Heterogeneity, Group Size and Collective Action: The Role of Institutions in Forest Management

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ABSTRACT

Collective action for sustainable management among resource-dependent populations has important policy implications. Despite considerable progress in identifying factors that affect the prospects for collective action, no consensus exists about the role played by heterogeneity and size of group. The debate continues in part because of a lack of uniform conceptualization of these factors, the existence of non-linear relationships, and the mediating role played by institutions. This article draws on research by scholars in the International Forestry Resources and Institutions (IFRI) research network which demonstrates that some forms of heterogeneity do not negatively affect some forms of collective action. More importantly, IFRI research draws out the interrelations among group size, heterogeneity, and institutions. Institutions can affect the level of heterogeneity or compensate for it. Group size appears to have a non-linear relationship to at least some forms of collective action. Moreover, group size may be as much an indicator of institutional success as a precondition for such success.

INTRODUCTION

Problems of collective action emerge from several sources, including inadequate information and conflicting interests, as well as the nature of the good itself. When people lack information, co-ordination is difficult despite common goals (assurance games). If multiple solutions exist but have different distributional consequences, competition over distributional issues can result in failures to co-operate (chicken games). Rivalry in consumption and difficulty of exclusion make provision and protection of common-pool resources particularly challenging. The temptation to let others bear the costs of providing joint benefits threatens provision of these goods. Obstacles to exclusion encourage individuals to free-ride on the efforts of others, resulting in under-provision or degradation of the common resource (for example, social dilemmas).

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A considerable body of theory suggests that collective-action problems will be overcome only rarely (Hardin, 1968; Olson, 1965; Sandler, 1992). Empirical studies, both experimental and field-based, show that these theoretical expectations are overly pessimistic; groups achieve co-operation and co-ordination in a wide variety of settings (Baland and Platteau, 2000; Bromley et al., 1992; National Research Council, 2002; Ostrom, 1990; Ostrom et al., 1994; Udéhn, 1993). Yet there is no guarantee that actors in any given situation will overcome co-ordination or social dilemma problems. Many groups fail to solve these problems. Others experience an unravelling of collective action after initial success.

Many natural resource systems, such as forests, fall under collective management or are subject to use by multiple individuals, often for a variety of purposes (Edwards and Steins, 1998; Quiggin, 1993). Failures to overcome collective-action problems contribute to the degradation or loss of natural resources around the world. Sustaining these resources in the face of demographic and economic pressures depends upon successful co-ordination and co-operation. An understanding of the factors influencing prospects for collective action for sustainable management among resource-dependent populations has important policy implications. This article focuses on the debate about the role of group size and heterogeneity. Recent contributions by scholars using the International Forestry Resources and Institutions (IFRI)[1] research programme suggest that the debate continues because of a lack of uniform conceptualization of these factors, the existence of non-linear relationships, and the mediating role played by institutions. We begin by describing the IFRI research programme. We then summarize the debate over group size and heterogeneity and review contributions from IFRI studies. These studies highlight the importance of how concepts are operationalized, of non-linear relations, and of institutions.

THE INTERNATIONAL FORESTRY RESOURCES AND INSTITUTIONS (IFRI) RESEARCH PROGRAMME

The IFRI research programme brings together a network of collaborating research centres (CRCs) in a long-term, comparative study of factors affecting forests and the people who use them (Ostrom, 1998a). Data collection encompasses biophysical measures of forest conditions, climate and soil conditions, demographic information, and economic indicators, as well as details about institutions affecting use of forest resources. IFRI researchers

1. The IFRI research programme involves the study of forests, people, and institutions by a network of collaborating research centres (CRCs). The Workshop in Political Theory and Policy Analysis and the Center for the Study of Institutions, Population, and Environmental Change at Indiana University are jointly responsible for co-ordination of this programme.

return to their study sites every three to five years. The interdisciplinary approach allows assessments of hypothesized relationships among demographic, economic, institutional, and biophysical variables. With the slow accumulation of time-series data, it will be possible to analyse social and institutional processes that take years to unfold.

Organization as a network of research centres facilitates comparative research. Scholars interested in IFRI's inherently interdisciplinary approach have formed CRCs in Africa, Asia, Latin America, and North America.[2] Members of the IFRI network use the same methods, collect data on a common set of variables,[3] and share data in a growing international database, thereby maintaining the comparability required for cross-sectional analysis. The IFRI database currently contains data on 157 study sites in thirteen countries, with the number of sites per country ranging from one to forty. By building an international database of comparable and repeated studies, IFRI scholars gain the ability to conduct large-N studies and time series analyses.[4]

IFRI studies encompass a wide array of forests and institutions. With studies in temperate forests in the US, the mountain forests of the Himalayas, and tropical forests in Africa, Asia, and Latin America, the research programme encompasses diverse ecological conditions. Forests range from a 1-hectare cultural or sacred forest in Uganda to a Bolivian forest reserve of just under 45,000 hectares. Many of these forests are owned and managed by a national government, reflecting historical preferences for state control of natural resources in many countries. Other forests fall under private or communal ownership. These categories mask further diversity. Communal management, for example, occurs when governments grant villagers formal control, but also when local residents exercise *de facto* control in the absence of formal rights. A number of these forests, owned as private property by groups of unrelated individuals, do not fit the general understanding of private or communal property. A variety of management regimes exist in government-owned forests, ranging from management for timber production, protection for wildlife or biodiversity conservation, to joint management with local residents for multiple uses.

