

Does Community Involvement Matter? How Collective Choice Affects Forests in Mexico*

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Abstract

While current natural resource policy emphasizes devolution, field applications and the few empirical analyses that have been conducted offer mixed results. Using original community-level survey data from Oaxaca, Mexico, a region with 90% common property forestland, this study describes how existing community governance structures accommodate an increasing local role in forest land management. Multidimensional performance indicators for group rule conformance and forest condition are constructed and regressed on measures of local and professional service providers' involvement in recognized community forums. Our results reveal that active use of these forums for disseminating information and seeking management plan approval improves both performance indicators, while attendance rate also leads to greater rule conformance. JEL Classification: O17, Q23.

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1 Introduction

Devolutionary resource management has brought the challenges of collective decisionmaking to the fore. In recent years, public policy efforts have increasingly incorporated local control and participatory methods into resource management strategies. However, it remains unclear through which mechanisms devolution achieves its goals. Studies of devolution show mixed results. Among the primary pitfalls, political elites may dominate the decisionmaking process, decisionmaking forums may be inadequately organized and government oversight or technical expertise may be insufficient. Along with rich case studies on participatory management, more causal empirical research capturing the nuances of institutional functioning in decisionmaking forums is needed.

This paper operationalizes the concept of local participation based on qualities of information exchange among stakeholders and multiple levels of resource governance. We characterize institutional functioning for resource management as a process of involvement, or interaction among local community members themselves and forestry professionals who apply technical expertise within a framework of state regulations. Drawing from research showing that access to information generally improves policy outcomes, we use this concept to determine how variations affect group conformance to rules and quality of the forest resource. Data from a sample of Mexican community governance institutions managing common property forest resources on behalf of their membership provides the factual foundation for the empirical analysis. Our results reveal that judicious use of general forums collective decisionmaking elicits cooperative behavior and higher institutional performance.

Access to information is at the core of many studies of common pool resources. One of the most consistent findings in the experimental economic literature on common pool resources is that communication among stakeholders increases the likelihood that they will cooperate, consequently enabling them to reach higher levels of return (Kopelman, Weber and Messick 2002, Ostrom, Gardner and Walker 1994, Baland and Platteau 1996). Further, one-way communication is “better” than no communication but two-way communication has an even stronger positive influence on cooperation. These results have undermined the characterization of the commons as a one-shot prisoners’ dilemma game in which the only equilibria is the

noncooperative outcome.

In real-life common property settings, communication occurs in existing decisionmaking forums or in forums especially created to address a management problem. Leading explanations of the benefits of communication are the elicitation of commitments to cooperate, delivering verbal criticism and building trust, so that the opportunity to gain knowledge about others actions, reveal information about one's own actions and enforce decisions is as much a function of communication as is gaining knowledge on technical matters. As any organizational structure will influence the interaction of participants (Zusman and Rausser 1994), forums which allow these processes to develop are likely to be more effective. Voting can even act like a communication device when no other communication is possible, as the voting process offers an opportunity for learning (Kopelman et al. 2002). In experimental research variations in communication have been found to matter, although in the field nonexperimental complexities often arise. In one of the few empirical studies of participation, Hoddinott, Adato, Besley and Haddad (2001) characterizes different degrees of decisionmaking control for public infrastructure projects. The analysis differentiates between *de facto* and *de jure* participation, where *de facto* participation more often achieves project goals. In other studies, the exclusion of women and the less wealthy or politically powerful from resource management decisions has been associated with less desirable income distribution patterns (Agarwal 2001, Sundar 2001).

Few studies empirically explore real-life forums of information exchange in local resource management institutions. In this paper, we use a unique dataset to complement a contextual description of a common property forest governance system with empirical analysis relating qualities of information channels to performance indicators. The research setting is the Mexican agrarian community sector with timber production. We focus on two information flows: intracommunity exchange and exchanges between the professional forester and the community within the General Assembly, the supreme community-level political body in each incorporated village. The research question is whether collective decisionmaking characteristics of these information channels affect performance indicators by encouraging cooperation with group objectives.

With data from a sample of 44 Mexican communities or work groups involved in timber production, we develop ecological performance indicators and analyze their empirical relationship to the quality of communication channels. Our two performance indicators are rule conformance and ecological condition of the

forest. We hypothesize that broadly-based communication through the community's General Assembly and higher attendance rates lead to higher performance ratings. We find that the use of general assemblies for disseminating technical information strongly affects the community's support of management goals and quality of the forest resource and that higher attendance rates lead to higher rule conformance but not necessarily sounder ecological condition. The indicators are conditioned on other noninstitutional variables as well, which have varying explanatory power. As such, this research complements work emphasizing the need to address both sociodemographic and physio-geographic characteristics for determining management behavior (e.g. see Deininger and Minten (2002)) and, by characterizing nuances of local stakeholder governance, refines the meaning of "participation" based on institutional access to and power over information. The results can be directly applied where technical personnel interface with local communities in advancing adaptive, ecosystem management approaches which incorporate both professional expertise and local knowledge (Klooster 2002b, Berkes, Folke and Colding 1998, Robbins 2000).

The paper is outlined as follows. Section 2 first gives a basic overview of Mexico's community governance system and its implication for forest management. It then turns to describing the communities surveyed during fieldwork, specifying data collection methodology, summary statistics, collective decisionmaking and measurement of performance indicators. The econometric analysis and results are presented in Section 3, followed by conclusions in Section 4.

