

What incentivizes local forest conservation efforts? Evidence from Bolivia

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Abstract: Efforts to promote forest conservation have focused on two separate types of policy reforms. Decentralization reforms have attempted to make local forest governance more accountable to demands from voters. Meanwhile, Payment for Ecosystem Services (PES) schemes like the REDD program (Reducing Emissions from Deforestation and Forest Degradation) have sought to use economic incentives to promote conservation. These programs make different assumptions about the incentives most likely to work in forest conservation. Decentralization reforms assume that citizen pressures on politicians will encourage conservation, while PES approaches assume that an economic incentive – money – is the best approach. Which type of incentive works best in settings with weak institutions? Here, using a unique longitudinal dataset of forest policy in 100 Bolivian municipalities, we examine the relationships between citizen pressures and economic incentives on forest policy. We find that both types of incentives are positively and significantly associated with government investments in forest conservation, and that the magnitudes of these relationships

are similar. Further, we find that economic incentives may be especially effective at promoting conservation where citizen pressures are weak or absent.

Keywords: Bolivia, decentralization, forestry, institutions, local governments, public goods

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I. Introduction

In recent years, many scholars and policy makers have accepted the idea that forest conservation is part of a successful climate change strategy (UN-REDD Programme 2010, 2011; United Nations Food and Agriculture Organization et al. 2008). However, how best to effectively promote forest conservation is poorly understood (Andersson et al. 2014). At least two policy approaches have been tried in the last decades.

The first of these is the decentralization approach. Starting in the 1970s, many governments around the world began to decentralize authority for natural resource management to regional, local, and/or community governments (Andersson and Van Laerhoven 2007; Ribot et al. 2008; Kauneckis and Andersson 2009). One common justification was that local and regional governments are more accountable to voters than national governments (Guerrero Figueroa 2002, 2003; World Resources Institute 2005a; Ribot 2008). In the last two decade or so, however, it has become clear that most of these decentralization reforms have had mixed results (Gibson and Lehoucq 2003; Andersson and Van Laerhoven 2007). Even so, decentralization, and the promotion of conservation through democratic accountability remains an important part of many pro-conservation policies.

Recently, the PES (payments for ecosystem services) approach – the second of these policy approaches – has begun to garner substantial attention. The promise behind PES schemes is that people who control some ecosystem are paid to conserve that ecosystem, ostensibly in return for the services provided by the ecosystem. For example, owners of forested lands might be paid in return for the carbon sequestration their forests provide. By paying for ecosystem services, the theory goes, PES schemes incentivize the conservation of resources providing those services.

Since the 2009 Copenhagen summit's failure to reach an agreement on a successor treaty to the Kyoto Protocol, we are left without a comprehensive global agreement on carbon emissions and climate change. Instead, the only tangible global program working to address climate change is a PES program called REDD (Reducing Emissions from Deforestation and Forest Degradation). As the program develops, it is becoming clear that payments to local governments – economic incentives – are likely to play an important role in future REDD activities (United Nations Food and Agriculture Organization et al. 2008; Angelsen et al. 2009; Ha

and Thuy 2009; Cerbu et al. 2011). As such, it is important to know whether such economic incentives effectively motivate governments to invest in forest conservation.

Here, we test the relative efficacy of these two types of conservation incentives – democratic pressures and economic benefits. Using a unique longitudinal dataset on forestry policy and politics in 100 Bolivian municipalities, we examine the effects of democratic pressures and economic incentives on forest policy. Bolivia is an excellent setting in which to examine the causes of effective local natural resource governance, because Bolivia is a country that has, over the last 20 years, devolved real authority to local governments for forest governance. In addition, Bolivia is a good place to examine the effects of economic incentives on investments in municipal forest conservation because Bolivian municipal governments often generate income from local forestry sources and receive transfers from national governments to provide forestry services.

We have structured this paper in the following way: We begin by reviewing existing research on the causes of effective local forest governance. Second, we present an argument about the conditions under which local politicians will decide to invest in forest governance. We then turn to our empirical case and present a summary of the formal-legal situation in Bolivian forestry governance. After outlining our data and methods, we present our statistical findings and discuss our results in three short sections outlining the results of three sets of tests. We find that both democratic pressures and economic benefits are associated with more energetic forest conservation policy, and our findings also suggest that economic incentives most strongly motivate conservation where democratic pressures are absent. We conclude with a discussion about the policy implications of these results and topics for future research.

2. Political and economic incentives in forest governance

Since at least the 1980s, hundreds of national governments around the world have promoted some form of decentralization (Ribot 2008). Early scholarly work on decentralization was mostly theoretical, and argued that decentralization was either highly desirable, or highly undesirable. Treisman (2007) presents a good summary of these arguments (11–15), which suggest that decentralization is either an unalloyed good or deeply harmful. He also identifies the fact that “decentralization reforms” around the world are not homogenous and often look dramatically different¹.

Here, we are concerned with “political decentralization,” which we define, following Treisman (2007) as “assigning some decision-making authority to lower tiers,” and/or “assigning residents of lower-level jurisdictions some rights

¹ The setting for the empirical work presented in this paper is Bolivia, which, starting in the 1990s, carried out a meaningful set of reforms which granted substantial funding and policy autonomy to around 300 municipal governments. We describe details of the Bolivian decentralization reforms below.

to select lower-level officials.” Our empirics are carried out in Bolivia where, as discussed below, decentralization reforms have included both of these elements.

More recent work has found little empirical support for extreme claims about the benefits or costs of decentralization. The effects of decentralization, it seems, mostly depend on local context. For example, the effects of decentralization on common pool resource governance may depend on local enforcement of forestry rules (Gibson et al. 2005), local institutional performance (Andersson and Gibson 2006), property rights (Agrawal and Ostrom 2001), heterogeneity (Poteete and Ostrom 2004), and/or central government supervision (Andersson and Gibson 2006), among other factors. One key finding is that “downward accountability” is important for promoting conservation and sustainable management of common pool resources in decentralized settings (World Resources Institute 2005b; Ribot 2002, 2008, 2009). Only rarely, however, have scholars tested the effects of democratic pressures on conservation policy using large-n, quantitative data. Such is our intention here.

The idea that economic incentives can motivate governments to invest in conservation seems to be behind much of the activity now taking place under the aegis of the United Nation’s REDD program. Although still in its initial stages, REDD may be the only functioning, multilateral instrument for addressing climate change in the wake of the failure of the 2009 Copenhagen climate summit to reach a binding successor agreement to the Kyoto protocol. Although the program is relatively small compared to Kyoto, it is nothing to sneeze at. REDD has already raised over 4 billion dollars, and seeks to raise at least 100 billion by 2020 (United Nations Food and Agriculture Organization et al. 2008; Phelps et al. 2010).

REDD was originally conceptualized as one part of a giant PES (payments for ecosystem services) scheme, envisioned under the Kyoto protocol, which would work to slow climate change by paying developing countries to conserve forests that they might otherwise cut down (Andersson et al. 2008; Angelsen 2010). Initially, it was assumed that these payments would connect carbon-emitting firms in the developed world with those who control forest land in the developing world through some sort of global carbon market – in effect, a giant cap and trade system that would internalize the externalities of carbon sequestration (Wertz-Kanounnikoff and Kongphan-apirak 2009). However, the absence of clear individual forest property rights in many developing countries, the failure of the international community to adopt a global carbon market system, the explicit rejection of market mechanisms by some national governments, including Bolivia, and the existence of many non-market-based, shovel-ready forest conservation projects has meant that REDD projects so far have been more likely to involve grants to community organizations, governments or NGOs, than to consist of payments for sequestered carbon (Angelsen et al. 2009; Cronkleton and Peredo-Vida 2009; Programa Indígena REDD Amazonia Bolivia; Hardcastle et al. 2011). The REDD program is complex and multifaceted, but Cerbu et al. (2011) present a good overview of the various components of the initiative, which we lack the space to describe here.

