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Social Capital and the Governance of Forest Resources

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Given recent research linking forests and the global carbon budget, forest management has become a central political issue at the national and international levels. If forests are to play a central role in reducing the threat of global warming as well as other important environmental issues, government policy toward forest management becomes pivotal. To improve outcbmes, contemporary forestry policies in developed and developing countries seek to shift some control over forest management to the community level. In a fundamental sense, such community level forestry policies seek to use the social capital of communities to help manage forests. But despite the centrality of social capital to community forestry plans, neither national governments nor international bodies have a very good understanding of the role played by social capital in forest management at the local level. Since communities through forest management could represent a solution to important environmental concerns, we argue that it is critical to understand the role played by social capital in the community-level management of forests. This paper seeks to evaluate the role of social capital in the local governance of forests. It does so by analyzing cross-national, panel data gathered at the community level in 47 forests representing 7 countries. We find that different measures of social capital have a measurable effects on the condition of forests. Taken together, there is evidence that social capital matters to forest conditions, regardless of national government policy.

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1. Introduction

Given recent research linking forests and the global carbon budget, forest management has become a central political issue at the national and international levels. For centuries governments have contended with the local consequences of forest harvesting, such as river siltation, soil erosion, and loss of wildlife. Over the past few decades, however, scientists have also noted the ecological roles forests play at the regional and global levels, including climate change. With emerging evidence that forests sequester a significant quantity of carbon - the same carbon that leads to global warming - the importance of forest management has been placed squarely on the agendas of policymakers, as evidenced by the United Nations Framework Convention on Climate Change and the subsequent Kyoto Protocols.

One of the major policy strategies currently being promoted is the creation of a market in carbon. Since trees remove carbon from the atmosphere less expensively than mechanical methods, those countries which generate excess carbon could buy carbon credits from those countries with excess trees. While the mechanisms for this market are yet to be worked out in full, some exchanges have already taken place.

If forests are to play a central role in reducing the threat of global warming, government policy toward forest management becomes pivotal. Until very recently, policy responses to forest management have employed two general strategies: privatization and nationalization. With privatization, governments allowed the development of forested lands, generally with little thought to good forest husbandry. With nationalization, governments hoped to pass and enforce laws that would harness the use of forests for economic development. Both strategies have led to mixed results. In the first waves of the industrial revolution, most forests in industrializing countries had been severely depleted. Only in the latter half of this century has significant reforestation occurred (albeit with far less species diversity). Forests in developing countries are still significant sources of timber, fuel, and additional agricultural land, and the rates of forest degradation are not diminishing significantly. Thirty years of foreign-funded, state-level forestry projects in these countries have brought far more failures than successes (Arnold 1992).

To improve outcomes, contemporary forestry policies in developed and developing countries seek to shift some control over forest management to the community level. Recognizing that communities may have the ability to monitor and enforce rules about forest use, policymakers have turned to various ways of devolving authority over forests to local people, usually without privatization. These policy moves signal that some governments are beginning to realize that the 500 million people who live in and around the world's forests will greatly determine the success or failure of their forest policies.

In a fundamental sense, such community level forestry policies seek to use the social capital of communities to help manage forests. Communities enjoy different levels of social capital with which they can enhance, filter, alter, or ignore a central government's forest policy. They also can create their own rules, generating local institutions and patterns of activity that can diverge widely from the expectations of legislators and bureaucrats. Community forestry projects seek to harness this social capital and direct it ways they determine to be appropriate, such as sustainable timber production or conservation.

Despite the centrality of social capital to community forestry plans, neither national governments nor international bodies have a very good understanding of the role played by social capital in forest management at the local level. Since communities could represent a solution to the threat of global climate change, since governments have begun to rely increasingly on local level forest management, and since markets for carbon are currently being constructed, we argue that it is critical to understand the role played by social capital in the community-level management of forests.

This paper seeks to evaluate the role of social capital in the local governance of forests. It does so by analyzing cross-national, panel data gathered at the community level in 47 forests from 7 countries (Uganda, Bolivia, Brazil, Nepal, Guatemala, Honduras, USA). We find that different measures of social capital have a measurable effects on the condition of forests. Taken together, there is strong evidence that social capital matters to forest conditions, regardless of national government policy.

We begin the analysis by addressing the past and current links between politics and forest resources, and the evolution of national forestry policy. In section four, we discuss the concept of social capital that we employ in this study. In sections five, six, and seven we describe the variables, their measurement, and the analysis used to measure the social capital and capture its effects. We discuss the implications of our findings in section eight.

2. Forests and Politics

Forests are inherently political. They have been mined for their resources, removed for agriculture, burned and planted as part of colonization efforts, and used by both militaries and their enemies as training grounds and hiding places. Access to these resources have made forests subject to both high and low politics for centuries.

Given growing concerns about the environment, the ecosystem services of forests have increased their possible economic and political values. Forests play significant roles in soil, water, and wildlife conservation. Such ecological concerns were usually in the political purview of entities related to the geographic extent of the problem. While the transboundary nature of many ecological issues have catapulted certain environmental issues (e.g. fish migration, acid rain) into the international spotlight, forests themselves had not, until more recently, been the object of as much bilateral or multinational negotiation.[1]

The growing consensus about the role played by forests in the global carbon cycle has changed all that. Data show that anthropogenic increases in the amount of greenhouse gases may threaten global climate patterns. Carbon dioxide (CO_2) is one of the most significant of these gases: it is highly reflective, has a long atmospheric lifetime, and is produced by human activity in large quantities (an estimated 50% of global warming changes can be attributed to CO_2) (Richards 1997: 5). There are two major strategies to limit the problem posed by increasing amounts of CO_2: (1) limit overall emissions (Nordhaus 1992; Marine and Richels 1990, Krause et al. 1993) and (2) remove CO_2 emissions from the atmosphere. The former can be politically and economically costly, especially in the short run. The latter creates a new way to value forests.