2 Land tenure, governance and forestry management in Mexico

Within a rich biological setting, Mexico's land tenure patterns pose an interesting case for participatory resource management research in that agrarian communities have a state-recognized corporate structure, defined territorial boundaries and usufructory rights over communal land. The communities, known as *ejidos* and *comunidades*, derive their legal basis from Article 27 of the 1917 Constitution created subsequent to the Mexican Revolution and which sought to redistribute or repatriate large land-holdings concentrated under the *hacienda* system to peasant populations. Individuals claiming land under this system are connected through membership in a community which holds title to the land. In most communities, the system falls

short of complete private property. Technically, all land in a community is communally-managed property. Individuals are given the right to plots of land for agriculture, livestock and dwellings but do not hold title nor are able to sell the land outside the community. The only exceptions are when the community has voted to privatize all individual plots, as provided by the Agrarian Reform of 1992, an action which has been mainly limited to urban *ejidos* (Goldring 1998) and did not affect sample communities in this study. Designated forest land is managed as common property for access by all members and is to revert to the state if privatized under the reform laws (Bray and Wexler 1996).

While the organizational structure is codified in Article 27, governance practices may be a mix of pre-colonial traditions and modern political systems. Many *comunidades* practice a system of rotating civic and religious responsibilities among registered community members based on merit accumulated by service in a rising hierarchy of civic positions, called *cargos* (Carlsen 1999, Segura 1988). In states with a strong indigenous population like Oaxaca, *Usos y Costumbres*, as this practice is called, remains widespread. In 1998, the State of Oaxaca formally accepted *Usos y Costumbres* as an official alternative to the national electoral process, although heads of a municipality must claim a party once elected (EDUCA 2001). Votes on major decisions affecting the community are taken in the General Assembly, the supreme governing body which decides on all principal issues of the community and in which each registered member of the community, called a *comunero* or *ejidatario*, has one vote. Voting is by consensus or majority rule, depending on community practices. Elections to office are held approximately every three years. Common property management responsibilities fall to the *Comisariado de Bienes Comunales* (CBC) or *Ejidales*, the civic office charged with attending to land issues within the community. These offices can be unsalaried, unspecialized towards forestry or any other management skill, and subject to the approximately three-year rotation term. Assemblies meet a minimum number of times per year as required by law, and extra meetings are called to discuss issues needing immediate community attention.

The implications for Mexico's forestry policy cannot be understated as approximately 80% of national forest resources are held by 8000 *ejidos* or *comunidades* (White and Martin 2002, Snook 1997). The state maintained and exercised the right to lease community forest land to private and semi-private firms up until 1982, when policy shifted to a more community-based approach (Klooster 2002a). In 1986, the government

formally recognized the rights of agrarian communities to commercialize their timber resources (Bray and Wexler 1996). In many places in Mexico, a “community forestry sector” has replaced parastatal and peripheral private harvesters. Since the liberalization of forestry policy, community patterns of accessing the forest have shifted from individuals harvesting forest products for domestic consumption and occasional sale to commercializing timber production collectively (Cabarle, Chapela and Madrid 1997, Antinori 2000, Antinori and Rausser 2000).

With greater control over forestry, community governance has absorbed its new economic role within the CBC’s responsibilities but with high organizational variability across communities. The CBC may be directly responsible for managing timber production or, in communities with more advanced processing capabilities, the community may form a *unidad* or *sociedad* that has legal standing as a production unit. Each individual member of the community is a *socio*, the term for a part-owner, partner, or shareholder in a labor-managed firm, yet shares are not defined nor traded. The CBC may appoint additional personnel to manage these community forestry enterprises, such as a general manager, chief of sales, logging foreman, or sawmill manager, as needed. Due to conflicts or historical idiosyncrasies, subgroups within the community will occasionally form, with each group claiming a portion of communal forest lands and appointing separate management teams, which may include separate CBCs or administrative heads, and holding separate assembly meetings for their membership to discuss group issues. Some communities have begun to pay the CBC a salary.

The technical services of a professional forester are integral to community timber production. Harvesting timber for commercial purposes requires a management plan prepared by a qualified forester and approved by the Ministry of Environmental and Natural Resources known by its Spanish acronym, SEMARNAT. Foresters are primarily responsible for providing the necessary documentation for its approval and directing the marking and felling of trees. Once government or timber company employees, today professional forestry services are privatized. Beyond the basic services, the forester-community relationship varies widely. The forester can provide technical training or hire locally for marking trees, inventory assessment or treatments, act as a liaison with the private sector in seeking markets and financing for projects and attend Assembly meetings where forestry matters are discussed to provide information.

Despite an apparent similarity to democratic governance, decisionmaking by *Usos and Costumbres* introduces quite different dynamics. In many communities, the practice of voting by a show of hands or other form of public display is common. In 1998, 73% of Oaxacan communities voted by *Usos y Costumbres* and 54% of those voted publically (Rendon 1998). Where consensus is the norm, that consensus has often been achieved with a significant amount of discussion to bring around everyone to a decision. Extensive communication and information sharing about each other's behavior and a personal, public commitment to accept the decision has occurred. As parallels are often made between participatory management and democracy, it is important to note distinctions, especially in regard to the power of local elites (Kumar 2002, Ribot 2002, Kumar and Corbridge 2003, Abraham and Platteau 2003). Abraham and Platteau (2003) argues that general forums for discussion may be a more appropriate medium for participatory management than "elected" leaders who may perpetuate a pattern of local favoritism. This observation may be relevant to Mexico as well. Although the General Assembly presents the opportunity for fairly broad representation, participation in decisionmaking varies, with consequences for forest management. In one study of a Oaxacan community with forest resources and a history of logging, forest benefits were narrowly channeled to local bosses through job allocation, under-the-table revenue distribution and manipulation of the General Assembly which discouraged participation in assemblies (Klooster 2000). Approval of timber contracts was sought more through threats, bribes and violence rather than open discussion. Individuals harvested pine without following management plan guidelines or community permission, most often selecting genetically stronger trees and leaving the deformed or diseased as seed trees (Klooster 1999, Snook 1997). This was in contrast to "successful" communities characterized by well-attended General Assembly meetings.