The IFRI research protocols were designed to further the study of collective action in the management of forest resources. Data collection includes measures of several potential dimensions of heterogeneity, including ethnicity,

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2. As of 2003, there are thirteen IFRI CRCs in eleven countries (see http://www.indiana.edu/~ifri/crcs.htm). The first were established in 1993. Revisits to study sites have begun in India, Nepal, Uganda, the USA, and Kenya (see Becker et al., 1995; Gombya-Ssembajjwe, 1999; Schweik et al., 1997).
3. Many IFRI research teams collect supplemental data to address specific research questions.
4. IFRI scholars often analyse a subset of the database. These partial analyses range from small-N studies involving one to three sites, to relatively large-N analyses involving fifteen or more sites.

caste, religion, wealth, occupation, location relative to the forest, reliance on the forest, and patterns of resource use. Teams also collect population data for groups of users with the same rights to and responsibilities for a forest, and for the settlements in which members of these user groups reside.[5] IFRI's interdisciplinary methodology allows comparisons between actual forest conditions and patterns of use associated with particular institutional arrangements. These features make IFRI an attractive resource for the study of relationships between group size, heterogeneity, and collective action for forest management.

PUZZLING OVER THE ROLE OF GROUP CHARACTERISTICS

To sustain long-term use of renewable resource systems like forests, collective action is needed to limit resource use and to undertake various forms of active management. Attributes of the resource itself, characteristics of the resource users, and relations between the group and the resource affect the degree of difficulty associated with establishing restrictions on entry or extraction: scholars have identified the condition of the resource and its size, the level of trust among users, their prior experience in organizing activities and their autonomy, and the level of salience or dependence they have on a resource. Numerous studies point to the importance of each of these attributes, giving rise to the broad consensus on their role (see Baland and Platteau, 2000; NRC, 2002; Ostrom, 1992, 1999).

Scholarly consensus breaks down, however, over other group characteristics hypothesized to influence prospects for collective action. Two of the most contentious debates concern the influence of group size and heterogeneity. Group size and heterogeneity are widely expected to affect prospects for trust and the degree of divergence in interests, and thus to influence prospects for collective action.[6] No consensus has emerged on the exact nature of the relationships or the relative importance of either factor. Lack of agreement on conceptual issues, such as classifying group size and sorting out various forms of heterogeneity, increases the difficulty of resolving these debates with empirical tests. Interactions among group characteristics, and between those characteristics and institutions, further complicate empirical analysis.[7] We outline both the theoretical arguments and the problems encountered in testing them empirically.

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5. 'User group' is an analytical category, referring to a set of individuals with a common understanding that they have the same rights and responsibilities to a forest. These individuals need not be organized in any manner, or even know all members of their group. User groups are thus *potential* units for collective action.
6. See Agrawal and Gibson (1999, 2001) for related discussions of the concept of community and associated assumptions of small size, frequent interactions, homogeneity, shared interests, and norms.
7. Compare Kollock (1998); Sandler (1992); Udéhn (1993).

Group Size

There are many reasons to expect increasing group size to decrease prospects for successful collective action. Opportunities for frequent interaction increase as the size of the group decreases, and frequent interactions create opportunities to build reputations. The expectation of future interactions increases the value of reputations for co-operative behaviour. Moreover, frequent interaction facilitates mutual monitoring. The reputation-building and mutual monitoring associated with frequent interactions suggest that smaller groups foster higher levels of trust. If high levels of trust create conditions amenable to collective action, group size should be negatively correlated with collective action.

Group size affects the calculus and strategy of collective action even if trust is not a limiting factor. Individuals may contribute because they think their contribution will make a difference, even if the benefits are dispersed among all group members. If individual contributions do not make a perceptible difference to the collective outcome, the individual incentive to contribute vanishes. The significance of each contribution depends on the technology of provision (Sandler, 1992) or production function (Oliver and Marwell, 2001); when contributions are summed, the perception that an individual contribution does not make a difference increases with group size. Concerns about avoiding sanctions for defection in ongoing interactions can also promote co-operation (Axelrod, 1984). As group size increases, threats of being defected against in the future become a less efficacious method of encouraging co-operation. Olson (1965) emphasized the influence of group size on the fixed costs of collective provision; transaction costs increase with group size, further raising the costs of initiating collective action.[8]

Olson (1965) hypothesized that group size influenced collective action in three ways: (1) larger groups would be less likely to achieve collective action at all, (2) the overall level of collective provision would be lower for larger groups that did achieve collective action, and (3) the degree of sub-optimality in collective provision would increase with group size. Subsequent work generally suggests that group size is less problematic for collective action than Olson thought.

Incorporating income effects into the analysis leads to significantly different conclusions about the level of collective provision (Andreoni, 1988; Chamberlin, 1974; Sandler, 1992). Most collective goods are normal goods, meaning that individuals who experience an increase in income decrease expenditure on the good by less than the amount of the increase in income. When a collective good is non-rival in consumption, a contribution by any member of the group may be thought of as an increase in income, however

8. The existence of transaction costs implies that there may be economies of scope (Sandler, 1992; see also Olson, 1965: 46–7). If this is so, it makes more sense for a large group that successfully organizes to take on a wide array of activities than to attempt to organize anew for each activity.

slight, for all other members. As Chamberlin's (1974) formal model demonstrated, the level of provision of normal collective goods *increases* with group size, despite decreases in the size of individual contributions. Oliver and Marwell (1988) draw similar conclusions by focusing on jointness of supply and heterogeneity in contribution levels. Under these conditions, the *number* of individual contributions needed to provide the collective good may decrease with the size of the group. With empirical and theoretical validation,[9] a relationship between increasing group size and increasing collective provision and decreasing individual contribution size became the conventional wisdom (see also Pecorino, 1999).

Esteban and Ray (2001) offer additional theoretical reasons for optimism about the level of collective provision. Their formal model involves groups competing for provision of a collective good with a mix of public and private attributes (for example, placement of a public amenity), and assumes an increasing marginal cost for individual contributions. If the marginal costs of individual contributions are sufficiently high, the probability of success increases with group size; larger groups achieve higher levels of collective provision than smaller groups and the effectiveness of a given group increases with its size, all else being equal. Given the realistic scenario of group competition, the sub-optimality of collective provision loses its relevance. Larger groups are more likely to achieve their desired outcome, even if the absolute level of collective provision is sub-optimal from the perspective of Pareto optimality. The Olsonian expectation of an inverse relationship between collective provision and group size is guaranteed to hold only if either the elasticity of individual effort is zero, or the elasticity of individual effort is between 0 and 1 and the good has no public attributes.

