NICHOLAS INSTITUTE REPORT

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

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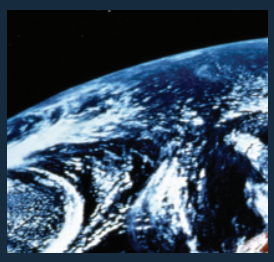


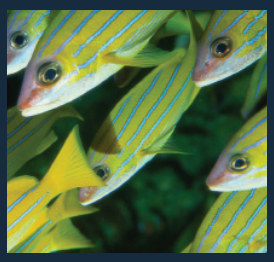


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Executive Summary

National and international efforts within the last few decades to reduce forest loss, while having some impact, have failed to substantially slow the loss of the world's forests. Forest loss, i.e., deforestation and forest degradation, is widespread and accounts for 12%–17% of the world's greenhouse gas (GHG) emissions. Global concern about climate change and the realization that reduced emissions from deforestation and degradation (REDD) can play a role in climate change mitigation make it critical to learn from our past experiences with policies to reduce forest loss.

Within the UN Framework Convention on Climate Change (UNFCCC), negotiators are actively 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 climate policy that includes incentives for REDD, and possibly other international forest carbon activities.

Such policies may mobilize new funds for forest conservation, including for addressing drivers of deforestation and forest degradation in developing countries. Climate-related incentives for REDD are likely to be performance-based, i.e., to emphasize the measurement, reporting, and verification of all results. The implementation of this emphasis, alongside the introduction of new financial incentives, could increase such policies' impacts on forest loss relative to the past.

Policy effectiveness, efficiency, and equity 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 deforestation and degradation and what has not, as well as the reasons for observed differences in outcomes. Investments and policies can then more effectively embrace and extend success while reducing risks of further failures.

This report aims to provide lessons to inform U.S. and international policymakers by analyzing dominant influences on deforestation and degradation. We study not only forest-focused policies, but also other policies that directly or indirectly influence forest loss, all in light of relevant nonpolicy factors such as trends in commodity prices. We provide examples of previous policies to draw lessons from successes and failures, then link those observations about the past to the decisions current policymakers must soon make within ongoing climate policy deliberations.

Drivers of Forest Loss

Agriculture is the primary driver of tropical deforestation. When tropical forest is cleared, land is almost always converted to crops and/or pasture. Thus deforestation is driven by expected benefits of producing staple foods, for local and/or national markets, as well as international commodities including biofuels, timber, and fiber. Incentives result from the local and global demand for commodities. Pressures are exacerbated by government support for agriculture, from road investment to provision of cheap credit and easier access to land title after clearing. Yet only some determinants can be shifted by policymakers within the context of REDD policies. For example, rising demand for soy may be outside the purview of REDD policy, yet research to facilitate substitute soy production in nonforest regions may be a related and relevant policy.

The limited profitability of sustainable forest management also causes forest loss. Low timber prices discourage long-run management. So do the lack of access to credit for forest users and the lack of secure resource tenure, e.g., a lack of secure land tenure in the relatively few forest areas that are not government-owned. Services provided by forests (e.g., species habitat) often fail to provide revenues that could affect land-use decisions. Yet policies that fund REDD could change these defaults, leading local actors to value service production and making it profitable to manage forests for storage of carbon as well as forest joint products such as species habitat.

While logging and fuelwood collection directly drive only forest degradation, not deforestation, they may also have indirect impacts within the tropics. In particular, the forest may be more accessible after processes of degradation and thus more likely to be cleared for agriculture.

International Forest Policies

Many international efforts have aimed to reduce forest loss. 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.

Loan Conditionality. Conditionality upon reform within forestry has risen in recent decades. Conditional loans attach specific reforms—improved law enforcement, expanded parks areas, economic policy changes—to lending from governments and multilateral financial institutions. Yet conditionality often failed to impose the sweeping policy changes that had been envisioned. Still, evidence of targeted, successful conditional loans exists—particularly for environmental issues. Loans catalyzed reform when the interests of lenders and key local stakeholders were aligned. Critical issues include reforms' connections to national or local development priorities.

Donor Coordination. Donor coordination aims to increase the effectiveness and efficiency of official development assistance (ODA) by reducing duplication, inefficiencies, and the administrative burden on recipient countries, while in addition increasing the strategic targeting of aid. Yet donor fragmentation, a technical assistance focus, and poor policy selection have persisted. Even good coordination may not yield benefits where governments do not share donors' goals, where contracts cannot be used effectively, and where officials can capture funds. For forests, while key past efforts have fallen short of expectations (TFAP), broader "donor coordination" encompasses varied institutional arrangements, some of which are promising (PPG7, NREG).

Debt Relief. Debt to foreign countries and to international banks may encourage forest loss. It may restrict enforcement budgets and may lead governments to raise revenues to service debt through timber royalties or taxes on agricultural exports. During the late 1990s, e.g., Indonesia may have faced international pressure to increase exports of timber, paper pulp and palm oil. Debt-for-nature swaps try to address this by reducing international debt, typically in exchange for establishing a conservation trust fund within the debtor nation. For instance under the 1998 Tropical Forest Conservation Act, by 2007 the U.S. reduced the debts of twelve Latin American countries plus Botswana. Yet a causal link to forest loss is hard to establish. Impact evaluations are few. One 2007 U.S. government evaluation of a debt-swap initiative in El Salvador did not quantify forest impacts but suggested that forest outcomes fell short of overambitious targets.

Demand Management. This policy shares with debt relief the advantage of external control. In principle, if the world wants less forest loss, then it can lower demands for destructive outputs. Most industrial roundwood harvested in developing countries is consumed there, but the trade in logs and processed products is significant, particularly via China, and trade in pulp products and agricultural commodities is large. This suggests a role for demand-side intervention. Its impacts will be greatest when it can also shape practices and standards within supplier countries. Efforts range from consumer campaigns to certification to treaties and policies, e.g., trade policy harmonization per CITES, the 2003 FLEGT Action Plan to prevent illegal imports to the EU, or the 2008 amendments to the U.S. Lacey Act. Yet all these must stand up to market forces. Ghana's experience from 1979 to the 1990s shows that inadequate policies will fail to dampen demand.

Domestic Forest Policies

Varied national and subnational initiatives have aimed to conserve forests. Their primary aim—reducing deforestation as well as forest degradation—has typically been only partially achieved, due to limits on how key drivers of forest loss were addressed. The impacts of protected areas and ecosystem services payments have been limited, due to the fact that they both tend to be located where forest threats are relatively low, although impacts on forest degradation are also important while not being as well understood. Concessions by their very nature should manage pressure for clearing, yet the details of such contracts (much as for the ecopayments contracts) are critical if the dominant local land-use incentives are to shift significantly. Decentralization does not automatically address any of these issues, but if incentives are aligned, then in some situations more local control over decision making could generate REDD and improve welfare.

Protected Areas. Protected areas are the most common explicit forest conservation policy and have increased substantially over the past two decades. As they tend to be in areas currently facing relatively low threat, they may lower deforestation less than expected and less than is typically assumed (see studies of Costa Rica, Brazilian Amazon, Mexico, and all areas globally). Better data could improve the evidence concerning potentially higher impacts on degradation, while for deforestation good data show that impacts vary across a landscape. Where threat is high and enforcement is strong, there can be significant avoided deforestation, such as the relatively big impacts of Chico Mendes Extractive Reserve in the Amazon near the Interoceanic Highway.

Ecopayments. Payments for ecosystem services (e.g., water quality, habitat, or carbon storage) can reward owners for limiting land use to conserve forests. Yet most programs are voluntary. Owners may offer their least productive land and be paid to retain forest that would remain in the absence of policy. Costa Rica's pioneering and inspirational program faced very low threat of deforestation and was not designed to target threat. Most paid forest would have remained standing without a payment. Looking ahead, planners could target clearing threat. Costa Rica's invaluable "learning laboratory" also shows the importance of the details of program design. After the policy was already in place, still an evolution over time and space in how payments were allocated reduced a bias towards low threat, raising payment impact on deforestation.

Concessions. Logging is often done through private concessions in government-owned forests. Often large foreign firms bid for contracts stating a volume or area to harvest in some period. Firms pay fees, or "royalties," usually based on area or volume, and revenues can be significant. Contracts can specify environmentally sensitive methods. Yet poor design and enforcement mean governments fail to capture revenue, protect habitat, exclude illegal loggers, and enforce methods. For REDD, governments could reduce carbon emissions within timber concessions, e.g., through additional enforcement of improved practices and the exclusion of illegal loggers. A concession model could also be employed in the design of REDD, as suggested by cases of national governments seeking international bidders to support conservation of forest that would otherwise be managed under resource concessions. In Indonesia, REDD projects establish new legal rights to carbon via ecosystem restoration concessions that preempt timber or oil palm.

Decentralization. Most tropical forests are owned by states. Millions who live in forests have only "use" rights and cannot block others' exploitation of the resources on which they depend. Yet recently governments have devolved forest ownership and/or management responsibilities to local institutions, and some evidence suggests decentralization can be effective in reducing forest loss. Some indigenous and community-managed areas within the Brazilian Amazon have been more effective than state-managed areas in blocking deforestation. Yet for this approach to generate REDD, critical institutional conditions must be in place. Local institutions must have secure rights to own and to manage the forest (e.g., to enter into contracts for carbon), financial incentives for forest conservation, and the state's support (contract enforcement at the least). Local institutions are also more effective when both transparent and downwardly accountable.

Other Domestic Policies

Adjusting other domestic policies with significant effects on forest loss may be as important for REDD as domestic forest policies. Yet little has been done to our knowledge. Below we describe development policies that affect deforestation and we suggest such policies could be adjusted.

Infrastructure Policies. Transport costs matter for agriculture, logging, and fuelwood collection. New road investments raise access, lower transport cost, and often yield more economic output as well as more forest loss. Critically, roads' impacts vary across space. New roads investments appear to increase forest loss less when located in already developed areas—with prior forest loss and roads. Thus, the total forest impact of a road policy is affected by road network design (analogous results may apply for energy transport). In addition, some have claimed that forest loss from such investments can be lowered when construction is sequenced or integrated with other policies (e.g., tenure, local services), raising quality of life while preserving natural wealth. An example could be park buffers around roads to imitate how some reserves are functioning.

Agricultural Policies. Agricultural commodity prices and production costs are important drivers of deforestation. Many governments subsidize agriculture through output prices (import tariffs on competing products, subsidized processing) and input prices (interest rates, fertilizer costs), as well as lower taxes. They also facilitate tenure for cleared land and help to reduce other risks like pests and disease through investments in research and development. Without support for forests, these encourage clearing. If they link with colonization, impacts rise due to migration. Concerning biofuels, if they are cultivated on croplands then clearing may expand into forests, as the supply of the displaced agricultural commodity (e.g., soy) falls and thus its price will rise. Biofuels subsidies for lands not in agricultural production, in contrast, could reduce forest loss.