Through the photosynthetic process the earth's forests annually remove tons of carbon from the atmosphere, acting as carbon "sinks" for the world.[2] Studies indicate that increasing the size of forests could extract significant amounts of carbon dioxide from the atmosphere (Moulton and Richards 1990). Further, the planting of forests may be substantially cheaper than any mechanical way to extract carbon from emissions.[3]

By signing the Framework Convention on Climate Change in 1992 in Rio De Janeiro, the national governments of 150 countries, placed forests squarely on the international political map.[4]

Those committing to the Convention agreed to work on and implement policies aimed at reducing, avoiding, or sequestering greenhouse gas emissions. While the language of the convention was left purposely ambiguous so as to gain more signatories, a crucial policy aspect was an agreement to return to 1990 emission levels, "individually or jointly." Joint implementation includes plans that allow industrialized countries to meet their emission reduction commitments outside their own borders (Richards 1996). Governments and companies are in the early stages of creating a market for "carbon credits": in October 1998 carmaker Peugot announced an investment of $10 million in a 12,000 hectare forest in Brazil to resolve its carbon excesses; in April 1998, Costa Rica announced it had sold 1 million "carbon titles"at $16 per title (El Mercurio 1998); Norway is constructing similar agreements with Mexico and Poland (Richards 1996). The United States Forestry Service has conducted its own research into the carbon sequestering potential in US forests.[5]

3. The Emergence of the Local in Forest Management Policy

Forest policy has undergone pronounced change over the last thirty years. While forest policies vary from country to country ~ especially between developed and developing countries ~ some general trends exist. Until and through the 1960s, forest policy had been technically-oriented, focusing on the commercial aspects of forest management. Forests could either be managed by the state or by private entities, but in either case it was seen as a valuable natural resource whose protection was ensured by the value of its stock and flow to the market. If the land underneath the trees was considered more valuable than the wood, governments generally did not stand in the way of forest clearing (Richards and Tucker 1988). This orientation also found its way into overseas aid programs: industrialized countries promoted the scientific, professional management of forest resources to meet economic goals of the governments of less developed countries. Vast timber plantations were the prescription of the day.

The confluence of the failure of most of the plantation projects and increasing understanding about the ecologically valuable roles played by forests in the 1970s shifted subsequent forest policies. In the late 1970s international donors, seeing the failures of top-down policies, began to sponsor forest projects that included the participation of local people. Timber plantations were downsized into community wood lots using local labor. However, these, too, met with mixed success. Although local people did participate in some ways, they rarely had input into the design of the projects. Donors rarely considered constructing institutions to help distribute program benefits or adjudicate disputes (Thomson and Freudenberger 1997; Persson 1998).

The 1980s witnessed the rise of community forestry, which sought to look first at community needs and then design a local forest program around them. Ideally, locals began to be included in all phases of project design, with the technical help of professional foresters. In many countries, community forestry coincided with efforts - domestic or external in origin - to decentralize and downsize governments. Dozens of countries founded community based programs of forest management, such as the Joint Forest Management in India, the Leasehold Forestry Program in Nepal, the Guesselbodi Project in Niger; the Turkana Rural Development Project in Kenya, and the Bay Region project in Somalia. Because local communities live with forests, are primary users of forest products, and create rules that significantly affect forest condition, their inclusion in forestry management schemes is now considered essential by many researchers and policymakers (Arnold, 1992). Research on common pool resources provided intellectual support for this shift in policy. Studies from around the world demonstrated that, under certain conditions, local communities are able to construct and implement their own rules about resource use, and that these rules could generate equitable and sustainable outcomes (e.g. Ostrom 1990, Bardhan 1995, Berger et al., forthcoming).

4. Social Capital as a Policy Resource

These community-level forestry management programs seek to use community-level social capital to enhance their chances for success. Because most central governments in the developing world do not spend the funds necessary to monitor and enforce their own forestry policies, participation by local communities becomes one way to augment the dearth of personnel and equipment. Local communities have a great deal more knowledge about the people who use a forest and, theoretically, can bring to bear their own sets of informal and formal institutions to monitor and sanction individuals where governments fail to reach. Governments and non-governmental organizations alike want to harness local sources of social capital to help meet their forestry goals.

We define social capital as the shared knowledge and understandings that individuals, who regularly interact with one another, bring to recurrent activities (Coleman 1988, Ostrom 1992). As individuals relate to one another regularly, they may develop trust, norms, rules, and expectations about their patterns of interaction. When this occurs the have more information, and can coordinate activities at a lower cost and credibly commit themselves to sequences of future actions. The presence of social capital is particularly important when individuals face collective-action situations where they might easily follow short-term, maximizing strategies that leave them worse off in comparison to the outcomes that could be achieved given available strategies.

Social capital is a real form of humanly-constructed capital, but one that is somewhat more difficult to measure than physical capital or human capital. All forms of capital involve using time and effort today to build assets and capabilities for tomorrow. The task can be one that provides benefits to large numbers of people or is harmful to others. (Weapons plants are physical capital devoted to destruction. Cartels use social capital to build alliances to benefit themselves and harm consumers.) Capital may be highly specialized and usable for a limited set of tasks or much more general and fungible.

As Fukuyama (1995) has stressed, different societies have tended to build different types of social capital that vary in their capacity to be useful across diverse settings. If individuals grow up placing primary importance on intensive relationships with their own family and distrusting outsiders, the level of social capital within families may be high, but not available for building more extensive networks of associations. On the other hand, if individuals grow up in an environment where they are taught to trust others (until shown wrong), it may be much easier to develop extensive networks of associations that enable individuals to create larger scale and effective organizations at relatively low cost. Thus, it is important not to view social capital as some magic ingredient that is developed everywhere in the same way and is always devoted to positive objectives. Coleman makes this clear: "A given form of social capital that is valuable in facilitating certain actions may be useless or even harmful for others" (Coleman 1988: 598; see also Portes and Landolt 1996, Dreze and Sen 1995)

Social capital shares fundamental similarities with physical capital and individual human capital. Some human-made capital is developed as a by-product of enjoyable activities. Hiking along the same trail produces enjoyment as well as keeping a physical trail open. Swimming is fun as well as an important way to build individual health. Playing sports together is a source of entertainment as well as teaching groups how to work together for a common goal. Building capital as a by-product of enjoyable activities is, however, not the only way that effective capital is developed. When individuals face challenging problems to solve - such as those involved in reducing the overuse of local forest resources - they have an advantage in solving these tough problems if they all live in one village, know one another well and have already developed some forms of association. It would be naive to think that these prior associations will automatically lead to the development of appropriate strategies for sustaining local forest conditions. Individuals who solve difficult collective action problems have to build new social capital to fit the specific problems they face.

