeda et al. 2009) and the world, i.e., a global dataset that trades off detail in the dataset for evaluation of a huge set of countries (Joppa and Pfaff 2009c).

Andam et al. 2008 estimate how much deforestation was avoided within Costa Rica from 1960 to 1997 due to over 150 protected areas. Costa Rica had one of the world's highest rates of deforestation during the 1960s and 1970s. Andam et al. 2008's "matching" greatly increased the similarity to protected areas of the characteristics of the comparison group of unprotected lands. Using this balanced sample, they find ~11% of the protected pixels would have been deforested in the absence of protection. They also do more traditional analysis. Comparing all protected to all unprotected pixels generates a far higher avoided deforestation estimate of 44% of the pixels. Using a 10km buffer zone corrects very little of this overestimate, yielding an estimate of 38%.

Building upon that analysis with an eye to providing policy guidance for raising impacts, Pfaff and Robalino et al. 2009 reconsider Costa Rica's protected areas for the period 1986–1997. They confirm the Andam et al. 2008 results (matching finds under 3% avoided deforestation, less than a third of traditional estimates around 9%). Yet their focus is impact variation across space.

Some protected areas have far more impact than others do. Within 85km of San Jose, impact was about 3% while further away it was around 1%. Within 6km of a national road 5% of forest was conserved, while further away the impact was about zero. Slope was critical. Areas on flatter land are estimated to have blocked 14% clearing while impact on steeper lands was close to zero.

2.1.2. Looking ahead

Protected areas do avoid some deforestation but much less than previously has been assumed. It is worth emphasizing that this does not imply criticism of existing protected areas' locations or their management. Such resource allocation decisions are driven by any number of motivations.

More important to guide future investment, impacts vary considerably across landscapes. Protection's land-cover impact is likely to be lower, for instance, farther from roads and cities as well as land with higher slopes. As global REDD payments are likely to be based on impacts, if goals that drove past siting of protection can be integrated with an interest in earning payments then given all other constraints planners looking ahead could target higher protection impacts.

2.2. Payments

Payments for ecosystems services such as water quality, species habitat, or carbon storage could reward landowners for limiting use of their land and for conserving ecosystems such as forests. Yet most proposed programs are voluntary and landowners may volunteer their least productive land then get paid for retaining forest that might well have remained without a financial reward. During the initial period of Costa Rica's pioneering program, for instance, payments were not highly targeted and the forests receiving payment were largely non-additional to the status quo. However, as noted for protected areas above, policy could explicitly aim for forest under threat. Costa Rica also shows evolution in program design can be critical. Shifts over time and space in how payments were allocated affected the bias towards low threat and thus also payment impact.

Much as for protected areas it seems clear why ecosystem services payments might work, i.e., prevent deforestation. If a desired outcome such as more forest or higher water quality were to be measured, and payments to a land owner were conditioned upon that measurement, then an incentive to shift land use towards the provision of ecosystem services could change land usage.

Thus again we focus on why the policy might not work. To the extent that where funds are allocated is a top-down decision, all the points made about protected areas' biases towards lower deforestation threats apply to payments as well. In addition, though, to the extent that the landowners' decisions to participate affect the allocation of payments, there is another reason to expect the policy locations to be biased

towards lower threat. In short, landowners are likely to volunteer their least profitable parcels, i.e., precisely those which are least likely to be deforested. Evaluating payments' impacts, then, once again requires attention to the right comparison group.

Landowner behavior raises other issues too. As frequently noted, the incentives for and choices of local land users will be essential to REDD. One group are households in subsistence communities who grow crops for their own use and collect non-timber forest products from unprotected open-access forest or locally protected community forests (Sills et al. 2003). Poor farmers who hold small lots for agricultureal production and devote labor to collection from the forest are very common. The most valuable products obtained from forests varies by region and forest type, with fuelwood being more predominant in arid Asia and Africa (see Arnold et al. 2006, Hyde and Amacher 2001, and Sills et al. 2003).

If REDD (including via payments) leads to higher quality or more extensive forest stocks and if households have access to these stocks, then households that rely on forests may be better off. These benefits can be on the order of several months of agricultural returns (Kohlin and Amacher 2005, Kohlin and Parks 2001) including via reduced collection times (Cooke 1998, Hyde and Kohlin 2000, Cooke et al. 2008, Macdonald et al. 2001 and Arnold et al. 2006). Under this scenario, REDD could bring both climate change mitigation and adaptation benefits, e.g. natural insurance (Pattanayak and Sills 2001).

If instead REDD occurs through payments that go largely to private landowners, then the additional rent may lead to stricter protection and higher enforcement of private forested areas and not only decrease the welfare of subsistence households but also shift activities to more degraded forests (Arnold et al. 2006, Cooke St. Claire et al. 2001, Vermeulen 2001). Further, not only would welfare be affected but also local protection behavior will respond. With respect to 2.1 above, the same may be true of strict protection that excludes local people who have had de facto but not de jure access to non-timber forest products.

Given these possibilities, farmers could be involved in policy design but that is complex. Arnold et al. 2006 find in a review that transfer of local wood fuel reserves to local communities can lead both to greater access for wood but also higher revenues that governments collect from forest use through taxes and royalties, in return for guaranteeing the government protection of its property rights (see also 2.4 below on Decentralization; note REDD brings in ideas of payments). Yet some argue that, at least for fuelwood, the transactions costs of any such efforts may be high (Hofstad 1997). In any case, we should note the possibility of "participatory payments schemes."

2.2.1. Case evidence

Initial Efforts

As summarized in Sills et al. (forthcoming), some early studies of the pioneering Costa Rican PSA (Programa de Servicios Ambientales) program find more forest and less agriculture on the fincas (essentially farms) that receive payments than on non-PSA fincas in the same regions. Yet the people and land participating in PSA differ from nonparticipants in terms of characteristics that affect land use (Ortiz et al. 2003; Miranda et al. 2003; Zbinden and Lee 2005). For example, landowners can only obtain PSA contracts on fincas for which they can establish clear ownership. Others are more likely to clear forest to establish property rights. Thus clearing may be lower on PSA fincas for reasons unrelated to PSA.

Studies also compared forest cover on a finca before and after establishment of the PSA. A telephone survey of 100 PSA landowners across Costa Rica found 43% of that forest already was protected while 36% was used for grazing before the contract (Ortiz et al. 2003). Yet forest cover rising on PSA fincas does not mean an increase is due to PSA, as forest cover was already increasing due to shifts in other factors (see Brockett and Gottfried 2002; de Camino et al. 2000; Miranda et al. 2006; Sánchez-Azofeifa et al. 2001). Evaluation should control for such a trend.

A variation on this approach is illustrated by Sierra and Russman (2006). They use land use on recently enrolled properties (contracts signed in last two years) to approximate what land use on properties enrolled for more than five years would have been had there been no PSA (this is very much in the spirit of impact evaluation discussed above, comparing to the counterfactual). They find that the PSA participants in the Osa Peninsula with recent contracts have significantly more land in agricultural production than earlier participants. They conclude that payments allow landholders to invest in off-farm enterprises and accelerate exit from agriculture. Yet such a view is only valid if the factors that determine when landowners enroll do not also influence land use.

Program Evaluation & Program Evolution

Just as for protected areas, to evaluate payment impact it helps to control explicitly for differences in land (and owner) characteristics between sites receiving payments and not. Recent evaluations apply "matching," both propensity-score matching (Rosenbaum 1983) and covariate matching (Abadie and Imbens 2005), to generate results that are robust to these analytic choices.

Pfaff, Robalino et al. 2008 find that PSA conservation contracts blocked 1986–1997 deforestation in under 0.1%, less than 1 in 1000, of the parcels enrolled in PSA. Thus, many of those who enrolled were unlikely to clear forest even had they not enrolled. We emphasize that this does not mean that all such payments programs in any country would have such low impact. Rather, it indicates that simply having payments does not guarantee impact. Context is crucial; there are many other factors protecting forest in Costa Rica, leaving little deforestation for payments to prevent. In this context, Arriagada (2008) finds that one important impact of the program is more regeneration of forest, apparently motivated by the option value of potential future PSA enrollment and payments.

Robalino, Pfaff et al. 2008 study 2000–2005, finding that about 0.4%, closer to 1 in 250, of enrolled parcels were saved from clearing. To first order, this is a similarly very low impact of ecoservices payments on deforestation. Yet despite the first-order similarity of the impact results, the difference between the 1997–2000 and the 2000–2005 findings conveys the importance of the background socioeconomic context for PSA. To start, while during 2000–2005 Costa Rica had net national reforestation there was more gross deforestation, i.e., more for payments to prevent.

At least as important for learning relevant to REDD policies, Robalino, Pfaff et al. 2008 note another change in PSA over time, the acknowledged shift towards more targeting of PSA after 2000. Targeting cannot change the low deforestation rate to be prevented in Costa Rica but it can and did affect the allocation of PSA payments and thus it changed the policy's impact too. That is also true of differences in allocation rules across offices within Costa Rica. Facing a stack of excess supply of volunteered parcels, how an office selected participants affects impacts.

