Does Tenure Matter to Resource Management? Property Rights and Forests in Guatemala*

by

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Abstract

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 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. Using measures of social and biological phenomena, we find that de jure property rights are not a powerful predictor of variations among these forests. Instead, we argue de facto institutions and their enforcement are much more important to forest management. Communities holding a forest in common can, under certain circumstances, create institutions to that manage their resources as—or more—successfully than private owners.

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Introduction

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? The accepted answers to these questions until a couple of decades ago 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 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 non-governmental 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 the spring 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 (McKean, forthcoming). Nevertheless, governments continue to replace and undermine most communal property rights institutions with private property (Ostrom, 1990; Bromley et al., 1992).

Fundamental issues confront policies that attempt to link property rights with resource outcomes. The type of formal property rights are 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 is also needed to understand management decisions. While 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. 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 protects 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, held and managed by one of these same two communities, boasts better conditions on some indicators than either of the two private forests; decades before, far more of the private lands had been forested; 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; Ostrom and Crawford, 1995), we define institutions as the "humanly devised constraints that structure human interactions" (North, 1990:3). We contend that the variation of 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 has likely led to greater forest destruction than communal rights.

We present our analysis in the following six sections. The next section of this paper 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 section 2, 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 which we discuss in section five. Our concluding section places our findings in comparative and theoretical perspective.

1. 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 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 though they know that if everyone did the same, the resource itself would be depleted. Many fear 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, it 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 anti-conservation 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).

Modem denunciations of common property emphasize share a disdain for communal tenure with more traditional liberal attacks on common property. Since the nineteenth 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 their societies. 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, 1984; 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 amount of case study research demonstrates that groups with common property rights have overcome their collective action problems and created institutions to manage their resources (e.g., Berkes et al., 1989; Bromley and Cernea, 1989; Ostrom, 1990). In fact, McKean (forthcoming) among others agues 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 may increase administrative efficiency over the resource.

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 is 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 "privateness"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 to enforce 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 funds limit the monitoring of their own laws, have no idea about what institutions 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.

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

Our study explores property rights and forest conditions in four sites located in eastern Guatemala (see figure 1). Las Cebollas, Tesoro, Finca San José, and Finca Tachoche are located in the Department of Chiquimula, in eastern Guatemala. This department is found in the extreme east of Guatemala and borders Honduras.

(Place Figure 1 about here)

Chiquimula in general contains tropical dry forests on steeply sloped terrain. Forests in this region are generally of the mixed hardwood and coniferous trees at elevations between 500 and 1800 meters above sea level; the elevation of our sites runs from 942 meters to 1678 meters above sea level and possess native, non-planted, pine-dominated forests (*Pinus oocarpa).* They all have relatively open canopies that have been heavily altered by humans.

Climatological data for each exact site does not exist, but such data are collected by the weather stations in Esquipulas and La Unión located near to the four sites (see Figure 1). Data from the weather station in Esquipulas indicates that the mean monthly temperatures between 1990-5 is 21.3°C in the dry season (November-March) and 23.3 °C in the remaining rainy months. Average rainfall for this area is 96 mm for the dry season and 1700 mm for the rainy season. Weather data in La Unión between 1970-9 is similar: mean monthly temperature in the area is 21 °C in the dry season and 22.4°C in the rainy season. Average rainfall is 174mm for the dry season and 1263mm for the rainy season.

Within the Department of Chiquimula, our western most 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 Conceptión Las Minas is Finca San José. It is 771 hectares in size and has three households. In the Municipality of Camotán, we investigated another private farm, Finca Tachoche, covering 400 hectares and containing ten households. Our last site, Tesoro, is a community in the very eastern part of this municipality and borders Honduras. It encompasses 1220 hectares and contains 115 households (See Table 1).

(Table 1 about here)

The sites and their surrounding areas are among the most rural in Guatemala. The 1994 population census reveals that an average of 90 percent of the population of these municipalities live in rural areas. Table 1 reveals that less than half of the population at least 15 years old is literate and fewer than five percent have electricity in their homes. Comparable figures for Guatemala as a whole indicates that 65 percent of the population is rural, 56 percent of households have access to electricity and 64 percent are literate. Finally, Table 1 indicates that the inhabitants of private farms and communities we studied are largely ladino, that is, Guatemalans who do not identify themselves as members of an indigenous group; 42 percent of Guatemalans, in contrast, do belong to indigenous groups. So, in general, these communities are populated by rural households that are typically ladino and tend to be poorer than the national average.