Finally, we note that the participation of women in formal community decisionmaking is low and one of the main critiques of *Usos y Costumbres* (Carlsen 1999). In fieldwork for this research, survey data shows that women with official status to vote at General Assembly meetings represented a small percentage of the voting body. In some cases, women are pointedly excluded and fined if they attempted to enter General Assembly meetings. No study has shown the impact of gender-based exclusion on Mexico's forest resources. We leave a rigorous analysis of gender and forest management in Mexico to future research.

2.1 Data

A sample of forest communities in Oaxaca was surveyed from 1997 to 1998. The unit of observation is agrarian communities or subgroups within the communities recognized by community members as the decisionmaking body for timber production. The criteria for including an observation in the study population are that the group owns land for which it has a current management plan and permit that allows commercial harvests, and commercial production occurred in the community during at least one of the three harvest seasons 94/95, 95/96, or 96/97 based on permit files from SEMARNAT. Out of a total population of 95 communities, which produce 80-95% of the commercial timber harvest in Oaxaca (*SEMARNAP* 1999), a random sample of 44 communities or work groups was selected.¹ The sample includes seven of the eight regions of Oaxaca² and four work groups. Pine is by far (82% in the 1996-97 season) the bulk of the total authorized volume. The communities in the sample comprise 22% of the total authorization of pine volume and 27% of authorized volume for other species (oak, *hojosas*, common tropical, cedar and mahogany) in 1997. Forestry production is more concentrated in the mountainous regions of the Sierras. One part of the survey was administered to community authorities responsible for forest administration, with one or more of the community authorities present, and a second part separately with the professional forester administering to the community's forest. Questions covered production and contracting details, description of the governance structure and history of timber harvesting in the community, access and use rules for nontimber products and general resource characteristics. Further demographic data was obtained from the *Instituto Nacional de Estadística, Geografía e Informática's* *Conteo 1990* and *Conteo 2000*.

2.2 Intracommunity participation in forestry enterprises

Three decisionmaking processes for managing timber production were explored with community authorities during field interviews: preparation of yearly harvest volume proposal, choice of buyer and distribution of profits. Responses are illustrated in Table 1 with data organized by most processed end product sold for

¹This fieldwork was conducted as part of a larger project on vertical integration of communities in the timber industry. The sample was randomly stratified according to end product sold by the community or work group. See Antinori (2000) for a complete description of the data.

²Number of observations per region are as follows: Cañada – 1, Costa – 5, Istmus – 3, Mixteca – 4, Sierra Norte – 14, Sierra Sur – 11, Valles Centrales – 6.

comparison of governance with scope of commercial activities at the collective level. The General Assembly is rarely a forum to prepare yearly harvest volume proposals. Follow-up questioning revealed that harvest rates are often considered a technical decision which the General Assembly as a general body is not sufficiently informed to undertake. The final decision to choose a particular buyer usually lies with community authorities. Harvest proposals and choice of buyer have a slight tendency for specialization away from the General Assembly at higher integration levels, although χ^2 statistics for each possible response (not shown) are insignificant at the 10% level or better, suggesting that the evolution of management proceeds differently across communities regardless of integration levels. The distribution of profits concerns the entire community and is mainly decided at the General Assembly level, consistent with the collective choice literature predicting that decisions with more direct impacts on a broad constituency are decided in open forums (Zusman 1992, Ostrom 1990). This pattern shows little variation across vertical integration levels.

Although smaller committees prepare the management plan, the plan is normally presented to the General Assembly for approval and ratification. Community authorities were asked at what point was the last harvest proposal presented to the General Assembly. Communities whose General Assemblies meet to discuss volumes usually meet before the harvest takes place. Three communities stated that the Assembly meets after the harvest, in which case they are only being informed of the volume harvested, although they also said they meet beforehand. Given the context of the interviews, this response indicated a less-than-forthright decisionmaking process in which ratification would logically precede harvesting. Two less integrated communities said that the General Assembly meets during the harvest to discuss volumes to be cut.

In all sample observations, interviewees indicated that the General Assembly remained the appropriate decisionmaking forum for general community matters, even if its functionality differed across the sample. In many communities, attendance in the General Assembly by a registered member is mandatory, and a person may be subject to fines if he does not attend.³ In our sample, all except one community reported attendance at General Assembly meetings of one-half or greater of the community's voting population present at the meetings, suggesting a fair degree of participation of the community in forestry matters. A lack of

³In some cases, the door is guarded by a person who keeps track of who goes in and out of the meetings.

Table 1: Community Decisionmaking in Timber Production

	Stump- age (16)	Round- wood (12)	Lumber (8)	Forest Products (7)
<i>Prepares proposed harvest volumes (n=41*)</i>				
Professional Forester	11	10	7	5
Forestry Authorities	4	5	2	2
General Assembly	4	4	1	0
Other	6	1	0	0
<i>Chooses buyer (n=30)</i>				
Professional Forester	0	2	0	0
Forestry Authorities	4	7	5	3
General Assembly	5	3	1	1
Other	3	2	1	1
<i>Decides distribution of profits (n=35)</i>				
Professional Forester	0	0	0	0
Forestry Authorities	2	1	1	2
General Assembly	11	9	5	4
Other	2	1	1	1
<i>When GA convenes to discuss volume (n=36)</i>				
Do not convene	3	4	4	2
Before harvest	7	7	4	3
After harvest	1	1	1	0
During harvest	1	1	0	0
<i>Attendance rate (n=22)</i>				
Less than one-quarter	0	0	0	0
One-quarter to one-half	1	0	0	0
One-half to three-quarters	5	4	2	2
Three-quarters or more	2	3	2	1
$\chi^2_6 = 2.43$ Pr = 0.88				

*Columns do not add to group totals due to multiple responses or missing observations.

significant variation with vertical integration for attendance suggests that the underlying civic functioning is not differentiated by level of investment in timber production processes.

