Does Privatization Protect Natural Resources? Property Rights and Forests in Guatemala*

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Abstract:

Objectives. Property rights are central to debates about natural resource policy. Governments traditionally have been seen as the appropriate custodians of natural resources for their citizens. More recently, many argue the privatization of property rights will ensure that users have incentives to manage their resources well. Common property, to the extent it is discussed at all, is seen as leading to the tragedy of the commons. We evaluate these claims by assessing property rights and forest conditions in two private and three communal forests in Guatemala. Methods. Data on biological and social phenomena from five forests (151 plots) and their associated communities were collected using the International Forestry Resources and Institutions Research Program protocols. Ordinary least squares regression was used to analyze four models. We examined t-scores for differences in coefficients for the different models. Results. The models demonstrate that de jure property rights are not a powerful predictor of variations among the sampled forests. Conclusions. We argue that de facto institutions and their enforcement are much more important than de jure property rights to forest management. Communities holding a forest in common can, under certain circumstances, create institutions to manage their resources as successfully as—or more successfully than—private owners.

Article:

At the core of natural resource policy lies the distribution of property rights. Which individual, group, or entity should hold the rights to a resource? Who will best manage the resource in the short and long term? Until a couple of decades ago, the accepted answer to these questions was generally "the government." The central governments of countries—especially developing nations—appropriated and used their countries' natural resources as they saw fit. To this end, politicians passed laws, established bureaucracies, and distributed rights to resources; over the last century, the model of central government as conservation's caretaker became well entrenched. Other forms of property rights, such as communal rights to resources, were considered archaic and irrational and became casualties of government action.

With the continued overexploitation of many natural resources and the spotty record of many governments qua conservationists, policymakers, practitioners, and scholars searched for new tools to achieve better conservation outcomes. Many now view the previous distribution of property rights as the central roadblock. Ownership by

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governments and communities, the conventional wisdom goes, fosters waste and the underutilization of natural resources. With the privatization of resources, on the other hand, owners experience directly the costs and benefits of their decisions and thus, under the logic of the market, should protect and use their valuable resources wisely.

This thinking has brought about important changes in the strategies of conservationists. Conservation organizations in industrialized democracies have begun the outright purchase of lands located in ecologically fragile areas. Multilateral organizations, governments, and nongovernmental organizations now encourage and fund policies in developing countries that encourage the privatization of resources such as fish, wildlife, water, and forests. From the tropical forests of the Amazon region to the plains of East Africa, de jure private property rights are touted as helping to prevent the wanton destruction of natural resources.

Curiously, this push for the privatization of natural resources comes at a time when an increasing amount of evidence demonstrates that communal property arrangements can result in satisfactory economic outcomes and successful resource husbandry. Research indicates that under some circumstances, groups can construct institutions of common property that can protect and manage natural resources better than private property (e.g., McKean, 2000; Gibson 2001; for a case concerning Guatemala forestry, see Elfas, 1997). Nevertheless, governments continue to replace and undermine most communal property rights institutions with private property (see Ostrom, 1990; Bromley et al., 1992; Reyes, 1998).

Fundamental issues confront policies that attempt to link property rights with resource outcomes. The type of formal property rights is insufficient to determine whether or not a resource will be managed well, since substantial differences may exist between de jure and de facto property rights. Further, information is also needed about the preferences of the owners of rights and the constraints imposed by other institutions on owners' management decisions. Although any number of individual case studies exist to demonstrate the superiority of one property rights system over another, little if any research attempts to compare systematically the performance of different sets of property rights over forest resources using measures from the social and natural sciences (Tucker, 1999). Indeed, what research that does exist regarding the effect of property rights on resources consistently notes the complex and dynamic nature of this relationship, indicating the difficulty of making unambiguous predictions about how rights can translate into resource condition (Libecap, 1989; Hughes, 1977; Friedman, 1985). Effective forest policy demands that researchers investigate more thoroughly the fundamental connection between rights and resource outcomes.

We argue that de jure (or formal) property rights do not predict the conditions of forests well. We do so by examining the property rights, institutions, and resource conditions of five forests in eastern Guatemala: two forests located on private property and three on common property. At first glance, the conditions of five forests in eastern Guatemala support the argument that de jure private property rights better protect forests than do communal rights: the forests of private owners appear to be in better overall condition than the forests held by two communities. But such a first glance overlooks crucial details: one communal forest boasts better conditions on some indicators than either of the two private forests; and decades before, far more of the private lands had been forested, and much of this private land has been cleared to raise cattle and grow coffee.