It is important to know, whether the potential for economic gain by governments – including local governments – can, in fact, motivate municipal politicians to

invest scarce resources in forest conservation, even where electoral pressures for conservation are weak. In the next section, we elaborate a theory which implies the (intuitive but largely untested) hypothesis that greater forestry income will be associated with greater investments in forestry policy.

Beyond the relationships between economic and political incentives (on the one hand) and forest conservation efforts (on the other hand), we also test two additional ideas which may be important for the way REDD and other PES schemes are carried out.

First, where citizens demand forestry services, economic incentives may be unnecessary to promote conservation. But where citizen demands for conservation are weak or absent, the potential for economic gain may allow governments to turn forest conservation into revenues that can be used to provide other services which make governments more popular with constituents. Thus, we test the hypothesis that financial incentives will have a greater marginal effect on investments in forest conservation where democratic pressures for conservation are weak.

Finally, we unpack “economic incentives” to determine whether funding transfers from central governments for forestry services (which are probably similar to the type of incentives for local governments which will emerge under REDD) function differently than locally-generated revenues. Contra advocates for REDD and other PES approaches, we initially hypothesized that locally-generated revenues will more effectively promote investments in forest conservation than funding transfers from above. We believed that funding transfers will be plagued with principal-agent problems (such as corruption) and all the problems of accountability in settings with weak institutions. We suspected that local fees and fines would be less susceptible to these problems and would therefore more effectively promote investments in forest conservation. What we found was quite different – both transfers and locally generated revenues are positively associated with government investments in forestry, and these relationships are similar in magnitude. We discuss these results in much greater detail below. Our findings are good news for proponents of REDD, which will likely involve significant funding transfers from national to local governments.

3. Theory

Conservation is costly, requiring investments in time and money. For example, forest guards must be paid and equipped, and new trees must be seeded, nursed, and planted, at a cost of time and money².

² We are aware that there is debate over the definition of “conservation” and the ethics of different conservation approaches, including protected areas and community conservation (Berkes 2007; Nagendra 2007; Andam et al. 2008, 2010). With very few exceptions, however, strategies for forest conservation require effective support from a number of sources, including governments (Berkes 2007). Our concern here is how to motivate local governments to invest in forest conservation defined broadly. In Bolivia, this typically includes policing and regulatory enforcement, technical assistance and support for community-based forestry efforts, and a range of other types of activities. Thus, our analysis applies to a range of conservation approaches, including community-based forestry, agroforestry, protected areas, and traditional forest management for sustainable timber harvest.

At the same time, conservation produces benefits which are felt locally, but also at larger scales. For example, forests in Bolivia may provide locals with the benefits of timber for firewood, non-timber forest products like thatch, food and medicinal plants, and wild game for food. Forests may also provide the benefits of clean surface water (both a local and regional benefit). And forests provide global benefits in the form of carbon sequestration, making forest conservation a global public good.

Scholars and policy makers have long argued that decentralization is a good way to maximize the benefits of forest conservation because (among other reasons) local governments are closer to their constituents and are more accountable to electoral pressures (Treisman 2007). Therefore, the argument goes, democratic pressures from voters are likely to make conservation more successful in decentralized regimes (World Resources Institute 2005b).

However, we argue that many of the benefits of forest conservation are felt outside of the local area, and therefore, decentralization may actually exacerbate problems with deforestation. This is because the (often) relatively small local benefits of forest conservation are outweighed by conservation's costs. This is especially true in settings where forest conservation competes with other land uses that provide substantial economic benefits but encourage deforestation, such as cattle ranching or agriculture. If forestry competes with agriculture, and agriculture provides more local benefits than forestry, local voters will be less likely to support sustainable forestry activities, and therefore, decentralization reforms may tend to encourage deforestation and forest degradation.

Where voter pressures are insufficient to encourage municipal investment in conservation, however, it may be that other types of benefits can encourage municipal governments to invest in forest conservation. We argue that the opportunity to generate municipal government revenue will, at the margins, make conservation relatively more beneficial. The potential to generate even relatively small revenues from forestry may, then, lead to greater conservation, lower rates of deforestation, and improve forest condition. In decentralized, developed settings like Bolivia, politicians may use revenues from forest conservation to promote other, more politically important projects. On the other hand, economic benefits for forestry conservation may serve only to line politicians' pockets in non-democratic or transitioning settings, though it is still possible that, even in corrupt or authoritarian settings, the potential for economic gain may motivate politicians to promote forest conservation.

4. A short case study

One case which demonstrates in real terms the way economic benefits may promote conservation is the municipality of Buena Vista, outside of the city of Santa Cruz and near Amboró national park, where mayors and municipal officials are uninterested in forest conservation for its own sake, but are motivated to

conserve because of economic benefits which can be used to satisfy other material and political needs.

In the mid-2000s, Buena Vista recognized that it could use forestry practices as a source of income which would subsidize other important municipal policies. In 2009, municipal government officials described to us how they had sought out the aid of conservation NGOs (non-governmental organizations) in the city of Santa Cruz, and with the help of these NGOs, developed a reforestation program paid for by tourists. Under this scheme, tourists staying in the municipality (generally passing through to see the national park) would pay a bed tax of \$10 (US) per person, per night. This fee would ostensibly be used to reforest some deforested area, each \$10 fee supposedly paying for one planted tree. However, the planting of trees in Bolivia costs much <\$10 each, and the remainder of the fee was used to subsidize other, politically more beneficial, services. Ultimately, the program led to a sustained reforestation effort, and it may not be coincidental that during the same period, annual rates of deforestation in the municipality dropped by about 50%. In some ways, Buena Vista's program appears typical – using forestry-related activities to generate municipal income, while using that income to subsidize other types of activities.

Other programs have similar characteristics, though it is also very common for municipal governments to simply charge fines for local violations of forestry rules, or to charge users fees to access forests or extract timber or non-timber forest products, then to use this income to subsidize other activities.

5. Municipal forest governance in Bolivia

Like most other Latin American countries, Bolivia was long organized as a *de facto* unitary state. This changed in the mid-1990s, when the Congress of Bolivia passed the 1994 *Ley Participación Popular* – essentially a package of decentralization reforms which granted substantial policy authority and 20% of national tax revenues to around 300 elected municipal governments (Andersson 2003; Pacheco 2006) around 190 of which were created by the reforms (Faguet 2004), though denying them the power to generate much revenue from local taxation. The newly-empowered municipalities are varied, but, based on our sample, are quite large on average (a mean area of around 5000 square km.), and relatively large in population, with an average of around 18,000 residents. Bolivian municipalities also tend to be quite poor, with low human development indices.