The size of individual contributions may be less sensitive to group size than predicted by formal models. Parents at many schools in California are not satisfied with the level of state financing and have mobilized to make voluntary contributions.[10] Brunner and Sonstelie (2003) analysed the relationship between voluntary contributions to schools and school enrolment, using 1994 data from the IRS. The level of contributions increased more slowly than increases in enrolment, implying a decline in per family contributions, as expected. The rate of decline, however, was considerably slower than expected. Brunner and Sonstelie argue that interactions among active group members (parents) play an important role in setting and enforcing expectations about the size of per family contributions. Whether this hypothesized dynamic accounts for the observations cannot be discerned with the available data, but the bottom line is clear: At least in this setting, individual decisions about the size of contributions are less sensitive to group size than expected.

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9. See especially the review in Sandler (1992: 49–51).
10. Local financing through taxation was deemed unconstitutional because it resulted in an inequitable distribution of resources for education.

Homogeneity/Heterogeneity of Groups

Homogeneity may also have a bearing on collective action. Sharing important social, cultural, or economic characteristics may increase the predictability of interactions (Fearon and Laitin, 1996). Predictability may in turn provide a basis for trust. Even if trust does not arise from predictability (for instance, if members of a homogeneous group consider themselves to be predictably opportunistic), common traits suggest common interests. Whether because it promotes trust or reflects common interests, homogeneity may facilitate collective action.

Considerable theoretical work has explored the relationship between group heterogeneity and the performance of common property institutions. Scholars have discussed multiple sources of heterogeneity. Baland and Platteau (2000) focus on the major sources of heterogeneity resulting from racial, ethnic, or other kinds of cultural divisions, and the differences in the nature of economic interests among individuals. Heckathorn (1993) develops a series of related theoretical models to try to tease apart the impact of diverse types of heterogeneity on collective action. He concludes that resource heterogeneity augments collective action in the early stages of organization but may impede collective action in groups that would otherwise have high levels of solidarity. Velded (2000) further specifies the diversity of forms of this variable by identifying five forms of heterogeneity: (1) heterogeneity in endowments; (2) political heterogeneity; (3) wealth and entitlements; (4) cultural heterogeneity; and (5) economic interests.

Although complementarities among resource uses can sometimes promote co-operative management of shared resources (Quiggin, 1993), competition among socially differentiated resource uses often gives rise to conflict. The effect of several forms of heterogeneity has been studied empirically in regard to irrigation systems (Bardhan and Dayton-Johnson, 2002; Lam, 1998; Tang, 1991, 1992). Several scholars have focused on important issues related to heterogeneity and forest regimes.[11] Kant (2000), for example, was concerned about how the product preferences of forest users would increase in diversity as income inequality became greater. Households with larger land holdings and livestock holdings are likely to have a higher demand for biomass as well as a greater need for animal fodder and agricultural compost. Poorer households, on the other hand, are more likely to be interested in the generation of cash or a way of increasing the production of non-timber forest products that are directly related to immediate consumption.

Thus, scholars presume that there will be conflict between those who are wealthier and those who are poorer in regard to the use of a forest. In her panel study of six villages in the middle hills of Nepal over a fourteen-year

11. For a recent review, see Kurian (2003).

period, for example, Cooke (2000) documents the creation of four new community forests. She finds that the time spent in collecting a unit of fuelwood for most households has dropped as a result of two factors: the increased planting of fuelwood trees on private property, and regrowth in the community forests due to more restrictive rules of harvesting. Not all households have been affected equally, however, by the restrictions. Households from the occupational castes have a higher demand for forest products, but tend to own substantially smaller plots of land. Thus, they cannot easily substitute their own wood for that in the community forests. The harvesting restrictions from the community forests are substantially more costly for these households than for others due to their need for greater amounts of charcoal to make iron tools — the primary source of their family income.

Such conflict may well weaken the effectiveness of self-organized groups, but the relationship between heterogeneity and collective action is non-linear and contingent upon other factors. Inequality in wealth, for example, interacts with the relative costs and benefits associated with co-operation in resource management to generate six distinctive situations: (1) sustainable use is in everybody's interest and no collective-action problem exists; (2) sustainable use is in everybody's interest but a collective-action problem exists; (3) sustainable use is in nobody's interest and mutual defection occurs; (4) the benefits of sustainable use accrued by the rich are sufficiently high that they coerce the poor into respecting conservationist practices; (5) sustainable use disproportionately benefits the poor who cannot enforce collective action; and (6) sustainable use disproportionately benefits the poor but collective action is achieved, either because the rich need co-operative relations with the poor in other aspects of social interaction or because institutions give weight to the numerical strength of the poor.[12]

Somanathan et al. (2002) examined the effect of heterogeneity of villages located in the Kumaun and Garhwal regions of northern India where forest councils (the *van panchayat* system) were established in many villages during the 1930s (see Agrawal, 2001; Agrawal and Yadama, 1997; Guha, 1989). Somanathan and colleagues measured forest crown cover derived from satellite data for 1998 and conducted a village-level survey during 1998–9 in sixty-five villages. They examined the potential effect of income inequality and caste heterogeneity on two measures of collective action — the number of *van panchayat* meetings held during the previous year and whether a community hired a watchman for their forest. They found a modestly positive relationship between income inequality and frequency of meetings and an insignificant impact of caste heterogeneity of this measure of collective action. Neither measure of heterogeneity had an effect on the probability of a village hiring a watchman. Nor did they find any relationship

12. Ruttan and Borgerhoff Mulder (1999) identify and discuss the first four situations.

between either form of heterogeneity and the extent of crown cover present in the forest managed by a village in 1998.