A growing body of work is now exploring the relationship between social capital and a variety of political and economic outcomes. Putnam's well known studies attempt to link levels of social capital with government performance (1993a; 1993b). Others have studied the effects of social capital on credit (Campos and Root 1996), local economies in post Soviet eastern Europe (Rose 1995a, 1995b), contributions to household welfare (Townsend 1994, Narayan and Pritchett 1996), water distribution (Hino 1993), as a replacement for formal economic institutions (Knack and Keefer 1996, Stone et al. 1992), education (Coleman and HofFer 1987, Francis et al. 1998), health (Dreze and Sen 1995), preventing policy implementation (Holmes 1997), and the economic well being of ethnic groups (Portes 1995, Light 1995).

The importance of social capital has become especially evident in the realm of local level environmental issues. Local associations — and their concomitant social capital ~ have played key roles in the management of common pool resources such as water (e.g. Lam 1998), wildlife (e.g. Murphree 199i; Western 1994; Marks 1984), and fish (e.g. Singleton 1999).

Forests pose particularly difficult collective action problems. Forests produce numerous products (e.g. timber, fuel wood, fodder, game, fruits, and ecological services) over different areas, each of which can possess different production cycles. Many of these products can be taken without being easily detected. The land beneath the trees is often more valuable to individuals in the short run than any bundle of other products. And the ecological services of forests presents all the free rider problems or a public good. And yet even in the case of forests, social capital in various forms has been identified as a significant variable in explaining the success of local level forest management and forests (e.g. Shephard, 1992; Merino, 1997; Alcorn and Toledo, 1998).

Given the possibility that social capital can do what central governments cannot in the realm of environmental policy, the efforts of many policymakers and donors have been focused on the development of community-level natural resource management.

5. Social Capital and Forests

Despite a growing consensus as to its importance, measuring social capital and its effects faces significant challenges (Grootaert 1998, Narayam and Pritchart 1997). The fundamental problem is trying to understand the direction of causality, i.e. determining whether an outcome being studied is an effect or a cause of social capital. In this study, the condition of the forest may be more important as a motivating factor for the emergence of social capital, rather than a variable dependent on social capital. Factors may also have an independent effect on a forest's condition, as well as an effect on the creation of social capital which, in turn, may have measurable effects on a forest. For instance, unless there is moderate scarcity and unless folks find forest salient (e.g. are dependant on it for something important to them), they are unlikely to develop or employ any social capital related to the forest (Gibson, forthcoming). Aware of these issues, we proceed in trying to measure the independent effects of important factors on forest condition.

Of course social capital alone cannot be the only factor contributing to collective action. The human capital of the community members as well as the physical attributes of the forest create conditions that can foment or retard collective action. In this analysis we examine the impact of four clusters of variables on forest conditions: attributes of user groups, attributes of forests, the local rules governing a forest, and the pattern of interaction among forest users. Some of these variables attempt to measure directly the level of social capital in a group. Others attempt to capture the costs of collective action regarding the self-governance of forest resources. All of them have been considered important in either the growing literature on social capital or the management of natural resources, or both. We expect that these variables will affect the likelihood that user groups will develop effective forms of social capital. We also assume that higher levels of social capital will lead to positive measures of forest conditions.[6] We explore each of these variables below.

Attributes of User Groups

The IFRI research protocols define the user group as "individuals who share and execute the same customary and/or legal rights to a product(s) from the same forest."[7] It is important to note that this concept does not require that the group be organized. The fieldwork upon which we base this study identified all of the groups using a forest, both organized and unorganized..

Size of User Group

Ever since the important work of Mancur Olson (1965), scholars have posited that smaller groups were more likely to overcome collective action problems than larger groups. Olson and others argue that smaller groups are able to keep transaction costs low, develop common norms, and to monitor each other more effectively than larger groups. More recent research has demonstrated that the effect of group size on collective action may not be so straightforward. The importance of size depends very much on other parts of the problem that users face, and thus the rate of increase in the costs and benefits of collective action may not be linear with size. For example, Agrawal (forthcoming) argues that smaller groups may be substantially disadvantaged in terms of having adequate resources to undertake a collective project even if they wanted to. Agrawal argues that the relationship between size of group and achievement of collective action may be curvilinear with both small groups and larger groups at a disadvantage.

Nevertheless, while considerable controversy still exists concerning the direction of its impact, we assume that costs and benefits are linear with user group size in these cases and hypothesize that size will be negatively related to forest condition. If the user group is organized, we argue that costs will increase with organizational efforts, and reduce the effectiveness of the group's institutions. If the user group is unorganized, an increase in the size of the group would translate into additional pressure on the forest's resources. In either case, increased size should be associated with poorer forest condition.

Age of User Group

As user groups age, they have had more time to develop and to use social capital. Time allows individuals in a group to interact more, to generate more trust among members, and to encounter different challenges with which to contend. These actions will help generate social capital. We expect that the older the user group, the more likely they enjoy higher levels of social capital, which in turn will have a positive effect on a forest's condition.