Decentralization in the forestry sector has been less dramatic, but the 1996 *Ley Forestal 1700* was designed to encourage sustainability in the forestry sector by lengthening the tenure of government leases to forestry firms for timber exploitation, making these leases renewable, and improving the security of tenure for the forest-dependent poor by creating new jurisdictions for the communal management of local forest resources, which are empowered to adopt and enforce plans for forest management at the community level, with technical help from

municipal governments (Contreras-Hermosilla and Vargas Ríos 2002; Pacheco 2006). In forestry, then, there are three meaningful levels of government in Bolivia – communities and indigenous groups; municipalities; and the national government. Bolivia also has a fourth level of government – the province – which plays little role in forest governance. Today, municipalities are required to monitor forestry leases and enforce national forestry rules and regulations within their boundaries (Andersson 2003; Andersson et al. 2006), although capacity is often lacking and municipal governments sometimes view these tasks as unimportant.

Fiscal decentralization in Bolivia has primarily taken the form of transfers of funding from the central government to municipal governments. In general, funds are not linked to the implementation of any particular policies (Contreras-Hermosilla and Vargas Ríos 2002; de Jong et al. 2004; Pacheco 2006). Transfers from forestry sources are provided annually to municipalities based on the size of the municipal territory currently under management as forestry leases. These funds are not linked to municipal policy in any way, except that over the very long term, as (20 year) forestry concessions expire, if they have been abused by concessionaires, concession size may decrease and thereby decrease municipal forestry revenue (Contreras-Hermosilla and Vargas Ríos 2002; de Jong et al. 2004; Oemer 2004). No other forestry-related income is allowed under law (Pacheco 2003).

However, many municipalities charge fees and fines for forestry-related services and enforcement – our survey data suggests that self-generated income in forestry represents a significant source of government revenue in many municipalities – as seen in Figure 1, a substantial number of municipalities receive local income from quasi-legal forest governance practices. Even though local fees and fines for forestry are not explicitly permitted under Bolivian law, many municipal governments seem to be gathering forestry fees and fines anyways, both as a way to generate revenue and as a regulatory tool.

Going forward, potentially the most important change in Bolivian forest conservation may be the implementation of projects associated with the agreement on the United Nations Framework Convention on Climate Change (UNFCCC) on Reducing Emissions from Deforestation and Forest Degradation (hereafter referred to as REDD). REDD initiatives connect donor governments in the developed world with developing countries who receive financial support for projects and programs that ostensibly reduce deforestation and forest degradation, thereby reducing greenhouse gas emissions (Phelps et al. 2010). REDD is an outgrowth of a minor component of the broader cap and trade system envisaged under the Kyoto Protocol (Cerbu et al. 2011).

REDD is complex, and there is not sufficient space to explicate the agreement and associated projects here, but it should be noted that Bolivia has held a complicated and sometimes contradictory position on REDD programs over the last decade or so, initially supporting REDD-like programs, then opposing market-based mechanisms for controlling deforestation such as REDD, and now accepting funds under the aegis of REDD to carry out non-market based programs

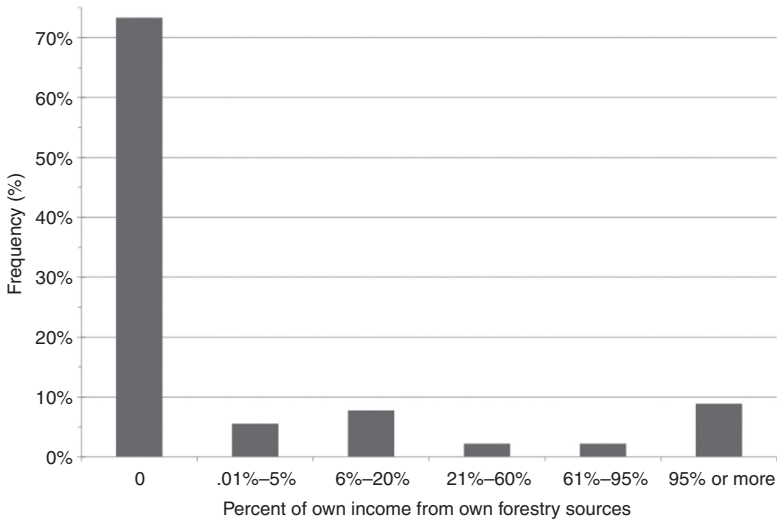


Figure 1: A substantial percentage of our sample (more than 15%) gather more than a sixth of locally-collected funds from forestry-related sources. According to estimates from our surveys with local government personnel in the 100 municipalities, more than 10% of all municipalities get more than 90% of their total incomes in the forestry sector from their own collection of local fees and taxes.

(Müller et al. 2014). Although Bolivia’s vocal opposition to the commodification of carbon emissions under REDD may be unique, Bolivia’s participation on the ground in REDD programs is similar to many other countries, where payments for ecosystem services such as carbon sequestration take a back seat to “readiness” activities such as capacity-building and non-market based conservation approaches (Wertz-Kanounnikoff and Kongphan-apirak 2009; Cerbu et al. 2011). As such, our investigation of the effects of different types of incentives for forest conservation in Bolivia, including democratic pressures and financial incentives, may be especially relevant to REDD activities in Bolivia and elsewhere. In short, given that payments for ecosystem services are likely to be only one part of REDD, will other strategies effectively motivate governments to promote forest conservation?

6. Data and methods

Most of our data are drawn from a unique, time-series cross-sectional survey dataset gathered from key-informant interviews with mayors, municipal forestry officials, and community leaders in 100 randomly selected municipalities in Bolivia during 2001 and 2007–2008. During the first wave, interviews were

conducted with mayors. Because greater funding was available for the second wave, 2007–2008 surveys were conducted also with forestry officials – the heads of “Municipal Forestry Units or UFM (for their acronym in Spanish) – and the heads of elected “*Comités de Vigilancia*” (oversight committees), with some questions duplicated in 2007–2008 across multiple respondents in order to confirm data with multiple sources, and with other questions answered by only one respondent in each municipality. Both survey waves included about 260 qualitative and quantitative questions on forest governance and municipal politics and policy. In general, survey questions were identical across the two survey waves. Descriptive statistics and sources of most variables used in our statistical analysis are presented here in Table 1. In cases where multiple sources of data were available for a single variable, we have used all available data sources to establish a single value for that variable, as described in Table 1 and below. A few variables require deeper explanation below.

6.1. Incentives

Our independent variables of interest are all five-point responses to survey questions about pressures municipal politicians face. Our “central government supervision” variable is a five-point question which asks, “How frequently were central government officials sent to the municipality to oversee or supervise municipal forestry activities?” Responses range from “never” to “very