A better predictor of these forests' variation is the institutions that comprise and buttress the de facto property rights, or "rules-in-use." Following other institutionalists (e.g., see North, 1990; Crawford and Ostrom, 1995), we define institutions as the "humanly devised constraints that structure human interactions" (North, 1990:3). We contend that the variations in the current conditions of the forest are best explained by examining the content and enforcement of institutions at the local level. Formal property rights overlap but are not the same as the set of de facto institutions we discover. Further, by examining the histories of the cases, we demonstrate that private property rights have likely led to greater forest destruction than communal rights.

We present our analysis in the following six sections. The first section of this article briefly reviews the arguments regarding the relative merits of private and common property rights, their effect on resource conditions, and the difference between de jure and de facto rights. In the second section, we explore the ecological and geographic background to our cases: two forests located on private property and three on common property. The third section identifies the rules-in-use regarding these forests as constructed by local residents. The fourth section presents our hypotheses and the statistical tests of the forests' conditions from which we generalize about the forests and property rights that we discuss in the fifth section. Our concluding section places our findings in comparative and theoretical perspective.

Property Rights and Resource Outcomes

Despite claims that private property outperforms other sets of rights— especially communal rights—in the management of a resource, there is little theoretical or empirical support for such a position. Arguments forwarding the benefits of privatization frequently call into doubt the ability of common property rights to help manage resources successfully. Garrett Hardin (1968) and others before and since his influential article assume that common property provides incentives that encourage individuals to maximize their return from the resource even in the face of overexploitation. Many fear such a "tragedy of the commons" and conclude that the effective protection of forests requires either their privatization or nationalization.

Holders of private property rights, of course, have no a priori reason to conserve the resources they own. Economic theory predicts that they will maximize the return on their resource. This means that if the forest is more valuable to them as timber than as standing forest, trees will be cut down, regardless of the costs that may accrue to society (e.g., loss of wildlife habitat, downstream sedimentation, etc.). Additional laws may be passed to try to prevent such anticonservation actions, but private property rights alone do not necessarily lead to long-term resource husbandry. The owner's preferences and extant prices will determine how the resource is used. Private ownership, therefore, does not guarantee that the forest will be well- managed or conserved (Clark, 1973, 1974; van Ginkel, 1989; Larson and Bromley, 1990).

Modern denunciations of common property share a disdain for communal tenure with more traditional liberal attacks on common property. Since the 19th century, proponents of the market in Latin America viewed common property as a relic of a backward or Indian past that impedes the economic development of society. Export-oriented landowners, especially in Guatemala, often led the attack against common property in order to force Indians to leave their communities and serve as wage laborers (Castellanos, 1985; McCreary, 1994). By encouraging the privatization of such lands, they hoped "to free" peasants from the constraints of tradition and community.

But research has shown that common property institutions do not necessarily lead to overexploitation. A substantial number of case studies demonstrate that groups with de jure and de facto common property rights have overcome their collective action problems and created institutions to manage their resources (e.g., Berkes, 1989; Bromley and Cernea, 1989; Ostrom, 1990). In fact, McKean (2000), among others, argues that common property may be better suited to the management of natural resources, since it allows for large systems to remain intact, reduces uncertainty of production by pooling resources, internalizes possible negative externalities, and increases administrative efficiency.

Even the distinction between private and communal property is unclear in most analyses. If private property means those rights allocated to an individual and communal rights refer to groups, then phenomena like modern corporate law are more about common than private property. If the labels refer to the kind of rights allocated, then analyses should examine and compare the actual bundles of rights held by different actors. The "private-ness" of property will vary along a continuum, rather than be easily categorized into private or not (Schlager and Ostrom, 1992).

A close empirical analysis of different rights bundles will also reveal that de jure and de facto property rights may or may not be the same. Depending on the government's ability and interest in enforcing its laws, individuals and groups can ignore and filter de jure property rights. Importantly, they also add their own rules, generating local institutions—rules-in-use—and patterns of activity that can diverge widely from legislators' and bureaucrats' expectations. Often governments, especially those whose revenues limit the monitoring of their own laws, have little understanding of the institutions that local communities have created to manage their own use of natural resources. Like private property institutions, these local de facto institutions may or may not contribute to successful resource management.