Land Tenure. Legal systems that award squatters' rights and then title to those who clear forest have long promoted deforestation. Even clearing for unprofitable use may allow the acquisition of title and facilitate credit or resale. The lack of secure tenure matters too since a risk of losing one's forests through expropriation reduces incentives for long-term sustainable management. It is difficult for individuals, and even communities, to stop

expropriation where timber trespass can occur. Because defending tenure is costly, when owners choose land uses they consider site protection costs within relative returns from uses such as grazing cattle versus managed forest or reserves. Carbon-based payments could increase the rents to holding forests but must overcome higher protection costs for forest. Those will be more important when government enforcement tends to be poor due to budget constraints, remoteness of forests and corruption.

Corruption. Government corruption is present in developing countries with large forest areas. It is not easily controllable and is a complex, multifaceted problem that is a constraint for REDD contracts. In forestry sectors, it usually takes one of two forms: large firms with political power may influence government policies or choices about concessions, at early stages of the process; or smaller firms may bribe state officials to overlook a contract's stipulations during processing, milling, or exporting. Even with efforts to restrict such activities, REDD payments could simply increase equilibrium bribes and transfer wealth to illegal loggers and officials whose objectives do not align with the governments promoting REDD. While it may seem attractive to overlook corruption and hope that carbon payments will help to reduce forest loss despite these issues, costly anti-corruption measures up front may be better than leaving corrupt actors unchecked.

Lessons Learned

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 asserts that opportunities to reduce carbon emissions are cheap and also abundant. Thus, if they generate carbon credits, those credits could "flood" cap-and-trade programs and reduce the incentive to invest in emissions reduction within rich countries. The other one asserts that reducing global deforestation is so daunting that significant reduction of this type is nearly impossible.

The first view is guided in part by the notion that the cost of stopping deforestation exactly equals the opportunity cost of the alternative land use (e.g., revenues generated by agriculture). In this view, these revenues may also be perceived often to be low (though they are not always so and can be very high) which suggests that conserving forests is relatively cheap. This view ties in with concerns that errors in negotiated emission baselines could yield many credits not backed by emission reductions. The second view appears to be guided by the failures of previous efforts to reduce deforestation and concerns that many countries still lack the governance capacity to effectively implement new such policy programs.

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

This realization could lead one towards 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 also 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 to significant land-use change. In addition, previous programs almost universally lacked self-evaluation mechanisms, which limited learning and thus modification. However as we have discussed above, many features of past policies could be drastically improved upon in the future.

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

Past failures suggest 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 many other details may be left to local actors better placed to significantly and sustainably shift relevant local processes. This avoids difficulty in monitoring and rewarding local process. Generally, consultation with those affected by these policies can aid in the development of effective and sustainable policy.

Such policies may not immediately come to pass, and even if the above describes future international regimes accurately, still domestic actors will have to decide how to try to lower GHG emissions in order to capture forest incentive payments. For these reasons, there is value in learning further from both the successes and the failures of the many previous types of forest intervention. Drawing from all the above: we can ask skeptically whether loan conditionality is likely to work without changed local practices; we can strongly encourage bringing the locally forest-dependent peoples into discussions; we can shift protected areas and ecopayments towards areas of higher forest threat and impact; and we can evaluate whether carbon-based payments may justify, even in local development terms alone, shifts in roads or in 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 the relevant institutions
- international forest carbon policies can adopt performance indicators so that incentives can be effectively applied; outcomes monitoring and evaluation will permit ongoing learning
- forested countries can rethink not only forest policy but also how agriculture and infrastructure policies affect forests; preferred strategies will differ as a function of local context
- international and domestic actors can re-examine whether actions work well in concert, e.g., policy influences on commodity demands versus subsidies for agriculture or biofuels

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

Introduction

National and international efforts within the last few decades to reduce forest loss, while having some impact, have failed to substantially slow the loss of the world's forests. Forest loss, i.e., both deforestation and forest degradation, is widespread, and it accounts for 12%–17% of the world's greenhouse gas (GHG) emissions. Global concern about climate change, alongside the realization that reducing emissions from deforestation and degradation (REDD) can play a role in climate change mitigation, makes it critical to learn from our past experiences of forest loss.

Within the UN Framework Convention on Climate Change (UNFCCC), negotiators are actively 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 climate policy which includes incentives for REDD and, possibly, other international forest carbon activities.

Such policies may mobilize new funds for forest conservation, including for addressing drivers of deforestation and forest degradation in developing countries. Climate-related incentives for REDD are likely to be performance-based, i.e., to emphasize the measurement, reporting, and verification of all results. The implementation of this emphasis, alongside the introduction of new financial incentives, could increase policies' impacts on forest loss relative to the past.

More generally, policy effectiveness, efficiency and equity 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 those differences in outcomes. Investments and policies then can more effectively embrace and extend success while reducing risks of further failures.

This report aims to provide such lessons to inform U.S. and international policymakers by analyzing the dominant influences upon deforestation and degradation. We study forest-focused and other policies that directly or indirectly influence forest loss, all in light of nonpolicy factors such as trends in commodity prices. We provide examples of previous policies and draw lessons from their successes and failures, then link those observations about the past to the key decisions that current policymakers must soon make within ongoing climate policy deliberations. We set out by highlighting activities that dominate deforestation and forest degradation, i.e., agriculture, logging, and fuelwood collection, and then we distinguish three categories of policies that could produce REDD. Next, Sections 1–3 provide evidence on the impacts of a number of past experiences within each of the three categories. We conclude with broader lessons learned.

Agriculture, Logging and Fuelwood Dominate Forest Loss

Agriculture

Agricultural expansion is the primary driver of deforestation within the tropics. When a tropical forest is cleared, land is almost always converted to agricultural crops and/or to pasture. Thus the deforestation is driven by the expected benefits of converting forest land for production of staple foods, for local as well as national markets, and of international commodities including biofuels, timber, and fiber. The incentives are being created by local and global demands for commodities. Pressures are exacerbated by government policies that support agricultural expansion, from road investment to provision of cheap credit and easier access to land titles when lands are cleared. Only some determinants can be shifted by policymakers. Others do not suggest REDD policies. For example, rising global demand for soy may be outside the purview of REDD policy, while research on soy cultivars for nonforest regions, for instance, could explicitly be a policy choice.

Logging and Fuelwood Collection

The limited profitability of sustainable forest management also causes forest loss. Low prices for timber, in part due to unsustainable and often illegal logging practices (e.g., Rhodes et al. 2006), discourage long-run management. So do the lack of access to credit and the lack of secure tenure for forest users in the (many fewer) forest areas that are not government owned. Critical services provided by forests (e.g., species habitat and water quality) often fail to provide any revenues that could affect land-use decisions. Yet climate policies that fund REDD could change these defaults and lead local actors to value additional forest services, making it profitable to manage the forest for the many local and global goods that forests provide, including the storage of forest carbon.

Logging, Fuelwood Collection, and Agriculture[1]

While logging and fuelwood collection directly drive only forest degradation, not deforestation, they may also have additional indirect impacts within the tropics. In particular, the forest may be more accessible after processes of degradation and thus more likely to be cleared for agriculture.

Three Policy Categories Produce REDD

Efforts to conserve forests must be viewed in light of the processes that are driving deforestation and forest degradation. Forest conservation policies (for instance, protected areas or payment for ecosystem services) attempt to impose or to induce changes in land use decisions. Such changes have a cost—the loss of income from production and sale of crops. Put another way, the drivers of forest loss are the determinants of the local private benefits of clearing and degradation of forest. Thus these drivers and associated benefits are critical to predicting land use and inducing REDD.

An important corollary is that whether local decisions are taken by private or public actors, these decisions have often ignored spillover effects, i.e., impacts of land uses on others' welfare. Thus, in the absence of an intervention that makes such connections, neither GHG emissions nor other external effects of deforestation or forest degradation affect the local land-use choices that yield forest loss. Land-use choice might well, however, shift if carbon-based incentives were created.

For REDD, any such incentives must overcome the factors that lead to deforestation and forest degradation, i.e., agriculture, logging and the collection of fuelwood.[2] These include biophysical land characteristics such as soil fertility, forest type, and climate. They are not shifted by policy, yet understanding their influences will help to identify interventions with greatest forest impact.

Other determinants can be shifted. For example, various public and private choices that affect the access to forest and the costs of transport to and from forested areas could be adjusted. For REDD policy, we will focus upon those determinants of land-use choices which can be shifted, and specifically three categories of REDD-generating policies. The first two are "conservation" or policies that explicitly target the forest: Section 1 examines international policies, and Section 2 studies forest policy in forested countries. Section 3 presents forest-relevant nonforest policy, i.e., domestic policies in forested countries that do not target forests but could affect forest loss.

Thus within forest-targeted policies, Section 1 and Section 2 distinguish interventions implemented by international actors such as loan conditionality, donor coordination, debt relief, and commodity demand management (all discussed in Section 1) from the interventions that are implemented by national or subnational actors in forested countries such as protected areas, ecopayments, forest concessions and decentralization (all discussed in Section 2). We make this external-vs.-internal distinction even if the latter interventions could potentially and do receive international support. From the external and macro-scale "forest action plans" to internal and micro-scale ecoservices contracts, we review what has and has not worked. In analyzing reasons for success and failure, we develop suggestions about which policies could effectively generate REDD. Section 3 then continues in this same vein but concerning clearly distinct policies, i.e., shifts in formulation or implementation of policies that do not explicitly focus on forests but rather upon development more generally such as infrastructure, agriculture, tenure and corruption. Given multiple ways to achieve development goals such as increased production and employment, in principle incentives for REDD could lead local policymakers to choose paths which involve a lowering of emissions.

1 Of course other activities matter too. In specific sites both mineral extraction and the reservoirs behind dams directly cause forest loss, although the controversies over these activities may be more significant than their direct impacts upon the forest. Indirect impact also matter, though. They may attract migrants who log, collect fuelwood, or convert forest land to agriculture. Also, in some regions, mining may generate significant demand for charcoal and, in turn, degradation and even deforestation.

2 Broad reviews are in Kaimowitz and Angelsen 1998, Geist and Lambin 2001, and Chomitz's 2006 "At Loggerheads" volume.

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. Loan Conditionality

The amount of loans and development assistance contingent upon forestry reform has risen in recent decades, with significant sums spent to create and improve forest management. 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 ranging 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 applied to enforce accountability. Conditionality 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 and enforce. Multilateral lending and macroeconomic policies were seen as a new way to address issues such as deforestation (Keohane and Levy 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 and Mourmouras 2005).

Yet evidence of more targeted, successful conditional loans exists—particularly around environmental issues. For the most part, successful loans catalyzed the domestic appetite for reform when the interests of lenders and recipient countries were aligned. 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). 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 (Keohane and Levy 1996):

- political power was not primarily aligned with logging or other extractive industries
- they advocated for targeted forest policy changes instead of long-term, comprehensive institutional reforms that may be potentially unconnected to the purpose of the loan itself
- they maintained and expanded domestic support for forestry sector reform among the public actors, as well as 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 or powerless 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 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 and Dubash 2000).

The results of lending programs are mixed. The poor examples, such as World Bank loans to Indonesia, failed to translate lending into new forest sector management and reform (concession allocation and management procedures). 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) 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 and Dubash 2000). In the Philippines, World Bank loans allowed the government to raise logging taxes, resist special interests, and enforce neglected forestry laws against 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 and Dubash 2000).