Education of Group Members

Education is often viewed as positively correlated with solving collective action problems. As a form of human capital, education allows individuals to make decisions from a larger choice set than individuals who are less educated. But education can be used for more than just cooperative ventures. The decades of research in the development field indicates that educated individuals are more likely to be entrepreneurial and more likely to have contacts with markets. Education thus may lead individuals to make choices that do not help a group's goals, but advance the interests of the individual. The more educated person, therefore, may plunder a forest rather than enter into any form or collective management. Thus, there is no clear theoretically based prediction for the effect that education may have on forest condition.

Reason for Group Formation

Groups are formed in many ways. Given recent policies of some government and conservation organizations, groups may be formed exogenously. By this we mean that an external agent - a District Forester or staff from a conservation agency - creates a forest user group by holding a meeting in the area, and encouraging those who attend to form a group. Other groups are formed endogenously, using their social capital developed in one sphere to create a new arena for their collective action. In this case, participants themselves decide if, why, and how they should organize. While some of these groups may not have a fully articulated structure, they have decided on the structure that they feel is appropriate given the problems they are facing.

We expect the groups which form endogenously have a positive effect on a forest. Given that locals determined that it was in their interest to organize, we argue that such groups are more likely to be effective at constructing and sustaining their own rules than exogenously formed groups.

Dependence of Group Members on Forest Products

Research indicates that users will be more likely to engage in collective action related to common-pool resources when a resource is salient to them (Ostrom forthcoming; Gibson, forthcoming; Ascher 1995). One way that a forest becomes salient to users is that they are dependant on it for obtaining a proportion of key forest products from a particular forest. In our empirical work, we have recorded information about the dependence of users of a forest to provide them fodder for feeding animals, fuel wood for cooking and heating, and timber for building structures. Where applicable, we also have recorded user groups' dependence on a forest for non-consumptive products such as recreation and places of worship.

Although some dependence on a forest product can encourage individuals to engage in collective action, high levels of dependence may lead to the over-consumption of the resource.

We would expect that as dependence increases for important products, the quality of the forest would decline.[8]

Dependence on a product alone, however, may not affect a forest, simply because the quantities needed might be small. In our model, we measure dependence on the forest for fodder, fuel, and timber. Fodder and fuel are generally needed all the time, whereas timber - at least for the local community — is not. Thus we posit negative values for fodder and fuel, and predict no direction for dependence on timber.

Attributes of the Forest

Theoretically, we expect four characteristics of a resource to affect the likelihood of collective action: moderate scarcity, reliable indicators, predictability, and spatial extent (Ostrom, forthcoming). In this study, we measure only spatial extent. By spatial extent we mean that the resource system is sufficient small, given the transportation and communication technology in use, that appropriators can develop accurate knowledge of external boundaries and internal rnicroenvironments. We measure spatial extent in two ways.

First, we record the size of the forest. Larger forests not only cover more territory, but they also have longer borders that may have to be defended from others' predations. Consequently, larger forests should be associated with higher costs of organizing collective action, and thus poorer forest conditions.

But forests are not all the same. Certain vegetation types (dense tropical forests) make monitoring the use of the forest much more difficult that other types (relatively open pine forest). Thus another way to measure spatial extent is assessing whether it is easy to observe users either entering or leaving a forests or while they are harvesting. Where users are more observable by others, we expect lower costs of collective action, and thus a higher probability of improved forest conditions.

Type of Rules

Groups that successfully overcome collective action problems develop commonly understood norms or rules that participants agree upon as guiding their behavior. These rules are a direct form of social capital. When collective action is focused on the management of a common-pool resource, participants generally must design and enforce rules related to entry and use patterns and not simply rely on shared norms. The temptations involved in managing these systems over the long run are substantial and without enforced rules-in-use, achieving better forest conditions is highly unlikely.

In this study we measure the existence and enforcement of three kinds of rules. The first rule is the restriction of who is allowed to enter and harvest from the forest. Such a rule is a necessary part of any successful resource management. Without such a rule it is hard to ask anyone group member to restrict their harvesting activities since anyone else can come along and harvest whatever products at any rate they pleas. Without restrictions on entry and harvesting, resources become open-access and are liable to be overused, as pointed out by Garrett Hardin (Hardin 1968).

The second rule we consider is the restriction on the use of fires in or near to the forest. Fire is an important tool to many rural communities. Burning fields can be an important way that farmers increase the fertility of their soils. Fires are also a way to clear the undergrowth of a forest, so that newer grasses can grow to feed livestock. In some areas, fires are also used to help clear a forest for the establishment of an agricultural plot. In any of these cases, the use of fire can easily create unintended forest fires which can damage forest resources as well as sweep over other farms (Sorrenson, 1998). We expect that a group that establishes rules about the use of fire should be associated with a forest in better condition than where fires are not restricted, conditions.

A third important type of rule relates directly to the condition of the forest. If groups have an active role in managing a forest, they are likely to have rules about maintenance activities such as clearing the forest of unwanted weeds or obstacles, and the planting of seeds and seedlings. The existence of such rules would demonstrate a high level of organization by the group, and thus a high level of social capital.

It is difficult to say a priori, however, how the existence of these rules relates to a forest's condition. It could be that a group established such rules only when a forest's condition is degraded. Thus, a highly organized group with rules about maintaining a forest could be associated with poorer quality forests. For this reason, we have no expectations about the effect of maintenance rules on the forest, although we include it as an important indicator of social capital.

For all three types of rules discussed above, enforcement is key. If rules are not enforced at all, they soon become "non rules" and do not affect anyone's behavior. In many of the case studies of effective forest management we have studied, users tend to enforce their rules in a very moderate manner for the first infraction observed, and only impose severe sanctions after a user has broken the rules many times (Ostrom, 1990). We expect that the frequency of sanctions by user groups will be associated with better forest conditions.