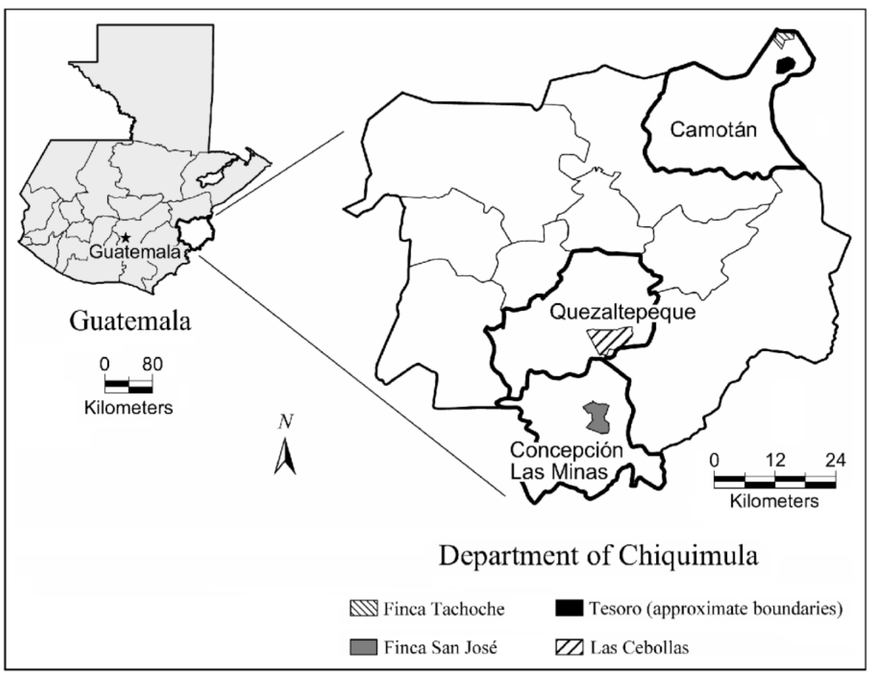
In sum, there is no reason to believe that a forest policy based on the establishment of either formal private or common property rights leads to good forest management. Instead, resource outcomes will be determined by the actors, their preferences, and the de facto institutions operating on the ground.

An Overview of the Sites: Geography, Demography, and Land Tenure

Our study explores property rights, local institutions, and forest conditions in four sites located in eastern Guatemala (see Figure 1). Social scientific data were collected using the International Forestry Resources and Institutions (IFRI) protocols. The IFRI protocols, designed by colleagues working through the Workshop in Political Theory and Policy Analysis at Indiana University under the leadership of Elinor Ostrom, are used to gather comparable data reflecting the social and natural sciences at the community level, with a heavy emphasis on the institutional arrangements at the local level. The 10 protocols include over 1,000 variables and are used by collaborating research centers in nearly a dozen countries. Fieldwork by research teams of 10 or so people lasts for about a month in most sites. The data collection process normally takes a month per site. (More information about IFRI can be found at <http://www.indiana.edu/~ifri>.)

FIGURE 1

Location of Study Sites in Guatemala



Las Cebollas, Tesoro, Finca San José, and Finca Tachoche are located in the Department of Chiquimula in eastern Guatemala. Chiquimula possesses mostly tropical dry forests of mixed hardwood and coniferous species on steeply sloped terrain. Our sites were dominated by native, nonplanted pine forests (*Pinus oocarpa*). These forests have relatively open canopies and have been altered heavily by humans. Within Chiquimula, the westernmost site is the Las Cebollas community, located in the municipality of Quezaltepeque. It covers 1,850 hectares and contains 43 households. In the neighboring municipality of Concepciôn Las Minas is Finca San José. It is 771 hectares in size and has three households. In the municipality of Camotân, we investigated another private farm, Finca Tachoche, covering 400 hectares and containing 10 households. The last site, Tesoro, is a community in the very eastern part of this municipality and borders Honduras. It encompasses 1,220 hectares and contains 115 households. The sites and their surrounding areas are among the most rural in

Guatemala: the 1994 population census revealed that an average of 90 percent of the population of these municipalities live in rural areas (INE, 1996).

Finca San José and Finca Tachoche consist of private property dating from the colonial period. These farms sell coffee and lumber. Both of these activities are more intensively pursued on Finca Tachoche, since the owner of Finca San José focuses more on raising cattle. Although the owner of Finca San José paid for a management plan regarding his forests in 1989 that outlined an extensive program of long-term timbering, he did not implement it. In contrast, Finca Tachoche rigorously follows a management plan that divides the farm into coffee-producing areas, forest reserves, reforested areas, and what are called "low-productivity" forests. Both plans have been approved by the appropriate government forestry unit, the National Institute of Forestry (Instituto Nacional de Bosques).

The sites on common property were settled during different points of the early 19th century on land formally belonging to their respective municipalities, known as *ejidos*. Using the nomenclature of Guatemalan political divisions, Tesoro is an *aldea* (a hamlet of usually fewer than 1,000 people) and Las Cebollas is a *caserio* (smaller than an aldea) (Prado Ponce, 1984:584). Like most rural districts of Guatemala, both consist of land parcels belonging to households and unclaimed land operating as a commons. Legally, these lands remain municipality-owned *ejidos* if the original settlers or their descendants never obtained title to the land. De facto, however, residents have developed elaborate and well-defined use rights over these lands. Individual parcels are typically fenced, and the boundaries are respected by all local residents. Their claimants use the parcels as *milpas*, fields on which to grow corn and beans, which are the staples of the local diet. Many households also cultivate coffee, a crop that became popular in the areas in the late 1980s.