Returning to average impacts, the details are relevant for REDD. Post-2000, there was less scope for landowners to bias enrollment towards land that would not have been cleared in the absence of payments. More top-down targeting of various goals appears to have accidently implemented a distribution not as correlated with deforestation threat. Robalino, Pfaff et al. 2008 find that PSA impact is the same as, or even a bit higher than, the national average deforestation rate (i.e., 0.3%). This evolution over time in the leading payments program is a great demonstration of the relevance of policy design.

2.2.2. Looking ahead

Ecosystem services payments can avoid deforestation but less obviously, or immediately, than what appears to be commonly assumed. This is no criticism of the underlying idea, which aims inherently to shift local incentives. However, real attention to policy design is required to do so.

Most important is to recognize that within "payments" some policy settings can achieve almost nothing while others could achieve a lot. Payments' land-cover impacts are likely to be lower, for instance, when selection into the program is driven predominantly by the land users' voluntary participation. That and agency choices can lead to paying land farther from roads and cities and with higher slopes and lower soil quality (limiting impacts just as for protected areas). Even then, a PES program could work if proper accounting for baseline is included in its design. More generally, attention to how contract details incent and measure land-use change is critical.

2.3. Concessions

In the large tropical forests of Africa and Asia, and increasingly also in Latin America, logging is often practiced through private concessions within government-owned forests. Many concessions are held by large foreign firms. With variations by country, concessions are often contracts between government owner and harvester, won by some type of bidding process, that designate a volume or area to harvest in some time period. Contracts cover small or large areas and are short- or long-term (see Gray 2000). Firms winning concessions pay fees, or "royalties," for their rights. Royalties are usually either lump sum fees charged based on the area harvested or, instead, fees based upon the volume or species removed. Royalty revenues can be significant.

Poor concession design has encouraged forest degradation and made illegal logging more pervasive and contributed to forest loss (Gray 2002). Concession design could in principle offer real potential for REDD; note that concessions have recently specified environmentally sensitive logging methods such as preservation of certain species, minimum size class harvesting, reduced impact logging, and other methods to reduce environmental impact (Karsenty et al. 2008, Cerruti et al. 2008). However, poorly designed contracts (including royalty structures) remain common. Further, enforcement problems are rife even where relevant concession laws have been reformed. As a result, governments fail to capture appropriate revenue, to protect habitat, to exclude illegal loggers (Merry et al. 2006) and to enforce the agreed methods of harvesting (Smith et al. 2006).

Yet concession design remains relevant to REDD and in two ways. Along the dimensions just discussed, a national government could reform its policies on timber harvesting concessions to reduce net forest carbon emissions below a national baseline, e.g., by providing incentives and increasing enforcing of reduced impact logging and other best management practices (Putz et al. 2008). In addition, at global scale one might conceptualize REDD policy as a market for carbon concessions with countries as the contractors. That description is consistent with the high-profile cases of national governments seeking international bidders to support conservation of forest that otherwise would be managed under resource concessions (see e.g., Ngoïla-Mintom in Cameroon). Further, in Indonesia NGOs developing REDD projects for the voluntary market and as pilots for a future compliance market are establishing additionality, permanence, and their legal right to the carbon through concessions that preempt timber or oil palm concessions (Madeira 2009).

2.3.1. Case evidence

Concessions remain the most common form of legal timber harvesting in developing countries. They are commonly found in the large tropical forests of central and western Africa, but also in more arid countries with deciduous forests such as Benin. Timber concessions are common in Asia, especially Indonesia and Malaysia, and they are becoming more common in Latin America. Brazil, for instance, has just agreed to open more than 70 million hectares in the Amazon for future harvest concessions. Many of the concession buyers are foreign logging firms that have enough capital resources to develop the type of management and harvesting plans that are typically required. However, Malaysia among other countries has promulgated policies, such as log export bans (see discussion in 1.4 above), to favor domestic bidders (Kishor et al. 2004).

There has been much debate within varied literatures about how to design concessions to ensure sustainable harvesting, reduce illegal logging incentives, and ensure adequate government rent capture. Topics include concession contract stipulations concerning harvesting and logging methods; the structure of royalties and fees; and government oversight and enforcement. All of them are relevant for thinking about the future of such contracts under REDD. Carbon payments could conceivably be structured through some type of carbon-concessions contracting system.

The design of concessions under ideal circumstances has been debated for many years, with several recommendations about design, i.e., royalty rates, enforcement effort, concession size, and environmentally sensitive logging effort (Hyde and Sedjo 1992). A common claim is that royalties are not used effectively to capture government revenues or to stem illegal logging.

Illegal logging typically comes in three forms: too much removal (area or volume); the failure to declare harvested volumes; and failure to use contracted logging methods or to harvest only the designated species (Barr 2001, Richards 1999, Gray 2000, and Hardner and Rice 2000). High grading, or removal of only the best or highest valued trees, is one realization of this issue.

A common idea is to raise royalty rates to increase government rent collection and also reduce excessive harvesting, thus lower logging impact (see Gray 2000, Vincent 1990, Merry et al. 2002, Palmer 2003). Others have called for a shift to area-based lump sum royalties instead of basing fees upon stated volume, which is often erroneously declared by the harvester (Barr 2001, Richards 1999, Gray 2000, Hardner and Rice 2000). Yet Boscolo and Vincent (2007) argue that even high area fees can induce unsustainable harvesting behavior. Another common idea is to increase (very costly) state enforcement effort in an attempt to catch and punish illegal harvest.

Yet early concessions literature did not deal with illegal logging that undeniably exists. Formal studies of illegal logging incentives in public concessions include Boscolo and Vincent (2000), who analyze the impact of royalties on use of minimum site impact (i.e., environmentally sensitive) logging practices by loggers. Clarke et al. (1993) study the role of penalty schemes and optimal dynamic enforcement expenditures on open access forest exploitation, while Walker and Smith (1993) model noncompliance choice by loggers facing a particular concessions contract.

Amacher et al. (2007) examines reform in royalties that can reduce illegal logging in the form of harvesting beyond concessions. They show that the royalty reform needed depends on harvesters' risk preferences (correlated with firm size) and the type of penalties the government could use for illegal logging of various forms. They also find that higher "royalty regression" (i.e., lower marginal royalties as volume increases) can raise reporting of harvest volumes and reduce cheating if a revenue neutral reform and other enforcement effort choices are jointly considered. This idea seems robust, as Boscolo and Vincent (2007) find a similar result in a different model.

2.3.2. Looking ahead

For REDD, a message from this literature is that all instruments (royalties, enforcement, and concession contract stipulations) must be designed together and not thought of independently if the goal is to ensure adequate government rent capture, a high level of emissions reductions, and minimized illegal logging that can erode these emissions reductions. Yet the applications of such concessions thinking will differ across countries. The works cited establish that successful use of these instruments depends critically on the structure of governance, resources the state has for enforcement, and other problems that can undermine concession design such as corruption.

Yet it remains the case that reform of timber concessions could help reduce deforestation and forest degradation. Better design and enforcement could raise adoption of reduced impact logging and other best

management practices that significantly enhance carbon storage (Pinard and Cropper 2000; www.raftprogram.org). Increased government revenue capture could be used for debt relief, (see 1.3 above). If concessions provide more income for the government, this can support the combating of corruption and illegal loggings on the frontier. These activities may in fact be complementary, as if some enforcement (for reduced impact e.g.) rises only in some areas then broader enforcement may be required to combat potential "leakage," or the displacement of logging activity toward more easily exploited areas such as smallholder or village-based forests.

In addition, under a project-based approach to REDD, countries could just swap harvest concessions for carbon concessions, with REDD payments compensating for the expected loss in rents from not harvesting. If all relevant local actors are adequately compensated, there could be several advantages for public goods production and even climate benefits in carbon concessions.

Finally, were such swaps to happen, we note that lowering timber supply could also have important impacts on timber markets. It can increase prices and divert demand, yielding leakage to forests outside concessions including in neighboring countries (as is believed to have resulted from China's restrictions on timber harvest). On the other hand, with greater enforcement and a global REDD regime higher timber prices could also provide an incentive afforestation/reforestation.

2.4. Decentralization

Many of the world's forests were once governed as common property regimes, with groups of users sharing management rights and responsibilities (McKean 2002). In the developing world, most of these traditional regimes were legally disavowed when colonial and then central state governments declared themselves the owners of all forests. In many tropical countries, still the majority of forests are owned by the state. This has left the millions who live in these forests with only usufruct or "use" rights to the forest and—at least in a legal sense—no rights to own, to manage, or to block others' exploitation of the resources upon which their livelihoods depend. As the persistence of tropical deforestation illustrates, central state ownership and management often has not worked in the sense of sustainable forest management and forest conservation.