A series of problematic World Bank loans in the 1990s confirmed the important role for domestic constituencies. 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 (Ross 2006). 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.[3]

1.1.2. Looking Ahead

An independent review by the World Resources Institute 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 (Seymour and Dubash 2000). 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.

Lessons for REDD include that reforms can reduce deforestation when there is 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. Financial 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 (with small modifications) the brief common features of successful forestry sector lending operations suggested by others (Keohane and Levy 1996), noting that some of the conditions are part of controllable policy design but others are not:

- political power was not primarily aligned with logging or other extractive industries
- they prioritized targeted forest policy changes, when feasible, even in the absence of long-term, comprehensive institutional reform (that may or may not be necessary)
- they maintained and expanded domestic support for forestry sector reform among public the actors, as well as beyond them, including by communicating policy strategies clearly and explicitly

3 It also said small countries without large wood product export industries and forest reserves were more likely to comply with conditions, although this last point was not definitive as small countries with powerful forest interests, such as Haiti, proved resistant to reforms while Cameroon, Nigeria, and Liberia complied with most conditions.

1.2. Donor Coordination

Donor coordination is intended to increase the effectiveness and efficiency of official 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 (Easterly 2007). This suggests a lack of learning and repetition of past mistakes, 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 (Easterly 2007).

Donor coordination is expected to maximize overall development impact, even if donors act separately, by directing resources to where they are most needed (Bigsten 2006). 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) has led donors to commit to "harmonize the operational policies, procedures, and practices of [their] institutions to improve the effectiveness of development assistance" in the 2003 Rome Declaration on Aid Harmonization, which was followed by the Paris Declaration on Aid Effectiveness in 2005 (Easterly 2007; OECD 2003). If successful, such coordination could improve upsides of aid (strengthening of domestic institutions and salaries for civil service, improvement in governance, and increase in 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 decisions 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 and recipients from maximizing overall development
- incomplete information hampers effective decision-making and administration to influence specific sectors and/or issues (Hallonen-Akatwijuka 2004)
- 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)

However, donor coordination will not overcome all. Research suggest that where recipient governments do not share donors' goals and in addition where contracts cannot be used effectively (see discussion of conditional loans above for instance) and where governments (officials) capture money designated for the poor or for public services (Easterly 2007; Torsvik 2005), coordination may not lead to benefits.

1.2.1. Case Evidence

Efforts to coordinate donor activity in the forestry sector 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. In addition to our discussion of the TFAP, we will describe the Pilot Program to Conserve the Brazilian Rain Forest with the G-7 (PPG7) and the incipient Natural Resources and Environmental Governance (NREG) Program of Ghana to enact cross-sectoral coordination by donor and recipient governments, still early in its development. We will also show that what might simply be called "donor coordination" encompasses a wide range of institutional arrangements, as illustrated through the variety within programs such as TFAP, the PPG7, and NREG.

1.2.1.1. Tropical Forestry Action Plan (TFAP). As an international initiative to reverse the tide of deforestation overtaking tropical forests, the TFAP may be the closest predecessor of REDD in its scope and ambition.[4] TFAP increased forest aid, coordinated spending, and developed national forest management plans. It focused almost exclusively on the forest sector, however (versus infrastructure, agricultural commodity trade, and development goals, which are all relevant). It also lost crucial political support in part due to insufficient participation by civil society and forest-dependent communities within the plans' development and implementation.

The precise goals and objectives of TFAP are muddied by revisions in its early stages but "The Basic Principles of the TFAP" 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)" (FAO 1989). 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 (nominally controlling 60% of all tropical forest area) developing national forest action plans (NFAPs) (Winterbottom 1990). Implementation was well under way by 1994 with 31 countries (in Africa and Asia/Pacific and Latin America and the Caribbean) implementing action plans (Humphreys 1996). TFAP even surpassed its goal of doubling forestry aid by increasing funding from US$400 million per year in 1985 to US$1.3 billion per year in 1990 (Sizer 1994; Oksanen et al. 1993).

At the same time, between 1980 and 1990, tropical deforestation increased by 40% to nearly 17 million hectares per year (FAO 1991). While it is impossible to know the deforestation rate in the absence of the TFAP, and therefore whether the initiative did actually help to slow forest loss, TFAP did not reduce forest loss as much as was hoped and TFAP is widely perceived to not have had significant impact on forest loss.

By 1990, disappointment with TFAP was widespread (Sizer 1994). A meeting of over 50 civil society organizations concluded that the TFAP was ineffective and, without dramatic reform, should be halted (Lyke and Fletcher 1992). Following this public outcry, FAO was compelled to commission its own independent review, which also found that the TFAP was in need of drastic reform (Ullsten et al. 1990). Following these critiques, the U.S. Congress stopped funding TFAP, as did the World Wildlife Fund and the World Resources Institute (a TFAP cofounder). A TFAP restructuring process was initiated at FAO, but the restructuring dialogue went on until at least 1996 and TFAP never reemerged (Humphreys 1996).

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. 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.

1.2.1.2. 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.[5] 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" (Oy 2000).

PPG7 tried local engagement and stakeholder support to improve the impacts of coordination efforts. For instance, extractive reserves and indigenous lands were created by not only delimiting boundaries but also creating networks of invested local stakeholders. Local involvement appears to yield effective management and with low amounts of external funding. PPG7 also

4 We comment on TFAP itself. The International Tropical Timber Organization (ITTO), which attempts to promote sustainable management of tropical forests through dialogue, grants, and improved information, could in principle be viewed as an ongoing institutionalized version of TFAP. While we do not profile the ITTO, we must mention it, as it is the major multilateral organization related to tropical forests created in the past three decades, particularly with respect to efforts to reduce forest degradation.

5 Financed by Brazil and the G-7 countries through bilateral aid and contributions to the Rain Forest Trust Fund administered by the World Bank. Sub-programs had five themes: (1) demonstration and experimentation, (2) conservation, (3) institutional strengthening, (4) scientific research, and (5) lessons and dissemination. Detailed information exists on specific sub-programs.

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modernized local 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 this example also shows that high capacity may not have a large impact in the absence of local political will or effective coordination across relevant agencies at multiple levels of government.

The review of PPG7 in 2000 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" (Oy 2000). Yet we note that in scope and financing, the PPG7 was the largest conservation program in the Amazon at the time.[6]

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 subprogram) 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 also helped with product development, marketing, social services, and monitoring of illegal activity. Costs per hectare managed were reported to be less than US$1 per hectare, and incomes may have risen (World Bank 2002).

PPTAL demarcated 59 indigenous territories covering 45.5 million hectares—or more than 10% of the Amazon forest (World Bank 2002). It is credited with innovative participatory methodology that allows more timely, accurate, and cost-effective demarcation. Both the World Bank and a 2000 program review highlight creation of the Amazon Working Group and a civil society network of over 700 NGOs, suggesting that the social capital was an important achievement of the program, in light of the abilities of such networks to monitor and to challenge anti-environmental policies.

The myriad programs and components of the PPG7, combined with the lack of rigorous evaluation of the initiative as a whole, make it difficult to assess the true impact of the PPG7 on forests. While the PPG7 had many 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, it is possible to assess the impact of the indigenous territories and extractive reserves on forests—and the establishment of these areas was due in large part to the PPG7. Recent scientific studies have found the indigenous territories and extractive reserves to have been somewhat effective in the blocking of deforestation in the Amazon (Nepstad et al. 2006b; Adeney et al. 2009).[7]

1.2.1.3. 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, the UK Department for International Development (DFID), the French Development Agency, Swiss Aid, and the Dutch 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 a 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 three-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 possible, since the Agriculture Ministry is not part of NREG even though agriculture is an important driver of deforestation. Further, some other government agencies that influence key drivers, such as transport and infrastructure, are not fully engaged. This may change as NREG is building an interministerial body to which the REDD Steering Committee will report. Such coordination will likely be critical to its success.

1.2.2. Looking Ahead

An effective REDD framework will require coordination of support for many quite distinct sectors. The benefits of harmonization 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 and/or purely donor-driven strategies. Any actions that affect deforestation should be productively harmonized within an overall REDD strategy. Effective and efficient REDD is likely to involve infrastructural as well as agricultural and other sectors within an overall strategy while providing a way for donors to align objectives with all of them.

A second key point is that donor coordination in of itself 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. Forest-dependent communities are key stakeholders in this process. In TFAP, civil society demanded consultative processes and the battle over broad consultations contributed to the overall failure of the initiative. Within PPG7, local civil society was consulted about land demarcation and protections. NREG tries to build creative platforms for coordination and consultation. In sum, the lessons from TFAP and PPG7 and early NREG evidence suggest that future successes are dependent on:

- collaboration between domestic governments and donors
- accountability to all the parties through transparent reporting
- integration of all relevant sectors' concerns
- seeking out donors' common interests with local stakeholders

1.3. Debt Relief

Given the significance of forested countries' domestic politics above, concerning debt relief we note that it is external actors who are the lenders and can forgive a debt.[8] Yet whether debt relief effectively targets deforestation remains an open question.

Debt relief involving 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). 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 US$117 million in local currency for conservation projects, including through the purchase of about US$168 million in debt (face value) for US$49 million between 1987 and 2006 (Sheikh 2006). It relies on external institutions willing to forgo funds in return for protection of the forest.

Even without direct contributions labeled for conservation, debt relief may increase forest conservation as 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, Kahn and McDonald (1995) find 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 (Sheikh 2006). In the 1990s,

6 While we focused on the Amazon here, the PPG7 also sought to address deforestation in the Atlantic Rain Forest of Brazil.

7 For more on such policy impact analyses in general and protected-area impacts specifically, see discussions in 2.1 and 2.2.

8 That is not true of all externally determined financial influences. The terms of trade facing a country also affect deforestation. When a country's currency is devalued, its exports become less expensive for others. Devaluation is often recommended for indebted countries that need to increase export revenue and is also associated with increased deforestation. This may be a direct result of increased demand for agricultural exports. It may also be the result of increased demand for timber exports, which leads timber companies to expand logging roads further into the forest, improving access for other agents. Simulation models, such as computable general equilibrium models, generally confirm these effects, showing that devaluation, trade liberalization, and lower agricultural export taxes increase deforestation (Kaimowitz and Angelsen [1998]: 64). Nepstad et al. (2006a) show that over decades the amount of soy exported from the Amazon tracks the Brazilian real's rate of exchange with other currencies. Cattaneo (2001) analytically formalizes the potential importance of this idea using a general equilibrium model. Thus here a financial factor (previously we noted biophysical constants like slope of land) is unlikely to be shifted for REDD rationales, i.e., is in the category of a constraint on planning and impacts of REDD, including as a source of uncertainty.

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however, Indonesia may have been pressured by international financial institutions to increase exports of timber, paper pulp and palm oil to, among other things, service debt payments.

Along these lines, some 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; Amacher 1999). Debt service also can tie up existing government revenue, making forest enforcement impossible for central governments located up to many hundreds of miles away from forest resources. Amacher et al. (2008b) find this would exacerbate illegal logging and the influence of bribes upon operation of concession and policy design. In this setting, "REDD transfers" 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 United States' 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 US$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 US$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 US$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 (TNC 2009). Working with the Club of Paris, Peru has also substantially reduced its debt with Germany, Canada, Finland, the Netherlands, 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 (Purnomo et al. 2007). Yet for this and many other examples cited above, impacts on forest have not yet been shown.