2.3 Forester-Community Interaction

A forester's primary link to the community is with the CBC as the community's representative for land issues. Table 2 summarizes foresters' survey responses in describing whether they also used the General Assembly, advisory councils, work teams and other means, with the General Assembly being the broadest form for communicating information. Statistical differences in using the General Assembly as a discussion forum for the forester are not significant across community production types, although the nature of information

exchanged may differ. As one forester explained, the more vertically integrated communities discuss forestry issues extensively and in more detail (e.g. budgets, production, management) among themselves with little input from the forester, although the forester is present to advise. In less vertically integrated communities, often characterized by less knowledge of forestry issues, the forester tends to explain general information and discussion frequently focuses on boundary issues and internal problems.

Table 2: Forester-Community Information Exchange (Number of Responses)

	Stumpage (16)	Roundwood (13)	Lumber (8)	F. Products (7)
GA meeting discussions $\chi^2_3 = 2.86$ Pr = 0.41	6	6	5	5
Small group discussions $\chi^2_3 = 4.33$ Pr = 0.23	0	2	1	2
Local hiring $\chi^2_3 = 3.15$ Pr = 0.37	14	10	7	4
Other $\chi^2_3 = 1.69$ Pr = 0.64	5	5	4	4

A second form is smaller advisory councils that may consist of *characterizados*, or respected or older members of the community who have completed much of their community service work, or others regarded as having valued knowledge for advising on community issues. In addition, the forester may form smaller teams made up of the CBC and other officers who develop management plans before presenting them to the General Assembly. Overall, the frequency of these forester-small group interaction is small. Finally, almost all foresters, regardless of vertical integration of the community, hired locally for labor-intensive projects.

These data should be used with caution. Many or all communities have Assembly meetings or send people to assist the forester. But the interest shared by the community in managing the forest varies greatly and affects real exchange of information. In addition, these questions do not gauge the degree of effort the forester makes to involve the community. However, a degree of consistency exists between responses from the forester and responses of the community authorities on involvement. For example, forester-community interaction through Assembly meetings, a forester-determined indicator, is positively correlated ($\rho = 0.31$) with attendance rate and negatively correlated ($\rho = -0.41$) with communities which met after the harvest had begun to approve harvest plans, both community-determined indicators.

2.4 Rule conformance and ecological condition in forestry

Resource performance measures typically rely on one measure such as agricultural productivity or deforestation rate. In doing so, the measures gloss over different dimensions of the agents' efforts. In complex institutional settings based on common property and communal governance, a single measure may be even less appropriate (Lam 1998, Poteete and Ostrom 2003). Lam (1998) shows the superior model fit of multi-dimensional versus single measure performance indicators in irrigation systems in Nepal using confirmatory factor analysis. Likewise, we take a multidimensional approach to constructing performance indicators for community forestry in Mexico.

We classify performance into two indicators, rule conformance which refers to the degree to which individual community members follow community-accepted forest management rules, and a measure of physical condition of the forest which encompasses ecosystemic services and commercial timber production. The two measures differentiate between actions of the community members and the physical condition of the forest. This distinction allows for the possibility that current management efforts do not correspond to current forest conditions, which may be a function of historical harvesting practices.

Forest management rules have developed through a combination of government programs and regulations and community customs. Consultations with professional foresters, forestry officials and community members informed the survey design and choice of measures for community management practices that signify rule conformance and characteristics of an ecologically sound forest, with the data crosschecked to the degree possible.⁴

The rule conformance measure derives from both forester and community interview data (see Table 3). First, the forester was asked to assess three aspects of forest management: *Community readiness for preventing and combating fires* refers to how well residents follow practices to prevent fires, their responsiveness and readiness to fire outbreaks, with answers recorded on a four-point scale. Human-induced fires are a leading cause of temperate forest cover loss. Individual farmers frequently prepare agricultural plots according to the *roza-tumba-quema* scheme that uses fire to clear fields. In addition, coal kilns are common. As fairly old

⁴The approach of seeking professional opinions reflects methodology used in other common property studies where forest condition and trends in forest condition require a variety of considerations and call for informed judgment (Varughese and Ostrom 2001, Tang 1994, Bardhan 2000).

customs in Mexico, farmers are generally aware of precautionary measures.⁵ SEMARNAT also makes efforts to heighten the awareness of communities in preventing fires. This includes educational presentations in regional or community meetings on both individual and cooperative practices, like fire brigades. *Clandestine tree harvesting* is a dummy variable that takes a value one, zero otherwise, if the forester indicated that unmanaged extraction of commercial size trees was frequent or somewhat frequent. A third measure accounts for *clearing forest land* for agriculture or pasture. Individual community members may request permission from the CBC to clear a parcel of forest to plant crops. In a well-managed forest, the CBC would limit this activity. The measure is a dummy variable equal to one if forest clearing occurred in the last three years before the survey. An additional variable scales the severity of the clearing. Second, for community-derived data, two variables from community interviews take the value one, zero otherwise, if the community had *rules in place for regulating collection of fuelwood and wood for domestic use*, usually the two products most heavily collected from forests besides commercial timber.

Physical condition of the forest refers not only to the commercial potential of a forest, but also its ability to retain soil and protect water quality and its degree of biodiversity relative to forests of similar physical and geographic conditions. Survey interviews with the forester and review of the management plan thus provide information for a combined measure of *ecological condition* of the forest for marketable and nonmarketable benefits. Where possible, these measures were checked against management plan data, field observations and informal discussions with informants to the degree possible.

Foresters were first asked to estimate the percentage of hectares according to a five-point scale for *commercial potential* considering existence of commercial-quality species, average diameter at breast height (DBH), climate and soil conditions. To augment their response, a review of the management plan assessed the percentage of forest in merchantable timber as determined by size class. Management plans generally specify the distribution of standing timber by age classes or DBH. Foresters indicated that size and age correlated fairly well for the pine forests under their management.⁶⁷ If an inventory was not available, we asked the

⁵The timeframe of the survey 1997-1998 included a particularly bad year for fires in Oaxaca, due to climatic conditions.