Remaining nonagricultural lands in such communities serve as commons. The rules and their level of enforcement for these communal lands vary between communities, but they generally permit all community members to use common areas for timber, pasture, firewood, and *ocote* (resinous pieces of pine trees used to start fires). Although we do not have past population figures for these communities, interviews with residents suggest that the size of the commons has decreased as new families have established their own households.

De Jure and De Facto Institutions Regarding the Forests

Governments, of course, generally pass numerous laws concerning natural resources. People at the local level, however, often modify or ignore such laws. If we seek to understand human impact on resource use, we must understand the institutions that people follow, not just the formal laws that may or may not be respected. As discussed in the previous section, both private property and common property can involve identical bundles of rights. But for either type of tenure to work, its institutions must be known and enforced. The following section explores which institutions are actually known, enforced, and followed at the study sites.

Finca San José and Finca Tachoche

The owner of the Finca San José makes known and vigorously enforces his rights to the trees on his land. His most widely known rule is a ban on individuals from neighboring *aldeas* and *caserios* from cutting trees on his property. He also makes it clear to locals that he does permit the use of dead or fallen trees for firewood, but he requests that villagers ask him before taking the wood. The owner also prevents outsiders' cattle from grazing on his lands. Interviews with residents in the surrounding area indicate that the owner interacts with his neighbors frequently and makes known both the boundaries of his property and his rules about access. Residents of the area indicate that most locals do respect the owner's rules.

Rules-in-use are also well known and enforced at the Finca Tachoche. Following the preferences of the farm's stockholders, the *finca* manager also does not permit members of local communities to enter the *finca* to cut trees, nor are cattle from other communities allowed to graze in the *finca*'s forest. Conversations with villagers in surrounding *aldeas* and *caserios* suggest that illegal use of *finca* forests is rare. The *finca*'s dozens of employees from the area have free access to the limbs trimmed during their cultivation, so firewood is readily available.

Protective Forest of Las Cebollas

Like those of the two private *finca* owners, the rules-in-use are also well known and enforced in the Protective Forest of Las Cebollas. Because several prominent families in the community established this forest to protect the water of an adjacent river, no one is allowed to cut trees or graze cattle in this area. These rules are also enforced: family members regularly walk the forest's boundaries, which are clearly marked through a combination of paths and barbed-wire fences. The community is also small enough in membership and size so as to make undetected transgression of these rules difficult. Consistent with these factors, our teams encountered neither foraging cattle nor wood-hunting community members while they were in this forest.

Communal Forests of Las Cebollas and of El Tesoro

In the other parts of forest that have not been set aside as protected lands by the community, however, there are far fewer rules governing the use of the forest—and even these few rules are rarely enforced. Members of Las Cebollas, like many communities in the region, consider the unprotected parts of their communal forest a source of timber, pasture, firewood, and *ocote*. Members have also created some *milpas* in the forest and allow cattle to roam free. The residents make no attempt to devise rules governing the use of such resources, despite the fact that there is noticeable degradation. Community members do have an informal rule that outsiders cannot use their forest's resources, but evidence exists that outsiders do occasionally use some parts of the Las Cebollas communal forest, and community members make no effort to limit it.

Although the community of Tesoro has recently tightened its rules governing its communal forest, until quite recently the community members treated their forest much like the unprotected parts of Las Cebollas: Tesoro's forests were open for locals to use in almost any way they wished, including clearing the forest for new agricultural fields. Two years ago, however, the community formed a Forest Committee that now limits the taking of firewood to dead trees and the use of timber only for home repair and construction. Most importantly, it has decreed a halt to the parcelization of the communal forest that since the late 1980s has led to the spread of coffee fields.

Hypotheses and Data Analysis

Our main hypothesis is that forests with enforced rules (rules-in-use, or de facto institutions) that limit forest exploitation will boast better forest conditions than those forests where rules are not enforced. Thus, rules-inuse should have a greater impact on the conditions of a forest than formal, de jure property rights, although we allow for the case that de jure and de facto institutions may coincide. This main hypothesis leads to two specific hypotheses about our five cases:

Hypothesis 1: Because the cutting of trees is restricted in the forests of Finca San José, Finca Tachoche, and the Las Cebollas Protective Forest, we expect them to possess better forest conditions than the communal forests of Tesoro and Las Cebollas. (Although Tesoro does now enforce rules, we do not expect this to have an influence on its forest, since the rules are so recent. It takes time for rules to leave their footprint on the landscape.) We measure forest conditions by the diameter at breast height (DBH) and basal area of trees and saplings, described below.