Finca San José and Finca Tachoche consist of property dating from the colonial period. The current owner of Finca San José is the son of a Swiss immigrant who purchased the estate in the 1920s from a Guatemalan family. Finca Tachoche is now a privately-held corporation, whose major stockholder is, coincidentally, a Swiss national. Finca Tachoche apparently lost half of its size in the early 1950s due to an agrarian reform launched during the government of President Jacobo Arbenz.

These farms sell coffee and lumber. Both activities are more intensively pursued on Finca Tachoche, since the owner of Finca San José focuses more on raising cattle. Although he paid for a management plan regarding his forests in 1989 which 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 *{Institute Nacional de Bosques).*

The sites on common property were settled during different points of the early nineteenth century on land formally belonging to their respective municipalities known as *ejidos.* Local residents assert that three ladino families founded Las Cebollas circa 1800 in an area over which the Chorti *cofradia* of San Francisco claim jurisdiction *{cofradias* are religious brotherhoods that often possess political influence in and near the communities where they are located). Current residents of Tesoro claim that four families established their community in 1798.

Using the nomenclature of Guatemalan political divisions, Las Cebollas is a *caserio* and Tesoro is an *aldea* — rural hamlets of slightly different sizes. *Caserios* are settlements smaller than *aldeas* and the latter typically house fewer than 1,000 individuals (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 respected by all local residents. Their claimants use the parcels as *milpas,* fields to grow corn and beans that are the staples of the local diet. Especially in Tesoro, many households also grow coffee, a crop that became widely grown in the late 1980s in this area.

Remaining non-agricultural lands serve as a 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, firewood, and *ocote* (resinous pieces of pine trees used to start fires). Wealthier households also graze their cattle on communal lands. Although we do not have past population figures for these communities, interviews with residents suggests that the size of the commons has decreased as new families established their own households.

3. 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 section two, both private property and common property can include 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 to locals and vigorously enforces his rights to the trees on his land. His most widely-known use rule is a ban on individuals from neighboring *aldeas* and *caserios* from cutting trees on his property. He also makes clear that he does allow locals to use 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 the rights to forest resources he gives to others. While some locals do not respect his rules, residents of the area indicate that most do. A long-standing dispute between the owner and a local village over one section of land exemplifies the owner's active engagement in enforcing his claims to his lands.

Use rules are also well-known and enforced at the Finca Tachoche. Following the preferences of the 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* suggests that illegal use of finca forests is rare. Even when asked whether their neighbors might be using the finca's resources without permission, local residents claimed that it was not occurring. This was seemingly confirmed by the finca manager: he stated that adjacent communities were not poaching resources from the property he is administering. But, even if they were doing so, he added, he would not be bothered by small numbers of poorer neighbors taking dead trees for use as firewood because such behavior might ensure that the finca maintained cordial relations with communities on its borders.

Protective Forest of Las Cebollas

Like the two private finca owners, the rules are also well-known and enforced in the Protective Forest of Las Cebollas. Because this forest was established to protect the water of the adjacent river, no one is to cut trees or graze cattle in this area. These rules are also enforced: the families that helped to found this patch of protected forest regularly walk its 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 we in this forest.

Communal Forests of Las Cebollas and of El Tesoro

In the parts of forest that had not been set aside as protected 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 as a source of timber, firewood, and *ocote*. Members have also created some *milpas* in this area, even though they admit that soil there is not particularly fertile. Cattle also roam free in the communal forest. 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 hav an informal rule that outsiders cannot use their forest's resources. However, evidence exists that outsiders do occasionally use some parts of the Las Cebollas communal forest and community members make no effort to limit this exploitation.

The community of Tesoro has recently tightened its rules governing its communal forest. Until quite recently, however, community members treated their forest much in the way that Las Cebollas does with its community forest: it is open for locals to use in almost anyway they wish, including clearing the forest for new agricultural fields. Two years ago, the community formed a Forest Committee which 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, led to spread of coffee fields.