Heterogeneity can be related to different types of production technologies — particularly when the technology used by one group has negative impacts on the use of a resource by others. A recent paper by Balasubramanian and Selvaraj (2003) examines the impact of a growing number of privately owned tube wells in South India on the level of collective action related to the maintenance of irrigation tanks (small dams that are linked to irrigation systems). Collective action in their study was positively related to rice yields produced on the fields served by an irrigation system. Increasing numbers of tube wells in a watershed (as well as the size of the user group) has a negative relationship with collective action. Those who have their own private supply of water are less oriented to contribute to maintenance activities. Further, as more groundwater is withdrawn in the watershed, the physical condition of the irrigation tank is threatened. On the other hand, they also found that inequality in wealth had a U-shaped relationship with collective action. Furthermore — related to the importance of institutions that we discuss later in this article — they also found that the existence of traditional governance structures including rules for allocating water enhances the level of collective action within a system.

Heterogeneity is commonly expected to be greater in larger groups.[13] Because each new group member may add diversity on one or more dimensions, it is possible for heterogeneity to increase more rapidly than a group's size. The predicted correspondence of small group size with homogeneity of interests provides another reason to expect size to influence prospects for collective action. Unfortunately, the desirability of collective action does not decrease with group size; rather, the importance of collective action grows with demand for common-pool resources. Population growth will indeed threaten natural resources if larger groups have less success at developing or sustaining institutions for collective management of resources. Lower levels of collective action in larger groups could account for the association between population growth rates and rates of deforestation in cross-national comparisons.[14]

Challenges

The lack of consensus reflects the impossibility of isolating the influence of group size or heterogeneity when these factors are interrelated with several

13. Baland and Platteau (2000: 365–6) argue that claims for the desirability of small groups rest more heavily on the expectation of homogeneity than benefits from frequent interactions.
14. See the extensive empirical research summarized in Kaimowitz and Angelsen (1998) and Rudel (1994). Some studies at these larger scales show no relationship. Mertens et al. (2000) explain the relationship between population growth and deforestation in Cameroon as mediated by a substantial economic crisis.

other variables. In addition, conceptual and practical problems exist with the hypothesized links between small size, homogeneity, and collective action. It is widely agreed that the influence of any given factor depends on the form of collective action under consideration. Yet the form of collective action in empirical studies is often not specified, or may be misspecified. The tendency to describe any collective dilemma as a prisoner's dilemma, public goods provision problem, or a tragedy of the commons continues (Kollock, 1998), despite repeated efforts to stress the variety of situations involving collective action (Kollock, 1998; Marwell and Oliver, 1993; Oliver and Marwell, 2001; Ostrom, 1990, 2003; Poteete and Ostrom, 2002; Sandler, 1992).

Even if the form of collective action is clearly defined, the concepts of group size and heterogeneity require clarification. In common use and most academic studies, group size refers to the number of individuals in a group that could engage in collective action. Olson (1965), however, used group size to refer to a number of different concepts. The interpretation of group size most consistent with his theoretical claims equates size with the individual gains per unit of collective provision (Esteban and Ray, 2001; Sandler, 1992). 'Size' becomes another way of referring to whether a group is privileged, intermediate, or latent. If large groups are defined as being latent, then the inverse relationship between size and collective action becomes true by definition. Yet Olson conflates his notion of privilege and latency with numerical size. Throughout his text, he refers to group size in terms of the number of members.[15] Oliver and Marwell (2001) consider these comments to amount to a second, empirical hypothesis that increases in numerical size dampen prospects for collective action. Subsequent theoretical and empirical work generally equates group size with the number of individuals.

Even with agreement that group size refers to the number of individuals, there is no consensus on the turning point between small and large groups. What is a small group? To what extent, if at all, does the assessment of size depend on context? How is context important and why? Theoretical models and large-N analyses look at size as a continuous variable. Yet the observed range of sizes in empirical and experimental studies is inevitably censored on one or both sides. In Brunner and Sonstelie's (2003) study, school enrolment ranges from a few hundred students to a maximum set by state education policy.[16] In experimental studies, logistical considerations limit the feasibility of working with truly large groups (Kollock, 1998).

15. Consider two examples: 'the partnership can be a workable institutional form when the number of partners is quite small, but is generally unsuccessful when the number of partners is very large' (Olson, 1965: 54); and 'social pressure and social incentives operate only in groups of smaller size, in the groups so small that the members can have face-to-face contact with one another' (ibid.: 62).
16. They report a mean enrolment of 673 and a standard deviation of 308 (Brunner and Sonstelie, 2003: 2171). The actual range is not reported.

A 'large' group may consist of no more than ten members (see Isaac and Walker, 1988). Under these circumstances, it is not empirically possible to determine whether changing group size has a constant effect on collective action as we move from dyads to very large groups involving millions of people.

The concept of homogeneity is even more problematic. Individuals differ from one another on many dimensions. Which of these differences affects prospects for collective action and why? Do any forms of heterogeneity promote rather than obstruct collective action? If so, which ones? In Olson's concept of privileged groups, heterogeneous groups enjoy advantages in collective action precisely because some members feel intensely enough about provision of a public good to contribute even if others do not; at the extreme, one or a few individuals provide the public good on their own (Hardin, 1982: Ch. 5; cf. Marwell and Oliver, 1993; Olson, 1965). The existence of individuals with a strong interest in collective action raises everybody's expectations about the likely aggregate level of co-operation.