Extensive areas of state-owned forests in the tropics are zoned as timber or as agricultural concessions. Others are zoned as parks and others simply as public lands with no designated use. As the authority to enforce rules here rests with a state entity whose presence is often minimal, due to budgets or corruption, open-access and the "tragedy of the commons' frequently result. McKean (2002) sums up the situation: "The transfer of property rights from traditional user groups to others eliminates incentives for monitoring and restrained use, converts owner-protectors into poachers, and thus exacerbates the resource depletion it was supposedly intended to prevent." The consequence is rampant illegal logging, clearing, and burning in many state-owned tropical forests, including within national parks (Curran et al. 2004; Jenkins 2008).

Yet over the past two decades, numerous central governments have devolved both forest ownership and management responsibilities to local institutions. As of 2001, at least 60 countries reported some decentralization reforms in natural resources (Agrawal 2001). Increasingly, this includes granting local communities property rights to forested lands (Sunderlin 2008). Goals of these reforms include all of improved efficiency, equity, and effectiveness of forest management.

Such decentralization has already taken many forms and that is likely to remain the case looking forward. Those forms include the devolution of property rights or management authority to a community, e.g., legally recognizing a traditional common property regime (see community forests in Cameroon and India for example). They also include the transfer of forest management responsibilities to state or to local governments (i.e., enforcing rules and collecting revenues).[50]

As to why such decentralization might help to reduce deforestation, for much of the 20th century individual private ownership and centralized state ownership were viewed as the options for overcoming "commons tragedies" but then from the late 1980s increasing interest was paid to cases where property rights and management responsibilities are held by groups of forest users (Ostrom 1990). Both cases and theories suggest groups can develop effective local institutions (Ostrom 1990). Some theories suggest common property regimes even can be the most efficient way to manage natural resources that are (1) remote, which emphasizes group monitoring and enforcement, or (2) biophysically more productive if managed as a large unit, rather than as fragmented patches (McKean 2002). Both conditions can hold in tropical forest regions.[51]

In addition, theories regarding decentralization posit that bringing government "closer to the people" will induce participation and increase the accountability of government institutions (Larson 2004). Local communities and governments may have better information about local conditions and preferences and therefore make better decisions about provision of collective goods (Andersson et al. 2006). Ribot and Larson expand on these ideas, arguing that in order for decentralization to work it must be democratic in nature. That is, sufficient powers must be transferred to a local institution and this institution must be downwardly accountable to the local population (Ribot 2002; Ribot and Larson 2005). According to Ribot (2002), "The underlying logic of decentralization is that democratic local institutions can better discern and are more likely to respond to local needs and aspirations because they have better access to information due to their close proximity and are more easily held accountable to local populations."

2.4.1. Case evidence

Taking stock of decentralization's impacts is constrained by a few factors. Despite many stories, empirical studies of impacts on forest cover and human welfare are few. Rigorous examinination of pre-decentralization conditions or specific characteristics of reform are limited. Also outcome measures differ cross the studies that do exist. Some have examined how characteristics of local institutions and decentralization reforms affect changes in forest cover (Alix-Garcia et al. 2004; Alix-Garcia 2007; Chhatre and Agrawal 2008) while others examine just local wood extraction (Edmonds 2002) or local institutional effort (Andersson et al. 2006) or human welfare (Cooper 2008; Jumbe and Angelsen 2006). Only a few studies compare decentralized outcomes with the impacts of centralized state management on forest cover (Nepstad et al. 2006; Somanathan et al. 2009). Only one includes the relative efficiency or implementation cost (Somanthan et al. 2009).

Further complicating assessment is the incomplete nature of many such power transfers. Some argue that evaluating impacts may be premature because often "decentralization" was in name only at least to this point (Ribot 2002; Shackleton et al. 2002). Ribot and Larson (2005) argue that often sufficient and secure powers have not been transferred to local institutions and that often these institutions are not downwardly accountable to the local population. Thus even with baselines and metrics, the "underlying logic" of decentralization would not be well tested.

Nevertheless, we attempt to summarize the empirical and case literature by considering the following characteristics of decentralization reforms: (1) To which institutional level were powers devolved? (2) How accountable are these institutions to the local population? (3) What powers were devolved? (4) How secure are such power transfers over the long term? and (5) Are reforms accompanied by land tenure reforms that grant local populations property rights and other complementary rights that matter (e.g., to citizenship, participation, access, and recourse)?

Decentralization can work

Our first summary is that decentralization can help conserve forests and increase benefits for local populations when secure powers are transferred to community-level institutions and in addition these

institutions are downwardly accountable. Throughout the developing world these conditions have produced gains. Numerous instances of effective community forest management have been documented for communities with clear and secure ownership or management rights.

Indigenous territories and community-managed extractive reserves have blocked clearing. One impressive case of community forest management is indigenous territories and extractive reserves in the Brazilian Amazon.[52] Here, inhabitants possess secure and exclusive use rights and thus the right to block outsiders from encroachment. Nepstad et al. (2006) and Adeney et al. (2009) have found that indigenous reserves do as well as parks in blocking deforestation and fire (Pfaff et al. 2008 add that while none of these areas reduces deforestation as much as typically claimed (see also 2.1 below), indigenous areas do better than state areas). Further, the exclusion of others seems to occur even in areas of intense deforestation pressure (Nepstad et al. 2005).[53]

Forests under community management in Kumaon, India, have been sustainably managed for decades (Agrawal 2001). Some conclude that Van Panchayats (community forest councils) have been more effective in conserving than state agencies (Somanathan et al. 2009). In Mexico, where most forests are held as common property, many communities sustainably manage forests (Alix-Garcia 2004). Since Bolivia's decentralization reforms in the 1990s, including recognition of 22 million hectares of indigenous lands (3m ha has been titled), improved forest management have been reported (Pacheco 2005). In Nicaragua, where the Bosawas Reserve overlaps lands demarcated for indigenous peoples it is better defended against encroachment and deforestation than are its areas solely under state management (Stocks et al. 2007). In Nepal, which began to devolve management rights to communities in the 1970s, community management has done a better job of maintaining and increasing forest cover than state management (Nagendra 2007).

Cases of community management increasing revenue and benefits for local populations have also been documented. Tanzania provides one example. The 2002 Forest Act in Tanzania devolved timber licensing and revenue collection responsibilities from the district to the village . . . Transparency and downward accountability have also been increased by requiring that village institutions document and publicly share all revenues and expenditures. The result has been an increase in revenue collection and the financing of public services for villages (Lund 2007).

Decentralization is not a panacea

Our second summary from these literatures is that decentralization could instead increase deforestation and for that matter inequality if attention is not paid to institutional conditions and economic incentives. It is important to state explicitly that decentralization is not a panacea. If the short-term economic incentives for conservation are not higher than those from commodities following any such decentralization reform, then we can expect that deforestation will increase.

Traditional communities, for instance, are not inherently focused on conservation alone. They and other local institutions may well aim to maximize economic returns from the forests and thus where conservation incentives are lacking, deforestation may rise under local control. Conversion of forests to agriculture has been observed in reserves in Mato Grosso (Fearnside 2005) as have been both intense logging and significant forest degradation (Asner et al. 2005).

Rapid and destructive logging has also plagued some community forests in Cameroon (Oyono 2005). It has been speculated that the management rights granted to these communities are not secure (for 25 year periods but may be renewed or revoked by the state). Thus residents may wish to accrue forest profits while they can, lacking incentives for sustainable management (Oyono). Another contributing factor may be a lack of transparent and downwardly accountable institutions, if this has allowed the village elites to

promote logging, e.g., to derive personal gain at the expense of community welfare (Oyono et al. 2003; Ribot 2002; Larson and Ribot 2007).

In Indonesia, deforestation appears to have increased following decentralization reforms, which (as in the Tanzania case noted above) devolved authority for granting timber licenses and collecting revenues, in this case to the district level. Districts were able to increase their revenue generation through logging. By many accounts, local communities have benefitted little. While local people may be granted timber licenses, they lack the capital to undertake the logging and thus usually contract with large logging companies who may promise to pay communities a fee based on harvesting volume or replant the area with cash crops (Resosudarmo 2004). Due to the local lack of secure property rights and access to fair judicial systems, and the states' inability or unwillingness to enforce these contracts, these communities have been vulnerable to exploitation (Engel and Palmer 2008). Further, the district-level institutions possessing the newly devolved powers are not necessarily close to or accountable to the local population (Resosudarmo 2004).

Decentralization may also not work well where the forest area under management is vast, and specifically vast relative to coverage by the relevant local populations. A recent analysis of community forests across the world found that local enforcement capacity significantly affects outcomes in community forests and that ongoing degradation is more likely in larger areas. This could be due to communities' difficulty in monitoring large tracts (Chhatre and Agrawal 2008).