4. 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 that those forests where rules are not enforced. Thus rules-in-use 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 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 more stems (tree and sapling density) and a higher basal area per area than the communal forests of Tesoro and Las Cebollas. (While Tesoro does now enforce rules, we do not expect this to have an influence on their forest since the rules are so recent. It takes time for rules to leave their footprint on the landscape). Tree and sapling density and basal area are common measures of forest condition (Spurr and Barnes, 1992).

Hypothesis 2: Because of the prohibition on cattle grazing in the forests of 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.

Analysts generally invoke one of two broad sets of variables to explain forest condition. In the ecological sciences, the most commonly used factors include elevation, slope aspect (direction the slope of the sample forest plot faces), slope steepness, precipitation, soil texture, and soil chemistry. The second set involves social factors i.e., interventions by humans, and can include measures 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 some of the variation played by broad biophysical and social factors. All the sites are within one government department—Chiquimula—and are within a similar type of forest—tropical dry. We assume that any factors originating outside the Chiquimula area will affect the five forests equally.

In each forest, we choose random plots over two strata: type of forest, and type of de facto institutions connected with the forest. Random plots help control for systematic bias caused by elevation, slope, slope orientation, and other ecological factors. We employed a nested plot system: in the largest plot with 18 meter sides we recorded the local name, scientific name, height, and diameters of all trees (defined as those woody plants that are over 10 centimeters in diameter at breast height [d.b.h.]). In a square with five meter sides, we recorded the local name, scientific name, height, and diameter of all saplings (defined as woody plants between 2.5 cm. and 10 cm. d.b.h.). For each plot we also noted evidence of fire, erosion, cattle, epiphytes, lianas, and fauna.

To test the effects of biophysical and institutional variables on forest condition, we constructed four regression models. In each of these models, we used ordinary least squares (OLS) 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 D.B.H./square meter)

Y_2 = SAPLING BASAL, the basal area of all saplings in plot (square centimeters/square meters)

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 percent slope of a plot

X_6= ORIENTATION, the direction a plot faces; compass directions were transformed by the equation Y = sin (x-90°) to obtain a more linear measure of the "southness" a plot faces

X_7 = ELEVATION, the elevation of a plot in meters

ε = a random disturbance term

Four dummy variables are used 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. By allowing each forest to vary in its quality, this will give us the most information about the differences among the forests. Our hypotheses are directional, and thus the more general specification will allow testing them without undue restrictions.

Table 2 presents the results of the regressions. Using R^2s, the fit of the models indicate that density of trees and saplings are 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.

Table 2 about here.

The set of biophysical variables do not explain large amounts of variance in these plots.

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 achieves significance. No biophysical variables significantly predict basal area for either trees or saplings.

We expect the significance of the slope variable, 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 also expect that elevation will not be significant, given that the elevations of plots do not vary greatly in the sites examined in this study. If we had taken samples from the cloud forests in this area where the type of species found is quite different than in the forests of this study, we would expect elevation to affect the density and basal area variables.

We would expect that the orientation variable would not be significant for either the tree or sapling regressions. The importance of orientation is generally correlated with distance from the equator. Where a forest is far from the equator, northern facing plots get less sun, and therefore harbor different trees than the south. Because our study sites are so close to the equator, we would expect that orientation would make little difference to the density or basal areas of trees. We do find it significant in the sapling regression — just barely so — which could indicate some effect in 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 3 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. (Table 3 about here.)

Tables 4-7 provide the results of these tests. The most striking finding from the regression on tree density (Table 4) is that Cebollas Protective is clearly better on this criteria than all the other forests. The t-tests clearly reject the null of no difference. Another finding, although weaker, is that Cebollas Communal has lower tree density than Finca San José. Both of these 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 of the communal forests of Cebollas or Tesoro. (Table 4 about here.)

Table 5 gives results for the hypothesis tests for the regression in sapling density. Here, 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. Although we do not make predictions about between-type forest condition, the Tesoro forest has fewer saplings per area than the Cebollas Communal forest, although this difference fails to obtain .05 level of significance. The strongest finding in Table 6 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 five percent level. (Tables 6 and 7 about here.)