Discussions about the role of homogeneity often assume that the relevant characteristics are known and can be arrayed along a single dimension. These assumptions are not borne out. Equally intense concerns about management of a forest arise from participation in different economic activities. It is difficult to predict whether people will hold opposing or complementary interests in such circumstances. Homogeneity on some dimensions often coincides with heterogeneity on others. Members of a group may have common economic interests, for example, but differ culturally. Cultural differences might impede the development of trust, or be associated with different understandings of the most pressing management issues. Individuals sometimes use cultural differences as the basis for excluding members of one group from the benefits of resources despite apparently shared economic interests (Baland and Platteau, 1998, 2000). On the other hand, internal policing in ethnically, religiously, or linguistically distinct populations can bolster cross-community co-operation (Fearon and Laitin, 1996). In other circumstances, heterogeneity may be complementary, as when no single sub-population has access to all of the resources needed for successful collective action (such as time, money, specialized skills).

EMPIRICAL RESULTS FROM IFRI STUDIES

The IFRI research strategy lends itself to systematic empirical testing of relationships between resource attributes and the attributes of groups and how these affect users' perceptions of benefits and costs. Analyses of IFRI data over the past several years have produced insights into the contested role of heterogeneity and group size. The Appendix (Table A1) summarizes the IFRI studies that have addressed these themes.

Group Heterogeneity

The confusion about the relevant forms of heterogeneity casts doubt on any simplistic relationship with either group size or collective action. Recent work begins to grapple with the implications of multiple forms of heterogeneity for collective action (Baland and Platteau, 2000; Quiggin, 1993; Ruttan and Borgerhoff Mulder, 1999). As IFRI scholars begin to differentiate among various forms of heterogeneity, they are finding that not all forms are associated with less collective action in forest management (Gautam, 2002; Varughese, 1999; Varughese and Ostrom, 2001). Evidence from IFRI studies draws attention to another fly in the ointment: heterogeneity, however understood, is itself affected by institutions (Gibson and Koontz, 1998; Varughese, 1999).

Ethnicity is traditionally thought to be a problematic form of heterogeneity. The impact of ethnic heterogeneity has been examined in two IFRI studies in Nepal. Varughese (1999) obtained information about the proportion of members of a user group from different castes and ethnic groups. From this data, he computed an index of fractionalization to measure sociocultural heterogeneity:

$$A = 1 - \sum_{i=1}^{n} (\mathrm{P}_i)^2$$

where $\mathrm{P_i}$ is the proportion of the total group population in the *i*th ethnic/caste group. *A* thus varies from 0 to 1. In essence, *A* measures the probability that any two individuals from a user group will be from the same sociocultural grouping. Varughese divided eighteen forest communities into three categories of low, moderate, and high heterogeneity. He then evaluated the level of collective action each community achieved in organizing group activities, monitoring forest use, and enforcing restrictions on harvesting. Of the five groups categorized as having a high level of heterogeneity, four achieved high levels of collective action. The eight groups with moderate levels of heterogeneity and the five groups with low levels of heterogeneity were split almost evenly across levels of collection action. Sociocultural heterogeneity was not associated with either higher or lower levels of collective action in his study.

Ambika Gautam (2002) also examined the role of sociocultural heterogeneity in his study of forest conditions in eight forests located in the Kabhrepalanchok District of Nepal. Gautam used the same measure of sociocultural heterogeneity as Varughese, described above, then divided the user groups in his study into those with high versus low (above or below the mean) levels of sociocultural fragmentation. Gautam analysed the impact of group heterogeneity directly on forest conditions since all of the forests in his study were located in one ecological zone and could be directly compared. He found no significant differences in regard to the number of species, the diameter of the trees, or their height. He did find

that the *number* of trees in a forest was negatively related to levels of heterogeneity among the members of the user group. Overall, ecological conditions — such as the slope, aspect, and elevation — explained forest conditions better than sociocultural heterogeneity.

The lack of association between sociocultural heterogeneity and collective action or actual forest conditions could be understood as an indication that a *particular* form of heterogeneity is not an important obstacle in this *particular* area of collective action. IFRI studies provide evidence that institutions mediate the effects of forms of heterogeneity that can be expected to influence interest in collective action, either by compensating for (Varughese, 1999; Varughese and Ostrom, 2001) or minimizing heterogeneity (Gibson and Koontz, 1998).

In addition to the normal way that people think about homogeneity and heterogeneity of interest, heterogeneity may derive from locational differences. In Nepal, for example, other scholars have shown that proximity to a forest is considered to influence the level of participation by groups (Chhetri and Pandey, 1992; Chhetri et al., 1998). Not only is the proximity of a group to a forest an important factor affecting collective action, but the difference in proximity among members of a group may also generate differences.

Locational differences are particularly important when groups are considering the distribution of responsibilities for input activities and the types of forest products that may be extracted from a forest. If a household lives within one or two hours' walk of the relevant forest, its members may be able to participate in various activities requiring their input, including patrolling the forest, planting new trees, weeding, thinning, and so on. If the household lives a full day's walk from the forest, however, the cost of participation is immense just in terms of travel time. Substantial differences in the distance that households live from a forest can lead to substantial conflict when users are discussing the allocation of duties and benefits.

Varughese (1999; see also Varughese and Ostrom, 2001) was able to measure the extent of locational differences for eighteen forests located in the middle hills of Nepal. Of these eighteen, the user groups in eleven of them were located relatively close to the relevant forest and were comparatively homogeneous in regard to the distance they lived away from the forest. Varughese expected to find that the seven locations with greater heterogeneity in regard to location would be less successful in organizing collective action than the eleven that were more homogeneous in this regard. Much to his surprise, he found the obverse. Five of the seven cases with greater locational heterogeneity (71 per cent) had higher collective activity despite the difficulties they faced in coping with the diversity of distances to the forest. Among the eleven groups with less diversity, five groups manifested high levels of collective activities and six groups manifested low levels. Thus, there was a negligible positive association between locational differences and the organization of collective action (Tau = .25).