1.3.2. Looking Ahead

Drawing any causal linkage between debt and deforestation currently 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 (Sheikh 2006). Ultimately, though, successes depend on "the viability of the programmes [and] strength of the organizations and communities implementing the programmes [with] swap proceeds" (Resor 1997).

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. Demand for pulp, paper, food, biofuel, and other agricultural products drives deforestation and destructive (and often illegal) logging. At a global level, though, most industrial roundwood harvested in developing countries is ultimately consumed within developing countries. Yet significant portion is traded to developed countries in the form of logs or processed products, particularly via China. There is also a very large international trade in pulp products and biofuels. The volume and value of these commodities is large, including an annual trade of timber (US$224.3 billion), soy (US$22 billion) and palm oil (US$12.7 billion) (Daviet 2009). Such trade linkages suggest a role for global demand-side interventions to reduce economic incentives for production of commodities on the forest frontier. Impact will, though, be limited if programs focus solely upon the consumption within developed countries. However, pressures from international buyers also can shape the industry practices and the standards within supplier countries.

Demand-side efforts may take many forms, ranging 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[9]; the European Union's 2003 FLEGT Action Plan to prevent illegal imports into the EU; the 2008 amendments to the United States' 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 deforestation without addressing demand face serious complications; e.g., 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). 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 (Daviet 2009).

1.4.1. Case Evidence

1.4.1.1. Private-sector initiatives (campaigns/certification). Campaigns to date have highlighted "the hamburger connection" to clearing in Central America from beef consumption in the U.S. as well as identifying "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 with support of 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). NGOs have pursued a similar approach, providing information to

9 Convention on International Trade in Endangered Species.

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 some high-deforestation areas by 2008, according to Greenpeace and the Brazilian Vegetable Oils Industry Association [AP 2008]). 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, facing such decentralized private choices with clear spillovers, given the inherent tradeoff between opportunity cost of participating and the potential to hurt the targeted firm (Delacote 2009). Further, 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 U.S., 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 as well, and another increasingly well-known example is the Roundtable on Sustainable Palm Oil (RSPO). Bitzer et al. (2008) note: "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." Such a dissemination of like efforts creates new dialogues and demand for participating producers.

Certification has its weaknesses. To the extent that it is being applied mostly to "parallel production systems" that affect only small fraction of area used for a crop, its impacts could well 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 (Cashore et al. 2006a). Thus the costs of certification may be outweighing the benefits, which have remained limited to rewards in markets versus, for instance, any public "push" (e.g., in forest sector governance) that would support adoption (Ebeling and Yasué 2009).

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 ones, at least. It is even possible this could yield a "race to the bottom" (Bitzer et al. 2008; Raynolds et al. 2007). On the other hand, Sasser et al. (2006) and Overdevest (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. 2008). Some consider the FSC to have been effective in engaging stakeholders through national working groups. For instance: ". . . 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 2007). Taking this point further, since governments predominantly own the forest within developing countries and most industrial roundwood is consumed domestically in those countries, for large impacts certification likely requires local buy-in.

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, for instance, suggests that this approach "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 Yasué 2009).

1.4.1.2. 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 (Lawson 2005).

The listing of ramin under the 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. 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" (Lawson 2005).

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 (see for example Boscolo and Vincent 2000; Kishor et al. 2004; Richards 1995; and von Amsberg 1998). At the least, then, identifying the conditions under which these policies will help seems critical.

1.4.1.3. 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 (EUROPA 2009).

These agreements are designed to ultimately "eliminate illegally-produced timber from partner countries' international and domestic trade" (FLEGT). 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 (Saunders et al.).

1.4.1.4. United States' 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 (USDA 2009). 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 very focus on its costs itself 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 (USDA 2009):

- 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, i.e., when it is not simply small lots for differentiated markets, and when all timber is labeled with its origin by mandate, then impacts could be significant.

Bilateral and unilateral instruments can complement one another, but enforcement 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 dimensions of interest within exporting countries' wood and forestry industries. 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—i.e., the largest developed-country markets for tropical wood products—a single systematic approach to deal with these markets-and-incentives issues has not emerged.

Many approaches applied in concert may have greater success, since coercion (law) and persuasion (campaigns) appear to be complementary. In forested countries with large enough domestic demand (e.g., in the case of 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 (Daviet 2009).

2. Domestic Forest Policies

Varied national and subnational initiatives have aimed to conserve forests. Their primary aim—reducing deforestation as well as forest degradation—has typically been only partially achieved, due to limitations in how key drivers of forest loss were (or were not) addressed. For protected areas and ecoservices payments, being located where the threat of deforestation is relatively low has limited deforestation impact, though impacts on forest degradation must also be considered. Concessions by their nature should manage clearing pressures, yet many details of such contracts (much as for ecopayments contracts) are critical if the local land-use incentives are really to shift. Finally, while decentralization does not automatically address these issues, if incentives are well aligned then, in some situations, local decisions could generate REDD while improving welfare.

2.1. Protected Areas

Protected areas are the most common explicit forest conservation policy, now covering ~12% of the Earth's land surface, and they have increased in area substantially over the past two decades. As they require money, and other resources, an important question is whether they "work." As they tend to be on land with relatively low threat of deforestation, though, protected areas may change deforestation less than expected relative to the outcomes without a conservation policy. In particular, less deforestation has been avoided by protected areas than typically is assumed (see recent study of Costa Rica, the Brazilian Amazon, Mexico, and all protected areas globally).

Better data could improve the limited evidence concerning potentially higher impacts on forest degradation. In fact, even for deforestation, the recent studies show impacts vary considerably across the landscape. Where deforestation threats are relatively high and still the enforcement is sufficiently strong, there can be significant avoided deforestation, such as relatively big impacts of Chico Mendes Extractive Reserve in the Brazilian Amazon nearby the Interoceanic Highway.

Protection is established for many reasons and protected areas have varied land-use strictures. Many have been focused on where specific ecological services like species or carbon are most intensely provided. Other protection, and other analyses of its impact, have different foci such as economic opportunities afforded to or taken from people nearby (Sims 2009). Impacts on locals, including access to nontimber forest products, can be critical for the political and distributional components of REDD. We focus on deforestation (drawing on Joppa and Pfaff 2010a's review).

Because the reason why protection can prevent deforestation is common knowledge, we focus on the reason why it may not. Consider a completely forested protected area. It may not be achieving anything in deforestation avoidance if the lands inside would be forested anyway, without the formal protection. If land is steeply sloped, e.g., this may discourage deforestation for crops (although perhaps not logging, as opposed to deforestation, which serves as a reminder that degradation impacts can be higher).

In fact, globally, national protected-area networks are often unrepresentative of national lands (Joppa and Pfaff 2009). On dimensions relevant for deforestation (in particular for agriculture), protected sites differ from all unprotected lands and even lands directly around protected areas. The former may not be surprising, as household and agency choices suggest why pressures may generate nonrandom locations for protection. The latter comparison is perhaps more surprising and, further, it is relevant to past efforts to evaluate impacts of protection (see Joppa and Pfaff 2010a) that now we see easily can overestimate avoided deforestation (Joppa and Pfaff 2010b).[10]

2.1.1. Case Evidence

2.1.1.1. Initial efforts. Protection's impacts on deforestation have long been evaluated (with less attention to forest degradation), but the methods used have varied. Some informal evaluations involve only that currently forest is standing, e.g., Costa Rica's protected areas are a success as they are forested. Fuller et al. (2004), for instance, say protection is not viable in Kalimantan given the considerable deforestation during 1996–2002. Yet conclusions based solely upon the current forest are highly problematic. To discern policy impact, we compare what occurred in an area to what would have happened without protection and the latter must be inferred. Several approaches have been tried.

10 Consider this example of nonrandom location following local differences in land characteristics. Egmont National Park in New Zealand contains a large volcanic cone but stops at the cone's edge. Thus the elevation in a buffer is markedly different from inside the protected area. More generally, if there are thresholds or boundaries in natural landscapes, those who create the protected areas are likely to be aware of them and might well choose to establish the protection along those very lines.

One might compare protected-area outcomes with deforestation in all of the unprotected areas. Gaveau et al. (2007) compare 30-year clearing of unprotected areas with lower clearing within protection. Similar comparisons are in Messina et al. (2006) for Ecuador's Amazon, Sánchez-Azofeifa et al. (1999) for Sarapiqui within Costa Rica, and DeFries et al. (2005) for the globe.

More commonly, analysts compare protected-area outcomes to the outcomes in "spatial buffers," i.e., in areas immediately surrounding the protected areas, in an effort to compare similar lands. Bruner et al. (2001) analyzes the deforestation in and around 93 protected areas across 22 tropical countries using survey data. Vina et al. (2007) update to 2001 a Woolong study (Liu et al. 2001). Across the entire period from 1965 on, they found habitat losses ~17% lower inside the reserve than in the buffer. Sader et al. (2001) compare the northern Guatemalan Maya Biosphere reserve (GMBR) with a buffer in four time periods, always finding higher clearing in the buffer zone. Kinnaird et al. 2003 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 then claim an impact.

2.1.1.2. "Apples-to-apples." Yet the characteristics of protected lands often differ not only from the entire set of unprotected areas but also from spatial buffers commonly assumed to be similar. "Matching" analyses can address such differences in deforestation-relevant land characteristics by constructing "apples to apples" comparisons. They use measurements of land characteristics to select the most similar unprotected locations for comparison. Only recently has matching been applied to protected areas, starting with Costa Rica (more below). Efforts are ongoing for the Brazilian Amazon (see Pfaff and Robalino 2009), the region around the InterOceanic Highway including Chico Mendes Extractive Reserve (Delgado et al. 2008), Mexico (Zepeda et al. 2010), and the world using a data set that trades off detail for evaluation of a huge set of countries (Joppa and Pfaff 2010b).

Andam et al. (2008) estimate how much deforestation was avoided within Costa Rica from 1960 to 1997 in over 150 protected areas. Costa Rica had high deforestation during the 1960s and 1970s. Their "matching" greatly increased the similarity to the protected areas of the unprotected areas selected for comparison. Their apples-to-apples comparison finds that ~11% of pixels protected would have been deforested without protection. Traditional analysis using the same data shows that comparing to all unprotected land estimates 44% avoided deforestation while comparing to a 10km spatial buffer zone corrects very little of this overestimate, yielding an estimate of 38%.

Building upon that to provide future policy guidance Pfaff, Robalino et al. (2009) reconsider Costa Rica's protected areas for 1986–1997. They confirm the Andam et al. (2008) story (with under 3% avoided deforestation versus traditional estimates of 9%) and then focus on variations in impact. Relevant for future REDD investments, they find that some protected areas have far more impact on deforestation than do others. For instance, within 85km of the capital of San Jose the avoided deforestation was about 3%. 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. Finally, slope was critical. For flatter land they estimate 14% avoidance, while on steeper land the impact 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, and further we note that evidence concerning their impacts on forest degradation is quite limited.