⁶Many management plans today apply the *Metodo de Desarrollo Silvicola*, that establishes a system of even-aged stands with seed-tree regeneration. This system is now favored over the *Metodo Mexicano de Ordenación de Montes* method that permitted less intensive cuts but tended to impoverish the genetic strength and composition of Oaxaca's pine-oak forests (Snook 1997).

⁷We looked for a distribution for the area of production as a whole. If information for the forest stand was not aggregated, we asked for average ages/DBH for each rotation area or subdivisions (*rodales* and *subrodales*) and averaged to obtain an

Table 3: Components of Ecological Indicators

<i>Variable</i>	Mean	Standard Error	Number of Obsvns.
Rule conformance			
Organizational preparedness for fire prevention	2.00	0.14	39
Very high (=1)			13
High (=2)			15
Low (=3)			9
Very low (=4)			2
Clandestine timber harvesting commonly occurs?*	0.26	0.07	43
Forest land clearing occurs?*	**0.26	0.07	43
Extent of clearing			
None (=0)			32
Low (= 1)			5
Medium/Large (=2)			
Rules exist for fuelwood collection*	0.54	0.08	43
Rules exist for collecting wood for domestic use*	0.77	0.07	43
Ecological condition			
Percent ha. with “good” or “very good” commercial quality	57.74	4.25	43
Percent ha. 30-60 cm DBH	50.40	3.94	41
Percent ha. with “good” or “very good” soil maintenance	73.84	5.00	38
Percent ha. with “very good” biodiversity	15.58	4.60	43

Source: Survey data

*Variable with 0 or 1 value, with 1 indicating a positive response.

**Equality with clandestine harvesting is coincidental. Values represent different communities.

forester for a general estimation using best judgment. For pine, merchantable timber is 30-60 centimeters DBH or 30-60 years of age. Therefore, this data is a measure of current commercial value and applies only to communities with pine stands.

Soil quality assessments considered soil coverage and erosion problems. Some management plans classify forest stands according to degree of erosion, which provide a check against the forester’s responses. *Biodiversity* was the most difficult to assess during the survey process. Without training in species diversity and ecosystems, foresters can differ in their assessment of biodiversity in the same forest. Therefore, responses should be viewed as first best approximations. Foresters were asked to judge biodiversity by comparing the community forest to the level possible for that type of forest considering climatic conditions, elevation, geography, soil type and number of forested hectares. Since the biodiversity measure is less refined as an estimate, only the percentage of hectares classified as “very good” is reported.

To obtain quantitative measures for rule conformance and forest condition, we apply factor analysis to

age/DBH class distribution.

inform our choice of measures. Factor analysis breaks up the variance among variables into “loadings” that explain the correlation among a larger set of variables into a smaller set of concepts (Mardia, Kent and Bibby 1979). This technique is appropriate when exploring hard-to-define characteristics, like general ability, attitudes, intelligence, or, in this case, rule conformance, of which observed variables are expressions. The resulting aggregation of variables determines a single index. Starting with the variables related to rule conformance, a principal factorization using the maximum likelihood method and retaining one factor shows that the variables are related in expected ways and vary positively with each other (Table 4). Increases in any of the six variables – contraband, readiness for fire control, occurrence of clearing forested areas, severity of clearing, and lack of rules for gathering fuelwood or wood for domestic use – indicate less rule conformance. The clearing variables carry the most weight, although all variables contribute to the loadings.⁸ Hypothesis tests indicate that the one factor performs better than no factors in explaining the data and that the first factor is sufficient to describe the data (at 10% significance level). Scoring the factor is an additional step that weights each variable to create the rule conformance index. We score this factor and multiply by (-1) so that increasing values indicate higher rule conformance (RC).⁹

The four forest condition variables describe the results of different natural and human processes. These variables appear to be more orthogonal to each other, meaning that each variable expresses a different aspect that is not closely related to the other variables. This is reflected in a more fairly even dispersion of weights in the factor loadings. In this case, a simple summation or average expresses practically similar information. As all variables expressing forest condition are measured in percentage of total forested hectares in each community or work group, the forest condition indicator (ECO) averages the number of hectares rated highly in soil maintenance, biodiversity and commercial qualities, in addition to percentage of hectares classified in the 30-60 cm DBH range.

⁸The principal component scoring, which drops the assumption of normality, results in weights comparable to the factor loadings.

⁹See Lam (1998) and Fujiie, Hayami and Kikuchi (2000) for other examples using principal components or factors as measures of performance in common pool resources.

Table 4: Factor Loadings

Rule Conformance, n=39		
Variable	First factor	Uniqueness
Fire control	0.54086	0.70747
Contraband	0.58941	0.65260
Clearing	0.95350	0.09083
Severity cleared	0.97997	0.03970
No fuelwood rules	0.29657	0.91205
No wood for domestic use rules	0.24472	0.94011
Ecological Condition, n=36		
Variable	First factor	Uniqueness
Biodiversity	0.24447	0.94024
Soil erosion	0.68725	0.52760
Commercial quality	0.32538	0.89413
DBH 30-60cm	0.53130	0.71776

3 Econometric Estimation

Standard ordinary least squares (OLS) and instrumental variables methods are applied to estimate two reduced form equations, one for rule conformance and one for ecological condition. Estimation is based on the following relationship:

$$y = f(X, Z, \epsilon) \tag{1}$$

where $y = \{RC, ECO\}$ is the dependent variable, X is a vector of organizational design variables representing broadness of community involvement in forest management decisionmaking, Z is the vector of proposed, relevant production and community characteristics and ϵ is the error term. The expected signs of the independent variables are illustrated in Table 5.