Varughese found that groups that were able to achieve higher levels of collective action while also facing substantial heterogeneity had designed institutional rules that specifically take heterogeneity into account. Two sites provide particularly interesting insights on how groups overcome problems of heterogeneity. In both sites the user groups developed written rules and regulations related to how they are organized. Both groups have overtly recognized the fact that their membership is scattered across a substantial terrain and developed a 'two-tier' system of user group membership. Households who live further away are able to pay extra fees in monetary form in exchange for reduced labour obligations. Moreover, those who cannot actually participate in the joint activities also pay a special membership fee so as to have access to forest products of special interest to them. This means that the user group obtains some monetary resources to complement the labour resources contributed to group activities. The group is able to draw on the support of a much larger group of local households than would otherwise be feasible. In some cases the monetary resources are used to pay full-time monitors so that the forest is well protected at all times. Thus, what would be a substantial problem has been overcome by the design of institutional arrangements to cope specifically with the difference in location of member households (Varughese, 1999; Varughese and Ostrom, 2001).

Institutions can also minimize forms of heterogeneity that are likely to pose problems for collective action. Different membership rules affected the emergence of heterogeneity in two communities with similar origins in southern Indiana. One community, given the pseudonym Maple, set relatively high costs of entry, restricted the use and transfer of land, and limited the recovery of investments upon exit. This community maintained highly homogeneous attitudes towards forest conservation over more than twenty years. Entry into the other community, referred to as Oak, initially involved lower cost, and exit was much easier. A moderate period of membership conveyed the right to obtain land with no restriction on use and the possibility of taking their land with them upon leaving the community. These rules allowed destruction of forest cover by members and reduction of the community's forest as membership changed.

Gibson and Koontz (1998) attribute differences in forest conservation to the degree of homogeneity of preferences within each community. In turn, each community's institutions influenced the degree of homogeneity. This argument is noteworthy for a number of reasons. First, it highlights the evolutionary nature of homogeneity, at least in preferences. Just as initial homogeneity influences the development of institutions for forest management, the evolution of homogeneity influences the survival of those institutions. Second, it identifies institutions as sources of homogeneity as well as potential products of it. The design of institutions can influence the direction taken as preferences evolve, and thus the prospects for sustained co-operation.

The case studies underline the importance of specifying the form of heterogeneity that is expected to influence collective action. The community

that maintained its forest over two decades shared a preference for forest conservation, but was diverse along other dimensions. In this case, religious, ideological, and socioeconomic heterogeneity did not undermine collective action in forest management.

The comparison also calls into question the relationship between group size and homogeneity. Although membership in each community varied over time, both were relatively small at the time of field visits. The number of households in the Maple community has remained stable at about fifteen households (thirty adults) for over fifteen years. The collapse of co-operation contributed to declining membership in the Oak community; the number of households dropped from seventeen to seven in the five years between field visits and had been much larger in the early years of its organization. Small groups need not be more homogeneous or co-operative; in some cases, small size reflects prior heterogeneity and conflict.

Nor is perceived heterogeneity of interests a permanent handicap. When an IFRI team first visited Loma Alta in Western Ecuador in 1995, the *comuna* owned a forest of 6,842 ha located at a substantial distance from the four settlements that comprised the *comuna* (Gibson and Becker, 2000). Even though the *comuna* had substantial powers to make rules related to forest use, considerable numbers of private plots had been allocated to individual farmers who cut down indigenous trees in order to plant *paja toquilla* used in the manufacture of panama hats. Land that was formally owned communally was left as *de facto* open access and was heavily deforested. Several factors contributed to the level of deforestation: (1) the strong interest of private plot-holders in growing their own trees and crops; (2) the fact that most residents thought of their forest as abundant and did not perceive a need to restrict usage; and (3) the potentially high cost of regulating a large and distant forest. Therefore, at the time of the first study, it appeared that deforestation would continue unabated in this area.

Becker returned to the site the following summer with a group of Earthwatch volunteers who took daily measurements of the fog captured by indigenous trees located on the windward slopes of the forest as contrasted to planted crops or trees in the same region (Becker, 1999). Students then helped make a video to show the community about the loss of precipitation stemming from conversion of their forested land — a loss that was linked to a stream that watered the agricultural crops of the area. The linkage between deforestation on distant hills to nearby, highly valued, agricultural land had not been recognized by community members. With the help of an NGO that provided further ecological and technical information, the community then created a 1,000 ha forest reserve and hired young men from the community to monitor it. Loma Alta has also started a modest ecotourism programme to replace some of the income lost because of the forest reserve (Becker, 2003). Recognition of ecological and economic linkages overshadowed the economic interests of a small but influential group of members and enabled the community to engage in collective action that appeared unlikely at the end of the first site visit (Gibson and Becker, 2000).

Group Size

Size of group is not consistently related to the homogeneity of interests within a group. Even if it were, the implications of size and homogeneity for collective action are not clear without the consideration of additional factors. Smaller groups are also handicapped by limited access to the resources needed for effective collective action. As group size drops, the levels of interaction that generate trust and facilitate collective action increase, but the time, monetary or other resources available for mobilization decrease. What do these countervailing pressures imply for the relationship between group size and collective action?

Very small communities in the Kumaon Hills of India develop rules for management of their forest, engage in mutual monitoring, and enforce their rules through social sanctions. These arrangements for self-governance do not guarantee that a community can defend its forest resources from encroachment from other communities or takeover by state agencies (Agrawal, 2000). Communities protect their forests against rule violations by both community members and outsiders by hiring forest guards. To be effective, guarding must continue over a period of several months. The ability of a community to raise resources affects not only its capacity to hire a guard but also the duration of guarding.

Agrawal and Yadama (1997) hypothesized that the duration of guarding plays an intervening role between market and demographic pressures and forest conditions. They supplemented IFRI data with a mail survey of 279 forest councils in the Kumaon Hills and assessed a multi-stage model using LISREL analysis.[17] Overall, group size had a negligible effect on forest condition: the positive indirect relationship between group size and forest condition outweighed the negatively direct relationship. Village population relative to the available resource had a modest negative overall effect on forest conditions. Population pressure's indirect effect on forest conditions was comparable in magnitude to its direct effect. The relationship between group size and institutional development is at least as important as any direct relationship between group size and forest conditions.