2.4.2. Looking ahead

Decentralization may be an effective policy tool for reducing deforestation. Yet for it to work requires attention to institutional conditions. First, local institutions require secure rights to own or manage the forest. In the context of REDD, clear rights to enter into forest carbon contracts in particular may be necessary. Second, local institutions need financial incentives for conservation. Third, local institutions need to be transparent and downwardly accountable for local populations to in turn face and receive financial incentives for conservation (carbon payments, better social services or other benefits). Fourth, if local populations have property and complementary rights (e.g., to citizenship, participation, and redress) then local institutions may be more likely to be downwardly accountable. Finally, local institutions require the support of central state authorities for managing their lands, e.g., technical assistance, capacity, enforcement of contracts, and more generally the ability to administer justice given conflict among local institutions (Larson 2004).

3. Other Domestic Policies

Adjusting other domestic policies with significant effects on deforestation may be as important for REDD outcomes as optimizing based upon past lessons the forest-focused domestic policies. Yet little experimentation of this type has occurred, to our knowledge. Thus we describe lessons on how these factors affect deforestation and simply suggest that such policies could be adjusted.

3.1. Infrastructure

Access and transport costs are key determinants of agriculture and logging. Investments in roads raise access, lower transport cost and often lead to both more economic output and deforestation. Critically, though, road impacts vary across space. Specifically, new road investments appear to increase deforestation less when in already developed areas with prior roads and deforestation. Thus a road network forest impact is affected by network design (pipelines seems analogous). In addition the government of Acre, an Amazonian state in Brazil, says deforestation can be lower if public actors sequence road construction with policies that clarify tenure and provide services, raising quality of life

while preserving natural wealth. Another sequencing example could be a buffer of parks around roads, imitating how Chico Mendes Extractive Reserve has functioned.

Above we note that agriculture has been the primary land use to which forest lands have been converted. An underlying model of such choices could have owners maximizing profits (or some broader objective including profits) in deciding among various alternative uses of the land. Improved access, i.e., the feasibility of transport and its cost, should increase net revenues from selling one's outputs. It also lowers the cost of inputs, from labor to fertilizers to machines. How this affects the profits from cleared land relative to that from forested land uses will drive choice. New roads could support forest but in many situations their net benefits for clearing are greater. On average across varied settings, then, such investments are expected to increase deforestation.

REDD must build upon but yet go beyond such a general conclusion on average impacts. Specifically, below we focus on heterogeneity in impacts, which creates the potential for policy to generate, REDD. If the impact of a new transport investment varies as a function of the setting into which the investment goes, then the choice of where to invest can affect deforestation rates. Further, other policy choices can be part of the setting that affects the impacts of transport policy.

3.1.1. Case evidence

Transport costs matter

The hypothesis about relevance of changes in transport infrastructure for deforestation is empirically supported. One can examine the behavior of the agents who decide whether to clear an area (e.g., Caviglia-Harris and Sills forthcoming). Regression analysis at this scale requires data from farm households with questions about the extent of deforestation (number of hectares or percent of landholding) and about factors that may influence it. Current research focuses on linking such survey data with measures of deforestation from remote sensing (Fox et al. 2002). Results generally show that improved access to roads and market centers raises deforestation.

A broader or higher-scale view of the evidence also supports this general conclusion. Recently, more economists study deforestation across regions within a country by combining census data with increasingly accessible remote sensing data (Pfaff 1999 is an early example). Where data are available, higher agricultural prices are generally found to be associated with more deforestation (Angelsen et al. 1999 on indices of agricultural output prices in Tanzania). Also, as noted above, biophysical factors (soil quality, slope, precipitation) are key constraints.

Controlling for the effects of those factors, transport access/cost as proxied by proximity to roads is correlated with new deforestation. Chomitz and Thomas 2003 find that distance to roads and precipitation are negatively correlated with deforestation in the Brazilian Amazon.[54] For Thailand, Cropper et al. 2001 find that the biophysical factors have the strongest correlation with deforestation but roads and population density are also positively related to deforestation.

Over two-thirds of Brazilian Amazon deforestation has taken place within 50km of major paved roads, resulting in the "arc of deforestation" across the southern Amazon (Nepstad et al. 2001, Laurance et al. 2002, Chomitz and Thomas 2001). Two major roads were inaugurated in the early 1960s: the BR-010 connecting Brasília (the national capital) to Belém (the capital of Pará) in the east, and the BR-364 connecting Cuiabá (the capital of Mato Grosso) to Porto Velho (the capital of Rondônia) in the west. These are two of the areas with greatest total deforestation.

Road impacts vary by location

In the early 1970s the Transamazonica/BR-230, which runs east to west across the states of Pará and Amazonas, and the BR-163, which runs south to north from Cuiabá (Mato Gross) to Santarém (Pará), were constructed but not paved. Their impact is magnified by the associated network of over 300,000 km of unofficial logging tracks (Brandão Jr. et al. 2007; Perz et al. 2008). Currently, the frontier with the highest clearing rates is in the central Amazon, along BR-163. Summarizing, across this enormous region subregions and their histories vary a great deal.

This suggests new roads' impacts could vary depending on where the roads are located.[55] Andersen et al. 2002 make this explicit by considering impacts as a function of prior clearing (as so much clearing follows the road corridors, prior deforestation is similar to prior road access). Using about 250 county-level observations, they estimate an interaction between roads and prior clearing, assuming that higher prior deforestation always raises or always lowers a road's forest impact. They find that as prior deforestation is higher, the forest impact of a new road is lower.

Pfaff et al. 2006a follows up on this concept, using over 6,000 census tract observations. That much data permits analysis of subsets of the tracts divided up by the level of prior clearing. As do Andersen et al. 2002, they find significant increases in clearing when roads are placed into locations with less than half of their originally forested areas cleared (which represent the great majority of census tracts). Unlike Andersen et al. 2002, the next highest level of prior clearing, 50%–75% of original forest, has higher road impacts. From 75% up, road impact is insignificant.

Pfaff et al. 2008 extends that with multiple time periods (1976–1987, as in Pfaff 2006a, along with 1986–1992 and 1992–2000). Breaking impacts down by the level of prior clearing, the impacts of new roads investments in pristine (0% prior clearing) are very similar to average impacts. In contrast, when there is some prior development, new roads raise deforestation more. However, with even greater prior clearing, new roads have less forest impact than the average.[56]

Pfaff et al. 2009 extends this to pixel data, providing more precise measures of whether a relevant road investment has occurred. When a new road is sited, for some forest parcels the old road will still be closer. Initial results suggest that when there was more prior development, as indicated by an old road nearby to the parcel, new road investments have no impact on clearing. At an intermediate distance to prior roads, new roads have their highest impact. They have some but less impact when the new road investment occurs quite far from even the closest prior roads, which is likely to indicate short-run limits on adjustment even if long-run impacts may be huge.

Conde and Pfaff 2008 provide supporting evidence from the Mayan forest (in Mexico, Belize, and Guatemala). Here, the short-run impact of new road investments relatively far from prior roads is lower than impacts closers to some prior development (there is not enough data in areas of higher prior development to test that aspect). They show that in more remote areas, it is only the road, not other characteristics, that shape the path of deforestation. Since we know from other work that new roads will follow old roads, despite lower short-run impacts these remote roads are opening up a long time path of increasing deforestation. Further, Conde 2008 examines the impacts of roads upon jaguar habitat, which reflects the importance for species of contiguous, uninterrupted forest. Fragmentation impacts are clearly higher from the more remote new roads.

Delgado et al. 2008a provide supporting evidence concerning higher prior development, focused on investments in the Inter-Oceanic Highway connecting the western Brazilian Amazon with Peru and running along the border of Brazil with Bolivia. The highway was well established in unpaved form by 1989 and the Brazilian part of the highway was paved from 2002–2004. The critical result for REDD is that distance from the highway is significantly negatively associated with deforestation during 1989–

2000, in all three countries, but is not significant for deforestation during 2000–2007. While the elimination of this corridor could lower clearing, the investment in paving did not shape local clearing given an already established local pattern of development. To link to the above, the existence of significant prior local development lessened new road impact.

Road impacts vary with policies?

While the conventional wisdom is that development and deforestation go hand in hand, the state government of Acre in the Brazilian Amazon has made an explicit focus of finding ways for quality of life to increase while natural wealth is preserved (Sills et al. 2006). Thus, appropriate policies are claimed to lower the forest impacts of new roads, for instance, which improve market access for products and facilitate access to services for rural residents.

The policies proposed for development with lower deforestation impact include public services (education, health, market information, extension, and training), accessible credit, the enforcement of environmental regulations, and support for mechanisms to compensate forest owners for ecological services (e.g., certification of forest products). Officials argue that such policies will permit such a "win-win" outcome for traditional forest residents, whose preferences and capital (human, social, physical, and natural) predispose them to forest-based development.