Yet this perspective is important for guiding future investment. Impacts vary across a landscape. Deforestation impact is likely to be lower on high slopes and land farther from roads and cities (noting that where development may arrive, long-run impacts may be higher than the short run). As global REDD payments are likely to be based on impacts, integrating past motivations with earning payments suggests that, given all other constraints, planners could target higher impact.

2.2. Ecopayments

Payments for ecosystems services such as water quality, species habitat, or carbon storage could reward landowners for limiting the uses of their lands to conserve ecosystems such as forests. Yet most proposed programs are voluntary. Landowners may volunteer their least productive land and then be paid to retain forest that might well have remained without a financial reward.

During the initial period of Costa Rica's pioneering program, which has inspired so many others, on average

deforestation threat was low and the payments were not targeted at threat and thus the forests receiving payment would largely have remained standing without payments. However, as for protected areas, looking ahead planners could explicitly aim payments at forest facing threats. Costa Rica's "learning laboratory for the world" also confirms that the details of program design can be critical. Even after the program was already in place, the evolution over time and space in how the payments were allocated affected the bias towards low threat and thus payment impact.

Here, as for protected areas, it is common knowledge why ecosystem services payments might prevent deforestation so we focus on why they might not work. When payment allocation drives of agency decisions, the forces leading protected areas to be biased to lower deforestation threats apply to payments too. And as noted, when landowners choose to participate, given their detailed knowledge of their own lands they can pick out parcels with poor soil quality or slopes to offer to the payments program. Those might remain forested even without payments, such that payment impacts could be low. Evaluating impacts correctly requires comparing to other similar parcels.

Landowner choice raises other issues too. One large relevant group is households in subsistence communities who grow crops for their own use and also collect nontimber forest products from unprotected open-access forest and/or locally protected community forests (Sills et al. 2003). The most valuable forest products vary by region and forest type, with fuelwood more predominant in arid Asia and Africa (see Arnold et al. 2006, Hyde and Amacher 2001, and Sills et al. 2003).

For these landowners, if REDD policies such as payments yield higher-quality or more extensive forest stocks to which households have access, households 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; Cooke et al. 2008; MacDonald et al. 2001; Arnold et al. 2006). Under this sort of scenario, REDD can bring both climate change mitigation and adaptation benefits, e.g., a form of natural insurance (Pattanayak and Sills 2001).

Yet if REDD policies largely benefit private forest stocks instead, the additional rent may lead to higher enforcement in, i.e., exclusion from, private forested areas. This may not only decrease the welfare of subsistence households but also shift their collection activity to more degraded forests (Arnold et al. 2006; Cooke St. Claire et al. 2001; Vermeulen 2001). This dynamic could also be relevant if official protected areas (see 2.1 above) are better enforced due to REDD payments.

Given these distinct possibilities, farmers could be involved in policy design. Arnold et al. (2006) find in a review that transfer of local wood fuel reserves to communities can raise access to wood as well as revenues governments collect through taxes and royalties in return for the guarantee of property rights (see 2.4 on decentralization). Yet at least for fuelwood, the transactions costs here may be high (Hofstad 1997). Still, we note the possibility of "participatory payments schemes."

2.2.1. Case Evidence

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

Studies also compare forest cover in a given finca before and after the establishment of the PSA. A telephone survey of 100 PSA landowners across Costa Rica found 43% of forest receiving payments already was protected while 36% was used for grazing before the contract (Ortiz et al. 2003). Yet even concerning the latter significant number, rising forest cover on PSA fincas does not necessarily mean that the increase is due to PSA. Forest cover could be 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. 2007). Evaluations should ideally control for such time trends.

A variation on this approach to evaluating payment impacts is illustrated by Sierra and Russman (2006). They study land use on recently enrolled properties (contracts signed in the last two years) to approximate what the land use on properties that had been enrolled for more than five years would have been had there been no payments program. They find the PSA participants in the Osa Peninsula with recent contracts have significantly more land in agricultural production than do earlier participants. They conclude that payments allow landholders to invest in off-farm enterprises and accelerate

exit from agriculture. Yet such observation is only valid for impact estimation if the factors that determine when landowners enroll do not also influence land use.

2.2.1.2. Program evaluation and program evolution. Just as for protected areas, in order to better evaluate impacts of ecoservices payments it helps to control explicitly for any observable differences in land and landowner characteristics between the sites that are receiving payments and the sites that are not. Recent evaluations apply the "matching" (just as above for protected areas) and both propensity-score matching (Rosenbaum and Rubin 1983) and covariate matching (Abadie and Imbens 2006) for results robust to these approaches.

Pfaff, Robalino and Sanchez (2008) find PSA contracts during the period 1986–1997 blocked deforestation in under 0.1%—i.e., less than 1 in 1000—of the parcels enrolled. Most of those enrolled were unlikely to clear the forest even absent any payment. This does not mean, of course, that payments in any country would have such low impact. Rather, it shows that impact depends on the socioeconomic setting driving deforestation and, thus, simply having payments does not guarantee much impact. In Costa Rica, there were are other factors already reducing rates of deforestation by the time the payments were created, leaving little for payments to do. Arriagada (2008) notes, however, that payments could still lead to regeneration of forest, e.g., motivated by the possible future payment.

Further, in a given socioeconomic setting much can evolve, including the design of the payments. Robalino, Pfaff et al. (2008) study the second time period for Costa Rican payments, 2000–2005, finding that about 0.4% (or closer to 1 in 250) of the enrolled parcels were saved from clearing. To first order, this is also very low-impact. On the other hand, it is over four times as high here. Thus it is worth understanding why impact shifted. To start, during 2000–2005 Costa Rica on net reforested but more gross deforestation occurred, i.e., more changes that payments could prevent.

Probably more important for policy lessons, though, is a shift noted in Robalino, Pfaff et al. (2008) away from a bias towards even lower than the (very low) average threat. This shift is said to have resulted from more top-down allocation of PSA, reducing the influence of volunteer landowners. On average, across the country, this reduction in low-threat biases raised the impact of payments. Also suggesting the importance of program design and implementation, differences in allocation rules across the agency offices within Costa Rica also yielded greatly varied impact of payments.

2.2.2. Looking Ahead

Ecosystem services payments can indeed avoid deforestation but any impact cannot be assumed. Even without any spillovers (such as from relocation of pressure to parcels with would otherwise have been forested), it is clear payments sometimes have little impact. The idea of shifting local incentives remains valid though attention to the details of program design is required for impact.

Deforestation impacts are likely to be lower when selection into the program is driven by choices by landowners to volunteer parcels. Yet as for protected areas, for various motivations agencies too may enroll lands that face lower-than-average deforestation threat, e.g., farther from roads or cities and with higher slope or lower soil quality. In either case, shifting details can raise impact.

2.3. Concessions

In the large tropical forests of Africa and Asia, and increasingly Latin America, logging is often practiced through private concessions in government-owned forests. Many are held by large foreign firms. With variation by country concessions are often contracts between government owner and harvester, won through a bidding process, that designate a volume or area to harvest in some time period. Contracts cover small or large areas and can be short- or long-term (see Gray 2000). Firms winning concessions pay fees, or "royalties," for their rights. Royalties are usually lump sum fees charged based on the area harvested or, instead, fees based on 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). Good design in principle offers potential for REDD. Concessions have recently specified environmentally sensitive methods such as the preservation of certain species, minimum-size-class harvesting, reduced-impact logging, and other methods to reduce environmental impact (Karsenty 2008; Cerutti et al. 2008). However, poor design of the contracts (including in the royalty structures) is common and 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 and Amacher 2005) and to enforce agreed harvest methods (Smith et al. 2003).

Yet concession design remains relevant to REDD. Domestically, any government could reform its policies on timber harvesting concessions to try to reduce

net forest carbon emissions below a national baseline, e.g., providing incentives and increasing enforcement of reduced-impact logging and other best practices (Pertz et al. 2007). At a global scale, one might conceptualize new REDD policy as a market for carbon concessions with countries as contractors. That idea 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 [Karsenty 2007], or Yasuní in Ecuador [Larrea and Warnars 2009]). In Indonesia, many NGOs developing REDD projects for the voluntary market and as pilots for any future compliance market are establishing additionality, permanence, and legal rights to the carbon through ecosystem restoration concessions that preempt timber or oil palm concessions (Madeira 2009; Departemen Kehutanan 2009).

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 and other countries have promulgated policies, such as log export bans (see discussion in 1.4), 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 2002; 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 2002; 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 2002; 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) examine 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 logging on the frontier. These activities may in fact be complementary, because if enforcement (e.g., for reduced impact) 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 (McKean 2002). In the developing world, most of these traditional regimes were legally disavowed when colonial and then central state governments declared themselves owners of all forests. In most tropical countries, the majority of forests are still 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. The persistence of tropical deforestation suggests that central state ownership and management often has not addressed these facts at least in the sense of having 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 as public lands with no designated use. As the authority to enforce 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 states: "The transfer of property rights from traditional user groups to others eliminates incentives for monitoring and restrained use, converts owner-protectors into poachers . . . " The consequences have included illegal logging, clearing, and burning in many state-owned tropical forests including in 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). The stated objectives of these reforms have included all of improved efficiency, greater equity, and the effectiveness of forest management.

Such decentralization has already taken many forms. That includes the devolution of property rights or management authority to a community, e.g., legally recognizing a traditional common-property regime (e.g., community forests in Cameroon and India). It also includes the transfer of forest management responsibilities to state or to local governments (i.e., enforcing rules and collecting revenues).[11]

11 Some distinguish these two types of reforms, categorizing power transfers to local-level authorities within government as "decentralization" and transfers to local-level authorities outside of government (such as communities) as "devolution." However, such distinctions may not always work, since in some cases community-level institutions may operate as a form of local government (as in Tanzania) or in some cases, both types of power transfers occur at the same time (as in Bolivia). Following Anne Larson's (2004) approach, we term all such reforms as decentralization.

As to why such decentralization might help to reduce forest loss, in particular by reducing degradation, while individual ownership and state ownership were long the options considered, from the late 1980s increasing interest was paid to cases where property rights and management responsibilities were held by groups of forest users and effective local institutions were developed (Ostrom 1990). Some suggest that common-property regimes even can be the most efficient way to manage natural resources that are (1) remote, emphasizing group monitoring and enforcement, or (2) biophysically more productive as a large unit versus as fragmented patches (McKean 2002). Both conditions can hold in tropical forest regions.[12]

Other 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 thus make better decisions about collective goods (Andersson and Lehoucq 2006). Ribot and Larson argue that for decentralization to work it must be democratic in nature. Sufficient powers must be transferred to institutions that are downwardly accountable to local populations (Ribot 2002; Ribot and Larson 2005).

2.4.1. Case Evidence

Assessment of decentralization's impacts is limited. Despite many stories, empirical studies of impacts on forest cover and human welfare are few. Rigorous examination of pre-decentralization conditions or specific characteristics of reform are limited. Outcome measures differ across the studies that exist. Some examine 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 (Nepstad et al. 2006b and Somanathan et al. 2009 on forest degradation [not on deforestation], noting that this study also compared community efforts with open access). Only one includes the relative efficiency or implementation cost (Somanathan et al. 2009).