Activity Levels

Besides designing rules to restrict the uses made of a forest, user groups may also require members to engage in activities that affect forest condition directly or indirectly. These activities build social capital as users relate to each other and form expectations about each other's behavior. Obviously, there are numerous activities unrelated to the forest that may be very important to the generation and maintenance of social capital. But if groups use the forest, they will likely perform activities that are directly related to the forest itself, such as harvesting, processing, and marketing forest products together, sanctioning outsiders who try to use their forest, and performing maintenance activities together. The more numerous these group activities, we would expect the more likely it is that the group enjoys higher levels of social capital. We expect that a higher activity level among group members will lead to better forest conditions.

6. Measurement

Since the IFRI data contain an immense amount of information about forests and the groups which use them, we use a multiple indicator approach to take advantage of this information and increase the reliability of each variable. This approach analyzes groups of variables that, *a priori*, are expected to measure the same concept. We use the idea that if two or more variables measure the same concept, they will be highly correlated. We began by identifying key concepts and the measure or measures that we expected would be associated with the concepts. Using factor analysis and varimax rotation, we evaluated whether the indicators measured the same concept. If so, each should load strongly on the first factor derived from the analysis. We dropped those variables clearly not measuring the concept, that is, those not loading on the first factor. We then performed a reliability analysis on the chosen measures. If Cronbach's

Alpha decreased when a single measure was deleted from a scale, that indicated that this variable was important for measuring the construct. In almost all cases the factor analyses identified the correct measures to use in a scale. A number of variables were dropped using this procedure, but that is expected given the large number of difficulties associated with measuring the abstract concepts discussed above. In our final analysis, we use 38 variables to measure the 19 concepts found in the following regressions.

Independent and Dependent Variables

Dependent Variable: Subjective Evaluation of Forests by Group Members; Evaluation by Foresters

In the IFRI research program, we collect a wide diversity of measures of forest condition that could potentially be used as the dependent variables in an analysis. In our field studies we do take a random sample of plots in each forest studied and conduct careful measurement of the trees, samples, and ground cover. For those analysis conducted within a similar forest biome, we can compare such measures as tree density, species richness, and basal area. Because the forests in this analysis are of different types — e.g. tropical moist, tropical dry, temperate deciduous — we needed to construct dependent variables that were independent of type. We employ two such measures. First, we use the subjective evaluation of the forest made by members of the groups who use it, based on a five point scale where five is "very abundant" and one is "very sparse." Second, the professional forester or botanist on each field team made assessments of the forest's vegetation density and species diversity. The same five point scale was used for each of these variables; the resultant combined scale ranges from 2 to 10.

Independent Variables

From the discussion of the likely important factors regarding forests and social capital in the previous section, we can construct a table of independent variables and the posited direction of the potential impact on forest conditions (see Table 1 below). The Data Appendix discusses how we constructed each of these variables from the raw data collected using the IFRI research protocols.

Table 1. Independent variables and predicted directions

Variable	Expected Direction
<u>Attributes of Users</u>	
Size of Group	Negative
Age of Group	Positive
Education	None posited
Group formed endogenously	Positive
Group formed exogenously	Negative
Dependance for Fodder	Negative
Dependance for Fuel	Negative
Dependance for Timber	None posited
<u>Attributes of Forest</u>	
Size of Forest	Negative
Ease of Observation	Positive
<u>Type of Rules</u>	
Restricting Entry	Positive
Restricting Use of Fires	Positive
Requiring Forest Maintenance	None posited
Enforcing Rules	Positive
<u>Activity Level</u>	
Activity Scale	Positive
Group Planting Activities	Positive

7. Data Analysis

Because of the small number of cases and resulting multicollinearity, we test the variables and their relationships using a Stein-rule estimator instead of ordinary least squares. The Stein-rule estimator performs much better based on a quadratic loss criterion. Further, we imputed some missing values for 13 cases, resulting in 47 cases for each regression. Details for both the imputation and estimation are provided in the Methodological Appendix. Tables 2 and 3 present the results of the regressions.

Attributes of the User Groups

Size, Age, Education, Reason for Forming Group, and Dependence

The independent variable measuring group size did not have any measurable impact on the condition of the forest. Although we had hypothesized a negative influence of size on forest condition, we were also cognizant of recent research that indicates size alone may not be a good predictor of successful collective action. More important are the different streams of benefits which can flow to individuals as group size increase, and these may not be linear (e.g., Arm 1999).

We hypothesized groups that have existed for longer periods should, all other things equal, have higher stores of social capital. While the estimation produced a small coefficient for age, the posterior distribution is largely centered on positive values. This is congruent with expectations that older groups would be associated with better forest conditions, and is an important finding for the role of social capital's influence on forests. Without understanding the importance of social capital, researchers might predict that older groups merely have more time to exploit these resources. Our finding indicates that time may also allow groups more interaction, more trust to develop, and more resource strategy innovation.

The estimation shows that one of measures of group formation, if an exogenous entity formed the user group, is strongly associated with a forest in poor condition. (Forest condition decreases by over 20% if users claim that their group was formed for any exogenous reason.) We hypothesized that an exogenously formed group was less likely to have a positive effect on a forest for a number of reasons: given its origins, the group may not be perceived as legitimate, its rules may not correspond to local conditions, and it would be less likely to be drawing upon and creating social capital. This can be a very important cautionary finding for those interested in forest interventions. (An alternative explanation for this result is that outside agents step in to create user groups when a forest is already in a highly degraded state; a time series analysis would help determine this.) The variable measuring the effect of endogenous reasons for group formation does not appear to affect forest conditions.

The education level of a group's members is also not a powerful predictor of forest conditions (zero is near the middle of the posterior distribution). The weakness of this variable could be a result of the multidirectional nature discussed earlier: higher education could help groups expand their strategies for collective action, but could also motivate individuals to expropriate resources.

The dependence variables for fodder and fuel have a strong negative effect on forest condition, as predicted. Interestingly, increasing reliance on timber has a strong positive influence on forest condition. This last result is perhaps the result of two factors. First, as discussed, a group may have a high dependence on a product but not use very much of it at any given time. In most rural areas, houses and fences require timber, but only infrequently and not in large quantities. Second, since timber might be valuable, user groups may take steps to take care of the forest that produces it.