We propose that interaction at the General Assembly level between the forester and community membership represents broad participation and is expected to increase management effectiveness and quality of the forest. The degree to which local elite control has undermined the community's collective choice mechanisms would be partially captured by this measure. Community involvement takes the value 1, 0 otherwise, if the General Assembly is used as a forum for discussion of forestry management with the forester. Because of the

Table 5: Expected Signs

	RC	ECO
Organizational characteristics:		
Broad participation	+	+
Attendance rate	+	+
Production characteristics:		
Logging roads	-	-
Years of harvesting	0	-
Community characteristics:		
Income	+	+
Coffee production	-	0

way the data was collected, there is possible simultaneity between Assembly-level involvement and RC and ECO, as these three variables are based on the forester’s assessment. For example, a forester may want to present a favorable picture of his work and report both broad involvement in the community and high marks for rule conformance and quality of the forest. In a check for bicausality, RC explains the involvement variable at the 5% significance level in an ordinary least squares regression with a set of other variables, whereas ECO does not have explanatory power in an analogous check. The endogeneity of the forester-community involvement variable in the RC model will be explored in the econometric analysis.

We assume attendance rate to be exogenous and use it as a second characteristic of governance “functioning.” Here, attendance rate is a measure of community members’ willingness to participate in collective forums, where higher attendance rates increase the scope of information exchange among community members in contrast to elite control of community forestry. A few studies use attendance rate as an endogenous measure of cooperation (e.g. de Janvry, Dutilly, Muñoz-Piña and Sadoulet (2001)). Zusman (1988) relates attendance rate to economic performance but notes an imperfect correlation between the two variables. Where general meetings are more frequent, attendance rate may drop in otherwise “well-functioning” communities as the marginal benefit of individual participation at each meeting may decline. In this paper, it is expected to have a positive effect on RC and a positive but weaker effect on ECO.¹⁰ More people attending as a percentage of the community membership indicates a recognition of the General Assembly as a viable

¹⁰RC and ECO fail to explain attendance rate in an OLS regression. Although this is an informal statistical test of bicausality, it supports our assumption of its exogeneity.

decisionmaking forum. The face-to-face interaction and voting process, it is hypothesized, contributes to a flow of cooperative behavior. The ecological condition of the forest, however, is a stock variable which could also be tempered by historical use patterns (included in the model) and frequency of meetings (not available).

Production characteristics consist of kilometers of logging roads for both indicators and years of harvesting for the ecological condition indicator. Logging roads may positively or negatively affect the indicators as defined. Roads facilitate access, encouraging forest exploitation (Palo 1999), yet, easier road access can enhance responsiveness to fires and the application of silvicultural treatments. Years of harvesting could degrade and reduce forests and is expected to have a negative impact on ecological health. In the regression model for RC, the years of harvesting coefficient is restricted to zero.

General community characteristics include income and alternative uses of the forest, here represented by coffee production. The income proxy is the percent of persons receiving income from owner-operated stores in the community. We choose this as a proxy, assuming that the shops represent an availability of wealth to generate demand for goods. Communities in the sample are located at distances far enough from each other where the presence of a store offers a real convenience for local residents. This proxy has a positive correlation of $\rho \geq 0.5$ with other common well-being indicators collected in the national census, such as percent of households with drainage, refrigerators, televisions and indoor lavatories, and is negatively correlated with percent of households using fuelwood as a source of energy, thus giving a degree of confidence in our choice of proxy, which is expected to have a positive impact on both indicators because of reduced reliance on marginal activities that degrade the forest.

A significant source of nontimber forest income, coffee grows in the warmer regions of Oaxaca and correlates positively with lower altitudes. Under the shade-tree method practiced in these regions, coffee plots compete with timber production, as they require shade best provided by broad-leafed trees with less commercial value. The variable for coffee production takes the value 1, 0 otherwise, if coffee production occurs in the community. Coffee production is expected to have a negative effect on RC as individuals are tempted to change the species mix to undermine the pine-oak structure, despite an increased incentive to

respond efficiently to fires to protect the coffee plants.¹¹ In addition, coffee prices during the nineties were decreasing, which could have put more pressure on farmers to diverge from group rules.¹² The effect on ecological condition is more ambiguous. ECO measures degradation of the forest in soil retention capability, biodiversity and commercial potential. While shade-tree coffee plots support soil retention and biodiversity (Perfecto, Rice, Greenberg and Van der Voort 1996, Blackman, Albers, Avalos and Crooks 2002), their cultivation may erode timber value represented by pine species without loss of tree cover (Blackman et al. 2002).

A vast literature on deforestation suggests a list of micro- and macroeconomic indicators to consider in predicting human impacts on forest cover. However, there are few variables which give consistently similar results across studies. In a review of the deforestation literature, Angelsen and Kaimowitz (1999) finds that population growth and national income have ambiguous effects across empirical studies, while more road infrastructure, increasing agricultural prices, lower wages and lack of off-farm employment generally increase deforestation rates. Institutional factors have received less attention, but some studies assess the connection (e.g. Bhattarai and Hammig (2001) and Panayatou (1997)). The lack of consensus on relationships suggests that even if an empirical model focuses on one variable of interest, a prudent approach is to check for effects of other variables common in the deforestation literature.

Additional variables associated with cooperation in the commons are also included in the empirical analysis, as well as vertical integration level, elevation and regional dummies. Heterogeneity in wealth, social status or culture can affect participation in common pool management, although it remains unclear from empirical evidence whether the effect is positive or negative (Varughese and Ostrom 2001, Baland and Platteau 1999, Banerjee, Mookerjee, Munshi and Ray 2001, Bardhan and Dayton-Johnson 2002, Kumar 2002). Land distribution as a measure of wealth disparity in the sample set is not directly available.¹³ We use membership status as our empirical proxy for heterogeneity, that is, the percent of households in which

¹¹Interviewees in communities with coffee cultivation expressed that they desired, within the limits of the law, to change the species mix from pine to broad-leaf and oak tree species because pine needles were not a good mulch (*abono*) for the coffee plants.