Further complicating assessment are incomplete power transfers within the decentralization efforts to date. Some argue that evaluating impacts is premature since often "decentralization" was in name only (Ribot 2002; Shackleton et al. 2002). Ribot and Larson (2005) say that often sufficient and secure powers have not been transferred to local institutions and that institutions are not downwardly accountable. Even with baselines and metrics, the "underlying logic" of decentralization may not be able to be well tested using current experiences. Nevertheless, we present some empirical and case literature.

2.4.1.1. Decentralization can work. Indigenous territories and community-managed extractive reserves appear to have blocked clearing, e.g., in the Brazilian Amazon.[13] Here, inhabitants possess secure and exclusive use rights and thus the right to block outsiders from encroachment. Nepstad et al. (2006b) and Adeney et al. (2009) have found that indigenous reserves do as well as parks in blocking deforestation and fire. Pfaff et al. (2010) find that all of these areas reduced deforestation less than is claimed (see 2.1) but that indigenous areas fared better than state areas. Exclusion of others occurs even in areas of intense pressure (Nepstad et al. 2006b).

Forests under community management in Kumaon, India, have been sustainably managed for decades (Agrawal 2001). Some conclude that Van Panchayats (community forest councils) are more effective in conserving than are state agencies (Somanathan et al. 2009). In Mexico, where most forests are held as common property, many communities sustainably manage forests (Alix-Garcia et al. 2004). Since Bolivia's decentralization reforms in the 1990s, including recognition of 22 million hectares of indigenous lands (3 million hectares have been titled), improved forest management is 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 areas solely under state management (Stocks et al. 2007). In Nepal, which devolved 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).

12 However, Dietz et al. (2003) argue that common-property regimes are most effective under a more limited set of conditions: (1) possible to monitor the resources and their use at low cost; (2) no more than moderate changes in socioeconomic conditions, population growth, technology, and resource use; (3) high social capital (so that community members can trust each other, enforce rules, and achieve monitoring at low costs); (4) possible to exclude outsiders at low costs; and (5) users support monitoring and enforcement of rules.

13 More land is under management by indigenous communities (21%) than is in protected areas (PAs) (14%) (Schwartzman and Zimmerman 2005). While Brazil's 1988 constitution required the demarcation of all indigenous lands by 1993, the task might have gone unfinished were it not for foreign donors and the PPG7. PPG7 also piloted participatory demarcation with indigenous peoples, reducing demarcation costs and likely increasing capacities of these communities to defend their territories (Fearnside 2005a).

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 accountability have been increased by requiring that village institutions document and publicly share all revenues and expenditures, yielding increases in revenue collection and the financing of public services (Lund 2007).

2.4.1.2. Decentralization is not a panacea. Yet decentralization can increase deforestation and inequality, if attention is not paid to institutional conditions and to economic incentives. If the short-term economic incentives for conservation are not higher than those from commodities, e.g., then we may well expect that deforestation will continue.

Traditional communities are not inherently focused on conservation alone. They and other locals may well aim to maximize economic returns from the forests, 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 2005b) as have logging and 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 (e.g., can be revoked by the state), so residents may wish to accrue forest profits while they can (Oyono 2004). Another factor may be a lack of downwardly accountability, if village elites promoted logging to derive personal gain at the expense of the community's welfare (Oyono et al. 2003; Ribot 2002; Larson and Ribot 2007).

In Indonesia, authority for granting timber and forest conversion licenses and collecting some revenues was rapidly decentralized to the district level during 1999-2002, followed by some re-centralization. This clearly did not slow degradation and conversion of forests (Barr et al. 2006; Capistrano 2008; Dahal and Adhikari 2008). By many accounts, despite a temporary increase in cash income, local communities have benefitted little. While locals may be granted timber licenses, they lack the capital to do logging and usually contract with large logging companies (Resosudarmo 2004). Lacking secure property rights and access to fair judicial systems, and the states' inability or unwillingness to enforce these contracts, communities have been vulnerable to exploitation (Engel and Palmer 2008). This has also led to dispute over property rights, with local elites often seeking to take advantage. As summarized by Barr (2006: 130), "although since decentralization, local communities' right to obtain a share in benefits is no longer disputed, their relatively weak legal bargaining power has allowed more powerful parties to reap more."

Findings are mixed regarding effects of the size of the forest area and group of users. With data from the International Forestry Resources and Institutions community forest program across nine countries, Chhatre and Agrawal (2008) find degradation is more likely in larger areas and say it may be harder to monitor larger tracts. Yet with the same dataset, the same authors later assert that larger community forests store more carbon and yield greater livelihood benefits (firewood, fodder, green biomass, construction wood) to users (Chhatre and Agrawal 2009). Nagendra 2007 studies Nepal, arguing decentralization may be most effective at intermediate group sizes: "When the number of users is too few relative to the total forest area, forest planting, maintenance, monitoring, and other critical tasks cannot be carried out effectively. When the number of users increases beyond a point, however, coordination becomes difficult and cooperation tends to break down, making the task of forest protection even more difficult." Nagendra focuses on reforestation. Conclusions such as the above could depend upon the issue at hand, e.g., externally-driven deforestation, internally-driven degradation, or internally-driven restoration.

2.4.2. Looking Ahead

Decentralization may turn out to be an effective policy tool for reducing forest degradation. Yet for it to work requires attention to local 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, such as the prospect of carbon payments. Third, local institutions need to be transparent and downwardly accountable to the 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 upon deforestation may be as important for REDD as optimizing conservation with lessons from past forest-focused domestic policies.[14] Yet little experimentation of this type has occurred, to our knowledge. Below we describe how these development policies affect deforestation and suggest that such policies could be adjusted.

3.1. Infrastructure Policies

Access and transport costs are key determinants of agriculture as well as of logging. Investments in new roads raise access, lower transport cost, and often lead to both more economic output and increased deforestation. Critically though, new road impacts vary across space. Specifically, new road investments appear to increase deforestation less when they are made in already developed areas, with prior roads and deforestation. Thus total forest impact is affected by network design (and an analogous point should apply to energy pipelines). In addition, the government of Acre, an Amazonian state in Brazil, claims that deforestation can be lower if public actors sequence or integrate road construction with other policies that clarify tenure and provide services in order to raise the quality of life while preserving natural wealth. Another integration example could be a buffer of parks around roads, imitating how Chico Mendes Extractive Reserve has functioned.

Since agriculture is the primary land use to which forest is converted, note that a model of such choices might include owners maximizing profits (or goals including profits) in deciding among alternative land uses. Improved access, i.e., feasibility of transport and its cost, should increase net revenues from outputs and lower costs of inputs from labor to fertilizers. How this affects the profits from clearing versus from forest will drive land use. New roads could support more forest in principle but in many situations the net benefits of such investments are greater given clearing. On average across varied settings, then, road investments are expected to increase deforestation.

To consider future potential REDD policies, though, we may go beyond points about averages. Below, for instance, we focus on the heterogeneity in impact that creates the potential for shifts in road policy to generate REDD. If the impact of a new road varies as a function of the setting into which the investment goes, then where one sites the investments affects total deforestation.

3.1.1. Case Evidence

3.1.1.1. Transport cost matters. That changes in transport infrastructure affect deforestation is empirically supported. One way to see this is to study the agents who decide whether to clear an area (see, e.g., Sills and Caviglia-Harris 2008). Regressions at this scale require data from farm households with questions about the extent of deforestation (number of hectares or percent of landholding) as well as about many factors that influence it. Current research focuses on linking such survey data with measures of deforestation from remote sensing (see Fox et al. 2003; Caviglia-Harris et al. 2009). Results of such analyses generally show improved access to roads and market centers raises deforestation.

At larger scales as well, the evidence supports this conclusion on the impact of transport cost. 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, one can see that higher agricultural prices are generally found to be associated with more deforestation (see Angelsen 1999, e.g., on indices of agricultural output prices in Tanzania). Biophysical factors (soil quality, slope, rainfall) can be key constraints.

Controlling for such factors, investments that raise transport access or lower its cost, as proxied by proximity to roads, are correlated with higher deforestation. Chomitz and Thomas (2003) find distance to roads and rainfall negatively correlated with deforestation in Brazilian Amazonia.[15] For Thailand, Cropper et al. (2001) find biophysical factors have the strongest correlation with deforestation. Yet roads and population density are clearly positively related to deforestation.

Stepping back even further, for broader descriptive facts, over two-thirds of Brazilian Amazon deforestation has

14 Von Thünen's (1966) useful simple framework emphasizes the importance for land use choices of distances to market center, suggesting that (1) deforestation can increase with improved access, (2) deforestation increases with profitability of agriculture and lower profits in forest, and (3) increasing forest profit would expand the "mining" of forest resources farther into the wilderness.

15 Since as found in Pfaff (1999) roads in one political unit could well affect clearing in neighbors, and in principle the sign of such an effect is ambiguous, Pfaff et al. (2007) looks at impacts of new roads on census tracts in the same county that do not receive road investments. Deforestation increases in census tracts within 100km of the census tract receiving the new road.

taken place within 50km of major paved roads, resulting in the oft-noted "arc of deforestation" in the southern Amazon (Nepstad et al. 2001; Laurance et al. 2001; Chomitz and Thomas 2003). In this region (examined further below), 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 also 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 clearing.

3.1.1.2. Road impacts vary by location. Continuing consideration of the Brazilian Amazon, in the early 1970s the Transamazônica/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 Grosso) to Santarém (Pará), were constructed but not paved. Their impact is magnified by a network of over 300,000km of unofficial logging tracks (Brandão and Souza 2006; Perz et al. 2007). Currently, the frontier with highest clearing rates is in the central Amazon, along BR-163. Across this enormous region, subregions vary a great deal.

New roads' impacts may vary considerably across space too, as a function of key details of the setting in which they are located.[16] Andersen et al. (2002) study road impact as a function of prior clearing within a county. With about 250 county-level observations they assume that higher prior deforestation always raises or always lowers a new road's forest impact. Among those options, they find that where prior deforestation is higher, the forest impact of a new road will be lower.

Pfaff, Robalino and Herrera (2009) reexamine variation in road investments' impacts using much more precise pixel data.[17] These permit the prior distance to the nearest road as a more spatially precise proxy for prior development. Unlike the interaction estimated in Andersen et al. 2002, this also permits a test of a new prediction of nonmonotonic effects of prior development upon new roads investments' short-run forest impacts. Thus, with high prior development, new roads' impacts can be quite low and even insignificant (as in Andersen et al. 2002). However, impact does not rise uniformly as prior development falls. Instead, it is highest at an intermediate level of prior development, what one might call the edge of development where more can easily occur. Further out from development centers, where little prior development has occurred, again impact of new roads is relatively low, at least in the short run (and varied long-run dynamics could arise, from road abandonment to enormous shifts over decades as new investments follow prior ones).