Attributes of the Forest

The analysis indicates that neither of the two measures we employ for the size of the forest conforms with our hypotheses. Larger forests are associated with better forest conditions. This result is counterintuitive, because we expect a larger forest will be more difficult to manage. Further, the ability to observe others in the forest has a negative association with forest conditions, which is also contrary to expectation that the easier it is to observe others, the lower the costs of monitoring a forest. This result could be the result of the lack of time series data, in the sense that the ability to observe others in a forest may not be due to the forest's vegetation type, but may be because the forest is already in a highly degraded condition.

Type of Rules

Rules about restrictions on who can enter and use a forest and on the use of fire have the predicted and strong effect on forest conditions: the entry rules distribution is largely centered on positive values; if rules about fire exist they improve the condition of the forest. It is clear that social capital in the form of rules appears to be a major factor in determining forest quality.

The frequency of enforcing rules, on the other hand, has a negative association with forest quality. We had surmised that those groups who enforced their rules would enjoy better forest conditions. We conjecture that the independent effect of sanctioning reflects the more problematic user groups who have had to rely heavily on sanctions given that forest conditions are already poor and social capital in the form of commonly accepted rules have not already been developed. Since these data are not dynamic, we may be uncovering a relationship that indicates stronger sanctions result from poor forest quality.

Activity Level

While the analysis shows that overall user group activity levels are associated with forest condition, we find the type of activity makes a difference. Those activities related to regenerating a forest, such as planting seedlings, bushes, and trees, are negatively related to forest condition. This is reasonable given that a group would not undertake these activities if the forest were in good condition. Activities that are not remedial in nature, such as harvesting, processing, marketing, and maintenance, on the other hand, are strongly related to better forest conditions. This an important finding: a priori one might think that if groups have organized themselves around the extraction of resources from a forest it might lead to overuse. Our data indicates the reverse to be true. We would argue that such organized extraction activities may indicate that groups have discovered a long term interest in the successful management of their forest resources.

Evaluations of Forest by Foresters

We tested this array of independent variables with another dependent variable, using the summary evaluation of the density of vegetation and species in a forest made by foresters. This model supports our expectations much more modestly than the subjective measure of forest conditions derived from in-depth interviews with users (see Table 3). Forest size continues to have the positive sign as before. There is more evidence that user group size has a negative relationship to forest quality. There is a negative relationship between endogenous reasons for group formation, as well as exogenous reason, so this result is hard to understand. The remainder of the findings are consistent with earlier results.

The fit for this regression is not nearly as good as for the regression using subjective user group evaluation of the forest. The primary finding is that fewer strong relationships exists using this dependent variable. The evaluation of foresters, based on density of vegetation, is probably not as refined as that based on the subjective evaluations of user groups. Local groups have a much longer experience with the condition of a forest and reflect on those aspects of forest conditions that are important to those using the forest. Thus, we place more weight on analysis using the user group evaluation of the forest.

8. Discussion

Our analysis presents some evidence that social capital influences the condition of a forest used by local groups. The most direct measures of social capital employed in this analysis ~ the existence of rules followed by a group and their activity levels -- were associated with forests in better condition. The evidence suggests that the governance of local forest resources is related to the store of social capital available to individuals. The higher the level of social capital, the greater the chance that a forest is in good condition.

But this analysis also demonstrates that the study of the governance of natural resources at the local level is quite complex. While education might contribute to the tools individuals have to engage in successful collective action, our analysis indicates that it is more likely to contribute to the exploitation of forests. Dependence on a forest for products can also be double-edged. The type of product and its intensity of use could either help users perceive the need to engage in collective solutions to over harvesting, or the dependence may overwhelm such attempts as people seek to harvest what they can. Forest size's positive effect on forest condition is a puzzle, as we expected large forests to be associated with high transaction costs in monitoring.

Clearly further analysis is necessary using these rich data. Our models only attempt to measure each variables's independent effect on forest condition. There are many ways, however, to model the interaction between users and their forests. One is to model these data across time. While much of our information comes from case studies, members of our research program have begun to return to the original sites to collect a second time slice of data. Since rules about forest use take time to be observed in a forest's condition, dynamic analyses of rules and forests is essential. Another way is to use detailed biological data for the dependent variable of future studies. This confronts difficulties as the different types of forests have quite different biological conditions. But as our database grows, we should be able to construct studies using forests of similar type.

This initial analysis, however, remains important to the understanding of forest governance and forest condition. Since local communities will ultimately determine forest conditions in most parts of the world, regardless of formal institutions such as laws, study of the ways in which they construct or fail to construct rules about forest use is crucial. This study is a first step at the systematic comparative analysis of how community level social capital affects forest governance at the local level.

Data Appendix

Dependent Variables	IFRI code	Question	Scale	
Y_x - Forest Condition	gconditi	How do most individuals in the user group rank the condition of this forest?	I/Very sparse 2/Somewhat sparse 3/About normal 4/Somewhat abundant 5/Very abundant	Range: 1-5
Y_2 - Forest Density scale	fVegdens fspecied	Density of vegetation in forest is: Density of species in forest is:	I/Very sparse 2/Somewhat sparse 3/About normal 4/Somewhat abundant 5/Very abundant	Range: 2-10
Independent Variables				
Forest size	fsize	What is the size of the forest?	In number of hectares	
Observation of other user groups	fobserve	Are harvesters from different user groups readily observed by each other while harvesting?	0/No - I/Yes	
User group density	uindnum	Number of users per user group	Continuous	
Years user group in existence	yexist	Years since user group first formed	Continuous	
Education scale	perlit perprime	Percentage of literate users Percentage of users with primary education		Average of two percentages
Endogenous reason for user group formation	endog	Endogenous reason for forming group	0/Absent - 1/Present	Excluded category: Misc.