Agrawal (2000) examined the relationship between group size and duration of guarding more closely. The smallest communities in the Kumaon Hills had less success in raising the resources needed to hire guards for several months every year than did somewhat larger communities (ibid.: 74). Noting that the inverse relationship between group size and resource mobilization is based on data from nine villages ranging in size from ten to seventy-five households, Agrawal speculated about an upper limit to the advantage of size. His suspicions were confirmed in an analysis

17. LISREL is a variety of path analysis.

of an expanded data set from the same region (Agrawal and Goyal, 2001). The larger data set covers twenty-eight village councils with 10 to 175 households. The increase in maximum group size from 75 to 175 households resulted in the emergence of a curvilinear relationship between group size and effective collective action for forest management. Medium-size groups proved more successful than smaller and larger groups in terms of total resources mobilized, per household contributions, meeting regularly, maintaining records, and enforcing their rules. The most starkly curvilinear relationships concern resource mobilization. Both total budgets and per-household contributions are highest for village councils with sixty-one to eighty households. These figures drop off sharply for both smaller and larger villages.

Data collected in Nepal's middle hills by George Varughese (1999, 2000) are relatively consistent with Agrawal's findings in regard to the greater difficulty of smaller villages in mounting various forms of collective action. Of ten communities that had moderately high or high levels of collective activity, seven had more than 100 households while only three had less than 100. Of the eight communities that had low or no collective action, five were smaller than 100 households and three were larger (see Varughese, 2000: 207, Table 8.4). Thus, the size of the community was negatively but insignificantly related to levels of collective activity. On the other hand, his data do not show any relationship between group size and the forest stock assessment made by a forester for each of the forests related to a village (ibid.: 201, Table 8.1).

Gautam (2002: 98) also examined whether the size of a user group was related to any of the measures of forest conditions he obtained. He found a significant, negative relationship ($p = .001$) between the size of the user group and the number of trees. Larger user groups with more than 300 households did consistently poorer in regard to the average DBH (diameter at breast height) of the sampled trees in the forests and their average height than groups with less than 300 households. He found a curvilinear relation between group size and the number of species. Group size was not correlated with forest conditions in a straight negative manner, but the forests governed by the very largest groups were in worse condition than those governed by smaller- to medium-sized groups.

Nagendra et al. (2003) add further nuance to our understanding of group size and forest management. Nagendra et al. compare forest conditions in two management systems found in Nepal's *terai*. Buffer zones established around National Parks attempt to provide protection to the forest and allow continued forest use by local residents. The communities benefit from tourism but must operate within fairly tight guidelines. Community forestry is a more general programme for handing over forests to user groups for management and use. Groups must develop management plans, but face somewhat fewer restrictions. Nagendra et al. analyse satellite imagery for twenty-three forests from 1989 and 2000,

before and after the formal introduction of community forestry and the creation of buffer zones in the early 1990s. The associated villages range in size from 75 to 1,237 households (450 to 8,000 individuals). They found that forest conditions in buffer zones are improving more than those in community forests, and that loss of forest cover is greater in community forests. The differences do not correspond to differences in forest size or group size. Buffer zones benefit from higher inputs, especially in terms of tourist revenues. In addition, buffer zones have a higher ratio of user group members to forest area. Higher population pressure is generally expected to accelerate degradation rather than promote conservation. Nagendra et al. speculate that the higher population concentration may facilitate mobilization for management and monitoring activities.

Rapidly increasing group size might be problematic even in the absence of an inverse relationship in cross-sectional comparisons. Varughese (1999: Ch. 3) found no relationship between direction of change in forest conditions and the rate of population growth in eighteen villages in Nepal's middle hills. He also found no relationship between current forest conditions and the rate of population growth. Once again, the level of collective action in the village provided a better predictor of forest conditions.

These studies show that heterogeneity and size of groups affect prospects for collective action, but not in a straightforward manner. Group size affects trust, predictability, and the ability to mobilize resources in different ways; the nature of its relationship with collective action appears to depend on the importance of trust and predictability relative to resource mobilization in particular contexts. Heterogeneity becomes important when it influences the distribution of interests in collective action, as in the empirical cases discussed above, or the ability to mobilize resources. Even then, institutions can be developed to moderate the level of heterogeneity or, where heterogeneity is unavoidable, compensate for it.

REAFFIRMING THE IMPORTANCE OF INSTITUTIONS

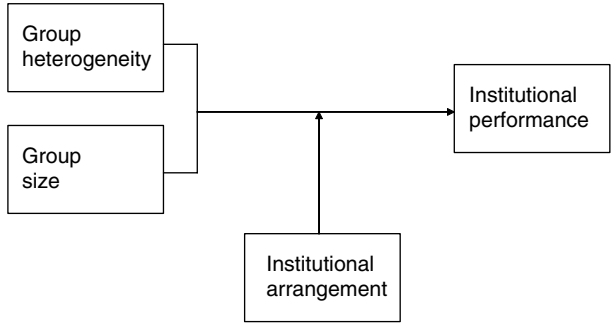
One finds an immense variety of local circumstances that affect whether local forest users organize themselves collectively to be long-term stewards of their forests. While many local success stories exist, all too many forests have suffered severe degradation at the hands of those highly dependent on nearby forest resources (see, for instance, Campbell et al., 2001; Gibson and Becker, 2000). Many forest management policies have been adopted without consulting prior research on the factors that are associated with successful forest management by national, regional, or local governments or by local forest groups themselves. Consistent findings are now emerging from IFRI studies in diverse regions of the world that provide general support for an evolving theory of collective action related to forest resources (see Gibson et al.,

2000; Ostrom, 1998b). We have certainly established that common-property regimes are not simply a 'relic' of earlier primitive institutions (McKean and Ostrom, 1995). On the other hand, the data clearly indicate that forest users are not all helplessly trapped in continued overuse of forest resources.