Hypothesis 2: Because of the prohibition on cattle grazing in Finca San José, Finca Tachoche, and the Las Cebollas Protective Forest, we expect them to possess more sapling stems and a higher sapling basal area than the communal forests of Tesoro and Las Cebollas, where cattle are not prevented from grazing. Cattle will forage and step on saplings, inhibiting their growth.

Studies of forest condition generally employ two broad sets of variables. In the ecological sciences, the most commonly used factors include elevation, slope aspect (direction in which the slope of the sample forest plot faces), slope steepness, precipitation, soil texture, and soil chemistry. The second set involves social factors, that is, interventions by humans, and can include measures of the number of trees cut, consumption of woody products, government laws, population pressure, agricultural activities, income levels, road construction, and religious practices.

Our sample of five forests reduces the variation introduced by broad biophysical, political, and social factors. All the sites are within one government department—Chiquimula—and are within a similar type of forest—tropical dry. All are subject to the same forestry regulations—the 1996 Forestry Law—and level of central and municipal government enforcement. We assume that any factors originating outside the Chiquimula area will affect the five forests equally.

In each forest, the IFRI protocols call for random plots to be located over two strata: type of forest, and type of de facto institutions connected with the forest. IFRI employs the standard forestry technique of nested plots to measure the forest. In the largest plot, with 18-meter sides, we recorded the local and scientific name, height, and diameter of all trees (defined as those woody plants that are over 10 cm. DBH). In a square with five-meter sides, we recorded the local and scientific name, height, and diameter of all saplings (defined as woody plants between 2.5 cm. and 10 cm. DBH). For each plot we also noted evidence of fire, erosion, cattle, epiphytes, lianas, and fauna. We measured 151 plots in this study.

To test the effects of biophysical and institutional variables on forest condition, we constructed four regression models. These four models are used in an attempt to measure comprehensively the forests in our study; in each of these models, we employed ordinary least squares regression using the same set of independent variables on different aspects of a forest's condition. The form of the model is

$$Y_x = \alpha + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4 + X_5\beta_5 + X_6\beta_6 + X_7\beta_7 + \varepsilon,$$

where

- Y = one of four biological measurements of the forest
- Y_1 = TREE BASAL, the basal area of all trees in plot (square centimeters of a cross-section of trunk at DBH/square meter)
- Y_2 = SAPLING BASAL, the basal area of all saplings in plot (square centimeters/square meter)
- Y_3 = TREE DENSITY, tree density in plot (number of stems at DBH per plot)
- Y_4 = SAPLING DENSITY, sapling density in plot (number of stems at DBH per plot)
- X_1 = TACHOCHE, a dummy variable for plots located in Finca Tachoche
- X_2 = SAN JOSE, a dummy variable for plots located in Finca San José
- X_3 = TESORO COMMUNAL, a dummy variable for plots located in the communal forest of Tesoro
- X_4 = CEBOLLAS COMMUNAL, a dummy variable for plots located in the communal forest of Las Cebollas
- X_5 = SLOPE, the percentage slope of a plot
- X_6 = ORIENTATION, the direction in which a plot faces (compass directions were transformed by the equation $Y = \sin(x - 90E)$ to obtain a more linear measure of the "southness" of the direction in which a plot faces; although all the plots are near the Equator, slopes facing south will be exposed to more sun than northern slopes, possibly affecting moisture and vegetation)
- X_7 = ELEVATION, the elevation of a plot in meters
- ε = a random disturbance term

There are innumerable ways to measure the condition of a forest. Our dependent variables represent three standard techniques (Spurr and Barnes, 1992). First, we divide the forest into saplings (DBH < 10 cm.) and trees (DBH ≥ 10 cm.). This helps us understand the structure of a forest. For example, if only saplings were found in a forest, this would indicate something had systematically affected the larger trees. Second, we use the density of trees and saplings as dependent variables. Density is simply the number of stems per area. This gives some indication about the state of the forest: all things being equal, if one forest has more tree stems than another, it has likely been less disturbed. Third, we also use the basal area of saplings and trees as a dependent variable. Basal area is a standard measure derived from the flat area that would appear if a tree's trunk was cut horizontally at DBH. This is calculated as $pi*(DBH/2)^2$. Basal area is a useful measure because it helps to measure the amount of wood in a forest, rather than merely the number of trees. For example, the basal area of forest A may be higher than that of forest B even though B has more trees: this would happen if A had fewer but larger trees than B. Using saplings, trees, density, and basal area gives more accurate comparisons of two forests than any single measure.