This idea that shifts in development permit REDD, holding fixed a level of development, is formalized in the ASDP (Acre Sustainable Development Program) to stimulate environmentally sustainable and economically viable practices among rural/forest low-income families.[57] Indicators of success include (a) counts of "benefited" poor households; (b) area of "recovered pastures"; (c) increase in benefited-household incomes; and (d) increase in agroforestry production.

Looking backward for evidence that policies can lower deforestation given development, Delgado et al. 2008b consider a particular (and perhaps unintentional) packaging of policies that could lower the impact of new investment in roads. Chico Mendes Extractive Reserve is located quite close to the Inter-Oceanic Highway in an area subject to considerable deforestation. As an extractive reserve, it is not surprising that Chico Mendes has been deforested to some extent over time. One might conclude it has had little impact while other, pristine parks in Acre had more.

However, using matching methods to compare Mendes' with outcomes in similar areas, Delgado et al. 2008b find Mendes avoided significant deforestation. Further, the other protected areas in the region but further from the highway are essentially uncleared but avoided essentially nothing as other forest as far from the highway (and otherwise similar) also has not been cleared.

Pipelines analogous?

Pipelines are another important form of infrastructural investment in forested frontiers. While they are intended primarily for transport of energy, in fact at least their maintenance roads create access to forested areas. Further, at this moment of highly variable and at times very high prices for energy, national governments are poised to make decisions about major expansions of energy transport such as within the western Amazon (Finer et al. 2008). As Finer et al. note, now over 150 oil and gas "blocks" (areas zones for hydrocarbon activities) cover almost 700,000 km^2 across the western Amazon and these blocks overlap the most species-rich parts of the Amazon. Within Ecuador and Peru, oil and gas blocks now cover more than two-thirds of the Amazon.

The REDD question here is whether there are pipeline choices governments can make to lower forest impacts, since the odds of simply not investing to extract the energy seem very low. One set of options is analogous to those for siting new roads: if compensated for the extra costs, could it make sense to travel

greater distances on existing pipeline routes instead of cutting new routes through the forest? Another set of options that is claimed to be feasible, for instance in the case of the Camisea pipeline in Peru, concerns "road-less" pipelines, i.e., limiting access to routes.

3.1.2. Looking ahead

Infrastructure investments, such as in transport of people and energy, will cause deforestation but of course their development goals are valid and thus the question is how to find favorable ratios. Then the critical point to recognize is that some new roads, for instance, will increase forest loss more than others (their development benefits surely will vary also but that is outside our scope).

REDD payments schemes that reward reduction of emissions relative to agreed baseline could provide incentives for tropical forested countries to consider adjusting development policy that affects deforestation rates. Holding development goals and impacts fixed, countries might wish to earn payments by, for instance, intensifying road investments along the existing routes instead of spreading out the road (or pipeline) network through currently highly forested areas.

A second critical point to consider is that other policies could cause road impacts to vary. As suggested in Acre's ASDP, integrating infrastructure investments that promote local welfare with various other policies may allow development yet raise the ratios for other gains achieved. An implication for REDD is that decentralized responses to carbon incentives could work well, allowing local decisions about integrated uptake conditional on the monitoring of global goals.

3.2. Agriculture

Tropical deforestation is driven by demand for agricultural land, with rare exceptions (charcoal production for pig iron factories in the Amazon, for example[Homma et al. 2006]). Von Thunen's model considers the manager of a parcel examining the relative returns to different land uses including maintaining forest or converting to agriculture. Returns to all land uses typically decrease with increasing distance to market. Relative returns are affected by technology (e.g., crop varieties or mechanization), infrastructure (e.g., processing facilities) and biophysical conditions (e.g., slope, soil quality and precipitation). In turn, policies affect prices, technology, and infrastructure.

Where land managers do not perceive any value to maintaining forest, deforestation can be seen as an input into agricultural production with a cost (of clearing land). It may also be an investment in an asset that may be used for several years, appreciate or depreciate in value, and sometimes be sold. Investment decisions are shaped by the availability and cost of credit, titling rules and tenure security (see next section) plus general economic conditions such as inflation.

In these frameworks, a factor that increases agricultural profits on newly deforested land will increase deforestation. The evidence below first addresses this straightforward prediction, then considers complexities: second-order effects; different types of producers; and endogeneity.

3.2.1. Case Evidence

Profit-driven deforestation

Agricultural profit rises with prices of outputs (crops, livestock products) and falls with prices of inputs (chemicals, labor), as consistently observed (see Angelsen and Kaimowitz 1999; Pfaff 1999, Barbier and Burgess 2001; Geist and Lambin 2002; Rudel et al. 2000; and Wibowo and Byron 1999). Deforestation has tracked, for instance, commodity prices of maize in Mexico (Barbier and Burgess 1996), soybeans in Brazil (Morten et al. 2008), and cocoa in West Africa. More recent is demand for biofuels that can be profitably cultivated, such as oil palm in the Indo-Malaysian forests and potentially in the Amazon and

Congo (Fitzherber et al. 2008; Koh and Wilcove 2008) whose production in forested areas is profitable but results in large net emissions of carbon (Fargione et al. 2008; Gibbs et al. 2008) Where biofuels compete for agricultural land, they can in addition also raise deforestation by reducing crop supply and increasing crop prices.

Price signals can be transmitted through trade policy. Opening up of trade may increase or decrease deforestation, respectively, in regions with or without comparative advantage in the production in question (Lopez and Galinato 2005). Policy may also directly affect the prices, e.g., through price floors. Less directly, government policies shape macroeconomic conditions that can affect domestic demand and production of agricultural commodities across multiple regions.

In many tropical forest regions, the two key inputs to agricultural production are land and labor and thus the "price" of using agricultural land is influenced by tenure and taxation policies, discussed in the next section, as well as the labor costs involved in cutting and burning the forest. Thus the existence of a labor market and the wage rate influence deforestation, establishing the possibility and cost of employing labor, including in light of competing demands (Shively 2001). Active labor markets with low wages can encourage clearing by reducing costs of deforestation and increasing the profitability of agriculture. Conversely, outmigration in search of higher wages may factor into reversals of net deforestation in Central America and the Caribbean.

In some regions, fertilizer and other agricultural chemicals are important inputs, and their prices are expected to be inversely correlated with agricultural profitability. Credit is yet another input to agriculture, with cheaper credit in general lowering the costs of agricultural production, thereby increasing profitability and the derived demand for agricultural land. Credit, machinery, and labor, however, also are all inputs into forest management. Thus shifts in their prices affect returns both to agriculture and to forestry and impacts on relative returns require specific study.

"Agricultural technology" includes crop and livestock varieties, planting and harvesting techniques, and management strategies (e.g., intercropping, pasture rotation). Brazil has made significant public investments in agricultural research and development to raise productivities, reduce risks (e.g., from pests and disease) and open markets (e.g., via phytosanitary measures) (see Arima et al. 2005 for example of cattle in Brazilian Amazon). Generally, while Angelsen and Kaimowitz (2001) rightly note that labor-intensive technological change can reduce pressure to clear forest when labor is a limiting factor, which can hold on a frontier, improved agricultural technology coupled with market integration, strong commodity prices and easy access to land has proved a recipe for rapid deforestation (Cattaneo 2001, Morton et al. 2006, Hecht 2005).[58]

Government provision of, or subsidies to, infrastructure and services such as processing plants and veterinary care also can have effect. In the context of colonization projects, impact is magnified by migration and the resulting expansion in the labor supply, as demonstrated by rapid deforestation within INCRA settlements in the Brazilian Amazon and transmigration settlements in Indonesia. Infrastructure and a labor influx have led to deforestation even where biophysical constraints deter agricultural production (Schneider et al. 2000; Murdiyarso and Lebel 2007).

Complexities

Policy affecting agricultural profitability on newly deforested land can also have indirect effects on the same household or the frontier region in question or in other parts of the country. These can reinforce or counteract the direct effects. This can be particularly true where markets are "incomplete," with a small number of participants or with significant barriers to transactions.

For example, increasing opportunities for off-farm labor generally increase wages and reduce labor allocated to farming. That would be expected to decrease deforestation. However, where credit markets are incomplete, it could relax cash or capital constraints on deforestation. Yet where most households are engaged in labor-intensive agriculture and are not clearing land for potential future sale, relaxing cash constraints could allow investments in more intensive and sustainable systems (Barrett 1999). There are even potential long-run general equilibrium effects of the development of off-farm labor markets with urbanization, increasing income, and greater regional demand for agricultural production (e.g., of milk and beef in the Brazilian Amazon).

It is useful to distinguish producers oriented towards commercial production for national or international markets from those oriented towards subsistence production supplemented with sales into the local market. The former—whether smallholders producing cocoa in West Africa or conglomerates developing oil palm plantations in Southeast Asia—may reduce deforestation in response to credit crunches and increased input costs (e.g., elimination of fertilizer subsidies). Yet the same conditions may counterintuitively raise deforestation by the latter, e.g., by migrants forced out of agriculture in their regions of origin who relocate to forest frontiers. Agricultural policy in those regions—including land tenure, insurance against climatic risk and price regimes—can have a critical influence on the forest frontier through its influence on migration decisions.