The final table of t-tests, Table 7, provides results for the sapling basal area regression. These results 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 or 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 as 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 they will be perfectly correlated with the dummy variables we use for each forest. We do have data, however, that indicates that population does not appear to be an important explanatory variable for the tree density and basal area of this study's five forests.

Table 8 shows four different measures of the population near each forest as well as measures of the four main indicators of forest condition used in this study, i.e., tree density, sapling density, tree basal area, and sapling basal area. These data indicate no clear relationship between population and forest conditions. Using municipal population data, we see that Tesoro, which has some of the worst forest conditions, is in the same municipality as Finca Tachoche, which boasts better forest conditions. Clearly municipal population data cannot explain what is happening in Cebollas, where the residents have both their communal and protective forest.

(Insert Table 8 here.)

Using a more localized measure of population—the number of residents within a three kilometer radius from the center of the study's five forests—we again find no clear impact of population on forest condition. For example, while Tesoro and Cebollas Communal have relatively high numbers of people living within three kilometers, the population around the Fincas San José and Tachoche are also relatively high, even though their forest conditions are quite different (the communal forests having generally poorer conditions). When those raw data are translated by the number of people per forested area, the results change considerably: Tachoche and Cebollas Protective forest emerge as the most densely populated, and yet their forests are also among the best in this sample, a result which runs counter to much conventional wisdom. 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, markets, etc. (see for example Rosero-Bixby and Palloni, 1998; Varughese, forthcoming).

5. 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. Regarding trees, 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 is 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 outperforms both private forests located on the fincas.

While 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 that reduces seed germination. Rules that prevent cattle from grazing in certain areas should 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 them while 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 irrigation project. But, scarcity was not 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 when a "privileged group" spearheads the creation of 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.

6. Conclusion

This paper addresses an important issue in political economy and natural resource policy: which set of property rights are best for the management of natural resources. Captivated by the powerful metaphor developed by Garrett Hardin, many researchers and policy-makers believe that commonly held property leads individuals to a tragedy of the commons, resulting to the degradation, if not destruction, of resources. Government or private property is often offered as a alternative. In this paper, 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 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 which do not have such rules.

While 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. While 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 find that some biophysical measures, including elevation and slope, do account for part of the variance among the forests we study.

Economists, on the other hand, are aware of institutions, especially the problem of externalities that are endemic to natural resource use. While the individual may gain from logging their land, the surrounding community and indeed the rest of the world must endure the costs of siltation, changed climate, loss of biodiversity, etc. Most 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. 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.

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. In the same community Hardin's tragedy is taking place alongside Ostrom's outcome of successful local-level collective action. 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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TABLE 1: GEOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS OF STUDY SITES

SITE	MUNI-CIPALITY	PROPERTY RIGHTS	SIZE (IN HECTARES)	NUMBER OF HOUSE-HOLDS	POPULATION	HOUSEHOLDS WITH ELECTRICITY (AS A PERCENTAGE OF ALL HH)	LITERACY (AS A PERCENTAGE OF PERSONS 15 YEARS OR OLDER)	INDIGENOUS POPULATION (AS A PERCENTAGE OF TOTAL POPULATION)
LAS CEBOLLAS	Quezalte-peque	Communal	1850	43 (43)	198	6%	33%	0%
TESORO	Camotán	Communal	220	90 (115)	488	0%	43%	20%
FINCA SAN JOSÉ	Concepción Las Minas	Private	771	2 (3)	7	50%	6%	0%
FINCA TACHOCHE	Camotán	Private	400	- (10)	- (20)	-	-	-

Source: Data in the columns 3-5 were collected during field work in July-August 1998. Our estimate of the number of households is in parenthesis.

The number of households and all socio-economic data stem from the 1994 population census (INE, n.d).

Note: The 1994 population census does not distinguish between Finca Tachoche and the Aldea of Tachoche, thus preventing us from listing its socio-economic characteristics.