We use four dummy variables to represent the five forests. The effect of the fifth forest, Cebollas Protective, cannot be included directly in the regression; its effect is merged with the intercept. We choose to include a dummy variable for each forest because this is the most general specification. Therefore, we do not assume that the only differences among the forests are due to institutional arrangements. Allowing each forest to vary in its quality gives us the most information about the differences among the forests. Our hypotheses are directional, and thus the more general specification allows testing them without undue restrictions.

TABLE 1

Regression Estimates of Forest Conditions

Independent Variables	Model 1 Tree Density	Model 2 Sapling Density	Model 3 Tree Basal Area	Model 4 Sapling Basal Area
Intercept	.077	.043	14.72	–4.65
	(.019)	(.15)	(13.57)	(9.05)
Community forests				
Las Cebollas Communal	–.039	–.056	–14.09	–.86
	(.007)	(.056)	(5.00)	(3.33)
Tesoro	–.036	–.134	–2.07	–.03
	(.009)	(.075)	(6.73)	(4.49)
Private forests				
Finca San José	–.031	–.013	–6.46	1.18
	(.007)	(.058)	(5.19)	(3.46)
Finca Tachoche	–.034	.027	–3.12	5.23
	(.009)	(.075)	(6.73)	(4.49)
Biophysical factors				
Orientation	–.0004	–.0284	–1.39	–1.19
	(.0024)	(.0189)	(1.70)	(1.13)
Slope	–.023	–.170	.110	2.18
	(.009)	(.071)	(6.37)	(4.24)
Elevation	.0047	.0212	11.01	4.33
	(.0105)	(.0834)	(7.50)	(5.00)
R^2	.32	.24	.12	.08
	(.018)	(.144)	(12.94)	(8.62)

NOTE: Tree density and sapling density refer to the number of stems per square meter. Tree and sapling basal area refer to the area of the stem at breast height (calculated as DBH * pi * radius squared). *N* = 151.

We have also included standard biophysical control variables that can be expected to affect the condition of a forest: slope, orientation, and elevation. We expect the slope variable to be significant, as trees have a more difficult time establishing themselves on steeper slopes. All things being equal, the flatter the plot, the higher the density of trees found there. We expect that elevation will not be significant, given that the elevations of plots do not vary greatly in the sites examined in this study. Orientation measures the direction faced by the plot. In northern latitudes, south-facing slopes can have far different vegetation than north-facing ones because of the extra sun received. Since Guatemala is fairly close to the Equator, we do not expect this variable to be significant for either the tree or sapling regression. But the systematic effects of microclimates make orientation an important control variable to include in attempts to explain forest conditions.

TABLE 2

Expected Direction of *t*-Scores Comparisons of Coefficients

	Las Cebollas Communal	Las Cebollas Protected	Tesoro	Finca San José
Las Cebollas Protected	Negative			
Tesoro	N.D.	Negative		
Finca San José	Negative	N.D.	Negative	
Finca Tachoche	Negative	N.D.	Negative	N.D.

NOTE: *t*-scores will be based on

$$t = \frac{\hat{\beta}_R - \hat{\beta}_C}{\sqrt{\mathrm{Var}(\hat{\beta}_R) + \mathrm{Var}(\hat{\beta}_C) - \mathrm{Cov}(\beta_R \beta_C)}}$$

where *R* is the row forest coefficient and *C* is the column forest coefficient. For example, a negative value indicates that the coefficient for the corresponding row forest dummy should be smaller than the coefficient for the corresponding column forest dummy. N.D. = No direction predicted.

Table 1 presents the results of the regressions. Using R2s, the fit of the models indicates that density of trees and saplings is easier to predict than the basal area of each. The regressions for tree density and basal area also fit better than the regressions explaining sapling density and basal area.

The set of biophysical variables does not explain much of the variance in these forests. Using a permissive ratio of coefficient to standard error of 1.5 as a judge of significance, only slope in the two density regressions and orientation in the sapling density equation achieve significance. No biophysical variables significantly predict basal area for either trees or saplings. Orientation is significant in the sapling regression—just barely so—which could indicate some microclimate effects of these hilly regions.

As we move from the biophysical variables of the regressions to the institutional factors affecting forest condition, the best way to evaluate the effect of each forest dummy variable in each regression is to compare the coefficients for each forest dummy with each other. If there is a statistically significant difference in coefficients, this indicates that the conditions of the forests differ. Using a t-test for difference in coefficients, we can thus test our hypotheses. Table 2 provides the hypothesized directions of the signs for the differences of coefficients for all possible comparisons. Our hypotheses were that our four dependent variables of forest condition should have higher values in Cebollas Protective, Finca Tachoche, and San José Finca than in Cebollas Communal and Tesoro Communal.