¹²Thanks to Allen Blackman for suggesting this point.

¹³Inequality in access to land can evolve over time even in agrarian communities that initially allot full members an equal amount of land for agricultural use. Informal internal land markets, encroachment on the non-parceled commons area or divisions to children in the *comunidades* can lead to imbalances in land access (Alain de Janvry, pers. com.).

a resident does not have full membership status¹⁴ (as *ejidatario* or *comunero*). Non-registered status means that an individual cannot attend General Assemblies nor have access to common pool benefits, like revenues generated from collective timber operations. As our argument purports the expected explanatory power of organizational characteristics, we do not anticipate any significant effect from variables other than the production and community characteristics noted in the table.

3.1 Results

We begin by first analyzing the forester-community interaction alone and then adding the intracommunity measure in ordinary least squares regressions. The number of observations available for hypothesis testing is less than the full survey sample due to missing data, and one observation was dropped because of an incomparable forestry organization. For both performance indicators, forester communication through the General Assembly has a positive and significant impact (Table 6, Equations (1) and (4)). Other measures of forester-community involvement along narrower channels had no explanatory power for either indicator (not shown).

Production and community characteristics have varying explanatory power. Coffee production and logging road infrastructure both have the expected negative and significant sign in RC, but insignificant signs in ECO due most likely to their ambiguous relationship to ecological condition. To check whether the coffee dummy was masking differences due to elevation, meters above sea level was added to the regression model. This measure produced insignificant explanatory power for rule conformance while the coffee dummy maintained significance, thus favoring the interpretation that the system of individual coffee plots does not necessarily promote group rule conformance in forest management. However, elevation is significant and positive at the 10% level for the ecological condition indicator. This effect works through the soil retention and biodiversity components of the ECO measure, as these qualities may have been better protected at higher elevations.

The income proxy has the expected positive and significant sign for both indicators.¹⁵ Years of harvesting

¹⁴These persons would mostly be classified as *posesionarios* or *avecindados* under Mexican agrarian law.

¹⁵The other measures of well-being obtained from Census, such as percent of households with drainage, electricity, gas stoves and those using fuelwood were alternately substituted for our income proxy and returned qualitatively similar results.

has a negative and significant impact on ECO, suggesting that forests subjected to a longer history of timber extraction have experienced more degradation. Overall, the model fit is much more satisfactory for RC than for ECO according to the R^2 goodness-of-fit measure. This set of regressions shows that, except for the forester-General Assembly involvement variable and income, variables influencing RC are distinct from those explaining ECO. The ECO model is more limited in its explanatory power but shows that broad communication of information in General Assemblies and higher income promote both rule conformance and quality of forest attributes, while historical logging practices additionally affect current quality of the forest.

Other variables associated with cooperation in the commons and deforestation were alternately added to Equations 1 and 4 (results not shown). Measures of population (log), population density relative to forested hectares, size of forested holdings, proximity of the village center to the forest, percent of non-*comunero* households representing heterogeneity in political status, existence and level of CBC payment and dummies for mountainous regions, Sierra Sur, Sierra Norte and history of parastatal leasing were tested but did not return significant results for either RC or ECO.¹⁶ Parcelization of forests among community members (even if managed under a common management plan) has a negative and significant effect (at the 5% level) on RC but zero impact on ECO. We tested several combinations of regressors with variables for proximity of the village to other population centers, with differing results across indicators. Closer proximity to the capital city of Oaxaca, measured as the number of driving hours from the village center to the capital, has no significant effect on RC but maintains a positive and significant effect (at the 10% level or better) on ECO. Closer proximity to a large population center (other than the capital city) has a negative and significant effect (at the 10% level) on RC but zero impact on ECO. The increased demand for fuelwood and wood for domestic use near population centers could encourage contraband harvesting, while access to the capital, where SEMARNAT offices and professional foresters are concentrated, facilitates technical assistance and silvicultural services, possibly explaining the positive results for ECO. The result for RC is consistent with studies claiming that proximity to population centers impedes cooperation (e.g. Abraham and Platteau (2003)), but is contradictory to those that predict a positive effect (de Janvry et al. 2001). The positive or zero impact of proximity to population centers on ECO contradicts studies of deforestation insofar as quality

¹⁶Further details are available from the authors.

of the forest stock is related to deforestation.

Vertical integration into the wood products market is not significant for either measure, indicating a range of production possibilities which are consistent with forest conservation and management goals within the community governance framework. Any added market access that vertical integration represents does not affect the measures of RC and ECO in this sample.¹⁷

A second set of regressions introduces the attendance rate variable, for which the available number of observations is smaller (Equations (2) and (4)). Although, the model fit for RC is again more satisfactory than for ECO, both regressions exhibit interesting patterns. Attendance rate at Assembly meetings has explanatory power for RC but negative and insignificant impacts on ECO. This implies that while a community may be collectively investing in its resource base, the process may be slow to register currently discernible improvements in the resource stock or the sample size is too small to pick up significant variations. The forester-community involvement variable maintains explanatory power in both equations at the 10% level or better. The income proxy loses significance in the ECO regression. Coffee production, again negative and significant in RC but insignificant in ECO, as practiced with the shade-tree method in Oaxaca, does not promote cooperation with group rules to manage the overall forest resource. The result suggests that where people have individual coffee plots, the incentives for group cooperation are likely to decrease, consistent with Ostrom (1990)'s conditions for long-lasting common property management systems (particularly low discount rates, homogeneous effects across stakeholders and burden of adhering to group rules). On the other hand, coffee production does not inevitably lead to forest degradation.¹⁸

To check for multicollinearity, we use the variance inflation factor (VIF) technique that calculates the multiple correlation coefficient of the explanatory variables (Chatterjee and Price 1991) in regressions reported in the tables. All VIFs are less than five and mean VIFs less than 2.50, well within the rule-of-thumb

¹⁷This is consistent with previous research which found that the form of contractual arrangement primarily affects investments specific to the commercial production process with an outside buyer and conducted at the community forestry enterprise level (Antinori 2000, Antinori and Rausser 2000), whereas rule conformance and ecological condition of the forest are general performance outcomes subject to the actions of the entire of community membership influenced by community governance characteristics. The vertical integration variable is exogenous as integration decisions were taken several years prior to 1998, the year in which the ecological indicators apply, and most stumpage communities had been harvesting as such for several years.