Table 1: Variables.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.	Source(s)
Total employees in forestry	218	1.22	1.63	0	10	'01 and '08 mayor surveys, '08 UFM (Municipal Forestry Unit)
Municipal budget in forestry (pct.)	218	2.62	4.71	0	40	'01 mayor, '08 mayor and '08 UFM survey
Relative importance of forestry	212	-0.80	1.08	-3	1.5	'01 and '08 mayor surveys
Importance of forestry as a revenue source	210	2.18	1.37	0	5	'01 mayor and '08 UFM surveys
Central government supervision	244	2.27	1.20	1	5	'01 and '08 mayor surveys
Frequency of community organization demands on forestry	244	2.45	1.10	1	5	'01 and '08 mayor surveys, '08 UFM survey, '08 CV (Oversight Committee) survey
Mayor's education	217	12.90	4.22	1	18	'01 and '08 mayor surveys
“Officialist” party	240	0.43	0.49	0	1	'01 and '08 mayor surveys
Forest cover (pct.)	244	55.82	41.43	0	100	Remote sensing data, '01 and '08
HDI (Human development Index)	242	0.57	0.08	0.347	0.759	2007 Bolivian government statistics
Municipal budget (millions of Bolivianos)	218	20.38	99.59	0	1293.40	2001 and 2007 Bolivian government statistics

frequently.” The “importance of forestry as a revenue source” is taken from the same surveys. This survey question asks how important forestry is as a source of revenue compared to other sources (much less important; less important; about the same; more important; much more important), and “frequency of community organization demands on forestry” asks how frequently community organizations provided opinions regarding forestry, compared to other policy areas, with similar responses (much less frequently, less frequently, about the same, more frequently, much more frequently). These variables represent three different types of pressures on municipal politicians to provide forestry services. These are, pressures from the central government (in the form of direct supervision), pressures from voters (in the form of community demands), and pressures to generate income (in terms of the income generated from forestry activities). Our interest here is in the last of these two variables. Likert scale variables such as these have been used extensively in the past to measure subjective and objective variables at the municipal level (Gibson et al. 2005; Andersson et al. 2006; Andersson and Van Laerhoven 2007; Andersson 2012), so we believe they are appropriate here.

Our first dependent variable, the “relative importance of forestry policy” is constructed from several survey questions. Mayors were asked to report the importance of forestry sector policy, and several other municipal government activities including education, security, roads, and health services. The importance of each policy area was recorded on a five point scale, ranging from “much less important” to “much more important” than other policy areas. Mayors were unwilling to report policy areas as “less important” or “much less important” than other areas, so the variable was left-skewed. To normalize the variable, we calculated the mean importance of each non-forestry policy in each municipality, and subtracted this value from the value of the importance of forestry, to create a normally-distributed variable with over 100 unique values. Higher values indicate that forestry is a higher priority relative to other areas of public goods and services. This variable is a strong proxy for municipal governments’ general willingness to invest in forest conservation.

The other dependent variables we use here are the “municipal budget in forestry,” the percent of the municipal budget dedicated to forestry activities, and “employees in forestry,” the total number of municipal employees engaged in forestry activities. These dependent variables were all constructed using our two waves of municipal survey data from 2001 and 2008 and are strong measures of municipal governments’ investments in forest conservation – investments in money, and investments in personnel.

“Officialist party” is a measure of the political party of the mayor. It is coded 1 if the party of the mayor is the party of the president at the same time. We also tested our models with several alternate party codings, with no substantive differences than those reported here.

The models we present here also include municipal-level human development index figures generated by the Bolivian central government as controls for level of economic development.

To test our second hypothesis, we create an interaction term in which we multiply “community organization demands” by “the importance of forestry as a revenue source.” We include this variable in a regression model to examine whether economic incentives are likely to have a stronger effect where pressures from below for conservation are lacking.

6.2. Types of financial incentives

In order to test the effects of different types of financial incentives, we use two additional independent variables in a second set of statistical models.

Specifically, many municipalities generate their own revenue in the forestry sector – by charging for permits, fines, and services – and that it is this possibility of revenue generation that gives forestry its primary importance (even though the legality of such actions is not clear under Bolivian law). We test this explanation by investigating whether the quantity of the municipalities’ own forest-related income is correlated with forestry-related investment decisions, and, conversely, whether the quantity of the central government transfers for forestry affect those same outcomes.

For these tests, we use “percent of forestry income from transfers,” which is the percentage of forestry funding the municipality receives through central government transfers, and the “percent of forestry income from own sources” – which is the sum of forestry income received for local permits, fines, fees for services, and an “other” category, which typically includes payments for the sale of forestry-related goods (saplings, or seed, for example).

6.3. Estimation techniques

We use poisson regression with standard errors adjusted for extradispersion with dependent variables “employees in forestry” and “budget in forestry”. Poisson regression is a generalized linear approach that is appropriate for dependent variables that are counts or are count-like, such as proportions or rates, that have a lower bound at 0, a long right tail, and inherent discreteness between values (Hoffman 2004; Rabe-Hesketh and Skrondal 2008)³. We tested all of the models we show here with deviance-adjusted standard errors (shown), chi-squared adjusted extradispersed poisson and negative binomial regressions with substantively identical results.

Because the data is cross-sectional, time-series data, we use a population-averaged Generalized Estimating Equation (GEE) time-series approach. (Liang and Zeger 1986; Zeger and Liang 1986; Zeger et al. 1988; Duncan et al. 1995; Horton and Lipsitz 1999). All the models here were tested in regressions which

³ Often, analysts transform poisson-like distributions to get a normal distribution, but we found that such log-linear models excluded large numbers of meaningful cases where the dependent variables were 0.

assume a range of different within-unit correlation matrices, with no substantive differences in our results.

Besides the results we report here, we also conducted a number of robustness checks on our statistical results. These included (a) re-testing our models after removing observations with high deviance residuals and high leverage cases, (b) including a much fuller set of controls, including a range of mayoral characteristics such as gender, ethnicity, and years in office, indigenous population, human development index (HDI) and HDI squared terms, total municipal size (natural logarithm, square kilometers), total forest size (natural logarithm, square kilometers), total number of municipal employees, (c) including and excluding these and the institutional controls in a series of sensitivity tests, (d) re-testing models with alternate working correlation matrices, and (e) re-testing models with a dummy variable for “wave” to address concerns about unobserved heterogeneity between survey waves. Using these tests, we were never able to change the direction or significance of our independent variables of interest. We also generated similar results where, rather than total employees engaged in forestry, we used a percentage of total municipal employees engaged in forestry as the dependent variable.

To test the hypothesis that financial incentives may be more important where citizen pressures are weak, we used an interaction term (as described above). As methodologists suggest that regression tables are not helpful in determining the joint significance of interaction results (Brambor et al. 2006), we use a set of graphics to visualize our results.

We recognize that quantitative techniques such as those used here have advantages and disadvantages, and only allow us, under ideal conditions, to approximate the relationships between variables. However, these estimation techniques may be helpful for exploring causal relationships and may, in turn, provide useful information to policy makers and scholars.

7. Incentives and investments in conservation

Our first set of results show that economic incentives – the financial importance of forestry to the municipality – are significantly and positively correlated with mayors’ assessments of the relative importance of forestry, the percent of municipal budgets in forestry, and the total number of municipal employees engaged in forestry. Political incentives – community demands for forestry – are also significantly associated with forestry-related outcomes.

The regression models we show in Table 2 summarize these findings. “Importance of forestry as a revenue source” is a highly significant predictor of the mayor’s rating of the importance of forest policy (compared to other policy areas), the number of employees allocated to the forestry sector, and the amount of money allocated to forestry in the municipal budget. These results also support the idea that democratic pressures can be an important source of motivation for forest conservation; “community organization pressure” is also significantly and

Table 2: Incentives for Forest Conservation.