Tables 3 and 4 provide the results of these tests. The most striking finding from the regression on tree density is that Cebollas Protective is clearly better on this criterion than all the other forests. The t-tests clearly reject the null of no difference. Another finding, although a weaker one, is that Cebollas Communal has lower tree density than Finca San José. Both of these

TABLE 3

t-Scores for Differences in Coefficients, Tree Density and Sapling Density Models

	Las Cebollas Communal	Las Cebollas Protected	Tesoro	Finca San José
Las Cebollas Protected	Tree –5.52* Sapling –1.01			
Tesoro	Tree –1.40 Sapling 1.42	Tree –3.81* Sapling –1.79*		
Finca San José	Tree –1.33 Sapling –0.99	Tree –4.33** Sapling –0.23	Tree –0.84 Sapling –2.90*	
Finca Tachoche	Tree –1.64 Sapling 2.20*	Tree –3.63** Sapling –0.36	Tree –0.40 Sapling –4.79*	Tree 0.51 Sapling –0.96

NOTE: For an explanation of how to interpret these numbers, see Table 2.

*significant at .05 level, one-tailed test.

**significant at .05 level, two-tailed test.

findings from the tree density regression conform to our hypotheses: the sites with enforced institutions—Cebollas Protective, Finca Tachoche, and Finca San José—have higher values for forest condition than either the communal forest of Cebollas or that of Tesoro.

Regarding the sapling density results, the major finding is that Tesoro Communal Forest, with no enforced rules about local expropriation or cattle grazing, has fewer saplings per area than forests with enforced rules, as per our hypotheses. Also conforming to our predictions is the weaker evidence that Finca Tachoche has higher sapling density than Cebollas Communal.

The strongest finding of the basal areas models in Table 4 is that Cebollas Communal Forest performs significantly worse than all other forests in tree basal area, conforming to our expectation. The average basal area per area in the Tachoche Forest is also greater than Tesoro, but this difference in coefficients does not achieve significance at the conventional 5 percent level. The sapling basal area regressions present the weakest, though not inconsequential, evidence in favor of our hypothesis. Tachoche has significantly higher sapling basal area than the communal forests, but neither the other private forests nor the protected forests show a significant difference in sapling basal area.

One factor that we did not include in the previous regressions was population, often considered one of the most important causes of environmental degradation. Because the effect of population is per forest, we cannot include population in our regressions, since it will be perfectly correlated with the dummy variables we use for each forest. Comparing four different

TABLE 4

t-Scores for Differences in Coefficients, Tree and Sapling Basal Area Models

	Las Cebollas Communal	Las Cebollas Protected	Tesoro	Finca San José
Las Cebollas Protected	Tree −2.82* Sapling −0.26			
Tesoro	Tree −2.45* Sapling −0.25	Tree −0.31 Sapling −0.01		
Finca San José	Tree −1.98* Sapling −0.25	Tree −1.24 Sapling 0.34	Tree −1.18 Sapling −0.48	
Finca Tachoche	Tree 2.20* Sapling −1.84*	Tree −0.46 Sapling 1.17	Tree 0.35 Sapling −2.62*	Tree −0.89 Sapling −1.62

NOTE: For an explanation of how to interpret these numbers, see Table 2.

*significant at .05 level, one-tailed test.

**significant at .05 level, two-tailed test.

measures of population in Table 5, however, we find no consistent relationship between population and forest condition. Like others, we argue that population by itself is a poor predictor of forest condition. Institutions can mediate the effect of population, as can other factors, such as dependence on forest products, transportation systems, and markets (see, e.g., RoseroBixby and Palloni, 1998; Varughese, 2000).

Discussion

Taken together, the results of the tests support the hypothesis that those forests with enforced rules outperform the two communal forests on the measures of forest conditions. Those forests with enforced rules generally had larger and more trees per area of land than did the communal forests. Regarding saplings, the same results held. And in no case was a communal forest better, in any category, than the private or protective forests.

These results would have conformed to the expectation that private property can outperform communal property if not for the Cebollas Protective Forest. Not only was the community at Las Cebollas able to create and enforce rules about a forest, they did it on de jure communal land, and they did it so well that their forest outperformed both private forests located on the *fincas*.