¹⁸We explored the ECO relationships by regressing each component of ECO on the set of independent variables in the base model. We found that the forester-community involvement variable holds its positive explanatory power only for commercial quality, suggesting that forester interactions in General Assembly meetings may be mostly oriented towards supporting industrial forestry goals.

Table 6: Estimation Results for Forestry Indicators

	Rule Conformance			Ecological Condition	
	OLS (1)	OLS (2)	IV (3)	OLS (4)	OLS (5)
Involvement of community	1.58** (6.57)	1.37** (3.89)	1.27** (2.22)	0.20** (2.87)	0.19* (1.91)
Attendance rate	–	0.58** (2.58)	–	–	-0.02 (-0.37)
Coffee production	-0.86** (-3.93)	-1.13** (-4.16)	-0.85** (-3.80)	-0.07 (-0.97)	-0.03 (-0.43)
Kilometers of logging roads (log)	-0.33** (-3.12)	-0.23* (-1.91)	-0.30** (-2.37)	0.004 (0.14)	0.01 (0.32)
Years of harvesting	–	–	–	-0.02* (-1.83)	-0.03** (-2.31)
Income	0.13** (3.58)	0.14** (2.25)	0.11 ** (1.98)	0.03** (2.53)	0.01 (0.86)
Constant	0.23 (0.57)	-2.02** (-2.33)	0.35 (0.75)	0.45 (3.67)	0.61** (2.93)
Number of observations	38	19	38	35	17
Prob. > F	0.00	0.00	0.00	0.08	0.39
R^2	0.63	0.86	0.62	0.28	0.42

Numbers in parentheses are t -statistics. “***” denotes statistical significance at the 5% level and “*” at the 10% level.

standards, so that evidence of multicollinearity is weak.

We use instrumental variables to check for endogeneity in the RC model between forester-General Assembly involvement and rule conformance. The choice of instruments entails identifying variables that correlate with the right-hand side variable in question but do not correlate with the error term. The magnitude of the instrumented General Assembly involvement variable in Equation 3 declines but maintains its significance. The Hausman statistic equals 0.35 with one degree of freedom, thus it fails to reject the null hypothesis that there is no significant difference between the OLS and IV estimators. We conclude that the OLS estimators are consistent and that the model is fundamentally sound.¹⁹

4 Conclusion

Rural community governance has a long history in Mexico, with political significance for natural resource management and devolutionary strategies. The fairly recent transition into community timber production has introduced a new economic role to which rural institutions are adapting. A question is which kind of decisionmaking processes produce measurable results in achieving community-accepted forestry management goals. The experimental literature suggests that communication among stakeholders consistently promotes cooperation in common pool resource use. In the field, research must analyze which governance mechanisms allow appropriate information exchange to occur. As empirical research is scant and common pool resource institutions typically complex, a reasonable approach calls for contextual description along with quantitative analysis to get beyond general notions of participation and local control.

Given state-proscribed management systems, we develop variables to measure the degree of broadness of resource management decisionmaking in the community and test the hypothesis that larger degrees of openness influence rule conformance and ecological condition of the forest, measured as multidimensional constructs of individual actions and ecosystem qualities, respectively. We find that broad-based participation

¹⁹Three instruments which meet the criteria for applying the instrumental variables technique are vertical integration level, local hiring by the forester, and years the forester has worked with the community. Each instrument is positively correlated (ρ equals approximately 0.30 for all three instruments) and uncorrelated with the error term in Equation 1. We grouped the first two variables as one set of instruments and the latter separately. Each instrument in each set explains the involvement variable at the 10% level or better in OLS regressions. The first set of instruments, that is vertical integration and local hiring, were used in Equation 3, although the second set (years forester has worked with community) also returned a Hausman statistic that fails to reject the null.

between the forester and the community members in the General Assembly forum is a significant predictor for measures of rule conformance in forest uses and ecological condition. Further, higher attendance rate at forestry-related meetings has a positive impact on rule conformance. A lesson to be drawn is that the modes of the state and private sector interaction at the local level matter. Even where some decisions are delegated to specialized subgroups in the community, it is suggested that government officials and professional service providers incorporate broadly inclusionary forums for presenting technical information, as general assemblies are often a sounder forum for information exchange. Their use may indicate a functioning governance system, all the more so in Mexico where the local General Assembly has a long history and remains the recognized, supreme governing body at the local level.

The research suggests several avenues for further research. First, the research approach used in this paper could be generalized to community management efforts elsewhere in the world where technical expertise combines with community governance systems and local knowledge in resource management. For devolution to succeed, the characteristics of access to the decisionmaking process should be evaluated further. Finding a balance between the need for specialized committees and broad inclusion into decisionmaking is one of the challenges of devolutionary policies. Use of open processes and forums, where they exist, promotes cooperation with rules and status of the resource but takes an understanding of the appropriate local governance mechanisms. Second, the relative performance of management effectiveness versus ecological condition indicates that institutional factors affect forest quality differently and requires more physical measurement of ecosystem characteristics. As always, much work remains in capturing socio-politico-cultural nuances in empirical analysis and linking measures to a theoretical framework of collective action.

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