TABLE 2: 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 (.019)	.043 (.15)	14.72 (13.57)	-4.65 (9.05)
COMMUNITY FORESTS				
LASCEBOLLAS-COMMUNAL	-.039 (.007)	-.056 (.056)	-14.09 (5.00)	-.86 (3.33)
TESORO	-.036 (.009)	-.134 (.075)	-2.07 (6.73)	-.03 (4.49)
PRIVATE FORESTS				
FINCA SAN JOSÉ	-.031 (.007)	-.013 (.058)	-6.46 (5.19)	1.18 (3.46)
FINCA TACHOCHE	-.034 (.009)	.027 (.075)	-3.12 (6.73)	5.23 (4.49)
BIOPHYSICAL FACTORS	-.0004 (.0024)	-.0284 (.0189)	-1.39 (1.70)	-1.19 (1.13)
ORIENTATION				
SLOPE	-.023 (.009)	-.170 (.071)	.110 (6.37)	2.18 (4.24)
ELEVATION	.0047 (.0105)	.0212 (.0834)	11.01 (7.50)	4.33 (5.00)
R^2	.32 (.018)	.24 (.144)	.12 (12.94)	.08 (8.62)
N=151				

Note: Tree 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 d.b.h. * pi * radius squared.).

TABLE 3: 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

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

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 4: T-SCORES FOR DIFFERENCES IN COEFFICIENTS, TREE DENSITY MODEL

	LAS CEBOLLAS COMMUNAL	LAS CEBOLLAS PROTECTED	TESORO	FINCA SAN JOSÉ
LAS CEBOLLAS PROTECTED	-5.52*			
TESORO	-.40	-3.81*		
FINCA SAN JOSÉ	-1.33	-4.33**	-.84	
FINCA TACHOCHE	-.64	-3.63**	-.40	.51

Note: For an explanation about how to interpret these numbers, see Table 3.

*= Significant at .05 level, one-tailed test.

**=Significant at .05 level, two-tailed test.

TABLE 5: T-SCORES FOR DIFFERENCES COEFFICIENTS, SAPLING DENSITY MODEL

	LAS CEBOLLAS COMMUNAL	LAS CEBOLLAS PROTECTED	TESORO	FINCA SAN JOSÉ
LAS CEBOLLAS PROTECTED	-1.01			
TESORO	1.42	-1.79*		
FINCA SAN JOSÉ	-.99	-.23	-2.90*	
FINCA TACHOCHE	2.20*	-.36	-4.79*	-.96

Note: For an explanation about how to interpret these numbers, see Table 3.

*= Significant at .05 level, one-tailed test.

**=Significant at .05 level, two-tailed test.

TABLE 6: T-SCORES FOR DIFFERENCES IN COEFFICIENTS, TREE BASAL AREA MODEL

	LAS CEBOLLAS COMMUNAL	LAS CEBOLLAS PROTECTED	TESORO	FINCA SAN JOSÉ
LAS CEBOLLAS PROTECTED	-2.82*			
TESORO	-2.45*	-.31		
FINCA SAN JOSÉ	-1.98*	-1.24	-1.18	
FINCA TACHOCHE	2.20*	-.46	.35	-.89

Note: For an explanation about how to interpret these numbers, see Table 3.

*= Significant at .05 level, one-tailed test.

**=Significant at .05 level, two-tailed test.

TABLE 7: T-SCORES FOR DIFFERENCES IN COEFFICIENTS, SAPLING DENSITY MODEL

	LAS CEBOLLAS COMMUNAL	LAS CEBOLLAS PROTECTED	TESORO	FINCA SAN JOSÉ
LAS CEBOLLAS PROTECTED	-.26			
TESORO	-.25	-.01		
FINCA SAN JOSÉ	-.25	.34	-.48	
FINCA TACHOCHE	-1.84*	1.17	-2.62*	-1.62

Note: For an explanation about how to interpret these numbers, see Table 3.

*= Significant at .05 level, one-tailed test.

**=Significant at .05 level, two-tailed test.

TABLE 8: POPULATION DENSITIES AND BIOPHYSICAL CONDITIONS

SITE	MUNICIPAL POPULATION	CONTIGUOUS POPULATION (3 KM² RADIUS)	MUNICIPAL POPULATION DENSITY (POP/KM²)	CONTIGUOUS POPULATION DENSITY (POP/KM²)	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
LAS CEBOLLAS 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

Sources: See Table 1.