Although the analysis tested the broad categories of communal and private, and enforced and unforced, we also note the effect of a more specific enforced rule, the prohibition of cattle in certain areas. Sustained cattle grazing can have deleterious consequences for a forest. Cattle can destroy trees by eating seedlings, foraging leaves and small limbs of saplings and trees, and compacting soil, which reduces rates of seed germination. Rules

TABLE 5

Population Densities and Biophysical Conditions

Site	Municipal Population	Contiguous Population (3 km^2 Radius)	Municipal Population Density (Pop/km^2)	Contiguous Population Density (Pop/km^2)	Tree Stems (Mean Number per Plot)	Sapling Stems (Mean Number per Plot)	Tree Basal Area (Mean Number per Plot)	Sapling Basal Area (Mean Number per Plot)
Las Cebollas								
Communal	25,351	1,410	105	256	0.03	.10	16.40	1.85
Protected	25,351	198	105	861	0.07	.18	33.88	4.36
Tesoro	28,670	1,229	119	559	0.03	.02	23.16	.57
Finca Tachoche	28,670	967	119	806	0.03	.20	22.70	6.46
Finca San José	12,241	1,128	58	627	0.04	.14	22.62	3.41

SOURCE: Table 1 and INE (1996).

NOTE: Population figures are from 1996.

that prevent cattle from grazing in certain areas should cause those areas to show more and larger saplings, as they are allowed to regenerate and grow. Our data show this to be true in the five forests we studied.

Why do some communities create and enforce rules whereas others do not? Scarcity is one reason why communities in our sites have taken steps to protect their common-pool resources. As the past in both communal areas demonstrates, households placed little value on protecting forests because they were more abundant. In the context of largely poor households seeking to make a livelihood on the land, forests were perceived as relatively unimportant and plentiful. This no doubt captures the views of the current residents of Las Cebollas about their community forest.

The perceived gains to protecting the protective forest for water management, however, encouraged a group of families in Las Cebollas to assume the costs of creating institutions to manage their forests so as to protect a watershed for an irrigation project. But scarcity is not a sufficient, even if it may prove to be a necessary, condition for a group to spend the time to devise and enforce rules over common-pool resources (Gibson, Dodds, and Turner, 1998). One solution to the collective action problem is for a "privileged group" to spearhead the creation of a collective good (Olson, 1965). This occurred in Las Cebollas: the families most dependent upon the irrigation system assumed the responsibility for designing and enforcing rules aimed at protecting their watershed.

Conclusion

This article addresses an important issue in political economy and natural resource policy: Which set of property rights is best for the management of natural resources? Captivated by the powerful metaphor developed by Garrett Hardin, many researchers and policymakers believe that commonly held property leads individuals to a tragedy of the commons, resulting in the degradation, if not destruction, of resources. Government or private property is often offered as an alternative. In this article, we assess part of this claim with data collected from five forests in eastern Guatemala.

Institutions clearly matter to forest conditions. Despite dissimilar formal tenure arrangements, we found that certain individuals and groups in eastern Guatemala have constructed de facto institutions to restrict the use of their forested lands. They have formulated plans about how they want their forests used. They have verbalized these plans with those most likely to use their forests if no restrictions existed. They have enforced these rules through means such as building fences and patrolling the boundaries of their forests. And they have sanctioned neighbors who illegally fell trees or otherwise change their forests. These rules have left their imprint on the landscape: forests with known and enforced rules are in better condition than those that do not have such rules.

Although some ecologists take into account land use practices, many have ignored property rights institutions. Ecologists' work features the influence of other, generally biophysical, factors to explain forest conditions. Although the natural variables must be taken into account, they may be insufficient to explain pattern and variation in forests that humans use. And this means most of the forests on the earth. In our analysis of forest conditions, we found that some biophysical measures, including elevation and slope, did account for part of the variance among the forests we studied.

Economists, on the other hand, are very aware of institutions, as is shown by their work regarding the externality problems associated with the use of natural resources. Although an individual may gain from logging his land, the surrounding community and indeed the rest of the world must endure the costs of the resulting siltation, such as changed climate and the loss of biodiversity. Most economists also consider—indeed advocate for—certain sets of formal private property rights. But we find that these formal institutions do not explain forest conditions well at the local level. Instead, de facto institutions—the enforced institutions followed at the local level—are better at explaining certain forest characteristics. Further, we discovered that the communal ownership and management institutions so often disparaged by economists have produced the best overall forest in our sample.

Standard conceptions of private property must give way to both more nuanced views of common property as a form of private property, which may be better suited to natural resource management, and an understanding that the creation of de jure rules may do little to change behavior at the local level. The circumstances and outcomes we find in Las Cebollas, in particular, instruct us to take a more sophisticated approach to the study of rights and resources. Hardin's tragedy is taking place alongside Ostrom's outcome of successful local-level collective action in the same community. If efficacious policy regarding both the rights and exploitation of natural resources is to take place, we must examine the sets of both formal and informal institutions that govern resource use.

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