Exogenous reason for user group formation	exog	Exogenous reason for forming group	0/Absent - 1/Present	
User group interaction scale	uharvin uprocin uprocout umktin usanctou umaintin umaintou	Cooperative harvesting inside forest Cooperative processing inside Cooperative processing outside Cooperative marketing/sales inside Monitoring/sanctioning outside Maintenance inside Maintenance outside	1/Never 2/Occasionally 3/Seasonally 4/Year round	Range: 7-28
User group planting activities scale	uplantse uplanttr uplantbu	Planted seedlings Planted trees Planted bushes	I/Done once a year 2/Done every several years 3/Done about every 5 years 4/Done about every 10 years 5/Rarely done 6/Never done	Range: 3-18
User group sanctioning activities	usanctin	Monitoring/sanctioning inside	I/Never 2/Occasionally 3/Seasonally 4/Year round	
Dependence on forest for fodder	gfodl	Percentage of fodder needs supplied by forest		
Dependence on forest for fuel	gfuell	Percentage of fuel needs supplied by forest		
Dependence of forest for timber	gtimb 1	Percentage of timber needs supplied by forest		

Existence of rules restricting changes in forest scale	fmaint fseeds fweeding	Maintenance/improvement Types of seedlings/seeds that may be planted Methods of weeding in relationship to product	0/No I/Yes	Range: 0-3
Existence of rules relating to fire scale	ffirewhe ffirewhl	When fires may be started Where fires may be started	0/No I/Yes	Range: 0-2
Restrictions on forest entry	fresl fres2 fres3 fres4 fres5 fres6 fres7 fres8	Anyone can enter Anyone who is citizen of country Anyone who is citizen of this state/district Anyone who lives in nearby village Anyone who joins particular organization Anyone who is a member of a particular ethnic group Anyone who is a member of a particular extended family Anyone who shares in a particular enterprise	0/fresl 1/ fres2 - fres4 2/ fres5 & fres8 3/ fres6 & fres7	

Methodological Appendix

We faced two daunting data analysis problems in using the DFRI data set. First, there were considerable cases with missing values. Many of these variable values will be collected later, but at this time we have not been able to collect them. Some method is required to impute these values, or these cases must be omitted. We use an imputation algorithm that has nice properties (King et al, 1998) A second problem is that there are a small number of cases that include values for our two dependent variables. Ordinary least squares (OLS) regression does not perform well in situations like ours where there are many right-hand-side variables relative to the number of cases. We use a Stein-rule estimator that is capable of performing much better than OLS.

Missing Right-Hand-Side Variables

Omitting a case every time a right-hand-side variable (or variables) is missing would result in a regression with an exceedingly small number of cases. Furthermore, this type of deletion, often called listwise deletion, is not appropriate. At best, listwise deletion causes imprecision in estimates, and at worst, it causes severe bias. Thus, most imputation procedures are preferred to simply dropping cases.

We used the procedure developed by King et al. (1998) because it performs very well and is easy to implement. [FN-Some imputation programs can take days to impute the data. The algorithm we use is an adaptation of these more unwieldy methods, and King et al. provide an easy to use computer program to implement the procedure. The software and paper are available at http://Gking.Harvard.Edu.] The procedure uses an Expected Maximization with importance sampling (EMis) algorithm to obtain the expected missing values. The theory and implementation of the Emis is complicated and elaborate, so we will not detail the computations here. Those interested in the details can consult King et al. 1998.

We also used the imputation procedure implemented in the statistical software STATA. This program imputes data by conditioning every missing value on all other right-hand-side variables. The difference in coefficients produced between the two procedures is small in our case, so the results we present in the paper are using the King et al. procedure. Both procedures allow us to include 13 cases that would be lost if using listwise deletion.

James and Stein Estimation

It is well known by most regression analysts that OLS is BLUE, the best (most precise) linear unbiased (or average correct) estimator, if a few assumptions hold. What is less well known is that OLS, and maximum likelihood estimators (MLEs) in general, of which OLS is one, does not perform all that well compared to biased and inconsistent estimators. In fact, Stein (1955) showed that there exist alternative estimators that, although biased, are in another sense more precise. Using a quadratic loss function of the following form,

$$L(b,\beta) = (b - \beta)'(b - \beta),$$

where b is the estimated coefficient vector, and p is the vector of true coefficients, OLS can be "dominated" by another estimator (if the number of regressors is at least two or more), where dominated means that the OLS loss will always be larger than the alternative estimator. This Stein-rule estimator uses "dummy" non-sample information. Intuitively, OLS and MLE maximize fit to data. Thus, the estimates are fit so closely to the sample estimates that these estimates may perform poorly outside the sample. Since it is P, the unknown coefficient vector we are interested in estimating, and is based on a population rather than the sample, many methods that deviate from the optimum produced by OLS or MLE do better using quadratic loss. Scientifically, minimizing the loss function makes more sense than minimizing the variance of a smaller class of unbiased estimators.

Judge and Bock (1978: 240) provide a general version of the Stein-rule estimator that is easy to use and takes the following form:

$P^1 = [(l-k/b'X'Xb)]b,$

where k is a constant (see Judge and Bock 1998: 240-244), X is the design matrix, and b is the vector of OLS coefficients. This estimator strictly dominates OLS as long as there are two or more regressors. The Stein-rule estimator is particularly attractive in cases where there exist a small number of cases or high multicollinearity (often these coexist) because it is precisely these instances that optimizing fit to sample data provides the poorest generalization to the population being studied.

Why have social scientists not made use of this estimator. There are two reasons. First, the attraction of OLS as a BLU estimator and MLE with very attractive asymptotic properties is very appealing. But, more importantly, the variance-covariance estimator of the Stein-rule estimator depends on the true vector or parameters p, values we are trying to estimate! Thus, we cannot derive the uncertainty around the estimates that is as important for scientific reporting as the coefficients themselves.

There is a solution to the fact that the variance-covariance matrix for Stein-rule estimates cannot be computed analytically. Following Yi (1991), we bootstrap standard errors and report these in this paper. The procedure is a standard bootstrap, and Yi finds that bootstrapping produces reasonably good estimates of variability. We use a nonparameteric version of the bootstrap, meaning that we do not make a distributional assumption about the dependent variable of the regression.