Estimation technique	GEE: linear model (OLS)	GEE: Deviance-adjusted extradispersed Poisson	
Dependent variable	Importance of forest policy	Forestry budget (pct. of total budget)	Forestry employees
Importance of forestry as a source of revenue	0.292 (0.00)***	0.181 (0.01)*	0.255 (0.00)***
Frequency of central government supervision	0.173 (0.00)**	0.102 (0.20)	0.036 (0.60)
Frequency of community demands	0.174 (0.01)*	0.365 (0.00)***	0.159 (0.04)*
Mayor's level of education	-0.025 (0.20)	-0.016 (0.52)	-0.033 (0.13)
'Officialist' party	-0.024 (0.87)	0.058 (0.75)	0.304 (0.05)+
Human Development Index (HDI)	-0.898 (0.36)	-1.001 (0.47)	5.625 (0.00)***
Forest cover (pct. of municipal area)	0 (0.84)	0.007 (0.03)*	-0.002 (0.54)
Forest area (ln square km.)	0.013 (0.79)	0.021 (0.76)	0.027 (0.60)
Municipal budget size (millions of)	0 (0.47)	0 (0.81)	-0.001 (0.37)
Constant	-1.627 (0.01)**	-0.685 (0.45)	-4.176 (0.00)***
Observations	178	180	180
Municipalities	104	104	104
Wald chi-square	64.15	43.17	65.79
Tolerance	7.63 e-7	2.33 e-7	2.909 e-7
Scale parameter		3.99	1.25

p-Values in parentheses. +significant at 10%; *significant at 5%; **significant at 1%; ***significant at 0.1%.

positively associated with these dependent variables. Other variables, such as “central government supervision” and “mayor’s education” are also significant, but only in one out of the three models.

Substantively, a change in our independent variable of interest – the importance of forestry as a revenue source – produces a notable change our dependent variables, as is visible in Figure 2. As shown in Figure 2, if the importance of forestry as a revenue source is varied from “unimportant” to “much more important than other sources”, the relative importance of forestry as a political priority increases substantially. As the importance of forestry as a revenue source increases through its range of values, the predicted percentage of the municipal budget dedicated to forestry also increases, from below 0.25% to over 1.25%. Though these percentages are small, this is a fourfold increase in the percentage dedicated to this policy area.

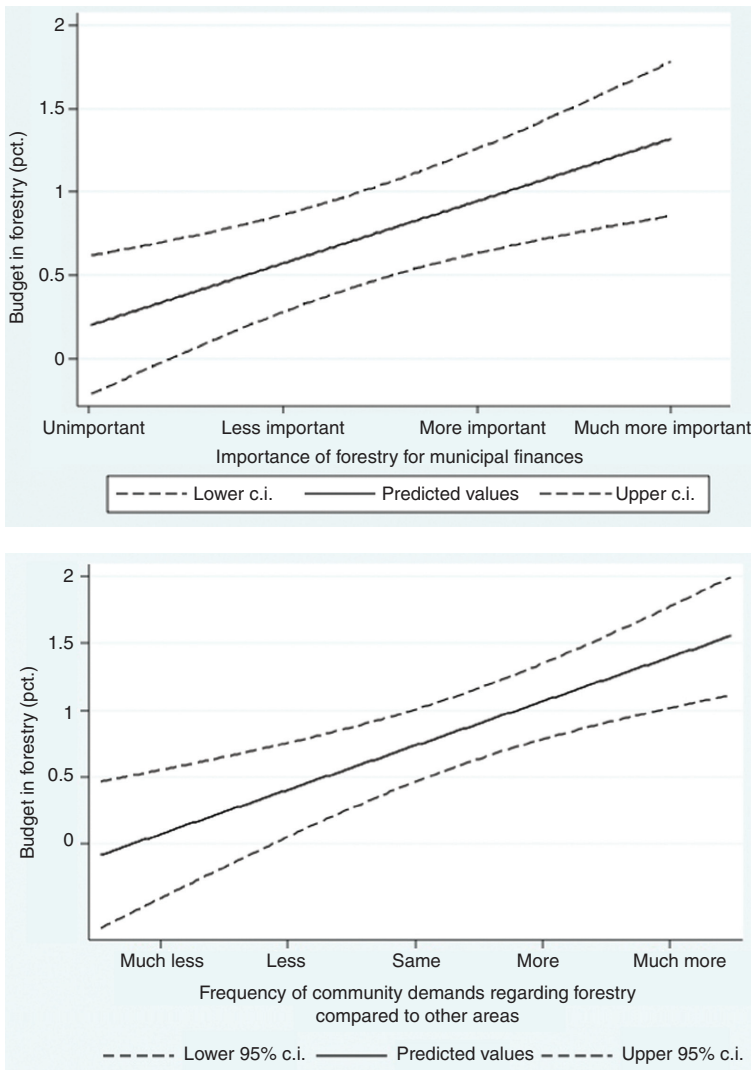


Figure 2: As the importance of forestry as a source of revenue increases, municipalities commit more resources to forestry. Likewise, as the frequency of community organization demands for forestry services increase, spending in forestry increases. This chart was made with all control variables set at their means, except for party, which was set at 1.

We also found a strong relationship between the frequency of community organization demands for forestry service and forestry expenditures, also visible in Figure 2.

Unsurprisingly, our quantitative analysis generates evidence that the municipalities which viewed forestry as more important, and also committed

more resources to forestry-related activities, are those with both strong economic and political incentives for forestry policy. An increase from very low to very high political and economic incentives results in large increases in predicted investment in forestry. Municipalities with very low financial and political incentives for forestry (both set at 1) will spend about 1% of their budgets on forestry (95% confidence intervals at 0.66–1.58%). Municipalities with very high political and economic incentives (both set at 5) will spend about 8 percent of their budgets on forestry (95% confidence intervals from 4.94 to 13.02%). Though these percentages are small, this is an 800% increase, which could have strong impacts on forest conservation.

8. Complements or substitutes?

We were interested to see if constituent pressures and financial incentives for forestry-related services are complements or substitutes – whether financial incentives are more important where community pressures are absent. Therefore, we created an interaction term – “the financial importance of forestry” multiplied by “community organization pressures for forestry” – and tested it in models with each of our dependent variables. This interaction was only significant in models using one of our dependent variables, but these results suggest that financial incentives for forest conservation have a stronger effect where community organization pressures are not strong.

Figure 3 shows the varying effect of community organization demands for forestry services on the percentage of municipal employees engaged in forestry activities where the financial importance of forestry activities are much more important, and much less important than other areas, respectively. The two graphics in figure three show (first) predicted values and (second) the marginal effects of financial incentives across levels of community organization demands. What the first graphic shows is that, where forestry conservation services are very important to citizens (grey lines), the relationship between community organization demands for forestry services and the percentage of municipal employees assigned to forestry tasks is insignificant. However, where financial incentives are weak, community organization demands have a strong and significant positive effect on this dependent variable. The second graphic, showing marginal effects of strong financial incentives, shows the same data in a slightly different way. These results suggest that financial incentives may have a more substantial effect on governments’ willingness to invest in forest conservation where pressures from below for forest conservation are not strong.