Creating dynamic indirect effects from all of the drivers noted above, deforestation itself can change economic conditions and foster further deforestation. At the farm level, cleared land may serve as collateral for lower-interest loans. At the regional scale, the resulting agricultural activities may attract services, processers, population and roads, reinforcing deforestation (see Schneider 1995; Mertens et al. 2002; Kaimowitz and Smith 2001, Kerr and Pfaff 2009, Pfaff et al. 2009). It is widely believed that this type of self-reinforcing process applies to deforestation "poles" in the Brazilian Amazon even where the initial changes were driven largely by policies.

In considering dynamics at this level, the possibility of "forest transitions" is also of note. Development dynamics shift over time, and perhaps with the level of income, or development, and may imply a shift from net forest loss to net gain. Some such shifts in direction are observed. Key components of such dynamics may be more intensive production in more productive areas along with outmigration from and perhaps targeted incentives for forest in marginal regions.

While rising income likely raises commodities demand, it could also allow investment in more intensive agriculture and could increase demand for environmental services and products provided by standing forests (see Foster and Rosenzweig 2003). Further, it has been observed that in some developed countries deforestation increased but then decreased as income grew.[59] Deforestation has stopped in a number of countries and forest area has been increasing not only in Costa Rica but also in countries such as the U.S. In looking for such patterns, some have found that the "turning point," or the income level where deforestation rates start to fall after previously rising with income growth, appears to vary across countries and to depend upon other conditions such as the distribution of wealth and political freedoms (Bhattarai and Hammig 2001).

However, we must recognize the importance of trade in satisfying local commodities demand based upon nonlocal resource use and deforestation.[60] Pfaff and Walker 2009 discuss the historical case of the New England region of the U.S., which from the early 1800s to the early 1900s significantly reforested while growing in both income and population. It could appear to suggest that deforestation reversals are to be expected, as forest scarcity did motivate efficient use of wood and wood substitutes. Yet significant imports of agriculture from the Midwestern region addressed food demand, at lower cost after railroads linked the regions, and significant imports of timber from Southern, Midwestern and Northwestern regions also addressed local demands. Thus, without bringing in commodities, something not possible at

the global scale, New England's regional deforestation reversal may have been greatly lessened or eliminated.

In light of these ideas, Pfaff and Walker 2009 consider the case of the Brazilian Amazon. Some parts of the region are reforesting and consistent with this view there will be specialization within the region with some areas producing and selling to others. Yet taking the Amazon as the region in question, if anything it appears that it exports products to the rest of Brazil, at least on net, which would not predict deforestation reversal. Then taking the country as the region, not only soy but also timber and beef are being exported to other countries. This may lower threats within those countries but would not appear to suggest that income will lower Amazon clearing.

3.2.2. Looking ahead

Where agricultural production on newly deforested land is profitable, perhaps the clearest route to reducing deforestation is to reduce output prices, which has happened via economic recession, overvaluation of exchange rates and conflict (Fearnside, Sunderlin, Lopez and Galinato 2005), none of which can be recommended as REDD policy. Demand management (see 1.4 above) is a more politically viable approach but with less of a track record though it could even be employed as domestic policy. For example, major beef processors in southern Brazil recently agreed to a Greenpeace plan not to purchase cattle from newly deforested areas. Governments could also try to increase profitability elsewhere, e.g., by targeting marginal lands. That may be one approach to managing demand for biofuels through various permitting processes (Searchinger et al. 2008).

There are more opportunities to change deforestation trajectories in regions where limited access or other biophysical conditions mean agriculture is marginally profitable with subsidies. There carbon payments could compensate for elimination of those subsidies, especially with the clarification of tenure and tax laws. Planning to avoid colonization projects and infrastructure in marginal locations could be one "win-win" for regional economies and global carbon emissions.

Improving agricultural technology can raise deforestation but this does not suggest that agricultural research and development should be discouraged, given effects on malnourishment (von Braun 2009), decreased reliance on forest biomass as a key input to agriculture (Benhin 2006)[61], facilitating conditions for forest conservation (Ewers et al. 2009), and even potential large-scale reductions in anthropogenic carbon emissions (Wise et al. 2009). The key is to couple such increased productivity with tenure, tax, credit, infrastructure and other policies that inhibit agricultural expansion into forest areas and support sustainable management of standing forests.

3.3. Tenure

Tenure regimes in which those who clear land acquire squatter's rights and later title have long promoted deforestation (Fearnside 2005). Clearing may be productive but even clearing not leading to profitable use may allow acquisition of title, facilitating credit and/or future resales. Clearing may even be required to obtain permanent title. That clearly encourages deforestation.

Further, risk of losing forest through expropriation reduces the incentives for long-term sustainable management. It can be particularly difficult for individuals and even communities (Honey-Rosés 2009) to stop expropriation through illegal logging where timber trespass can occur in private forest, a risk that varies by setting but yet is widespread. Illegal logging is believed to contribute a significant part of the timber harvest across all major tropical forest regions. Up to 80% of all logging in Latin America is thought to be illegal (see Guertin 2003's examination of trade flows between Latin America and developed countries), including everything from trespass to lack of requisite paperwork. In Cameroon, illegal logging statistics often combine and confuse different types of violations by actors operating at

different scales (Cerutti and Tacconi 2006) yet clearly the risk of illegal logging is a barrier to sustainable forest management (Putz et al. 2009).

Owners choose among land uses, often clearing for agriculture or grazing, plantations, and unmanaged native forest land or protected reserves. The costs of site protection affect the relative returns from land uses. While carbon-based payments could increase rents to holding or establishing forests, those rents must overcome the higher site protection costs for forest land. Private costs of protection are important when government enforcement of property ownership tends to be poor due to budget constraints, remoteness of forests, and corruption in forest sectors.

Three forms of illegal logging threaten the native forests and production of REDD. First, small-scale timber trespass can occur on privately owned forest at almost any time. Second, large-scale illegal pulse harvesting of native (often public) forests occur when prices and costs make these activities profitable. Third, when forests are harvested, unsustainable (and illegal) logging practices can reduce soil productivity and carbon storage—examples are damage to residual trees and the destruction of soil resources through site insensitive logging and "high grading" or harvesting only the best formed, largest, or more valuable trees (Putz et al. 2009).

Interventions affecting land tenure and land markets could both facilitate implementation of REDD (by clarifying rights and responsibilities) and directly generate REDD (by discouraging deforestation to establish ownership and obtain credit). Fundamentally, deforestation should not be a rewarded with or required for title. For instance, when the routes for new infrastructure are announced, deforestation can precede the installation of the new infrastructure because forward-looking actors clear for title in advance of rising land demand.[62] This liquidation of forest for the private gains from resale, e.g., is avoidable through policy.[63] Still, incomplete and overlapping property records that do not recognize traditional land tenure provide opportunities for powerful actors to acquire titles to vast tracks of land this way (Fearnside 2005, Brito and Barreto 2005).

Government detection rates and fines for illegal logging matter and could be increased with REDD payments. For a private landowner, this could lower the costs of site protection and increase forest returns. This also reduces the supply of illegally obtained timber, increasing the returns to holding forests. However, governments in countries with large publicly owned tropical forests or large remote privately owned forests often do not punish forest crimes and, when they do, fines are low or never collected. Further, in most developing tropical countries the returns captured by government from forest harvest is low and thus motivation for the government to protect these forests is also low (noting that reasons for low returns include transport and site protection costs). In principle, REDD payment to forest landowners may raise forest-related tax bases so governments view preserved forests as important revenue sources.

3.3.1. Case evidence

Costly protection and investment disincentives

If expropriation of land is possible, actors are less likely to make investments. This could be public expropriation, such as for a protected area, or private expropriation by squatters under an "adverse tenure" system—one who makes use of the land can acquire possession. In Brazil, expropriation risk is higher if land is not in a "beneficial use" (Alston et al. 2000). The literature shows that these risks create strong disincentives for forestry (Miceli et al. 2002, Mendelsohn 1994, Barbier and Burgess 2001b, Zhang 2001, Amacher et al. 2008). Many of these studies find that under high property rights insecurities, the potential for timber trespass on private land may render forest management and protection not worth it relative to agriculture and grazing.

Expropriation risk's impact on deforestation has been found in numerous cases, including Armsberg (1998), Alston et al. (2000), Contreras-Hermosilla (2000), Blaser and Douglas (2000), and van Kooten et al. (1999). Alston et al. (2000) argue that de facto in the Amazon only land clearing for at least five years protects against such risk. Blaser and Douglas (2000) have made the case that under current policy expropriation deters intensive management for tropical forests. Wibowo and Byron (1999) argue there is a risk of eviction of landowners who invest long term.