Conde and Pfaff (2008) show supporting pixel evidence from the Mayan forest (in Mexico, Belize, and Guatemala). The short-run impact of the new road investments further from prior roads is lower than the impact of new road investments closer to prior development (noting there is not enough data in areas of very high prior development to test that element of the nonmonotonicity seen above). Further, it is clear that within the more remote areas, it is only the road investment and not other characteristics that significantly shape spatial paths of clearing. Conde et al. 2010's examination of road impact upon jaguar habitat also reminds us that low short-run deforestation impacts in the more remote, pristine areas could imply large additional impacts. Fragmentation impacts are clearly much higher as a result of more remote new roads and can matter to species.

Delgado et al. (2010) provide supporting pixel evidence for areas of higher prior development and clearing, focusing on the Inter-Oceanic Highway connecting the western Brazilian Amazon with Peru, running along the border of Brazil with Bolivia. The highway was established in unpaved form by 1989 and then the Brazilian section was paved during 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 it is not significant for deforestation during 2000-2007. While eliminating this transport corridor would surely slow clearing, the paving did not shape local clearing given an already established local pattern of development. Linking to the results above, the existence of significant prior local development lessened new road impact.

3.1.1.3. Road impacts vary with other policies? While often development and deforestation go hand in hand, the Acre state government in the Brazilian Amazon is trying to find ways for quality of life to increase while natural wealth is preserved (Sills et al. 2006). Policies are claimed to lower forest impacts of new roads, e.g., while roads raise market access for goods and facilitate access to services for rural residents.

Policies proposed to develop with lower forest impact include public services (education, health, market information, extension, and training), credit, enforcement of environmental regulations, and supporting ecoservice provision (e.g., certifying forest products). Officials say such policies permit a "win-win" for traditional forest residents, whose preferences as well as current capital (human, social, physical, and natural) predispose them to forest-based development. Generating REDD given development is formalized in an ASDP (Acre Sustainable Development Program).

For evidence that such complementary policies could lower deforestation, given development, Delgado et al. (2008) consider a (perhaps less intentional) bundling of conservation policy with development policy. Chico Mendes Extractive Reserve is close to the Inter-Oceanic Highway in an area subject to deforestation. As an extractive reserve, it is not surprising that it has some deforested area, yet one might conclude it has had little impact while other, pristine parks in Acre have had more.

A more apples-to-apples comparison of observed outcomes with similar locations without protected areas suggests the opposite. Comparing Mendes with areas facing similarly high deforestation threat, Delgado et al. (2008) find that it avoided significant deforestation. Furthermore, other protected areas in the region, considerably farther from the highway and essentially uncleared, have avoided almost no deforestation. This is because unprotected areas are also uncleared when they are similarly far from the highway.

3.1.1.4. Pipeline analog. Pipelines are also important infrastructure in forested frontiers. While intended for transport of energy, at least their maintenance roads create access to forested areas. Give highly variable and at times very high prices for energy, national governments are poised to make decisions on major expansions of energy transport, such as within the western Amazon. As Finer et al. (2008) note, over 150 oil and gas "blocks" (areas zones for hydrocarbon activities) cover almost 700,000km^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.

As the odds of not extracting energy are low, are there pipeline options for government to lower forest impacts? One set of options is analogous to those for roads: if compensated for the extra costs, could it make sense to go farther 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 the transport of both people and energy on the frontier, are very likely to significantly increase deforestation in the absence of other policies. Development goals are prominent and valid so a question is how to find favorable ratios of distinct outcomes. A critical point to recognize is that some new roads, for instance, will increase forest loss more than others. (Their development benefits surely also will vary but that is outside our scope.)

REDD payments rewarding reduced emissions could provide incentives for tropical forested countries to consider adjusting development policies that affect deforestation rates. Holding development goals fixed, countries might earn payments by for instance intensifying new road investments along existing routes, instead of spreading networks through highly forested areas.

A second critical point is that other complementary policy investments could affect road impacts. As Acre suggests, integrating new infrastructure that promotes local welfare with other policies may allow planned development while increasing the ratio of other gains that are also achieved. An implication for REDD may be that, conditional upon the close monitoring of global goals, a decentralized response to carbon incentives could permit an integration with local development.

3.2. Agricultural Policies

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

16 Impacts vary over time as well. Over time in the Amazon, not only have 700,000km^2 or about 17% of the forest in Brazil been converted to other land uses (INPE 2008), but also land-use dynamics continue to shift. The process was initiated by government to integrate the remote region with the rest of the country using roads, colonization projects, and agricultural subsidies (Mahar 1989). Today deforestation is largely driven by private investors seeking profits by supplying global and domestic markets for timber, soybeans, and beef (Margulis 2003; Nepstad et al. 2006; Lentini et al. 2005; Arima and Barreto 2005). The logging industry plays a critical role in opening new areas by building unofficial new roads (Veríssimo et al. 2002; Brandão and Souza 2006; Perz et al. 2007). Yet government also still contributes to deforestation by investing in infrastructure, facilitating credit for agriculture, and recognizing and supporting new settlements of small farmers in forested areas (Fearnside 2005c; Barreto et al. 2008).

17 This advance in data permits considerably more precision even than within the work in Pfaff et al. (2006) and Pfaff et al. (2008), which went beyond the county data using over 6,000 census tract observations that allow splitting the sample by prior clearing. Both analyses, as in Andersen et al. (2002), proxied prior development using prior deforestation. Across multiple periods, these analyses confirm that new roads' forest impacts vary with setting but do not find road investments to ever lower deforestation.

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

If maintaining forest has little value, deforestation can be seen as an input into agricultural production with a cost of clearing. It may create an asset used for several years that can appreciate or depreciate and sometimes be sold. Such investment decisions will be 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, any changes in key factors that increase agricultural profits on newly deforested land will increase deforestation. The evidence below first addresses this straightforward prediction and then considers complexities: second-order effects, different types of producers, and endogeneity.

3.2.1. Case Evidence

3.2.1.1. 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 2001a; Geist and Lambin 2002; Rudel et al. 2000; 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 from crops that can be profitably cultivated in lands cleared of tropical forest, such as oil palm in the Indo-Malaysian forests and potentially in the Amazon and Congo (Fitzherbert et al. 2008; Koh and Wilcove 2008). This production of biofuels on deforested lands results in a large "carbon debt" that is only paid back through substitution for fossil fuels over many years (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, out-migration 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 productivity, 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).[18]

18 Much of the empirical literature on pasture management in the Amazon suggests that improved production technology encourages deforestation. Reis and Margulis (1994) found that deforestation rates were positively correlated with cattle density in a municipal-level analysis in the Amazon. Using a CGE model, Cattaneo (2001) finds improvements in livestock technology provide highest returns to farmers but dramatically increase long-run deforestation. Limits on financial resources and on physical inputs such as phosphates are indicated as factors that diminish the prospects of maintaining nondecreasing levels of productivity in the majority of pastures in the region (Fearnside 2002). In a cross-sectional analysis, Seidl et al. (2001) find negligible increase in pasture area consequent to an increase in the size of the cattle herd but a much larger impact of mechanization on forest clearing among farmers with a tractor, which supports the theoretical prediction that labor-saving technological change promotes deforestation. Even in the situation of labor scarcity that characterizes many parts of the Amazon, returns to labor in low-intensity livestock systems exceed those in perennial agriculture or forest extraction and lead small farmers towards more forest clearing for pastures (Vosti et al. 2001). Integration of the frontier into regional markets leads to higher rates of deforestation (Vosti et al. 2001). Walker et al. (2000) find that following such market integration in parts of Western Amazon, changes in the producer prices favored beef and milk over other cash crops and encouraged expansion of pastures.

Government provision of, or subsidies to, infrastructure and services such as processing plants and veterinary care also can have impact. 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 (Instituto Nacional de Colonizaçao e Reforma Agrária) 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).

3.2.1.2. 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, processors, population and roads, reinforcing deforestation (see for instance Schneider 1995; Mertens et al. 2002; Kaimowitz and Smith 2001;Pfaff et al. 2007; and Pfaff, Robalino and Herrera 2009). It is widely believed that this type of self-reinforcing process applies to the deforestation "poles" in the Brazilian Amazon, even where the initial forest changes may have been 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 out-migration 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 most developed countries deforestation increased but then decreased as income grew (see, e.g., Clawson 1979).[19] 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. Pfaff and Walker (2010) 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

19 Within discussions of environmental degradation, this pattern of rising then falling degradation along the path of development is sometimes called an "environmental Kuznets curve" (see early evidence concerning this possibility in Grossman and Krueger 1995). The evidence for such paths varies by pollutant and by study. There are good reasons to believe that under some conditions one would expect such a path, yet there is no reason to assume that it will occur everywhere (Pfaff et al. 2004).

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 canals and 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 (2010) 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 deforesting for agricultural production is profitable, perhaps the clearest route to reducing deforestation is to reduce output prices. This has happened via economic recession, overvaluation of exchange rates, and conflict (Fearnside 2005c; Sunderlin and Pokam 2002;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. It could 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., 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 2008), decreased reliance on forest biomass as a key input to agriculture (Benhin 2006),[20] 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. Land Tenure

Tenure regimes in which those who clear acquire squatter's rights and later title have long promoted deforestation (Fearnside 2005a). 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.

Lack of secure tenure matters too. Risk of losing forest through expropriation reduces the incentives for long-term sustainable management. It can be 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 be a significant part of timber harvest across all major tropical forest regions. Although estimates vary, illegal logging in Latin America is not uncommon (see Guertin 2003's examination of trade flows between Latin America and developed countries, and examples cited in Contreras-Hermosilla 2000). It includes everything from trespass to lack of requisite paperwork. In Cameroon, the illegal logging statistics often combine and confuse different types of violations by actors operating at different scales (Cerutti and Tacconi 2008). Yet clearly the risk of illegal logging is a barrier to sustainable forest management (Putz et al. 2009).

Defending tenure is costly. Owners choose among land uses, often clearing for agriculture or grazing, plantations, and unmanaged native forest land or protected reserves and the costs of site protection affect the relative

20 Clearing forest for agriculture often provides both an immediate cash in-flow (from sale of timber) and short-term enhancement of soil fertility. This is key to the economic logic of cattle ranching in the Amazon and oil palm plantations in Southeast Asia. Small farmers also rely on the fertility boost from burning or rotting forest biomass. Traditional shifting cultivation systems sustain forest cover on a landscape scale, but the addition of stressors such as population growth and introduced plant species can make small-scale slash-and-burn agriculture the first step to large-scale and permanent deforestation.

returns from land uses. While carbon-based payments could increase rents to holding or establishing forests, any such rents must overcome the higher site protection costs for forested 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 occurs 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 harvesting only the best-formed, largest, or more valuable trees rather than following government-mandated cutting guidelines (Putz 2005).

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 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.[21] This sort of liquidation of forest for the private gains from resale, e.g., is avoidable through policy.[22] Still, incomplete and overlapping property records that do not recognize traditional land tenure continue to provide opportunities for powerful actors to acquire titles to vast tracks of land in this way (Fearnside 2005a; Brito and Barreto 2009).

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 and 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 return captured by government from the forest harvest is low and thus motivation for the government to protect these forests is also low (noting that reasons for low returns include both transport costs 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

3.3.1.1. 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 (Mendelsohn 1994; Barbier and Burgess 2001b; Zhang 2001; Amacher et al. 2008a). Many of these studies find that under high property-rights insecurities, i.e., a lack of secure tenure, the potential for timber trespass on private land may render forest management and protection not worthwhile relative to agriculture and grazing.