9. Local sources of income vs. transfers

As seen in Table 3, our findings suggest that both transfers and locally generated revenues incentivize investments in forest conservation. In the three models we show here, two models show a significant and positive correlation between “central government transfers” and forestry outcomes – number of municipal employees in forestry and the percent of the municipal budget in forestry – and

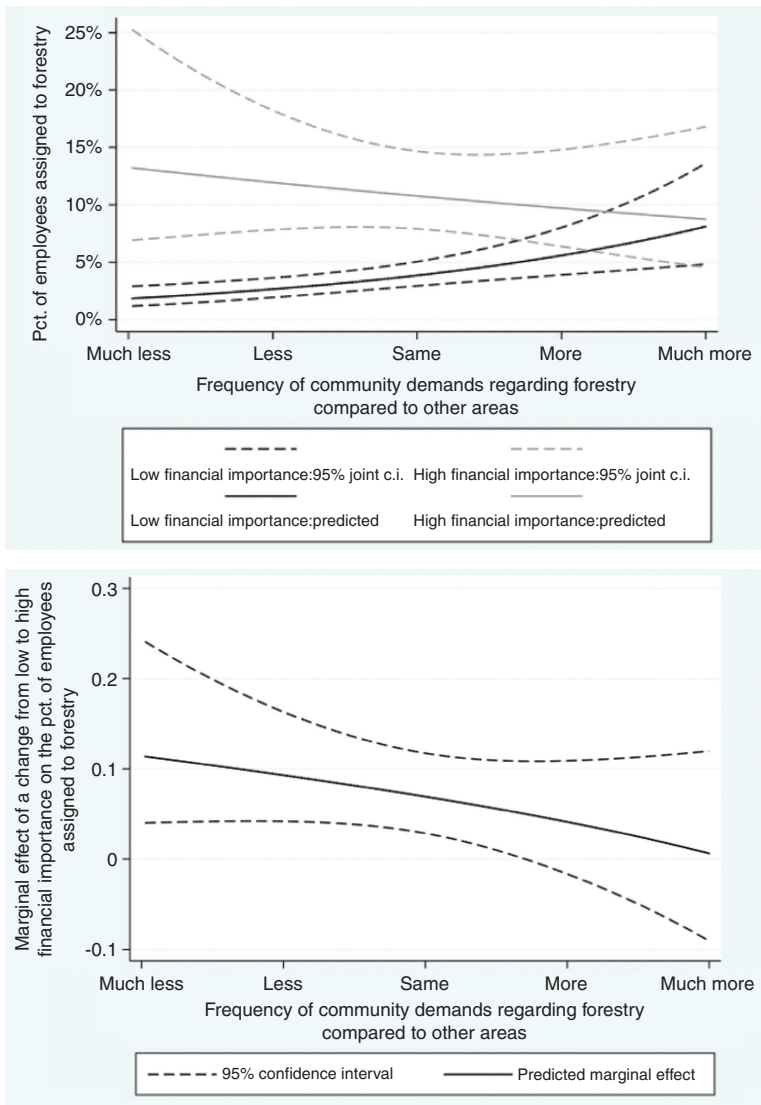


Figure 3: Our statistical models provide some evidence that financial incentives have a greater impact on forest conservation investment when pressures from below are not strong. Here, the effect of financial incentives on the percentage of municipal employees assigned to forestry is significant where community organization pressures are low, but not when they are high. The top graph shows predicted values and the bottom graph shows marginal effects of a shift from forestry activities being “much less important” than other areas to “much more important.” These graphs were made with all control variables set at their means, except for party, which was set at 1.

three models show significant and positive correlations between “own forestry income” and investments in forest conservation.

This third set of models also shows that forestry transfers are significantly related to investments in conservation. This suggests that mayors and other officials dedicate resources to forestry not only to increase their short-term income, but to protect long-term income from forestry activities. Substantively, the relationship between forestry transfers from the central government and our dependent variables are similar in scale to the effects of “own forestry income”.

10. Discussion

Although the REDD approach emerged based on a simple theoretical logic that payments can motivate individuals in developing countries to conserve forests

Table 3: Types of Financial Incentives.

Estimation technique	GEE: linear model (OLS)	GEE: extradispersed Poisson	
Dependent variable	Importance of forest policy	Forestry budget (pct. of total budget)	Forestry employees
Forestry income: own income	0.004 (0.21)	0.009 (0.01)*	0.008 (0.01)**
Forestry income: central government transfers	0.008 (0.00)**	0.008 (0.08)+	0.006 (0.04)*
Frequency of central government supervision	0.19 (0.04)*	0.169 (0.13)	0.039 (0.64)
Frequency of community demands	0.266 (0.03)*	0.422 (0.00)**	0.381 (0.00)**
Mayor’s level of education	-0.016 (0.53)	-0.013 (0.70)	-0.05 (0.05)+
‘Officialist’ party	-0.217 (0.39)	0.257 (0.41)	0.357 (0.16)
Human Development Index (HDI)	-2.632 (0.10)+	-2.253 (0.28)	5.433 (0.00)**
Forest cover (pct. of municipal area)	-0.002 (0.60)	0.003 (0.60)	0.002 (0.63)
Forest area (ln square km.)	-0.001 (0.99)	0.01 (0.93)	0.24 (0.01)*
Municipal budget size (millions of)	0 (0.32)	0 (0.83)	0 (0.72)
Constant	-0.308 (0.83)	0.141 (0.94)	-7.313 (0.00)**
Observations	94	94	94
log pseudolikelihood/ deviance	-132.01	498.54	86.33
AIC	3.04		
BIC	-285.8	121.44	-290.72
Scale parameter	1.09	1	1

Robust p-Values in parentheses. +significant at 10%; *significant at 5%; **significant at 1%.

(Angelsen et al. 2009), the reality of REDD may be substantially different from the PES ideal, raising real questions about its efficacy (Cerbu et al. 2011). Will governments be motivated by payments in the same way as individuals, especially in institutionally weak settings like those around the developing world? Further, how compatible is the REDD approach with local democracy and decentralization, which may be threatened by the REDD approach (Phelps et al. 2010)?

In general, our results are good news for REDD as it is likely to be carried out on the ground. Our statistical findings suggest that economic incentives tend to motivate local governments in much the same way that they motivate individuals. Our results also imply that demands from citizens tend to motivate local governments to promote sustainable forest governance. Finally, our statistical models lead us to believe that economic incentives are a useful complement to democratic pressures for forest governance, in that economic benefits appear to motivate governments most where democratic pressures are weak.

Outside of discussions on REDD, our results also argue strongly for the devolution of complete regulatory authority – including the ability to fine and charge fees – in settings where forestry is decentralized to sub-national governments, consistent with calls from decentralization scholars (Ribot et al. 2006).

In regression models like those used here, spuriousness and omitted variable bias are often concerns. Specifically, it is possible that some third factor promotes both municipal revenues from forestry and investments in forest conservation. However, we have controlled for most possible confounding variables, including forest size (as a percentage of municipal territory, and, in a separate set of models, total municipal size and total forest size), municipal politicians' levels of education, human development, and total budget size. Controlling for the size of local forests should adequately address the concern that these results reflect the fact that forest governance and government forestry services will be greater where forest incomes are higher only because forests in those settings are larger and more lucrative, and other controls should adequately address most other concerns about spuriousness.

A second common issue in multivariate regression is potential reverse causality. Specifically, where policies for conservation are pursued more energetically, they are likely to generate revenues for municipalities. Such a causal chain might be possible, but reverse causality in our second set of statistical models – the models presented in Table 3 – is highly unlikely. These models show the relationship between locally-generated revenues and investments on one hand, and central government transfers for forestry and investments in forestry on the other hand. Forestry transfers from central governments are exogenous, because the quantity of such transfers is a result of decisions made by central governments. Specifically, these transfers are determined by how much forest is leased to concessionaires in a given municipality. Local governments have no part in these decisions. And yet, these transfers as associated with greater investments in forestry. The fact that these relationships are positive

and significant strongly suggests that exogenous changes in forestry income have an effect on local governments' willingness to invest in forest conservation activities, even if some reverse causality is present.