Land tenure regimes differ across countries, though. Sometimes they add to uncertainty landowners have about adopting forest production. Within Amazonia, land is typically formally settled and even sometimes titled through government action in designated areas, and informally settled by those with some minimal rights and squatted by those with the least amount of rights. Individuals with land in multiple regimes clearly perceive differences in land rents and values. Merry et al. (2008) show the type of property rights regime is critical in assessing the value that households attach to holding forests, while Amacher et al. 2009 find that property rights regimes affect the incentives to sell wood from smallholder plots. This is significant as close to 20% of all removals in Amazonia are from smallholder lots (Nepstad et al. 2004).

In Africa, land tenure regimes are even more complicated, with many influences including communal and familial customs defining tenure and use of land as well as state and statutory rights imposed by distant central governments. Due to the complexity of decentralized titling in many countries, formal registration of land rights is rare (Cotula et al. 2004). In addition, property insecurities and need for local site protection common in Latin America and Asia are present and all of these increase incentives to clear forests for short-term agricultural returns.

Other Amazonian analyses cite incomplete land markets and/or real estate speculation as key contributing factors to deforestation there (Fujisaka et al. 1996, Fearnside 2001, 2002, Kirby et al. 2006).[64] Speculation is linked with acquiring tenure through clearing for cattle pasture, which establishes boundaries (Hecht 1993, Fearnside 2005). This was often cited in the 1980s, when subsidies and inflation made land a good investment (Moran 1993). Inflation erodes value of alternatives and contributes to the retirement of real debt acquired through real estate loans (Just and Miranowski 1993). When real land prices are expected to rise faster than real returns on alternatives investments in real estate, which here imply deforestation, become more attractive.

Land tenure regimes can link indirectly to costly private site protection. Hotte 2005 and Clarke et al. 1993 examine agricultural land users' costly private enforcement, such as building fences or expending resources to obtain formal title. Hotte 2005 also shows conditions in which a landowner has an incentive to overexploit land, lacking clear ownership rights, to prevent returns from being captured by illegal trespassers. Miceli et al. 2002 analyze the merits of titling systems in resolving land claims, finding that formal title but not informal provides incentives to protect. Generally, when property rights are not secure and timber prices are reasonably high, we expect illegal logging to erode returns from carbon storage in government-held or private forest areas.

Migration and population links

Insecure property rights are also believed to affect population's impacts on agricultural forested frontiers. Perz et al. (2005) find a Pan-Amazon correlation of rapid population growth in rural areas and deforestation. Fertility rates are high but in-migration is the main driver of the population growth and is in turn partly driven by tenure insecurity (Carr 2005, Bilsborrow 2002). Other studies identify tenure as a "pull factor," with people migrating to areas where access has been newly established and they can obtain their own plots of land (see discussions in Amacher and Hyde 1996, Amacher et al. 1998, Barnes et al. 2002, and Merry and Amacher 2008).

Amacher et al. 2008 examines endogenous costly site protection by landowners, showing how migration pressure, insecure property rights, and costly enforcement (public and private) are linked in determining land returns. This addresses disagreement about wages, population growth, and property rights (Barbier and Burgess 2001b, Angelsen and Kaimowitz 1999, Shively 2002, and Shively and Pagiola 2004). Net effects on incentives to hold or establish forests depend on whether "push" effects of population growth are larger or smaller than the effect of population on the availability of labor for the protection of forests, both locally and by large landowners.

REDD could in principle seek to influence deforestation through demographic channels including population growth rates, migration patterns, and the spatial distribution of population. Pfaff 1999 shows that this spatial distribution affects Brazilian Amazonian regions' deforestation rates, as deforestation per person is lower for concentrated populations.[65] Such dynamics vary across the globe but in most of Latin America, internal migration is the key factor in population growth on the forest frontier and could be influenced by policies that increase the desirability of urban destinations. Tenure security interacts with migration in myriad ways, e.g., by facilitating credit for intensification or conversion to cattle that reduced the need for labor (Carr 2005).

Plantations?

There is growing use of land use for plantations, some privately protected when tenure is less secure. Potential carbon storage could be quite high. ITTO 2005 estimates that there are now nearly 45 million hectares of forest plantations established in Asia and the Pacific. Latin America (5.6 million hectares) and Africa (825,000 hectares) have smaller investments but there are private and community managed plantations in India, Bangladesh and Indonesia in addition to Brazil (Albers et al. 1996, Hyde et al. 1996). Plantations could be an important source of timber from previously grazed and abandoned land (FAO 2005). Malaysia is providing an incentive to establish forest plantations to relieve pressure on natural forests. How this connects with REDD has been controversial.

As Malaysia's policy suggests, we must keep in mind that public native forest and private plantations compete with each other in land and output markets. REDD could potentially be either supported or undermined by policies that affect the returns on plantations (concerning impacts of timber prices, for instance, Amacher et al. 2008 show land use responding to returns at the margin). Which land use does relatively better under REDD will depend on the way that payments to landowners are structured. If carbon payments are based on forest growth, i.e., carbon uptake, plantations can yield greater payments than natural or native (often overmature) forests. High enough payments could crowd out native forests via conversion to plantations by private landowners and even governments. Also when property rights are insecure, plantations become more easily protected than natural forests. Whatever the reason, this type of crowding out represents a potential unintended consequence of REDD that could lowers the provision of global public goods in the long run.

Generally, renewable forest resources need not inevitably be exhausted as the resource can be managed (on Amazonian forest see, e.g., Schmidt 1991; Whitmore 1991; Vincent 1992; Veríssimo et al. 1992; Uhl et al. 1997; Rice et al. 1998; Boltz et al. 2001; Pearce et al. 2003). In the past, however there has been only limited uptake of best management practices in the harvest of timber—let alone long-term sustainable forest management—due to a variety of factors including lack of credit, uncertain land tenure, and competition from illegal logging (Applegate et al. 2004; Bacha 2003; Barbier 1995; Putz et al. 2000; Uhl et al. 1997, Verissimo et al. 2002).

3.3.2. Looking ahead

While REDD payments could indeed bring the public benefits of forest to the attention of private landowners, payments will not necessarily make forest ownership profitable in locations where it is

difficult to protect forests from squatters and illegal logging. Where forest rents did not involve the benefit of REDD payments, Wibowo and Byron 1999, Barbier and Burgess 2001 and Bohn and Deacon 2000 find in cross-country studies that insecure property rights and lack of government enforcement were both highly significant predictors of the lack of investment in the development of forest capital (e.g., by reforestation). Clear rights may be essentially necessary for such investments in forest, which would reduce deforestation and generate REDD. Yet, as rights can also facilitate investments in production (fences, perennial crops), they may not be sufficient. Also of uncertain impact are market prices for timber. They increase returns from illegal logging, decreasing incentives for landowners to hold forested lands, yet at the same time increase the returns from legal forest management, thus directly increasing the incentive to maintain forest.

Payments for REDD will also need to create the right incentives for owners to hold land in forest for some time. In most of the tropical countries of Africa, Asia, and Latin and Central America with potential for large-scale carbon credits, incentives depend on the extent of illegal logging and property-rights insecurities, which is linked to the ability and willingness of budget-constrained governments to enforce ownership rights. Insecure tenure lowers REDD incentives in that a high cost of protecting one's site translates into a high cost of participation in REDD. Perhaps signing up to generate REDD could even help to establish rights. More generally, the details of the REDD contract, e.g., liability for outcomes of illegal incursions, will affect REDD.

In summary, the impact of REDD payments on land use and ultimately on deforestation clearly will depend on property risks and the effects of payments on returns landowners receive from several competing land uses. Payments could be structured with all of these issues in mind.

3.4. Corruption

Government corruption is undeniably present in developing countries with large forest areas and is a constraint for REDD contracts, most clearly linked to concessions (discussion in 3.3 above). Analysts observe a loss of forest rents due to corruption (e.g. Human Rights Watch 2009). That could arise in carbon concessions unless steps are taken. Because the precise nature of corruption and debt differs across countries, the best design of a carbon emissions programs in one country may not apply to another country. This has implications for REDD (oft ignored but touched on by Karsenty 2008's recent review).

Corruption is not easily controllable, even for well-meaning governments, as a complex and multifaceted problem. For forestry and particularly forest concessions, corruption is usually in one of two forms: large firms with political power influence government policies or choices about concessions at early stages; or smaller firms bribe state officials to overlook contracts' stipulations during any of the processes of harvesting and milling and then exporting wood.

In a corrupt setting, even with restrictions REDD payments may just increase equilibrium bribes and then transfer wealth from the forest owner to illegal loggers and government officials whose objectives do not align with the central government. While it may seem compelling just to overlook corruption and expect that carbon payments will increase forest despite these issues, even costly re-design to reduce corruption may be better than leaving corrupt actors unchecked.