The impact of expropriation risk on deforestation has been found in numerous cases, including Armsberg (1998), Alston et al. (2000), Bohn and Deacon (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 risk deters intensive management for tropical forests. Wibowo and Byron (1999) argue there is a risk of eviction faced by landowners who invest for the long term.

Land tenure regimes differ across countries, though. Sometimes they add to uncertainty landowners have about forest production. Within Amazonia, land is typically formally settled and even sometimes titled through government action in designated areas, informally settled by those with 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. (2009a) find that property rights regimes affect the incentives to sell wood from smallholder plots. This is

21 Acre Sustainable Development Program registered all land claims along route of BR-364 to Cruzeiro do Sul before paving.

22 Several of the proposals to the Fundo Amazônia focus on sorting out land tenure and titling, as a prerequisite to REDD.

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-rights insecurities and the need for local site protection to defend one's tenure, which are common in Latin America and Asia, are present also here, 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 contributing factors to deforestation (Fujisaka et al. 1996; Fearnside 2001, 2002; Kirby et al. 2006).[23] Speculation is linked with acquiring tenure through clearing for cattle pasture, which establishes boundaries (Hecht 1993; Fearnside 2005a). This was often cited in the 1980s, when subsidies and inflation made land a good investment (Moran 1993). Inflation erodes the value of alternatives and contributes to the retirement of real debt acquired through real estate loans (Just and Miranowski 1993). When real land prices may rise faster than real returns on alternatives, investments in real estate (here deforestation) is 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 lacking clear rights has an incentive to overexploit land to prevent returns being captured by illegal trespassers. Miceli et al. (2002) analyze the merits of titling systems in resolving land claims, finding that formal title provides incentives to protect while informal title does not. 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.

3.3.1.2. Migration and population. Insecure property rights are believed to affect population's impacts on agricultural forested frontiers. Perz et al. (2005), Pan-Amazon, correlate rapid population growth in rural areas with deforestation. Fertility rates are high but in-migration is the main driver of the population growth, and both are partly driven by tenure insecurity (Carr 2004; Carr et al. 2006; 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 (Amacher et al. 1998; Barnes et al. 2002; Merry and Amacher 2008).

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

REDD could 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. Deforestation per person is lower for concentrated populations.[24] Dynamics vary globally but in most of Latin America, internal migration is the key 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 2004).

3.3.1.3. 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 in Asia and the Pacific. Both 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 1996; Hyde et al. 1996). Plantations could be an important source of timber from land previously both grazed and abandoned (FAO 2005). Malaysia is providing an incentive to establish forest plantations to relieve pressure on natural forests.

An issue raised by this idea is that public native forest and private plantations could compete with each other in land and output markets (this may depend on use of degraded lands). REDD could potentially be either supported or undermined by policies affecting returns on plantations (concerning impacts of timber prices, Amacher et al. [2008a] 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 strictly on forest growth, i.e., carbon uptake (not considering a penalty if forests are cleared for plantations), plantations can generate greater payments than natural or native (often over-mature) forests. 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 lower provision of global public goods in the long run.

Generally, renewable forest resources need not be exhausted. Resources can be managed (Amazonian forests see in Whitmore 1991; Vincent 1990; Veríssimo et al. 1992; Uhl et al. 1997; Boltz et al. 2001). In the past, there has been only limited uptake of the best management practices in the harvest of timber—let alone long-term sustainable forest management—due to factors including the lack of credit, uncertain land tenure, and competition from illegal logging (Applegate et al. 2004; Bacha 2003; Putz et al. 2000; Uhl et al. 1997; Veríssimo et al. 2002).

3.3.2. Looking Ahead

While REDD payments could bring the public benefits of forest to the attention of private landowners, they will not necessarily make forest ownership profitable 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 (2001a), 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 on property-rights insecurities, linked to the ability and willingness of budget-constrained governments to enforce right of ownership. Insecure tenure lowers REDD incentives as 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, details of REDD contracts, e.g., liability for outcomes of illegal incursions, will affect REDD.

In summary, the impacts of REDD payments upon land use, and ultimately on deforestation, clearly will depend on property risks as well as the effects of payments upon the returns that landowners receive from each of 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 as linked to concessions (see discussion of concessions in 3.3). Analysts have observed loss of forest rents due to corruption (e.g., Human Rights Watch 2009). Because the precise nature of corruption differs across countries and because the relationship between corruption and stability is also likely to vary (see, e.g., discussion in Ferreira and Vincent 2010), the best design of a carbon emissions programs within one country may not apply to any other country. This has implications for REDD that are often ignored (but were touched on by Karsenty 2008's recent review).

23 Most studies of property-values impacts on land-use choices in the Amazon use proxies due to data limitations. Several have assumed that property values can be represented by distance to markets and to other infrastructure (Alston et al. 1995; Mertens and Lambin 2000). Chomitz and Thomas (2003) use cattle stocking rates as a proxy for land value, arguing that higher-valued land is used more intensively. Specific determinants of transactions in Amazonian land markets that have been identified include soil quality (Moran et al. 2002), type of title (Vosti et al. 2001), extent of and access to road system (Fujisaka et al. 1996), and percent of land in pasture (Mertens et al. 2002). Ozorio and Campari (1995) note that small farms in the Amazon are not just agricultural production units but also key for home production and as residences for family who earn off-farm income.

24 While areas with high population densities generally have experienced more deforestation, this might be because other conditions like high agricultural yields encouraged both population growth and deforestation. Another possible dynamic is that deforestation can drive the changes in population, e.g., deforestation and development encourages immigration to a region. One would like to analyze the impacts of the shifts in population not due to deforestation or common causes such as yields. A third issue related to the empirical associations between population and deforestation arises with data from the Food and Agriculture Organization (FAO) of the United Nations. Historically, FAO has compiled statistics on forest cover that are reported by country governments, and when they were not available, FAO predicted forest cover with a model that included population.

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

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

In a corrupt setting, even with effort to restrict this, REDD payments could simply 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 promoting REDD. While it may seem compelling just to overlook corruption and expect that carbon payments will support increased forest despite all 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 documented in Africa, Asia, and Latin America, typically via bribery of government officials to overlook infractions including harvesting more than allowed (Contreras-Hermosilla [2002] offers a review that points to bribery and corruption where forests are sold throughout the world). Bribes have been singled out as part of forestry in tropical countries, confounding central governments' attempts to promulgate forest policy (see Palmer 2005 and Smith et al. 2003 for Asian cases, and Siebert and Elwert 2004 for cases in Africa). Officials accept bribes for allowing illegal timber trade in Tanzania and Cameroon, countries with large government forests, where the risk of detecting illegal logging is low and enforcement is 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, when there are high rents to government-owned resources, and when the probability of detection or punishment is low. For a government with sufficient financial resources, however, from this perspective it appears that corruption could be limited by employing a well-financed strong enforcement system.

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

Limited financial resources and distant resources makes these efforts difficult. Contreras-Hermosilla (2002) finds high corruption with underpaid government forest inspectors. This analysis also highlights complex regulations involving property rights, bureaucratic steps required in obtaining permits to use or establish productive forests, low penalties for illegal logging, and clearly the open-access nature of native forests.

Detection of bribery is not enough. Unless penalties are high, the incentives to cheat by inspectors and on the part of the illegal loggers will be high regardless of the inspector's base wage. This is because the harvester will always be made 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 only 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. 2005; Delacote 2008). Fair bidding processes could be a priority for REDD to succeed (Barbier et al. 2005's open economy model shows corrupting influence of forest exploitation lobbies).

For monitoring, Mishra (2004) suggests that the most important reform is to have multiple horizontal levels of government monitoring use of government resources, i.e., "overlapping jurisdictions" in Mishra's terms (noting implications for detection probabilities, optimal penalty levels, and the costs of monitoring as well). 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.

Yet different levels of government may have different objectives. Local officials may attach more value to wood from their jurisdictions. Thus one important design question is how carbon payments arrive to the localities. If higher levels of governments collect revenue, and this can be shared with the localities, then there may be ways of bringing the incentives of all governments in line for the generation of REDD.

3.4.2. Looking Ahead

Considering policy design, assuming officials can be bribed, Delacote (2008) finds corruption may induce larger concessions and less stringent use regulations. Amacher et al. (2008b) consider harvester behavior and a government concession design with corruption, comparing this to when officials cannot be bribed. 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 cause changes in bribes that undermine control. Concession design clearly should reflect such issues as real constraints.

Concession design involving environmentally sensitive harvesting regulations also should bear in mind the issue of bribery. Generally, moving forward with carbon concessions for REDD is sensible only with an understanding of the potential for corruption. Corruption usually reinforces bad aspects of designs and the revenue problems faced by governments tend to make these aspects worse. The ultimate successes of REDD within this area, in terms of deforestation, forest degradation, and local welfare, surely will be a function of the existing levels of corruption at all levels of government, as well as the government debt, and last but not least, both 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 asserts that opportunities to reduce carbon emissions are cheap and also abundant. Thus, if they generate carbon credits, those credits could "flood" cap-and-trade programs and reduce the incentive to invest in emissions reduction within rich countries. The other one asserts that reducing global deforestation is so daunting that significant reduction of this type is nearly impossible.

The first view is guided in part by the notion that the cost of stopping deforestation exactly equals the opportunity cost of the alternative land use (e.g., revenues generated by agriculture). In this view, these revenues may also be perceived often to be low (though they are not always so and can be very high) which suggests that conserving forests is relatively cheap. This view ties in with concerns that errors in negotiated emission baselines could yield many credits not backed by emission reductions. The second view appears to be guided by the failures of previous efforts to reduce deforestation and concerns that many countries still lack the governance capacity to effectively implement new such policy programs.

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

This realization could lead one towards 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 also 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 to significant land-use change. In addition, previous programs almost universally lacked self-evaluation mechanisms, which limited learning and thus modification. However as we have discussed above, many features of past policies could be drastically improved upon in the future.

4.2. Designing Policy for REDD Feasibility

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

Past failures suggest 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 many other details may be left to local actors better placed to significantly and sustainably shift relevant local processes. This avoids difficulty in monitoring and rewarding local process. Generally, consultation with those affected by these policies can aid in the development of effective and sustainable policy.

Such policies may not immediately come to pass, and even if the above describes future international regimes accurately, still domestic actors will have to decide how to try to lower GHG emissions in order to capture forest incentive payments. For these reasons, there is value in learning further from both the successes and the failures of the many previous types of forest intervention. Drawing from all the above, for instance: we can ask skeptically whether loan conditionality is likely to work without changed local practices; we can strongly encourage bringing the locally forest-dependent peoples into discussions; we can shift protected areas and ecopayments towards areas of higher forest threat and impact; and we can evaluate whether carbon-based payments may justify, in local development terms alone, shifts in roads or in 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 the 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
- international and domestic actors can re-examine whether actions work well in concert, e.g., policy influences on commodity demands vs. subsidies for agriculture or biofuels

In summary, it is possible to identify key 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.

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