II. Conclusion

Here, we are interested in the links between sustainable forest governance, on the one hand, and economic and political incentives, on the other hand. We attempt to determine whether economic benefits motivate governments to promote forest conservation, and whether economic benefits complement political/democratic incentives.

Our statistical results suggest several conclusions. First, pressures from voters seem to be an important motivator of forestry policy. This provides further and quantitative support for earlier assertions by many decentralization scholars (Agrawal and Ribot 1999; Andersson et al. 2006; Chhatre 2008). Second, economic benefits for municipal governments – the raising of funds from forestry sources – seem to have a similar effect. And third, we find that economic incentives appear to be more effective where electoral pressures for investments in conservation are not already present, suggesting that economic pressures may be an effective substitute for electoral pressures where those electoral pressures are missing. Finally, we find that both locally-generated revenues and transfers from higher levels of government effectively incentivize investments in forestry. This last point is important because payments to municipal payments under REDD are likely to appear very similar to the forestry transfers that Bolivian municipalities already receive from their central government.

We argue, therefore, that strong conservation policy will be more likely where reforms create a range of incentives to invest in conservation. Citizen pressure often may drive conservation, but encouraging municipalities to generate their own revenues from forestry sources and more closely linking forest outcomes to funding transfers may also result in reduced deforestation. Likewise, REDD-like payments for forest conservation may play an important role in motivating municipal governments to provide the global public good of carbon sequestration.

Our results are also consistent with earlier research (Gibson and Lehoucq 2003; Andersson and Gibson 2006; Andersson and Van Laerhoven 2007; Andersson et al. 2014) which suggests that pressures from below can have important, desirable impacts on municipal governments' willingness to invest in conservation.

In general, therefore, these results may be taken to mean that, at the level of the national political system, decentralization reforms which incentivize municipal politicians to promote conservation using a variety of mechanisms may be more successful than those which rely on, for example, electoral incentives alone. If the goal is to increase local governments' investments in global public goods, creating opportunities for economic benefits may reinforce electoral incentives.

In particular, creating opportunities for local authorities to generate government revenue from conservation policy – or any other policy – can have an unexpectedly large effect on local government policy. So, for example, explicitly legalizing the taking of fees and charging of fines for forestry activity might have a great and desirable impact on local governments' willingness to invest in forest conservation in Bolivia. Likewise, similar policy reforms could have substantial effects elsewhere around the globe or in other policy areas.

This may be good news for advocates of REDD and other PES schemes that seek to promote conservation by transferring funds from wealthy carbon emitters to poor states with large zones of carbon-sequestering forest. It is clear that REDD will predominantly operate through government to government transfers (Quintero et al. 2009; Wertz-Kanounnikoff and Kongphan-apirak 2009). Our results here suggest that economic benefits may incentivize governments to invest in conservation, which may be very good news in an era of otherwise failing global climate change policy.

Literature cited

- Agrawal, A. and J. Ribot. 1999. Accountability in Decentralization: a Framework with South Asian and West African Cases. *The Journal of Developing Areas* 33(4):473–502.
- Agrawal, A. and E. Ostrom. 2001. Collective Action, Property Rights, and Decentralization in Resource Use in India and Nepal. *Politics & Society* 29(4):485–514. doi:10.1177/0032329201029004002.
- Andam, K. S., P. J. Ferraro, A. Pfaff, G. A. Sanchez-Azofeifa, and J. A. Robalino. 2008. Measuring the Effectiveness of Protected Area Networks in Reducing Deforestation. *Proceedings of the National Academy of Sciences* 105(42):16089–16094.
- Andam, K. S., P. J. Ferraro, K. R. E. Sims, A. Healy, and M. B. Holland. 2010. Protected Areas Reduced Poverty in Costa Rica and Thailand. *The Proceedings of the National Academy of Sciences* 107(22):9996–1001. doi:10.1073/pnas.0914177107/-/DCSupplemental/sapp.pdf.
- Andersson, K. 2003. What Motivates Municipal Governments? Uncovering the Institutional Incentives for Municipal Governance of Forest Resources in Bolivia. *The Journal of Environment & Development* 12(1):5–27. doi:10.1177/1070496502250435.
- Andersson, K. 2012. Local Governance of Forests and the Role of External Organizations: Some Ties Matter More Than Others. *World Development* 43:1–12. doi:10.1016/j.worlddev.2012.09.001.
- Andersson, K. and C. C. Gibson. 2006. Decentralized Governance and Environmental Change. *Journal of Policy Analysis and Management* 26(1): 99–123. doi:10.1002/pam.20229.

- Andersson, K. and F. Van Laerhoven. 2007. From Local Strongman to Facilitator: Institutional Incentives for Participatory Municipal Governance in Latin America. *Comparative Political Studies* 40(9):1085–1111.
- Andersson, K., C. C. Gibson, and F. Lehoucq. 2006. Municipal Politics and Forest Governance: Comparative Analysis of Decentralization in Bolivia and Guatemala. *World Development* 34(3):576–595. doi:10.1016/j.worlddev.2005.08.009.
- Andersson, K., T. P. Evans, and K. R. Richards. 2008. National Forest Carbon Inventories: Policy Needs and Assessment Capacity. *Climatic Change* 93(1–2):69–101. doi:10.1007/s10584-008-9526-6.
- Andersson, K., T. Evans, and G. Wright. 2014. Decentralization and Deforestation: Comparing Local Forest Governance Regimes in Latin America. In *State and Environment: the Comparative Study of Environmental Governance*, ed. A. Duit, 239–264. Cambridge, MA: MIT Press.
- Angelsen, A. 2010. Policies for Reduced Deforestation and Their Impact on Agricultural Production. *Proceedings of the National Academy of Sciences* 107(46):19639–19644. doi:10.1073/pnas.0912014107.
- Angelsen, A., M. Brockhaus, E. Sills, W. Sunderlin, and S. Wertz-Kanounnikoff, eds. 2009. *Realising REDD+: National Strategy and Policy Options*. Bogor Barat, Indonesia: The Center for International Forestry Research (CIFOR).
- Berkes, F. 2007. Community-Based Conservation in a Globalized World. *Proceedings of the National Academy of Sciences of the United States of America* 104(39):15188–15193.
- Brambor, T., W. R. Clark, and M. Golder. 2006. Understanding Interaction Models: Improving Empirical Analyses. *Political Analysis* 14(1):63–82. doi:10.1093/pan/mpi014.
- Cerbu, G. A., B. M. Swallow, and D. Y. Thompson. 2011. Locating REDD: a Global Survey and Analysis of REDD Readiness and Demonstration Activities. *Environmental Science and Policy* 14(2):168–180.
- Chhatre, A. 2008. Political Articulation and Accountability in Decentralisation: Theory and Evidence From India. *Conservation and Society* 6(1):12–23.
- Contreras-Hermosilla, A. and M. T. Vargas Ríos. 2002. *Social, Environmental and Economic Dimensions of Forest Policy Reforms in Bolivia*. Bogor, Indonesia: Center for International Forestry Research.
- Cronkleton, P. and B. Peredo-Vida. 2009. REDD+ Realities in Bolivia. In *Realising REDD+: National Strategy and Policy Options*, eds. A. Angelsen, M. Brockhaus, E. Sills, W. Sunderlin, and S. Wertz-Kanounnikoff. Bogor Barat, Indonesia: The Center for International Forestry Research (CIFOR).
- Duncan, T. E., S. C. Duncan, H. Hops, and M. Stoolmiller. 1995. An Analysis of the Relationship Between Parent and Adolescent Marijuana Use via Generalized Estimating Equation Methodology. *Multivariate Behavioral Research* 30(3):317–339.
- Faguet, J.-P. 2004. Does Decentralization Increase Government Responsiveness to Local Needs? Evidence From Bolivia. *Journal of Public Economics* 88(3–4):867–893. doi:10.1016/S0047-2727(02)00185-8.