3.4.1. Case evidence

In the forest sector, corruption is well documented in Africa, Asia, and Latin America, typically via bribery of government officials to overlook infractions including harvesting more than is allowed (Contreras-Hermosa 2000 offers a review that points to bribery and corruption where forests are sold throughout the world). Bribes have been singled out as an inherent part of forestry in tropical countries, confounding any central government's attempt to promulgate forest policy of any type (see e.g., Palmer

2000, 2005 and Smith 2003 for Asian cases, and Siebert and Elwert 2004 for discussion of cases in Africa). Officials are known to accept bribes for allowing illegal timber trade in Tanzania and Cameroon, countries with large government forests, where risk of detecting illegal logging is low and enforcement is highly lacking (only 4% of offenders are punished, while 20% of citations are typically dropped). Other tropical forested countries with similar circumstances include Ghana and Liberia. In Benin, an arid country, enforcement of forest rights is low and illegal logging is high largely due to scope for bribery.

A large economic literature comments on situations where corruption must be reduced. Jain 2001 finds corruption when discretionary power is held by government officials in positions with access to bribes, situations where there are high rents to government-owned resources, and a low probability of detection or punishment. For a government with sufficient financial resources, it appears corruption can be limited by employing a well-financed strong enforcement system.

Jain 2001 further suggests that high wages paid to public officials can be effective if there is a relatively high probability of detection of bribery. A problem with raising wages is that they can lead to greater government debt and less ability to enforce property rights and thus maintain forest returns at high enough levels (see 1.3 Debt above) to ensure REDD emissions reductions.

Limited financial resources and monitoring distant resources makes these efforts difficult. Contreras-Hermosa 2000 finds high corruption with underpaid government forest inspectors, as others have noted outside of forestry. This analysis also highlights complex regulations involving property rights, the numerous bureaucratic steps required in obtaining permits to use or establish productive forests, low penalties for illegal logging, and the open access nature of native forests.

Detection of bribery is not enough. Unless penalties are high, the incentives to cheat by inspectors and illegal loggers will be high regardless of the inspector's wage. This is because the harvester will always be better off paying the bribe, given that expected costs as a result of being detected bribing by the central government are lower than his expected costs from honest action.

Mishra 2004 argues that penalties and inspector compensation can work in the same or opposite directions in affecting bribery incentives and that the only way to truly eradicate bribery is by having high enough wages for government officials. Finally, competition among firms has been shown clearly to decrease bribery (Barbier et al., Delacote 2009), suggesting that full access to carbon payments and fair bidding processes could be a priority for REDD processes to be effective.

In terms of government monitoring strategies, Mishra 2002 and Basu et al. 1992 suggest that the most important reform is to have multiple horizontal levels of government involved in monitoring use of government resources, "overlapping jurisdictions" in Mishra's terms (noting implications for detection probabilities, optimal penalty levels and the costs of monitoring too). Then more than one logging inspector is involved with a given harvesting setting and a logging inspector from one department can be compensated for reporting bribery by another official.

Of course, different levels of government may have different objectives. Local officials might, for instance, attach more value to wood from their jurisdictions. This thinking suggests that one important design question is whether and how carbon payments make it to the localities. If higher levels of governments collect revenue and this revenue can be shared with the localities, there may be ways of bringing incentives of all governments in line for the generation of REDD.

Finally, considering different levels of government, at a more macro scale Barbier et al. 2005's open economy model of corruption examines how lobbying by groups involved in forest resource exploitation influence corrupt resource rich governments and ultimately deforestation and trade. Corruption can lead

to greater deforestation but terms of trade play an important role, suggesting that macro policies need to be considered as a way of mitigating corruption's effects.

3.4.2. Looking ahead

On forest concession design assuming officials can be bribed to either designate more favorable concession conditions or overlook poor performance or illegal logging, Delacote 2005 finds that corruption may induce designation of larger concessions as well as less stringent use regulations. Amacher et al. 2008 considers harvester behavior and a government concession design problem with corruption, comparing to when officials cannot be bribed, and examining parameters such as concession size and enforcement strategy. Where corruption is controlled, concessions can be larger and royalties smaller as enforcement is more efficient and cheaper. Yet blindly increasing royalties or reducing concession size may simply cause changes in bribes that undermine control. This effectively summarizes the above, in that concession design clearly should reflect this issue.

Concession design involving environmentally sensitive harvesting regulations also should bear in mind bribery. Generally, moving forward with carbon concessions for REDD is sensible only with an understanding of corruption. Corruption usually reinforces bad aspects of designs and revenue problems faced by governments make these aspects worse. The ultimate success of REDD in this area in terms of deforestation, forest degradation and local welfare, depends upon corruption at all levels of government, the government debt, and local and federal governments' ability to govern within frontier regions through revised monitoring and enforcement strategies.

4. Lessons Learned

4.1. Neither too easy nor too hard

Two opposite schools of thought are emerging regarding the role of international forest carbon and REDD in U.S. and global climate policy. One is that opportunities to reduce carbon emissions are cheap and abundant, and if they generate carbon credits, these credits can "flood" cap-and-trade programs, reducing incentives for emissions reduction in rich countries. The other is that reducing global deforestation is so daunting that significant reductions of this type are nearly impossible.

The first view is guided in part by the notion that the cost of stopping such deforestation equals the opportunity cost of the alternative land use (e.g., revenues generated by agriculture). These revenues are often low, seemingly suggesting that conserving forests is relatively cheap. This view also stems from concern that negotiations may produce erroneous high deforestation emission baselines, yielding credits not backed by real emission reductions. The second view is underpinned by the failures of previous efforts to reduce deforestation as well as concerns that many countries still lack the governance capacity to effectively implement new such programs.

Reality lies in between these extremes. There are opportunities to avoid deforestation in much of the tropics, and at low cost compared to other efforts to reduce GHG emissions. Yet claims about the size of the opportunities immediately available have likely been overstated. Actual costs of reducing deforestation include costs to reform land tenure, distribute payments, and establish, manage, and monitor protected areas. Further, continued demand for wood and agricultural products, population pressures, weak governance, and other institutional factors are limits on short-run dramatic reductions in deforestation. Thus commonly used measures of opportunity costs provide a minimum, not a typical, cost estimate for implementing REDD.

This realization feeds into the second view, and indeed reviewing the results of past efforts to halt tropical deforestation is sobering. Many policies did not target drivers behind deforestation and thus were largely ineffective. In many cases this was due to insufficient consideration of how to target lands under real threat of deforestation. Interventions often failed due to limited local engagement and insufficient stakeholder participation, while weak governance, corruption, and lack of land titles and law enforcement created further barriers. In addition, previous programs almost universally lacked self-evaluation mechanisms, which limited learning and modification. However, as we have discussed, many features of past policies could be drastically improved.

4.2. Designing policy to make more REDD feasible

The prospect of rewards for international forest carbon conservation under future U.S. and international climate policies has brought new energy to the protection of tropical forests. Yet the debate has not been informed by close consideration of the international and domestic policies required if REDD is to play a significant role. In summary, we believe that international intervention can lower deforestation with the support of local actors and smart policy design.

Past failures suggest that there are potential benefits from program requirements that are broad enough to encourage locally appropriate interventions. For instance, if comprehensive monitoring captures GHG emissions reductions, then requirements and incentives can be based on that aggregate outcome, and other details may be left to local actors better placed to significantly and sustainably shift relevant processes. This avoids the difficulties of monitoring and rewarding local process. Generally, consultation with those affected by these policies can aid development of effective and sustainable policy.

Such policies may not immediately come to pass, and even if the above describes future international regimes, domestic actors will have to decide how to try to lower GHG emissions to capture incentive payments. For these reasons, there is value in learning further from both the successes and the failures of previous types of forest interventions. Drawing from all the above: we can ask skeptically whether loan conditionality is likely to work without changed practices; we can strongly encourage bringing the locally forest-dependent into discussions; we can shift protected areas and ecopayments towards areas of higher forest threats; we can evaluate whether carbon-based payments justify, in local development terms alone, shifts in roads or subsidies.

Moving forward:

- the U.S., in concert with international actors, can help forested countries with the costs of conserving forest carbon, including with costs of strengthening relevant institutions

- international forest carbon policies can adopt performance indicators so that incentives can be effectively applied; monitoring and evaluation will permit ongoing learning

- forested countries can rethink not only forest policy but also how agriculture and infrastructure policies affect forests; strategies will differ as a function of local context

- all international actors can re-examine whether all actions are working well in concert, e.g., policy influences on commodity demands and subsidies for agriculture or biofuels

In summary, it is possible to identify important deforestation drivers and to align local, regional, national, and international incentives in many settings. Climate protection provides a new way for forest protection to contribute and to succeed if we learn lessons from the past.

References

To reduce the size of this hardcopy dissemination draft, the references and endnotes will not all be listed in this file. They are available upon request and they will be included in a longer form at http://www.nicholas.duke.edu/institute.