The bootstrap proceeds as follows. We estimate the OLS coefficients (using the imputations described above) and produce the vector of errors. We resample the errors N times, and then compute the Stein-rule estimates from the dependent variables that are constructed from the errors. We repeat this step 1000 times, and from the 1000 vectors of Stein-rule estimates, we drop the lowest 5% and highest 5% for each coefficient. The extremes of the distribution of each coefficient then become the lower and upper limit on the 90% posterior distributions reported for each regression.

Note that we use the term posterior distribution instead of confidence interval. We do so because the Stein-rule estimator can be given a Bayesian justification, because Bayesian methods allow for the use of nonsanjiple information, which the Stein-rule estimator does use. Focusing on this distribution, rather than comparing thej coefficient to a standard error (which we did compute), does not require any parametric assumption to be majie. Interpretation of the standard error (the standard deviation for each set of coefficients) would require the assumption of normality.

Table 2. Non-parametric Stein Rule Regression Estimates of Forest Condition

Independent Variable		Coefficient	90% Posterior Distribution Range Lower bound	Upper bound
	Constant	2.74	1.27	4.22
Attributes of Users				
	Size of Group	-1.3e-06	-2.6e-04	2.3e-04
	Age of Group	2.4e-03	-4.3e-04	5.4e-03
	Group formed endogenously	-0.07	-0.69	0.56
	Group formed exogenously	-1.04	-1.96	-.019
	Education scale	-0.19	-1.16	0.71
	Dependence on forest for fodder	-1.08	-1.86	-0.33
	Dependence on forest for fuel	-0.67	-1.32	-0.06
	Dependence on forest for timber	1.17	0.51	1.78
Attributes of Forest				
	Forest Size	3.3e-05	2.6e-07	6.2e-05
	Ease of Observation	-0.47	-1.02	0.10
Type of Rules				
	Restricting Entry	0.17	-0.04	0.35
	Restricting Fire	0.83	0.53	1.11
	Requiring Forest Maintenance	-0.029 (0.13)	-0.25	0.18
	Enforcing rules	-.059	-0.82	-0.35
Activity Level				
	Activity scale	0.07	0.022	0.13
	Group planting activities	-0.07	-0.14	-0.003
	Number of observations	47		
	Mean squared error	0.913		
	R^2	0.595		

Table 3. Non-parametric James-Stein Rule Regression Estimates of Forest Density Scale

	Independent Variable	Coefficient	90% Posterior Distribution Range Lower bound	Upper bound
	Constant	6.47	3.42	9.36
Attributes of Users				
	Size of group	2.3e-04	-2.4e-04	7.1e-04
	Age of group	-0.001	-0.008	0.004
	Group formed endogenously	-1.87	-3.25	-0.48
	Group formed exogenously	-1.58	-3.26	0.11
	Education scale	0.62	-1.61	2.64
	Dependence on forest for fodder	-3.09	-4.92	-1.23
	Dependence on forest for fuel	-0.15	-1.33	1.06
	Dependence on forest for timber	1.21	0.003	2.40
Attributes of Forest				
	Forest Size	1.8e-04	6.4e-05	3.0e-04
	Ease of observation	-0.33	-1.55	0.89
Type of Rules				
	Restricting entry	-0.02	-0.41	0.36
	Restricting fire	1.08	0.50	1.66
	Requiring forest maintenance	0.10	-0.32	0.52
	Enforcing rules	-0.54	-1.06	0.004
Activity Level				
	Group activity scale	0.04	-0.07	0.14
	Group planting activities	-0.006	-0.15	0.13
	Number of observations	48		
	Mean squared error	3.423		
	R^2	0.578		

Notes

1. However, there have been various development projects featuring forests.

2. Estimates about the amount of carbon that forests can "fix" vary tremendously by author, by region, by species, etc. See National Academy of Sciences (NAS) 1991, *Policy Implications of Greenhouse Warming-Synthesis Panel;* Richards 1997.

3. Richards (1997) argues that most studies of the costs of carbon sequestration are seriously flawed. While they show enormous variation based on the estimation technique, many are in the $10-40 per ton range. The costs of filtering carbon mechanically at the source of emissions is roughly $50 per ton.

4. Framework Convention on Climate Change, 31 International Legal Materials 849 (1992).

5. Steve Raynor and Kenneth Richards, "I Think That I Shall Never See... A Lovely Forest Policy: Land Use Programs for Conservation of Forests," Proceedings of the Tsukuba Workshop of the IPCC Working Group III

6.The data for this analysis have been collected by a network of collaborating research centers who jointly participate in the International Forestry Resources and Institutions Research Program (IFRI). Field studies using a common set of protocols have been conducted in Bolivia, Nepal, Uganda, the United States, Guatemala, Ecuador, Madagascar, and India. The IFRI protocols contain multiple variables related both to the biophysical conditions of forests as well as extensive socioeconomic information about the presence of user groups, their rules, their activities, and their interactions.

7.See Ostrom et al., IFRI Training Manual.

8.These simple measures of dependence do not get at other related and important issues. For example, one interesting question is whether there is some difference between groups that are dependent on a forest for fodder or fuel wood which involve immediate needs or for timber which involves a longer time horizon. Another interesting question is whether user groups that are highly dependant on a forest for immediate survival needs (such as fuel wood and fodder) may place a higher demand on a forest and thereby lower the quality of the forest independent of the level of social capital present. Thus, if user groups are highly dependant on a forest for their fuelwood and fodder, holding other variables constant, we posit that they will have more difficulty sustaining their forest resources. On the other hand, user groups highly dependant on a forest for timber may overcome more easily overcome the temptation to overharvest. This is obviously affected by many other variables that cannot be addressed in this study as to whether the timber is sold commercially, whether transportation is available, and the commercial value of the timber they harvest.

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