- Gibson, C. C. and F. Lehoucq. 2003. The Local Politics of Decentralized Environmental Policy in Guatemala. *The Journal of Environment Development* 12(1):28–49.
- Gibson, C. C., J. T. Williams, and E. Ostrom. 2005. Local Enforcement and Better Forests. *World Development* 33(2):273–284. doi:10.1016/j.worlddev.2004.07.013.
- Guerrero Figueroa, L. 2002. *Sembrando Descentralización Y Concertación*. Lima, Peru: Láser Producciones.
- Guerrero Figueroa, L. 2003. *Institucionalidad Y Descentralización Democrática*. Lima, Peru: Láser Producciones.
- Ha, H. T. M. and P. T. Thuy. 2009. REDD+ Realities in Vietnam. In *Realising REDD+: National Strategy and Policy Options*, eds. A. Angelsen, M. Brockhaus, E. Sills, W. Sunderlin, and S. Wertz-Kanounnikoff. Bogor Barat, Indonesia: The Center for International Forestry Research (CIFOR).
- Hardcastle, P., D. Davenport, P. Cowling, and C. Watson. 2011. *Discussion of Effectiveness of Multilateral REDD+ Initiatives*. Bristol, UK: The IDL Group.
- Hoffman, J. P. 2004. *Generalized Linear Models: an Applied Approach*. Boston: Pearson Education, Inc.
- Horton, N. J. and S. R. Lipsitz. 1999. Review of Software to Fit Generalized Estimating Equation Regression Models. *The American Statistician* 53(2):160–169.
- de Jong, W., M. Becker, S. Ruiz, and C. Gottwald. 2004. *Retos Y Perspectivas Del Nuevo Régimen Forestal en El Norte Amazónico Boliviano*. ed. W. de Jong. Bogor Barat, Indonesia: Center for International Forestry Research (CIFOR).
- Kauneckis, D. and K. Andersson. 2009. Making Decentralization Work: a Cross-National Examination of Local Governments and Natural Resource Governance in Latin America. *Studies in Comparative International Development* 44(1): 23–46. doi:10.1007/s12116-008-9036-6.
- Liang, K.-Y. and S. L. Zeger. 1986. Longitudinal Data Analysis Using Generalized Linear Models. *Biometrika* 73(1):13–22.
- Müller, R., P. Pacheco, and J. C. Montero. 2014. *The Context of Deforestation and Forest Degradation in Bolivia*. Bogor, Indonesia: Center for International Forestry Research.
- Nagendra, H. 2007. Drivers of Reforestation in Human-Dominated Forests. *Proceedings of the National Academy of Sciences of the United States of America* 104(39):15218–15223.
- Oemer, Claudia. 2004. Living conditions of forest dependent-people in the northern Bolivian Amazon: a case study of El Sena municipality. PhD diss., Thesis, Faculty of Forestry and Environmental Sciences, Albert-Ludwigs-University, Freiburg.
- Pacheco, P. 2003. Municipalities and Local Participation in Forest Management in Bolivia. In *Municipalities and Local Participation in Forest Management in Latin America*, eds. L. Ferroukhi and B. Barat, Indonesia: CIFOR (Center for International Forestry Research).

- Pacheco, P. 2006. *Descentralización Forestal en Bolivia: Implicaciones en El Gobierno De Los Recursos Forestales Y El Bienestar De Los Grupos Marginados*. La Paz, Bolivia: CIFOR.
- Phelps, J., E. L. Webb, and A. Agrawal. 2010. Does REDD+ Threaten to Recentralize Forest Governance?. *Science* 328(5976):312–313. doi:10.1126/science.1187774.
- Poteete, A. R. and E. Ostrom. 2004. Heterogeneity, Group Size and Collective Action: the Role of Institutions in Forest Management. *Development and Change* 35(3):435–461.
- Programa Indígena REDD Amazonia Bolivia. *The Indigenous REDD Program in the Bolivian Amazon*. Fundación Amigos de la Naturaleza (FAN) Bolivia.
- Quintero, M., S. Wunder, and R. D. Estrada. 2009. For Services Rendered? Modeling Hydrology and Livelihoods in Andean Payments for Environmental Services Schemes. *Forest Ecology and Management* 258(9):1871–1880.
- Rabe-Hesketh, S. and A. Skrondal. 2008. *Multilevel and Longitudinal Modeling Using Stata*. College Station, Texas: Stata Press.
- Ribot, J. C. 2002. *Democratic Decentralization of Natural Resources*. Washington DC: World Resources Institute.
- Ribot, J. C. 2008. *Building Local Democracy Through Natural Resource Interventions: an Environmentalist's Responsibility*. Washington DC: World Resources Institute.
- Ribot, J. C. 2009. Authority over Forests: Empowerment and Subordination in Senegal's Democratic Decentralization. *Development and Change* 40(1):105–129.
- Ribot, J. C., A. Agrawal, and A. Larson. 2006. Recentralizing While Decentralizing: How National Governments Reappropriate Forest Resources. *World Development* 34(11):1864–1886. doi:10.1016/j.worlddev.2005.11.020.
- Ribot, J. C., A. Chhatre, and T. Lankina. 2008. Introduction: Institutional Choice and Recognition in the Formation and Consolidation of Local Democracy. *Conservation and Society* 6(1):1–11.
- Treisman, D. 2007. *The Architecture of Government: Rethinking Political Decentralization*. Cambridge: Cambridge University Press.
- UN-REDD Programme. 2010. *National Programme Document - Bolivia*. UN-REDD Programme.
- UN-REDD Programme. 2011. *UN-REDD Programme Newsletter*. Durban, South Africa: UN-REDD Programme.
- United Nations Food and Agriculture Organization, The United Nations Development Program, The United Nations Environment Program, and undefined author. 2008. *UN Collaborative Programme on Reducing Emissions From Deforestation and Forest Degradation in Developing Countries*
- Wertz-Kanounnikoff, S. and M. Kongphan-apirak. 2009. *Emerging REDD+: a Preliminary Survey of Demonstration and Readiness Activities*. Bogor, Indonesia: The Center for International Forestry Research (CIFOR).
- World Resources Institute. 2005a. *A Guide to World Resources 2005. the Wealth of the Poor: Managing Ecosystems to Fight Poverty*. Edited by World Resources Institute. Washington DC: World Resources Institute.

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- World Resources Institute. 2005b. *World Resources 2005: the Wealth of the Poor*. Washington DC: World Resources Institute.
- Zeger, S. L. and K.-Y. Liang. 1986. Longitudinal Data Analysis for Discrete and Continuous Outcomes. *Biometrics* 42(1):121–130.
- Zeger, S. L., K.-Y. Liang, and P. S. Albert. 1988. Models for Longitudinal Data: a Generalized Estimating Equation Approach. *Biometrics* 44(4):1049–1060.