Collective action is costly. Actors must overcome co-ordination problems, distributional struggles, and the incentive problems associated with common-pool resources. Characteristics of groups, such as their size and degree of homogeneity, gain importance because they influence the severity of co-ordination problems and distributional struggles. Predictability of interactions, for instance, aids co-ordination. Shared or complementary interests reduce the severity of distributional struggles.

The IFRI studies reviewed in this article contribute to our understanding of group size and heterogeneity by differentiating among various forms of heterogeneity, considering the mediating role of institutions, and being attentive to the possibility of non-linear and contingent relationships. Not all forms of heterogeneity are problematic for all forms of collective action. Increasing group size — whether in static or dynamic comparisons — does not condemn groups to deteriorating collective action. How size and homogeneity affect predictability of social interactions and the distribution of interests appears to be contextually driven (see Figure 1). The contingent and nonlinear relationships in these IFRI studies reinforce similar findings in other recent studies (Stern et al., 2002). Rather than having independent linear relationships with collective action, the importance of specific attributes of groups may depend on configurations of other attributes of

Figure 1. Schematic Representation of Contingent Relationship between Group Characteristics and Institutional Performance



Source: Adapted from Stern et al. (2002: 447).

the resource and resource users. What appeared to be divergent findings in earlier studies may instead reflect interaction effects and contingent relations that were not recognized.

Instead of further contests over the effect of group heterogeneity and size of group as to their positive or negative determinate role, we see these group characteristics as challenges or opportunities facing individuals in a group that is jointly using any resource. Groups that are heterogeneous may be able to devise institutions that enable them to draw on complementarities to build a stronger foundation for collective action. Larger groups may face higher transaction costs, but they also can draw on more resources than smaller groups to engage in collective action. Organizing any group to achieve sustainable use of common property is always a struggle (Dietz et al., 2003). The temptation to free-ride on the efforts of others is always present to some extent. The design of institutions that help a group distribute the benefits and costs of their efforts in a way that is perceived to be legitimate, effective, and fair to that group is more important than the particular attributes of the group itself. Thus, scholars and public officials should not presume a determinate relationship between heterogeneity or size of groups and the level of collective action.

The studies reviewed in this article call into question the notion that simple recipes for collective action of all types can be developed. A single optimal design of institutional rules does *not* exist. Given the wide variety of characteristics that groups possess, as well as the diversity of ecological conditions they face, rules that work well to facilitate collective action for one group may or may not work well when used by others. Recent fads to impose a particular type of local institution on local forest user groups in developing countries are especially worrisome given the evidence concerning the diversity of rules that have been used in practice across multiple locations. We need to pay more attention to the diversity of institutional arrangements that can be used to overcome collective-action problems rather than quick fixes. Our message is one of good news and bad news. The bad news is that there is no simple recipe for successful collective action. The good news is that heterogeneity or large numbers of potential participants do not pre-ordain failures in collective action.

Recognizing that group characteristics such as certain forms of heterogeneity or extremely large or small numbers pose problems for collective action, policy-makers can strive to develop institutions that explicitly address these problems. Since institutional development itself requires collective action, this possibility does not guarantee success. It does offer reason for optimism. Moreover, careful study of how diverse institutions have helped groups solve problems of collective action provides useful lessons regarding how others have coped with particular problems. Those applying such lessons then need to draw on local knowledge so as to craft institutions that generate incentives to overcome collective action and that are perceived by participants to be legitimate and fair.

APPENDIX

Table A1. Summary of IFRI Studies Concerning Group Size and Heterogeneity

Study	Location	Group Size Studied	Heterogeneity Studied	No. of Groups	Range of Group Sizes (households)	Findings
Agrawal and Yadama (1997)	Almora, Nainital, and Pithoragarh Districts, Kumaon, India	Yes	No	279	18–220	Supplements IFRI data for 41 councils with mail survey of close to 300 councils. Uses LISREL to examine direct and indirect effects. Group size has a negligible overall relationship with forest condition. Population pressure has both direct and indirect influence on forest conditions mediated by the number of months a guard was hired.
Agrawal (2000)	Almora and Pithoragarh Districts, Kumaon, India	Yes	No	9	10–75	Six small forest councils (<30 households), three larger councils (>50 households) were studied. Smaller forest councils had greater difficulty protecting their forest resources, while larger councils were more successful.
Agrawal and Goyal (2001)	Almora, Nainital, and Pithoragarh Districts, Kumaon, India	Yes	No	28	10–175	Finds a curvilinear relationship between group size and the mobilization of resources to hire guards to monitor forest resources.
Gautam (2002)	Middle Hills Districts, Nepal	Yes	Yes	8	44–1288	Larger forest user groups tended to have poorer forest conditions. Ethnic heterogeneity did not influence forest condition.

Table A1. (continued)

Study	Location	Group Size Studied	Heterogeneity Studied	No. of Groups	Range of Group Sizes (households)	Findings
Gibson (2001)	Eastern Guatemala	No	Yes	2	43–69	Heterogeneity in the value of forest products led to the protection of one forest that served as the key watershed for the community's irrigation system. No perceived scarcity of fuel-wood or timber in two other forests led to no effort to control harvesting.
Gibson and Becker (2000); Becker (1999, 2003)	Western Ecuador	No	Yes	4	28–60	Substantial diversity of interests at time of first visit led to little interest in preserving forest. A scientific study of impact of deforestation on local water supply augmented by NGO assistance led to creation of a Forest Reserve.
Gibson and Koontz (1998)	Southern Indiana, USA	No	Yes	2	7–100	Entry rules enabled one community to recruit members who shared similar interests about their forest and who sustained their forest over time. Easy entry into second community and rules allowing members to acquire land upon exit led to reduction in forest extent. Range of group sizes includes historical changes.
Nagendra, Karmacharya and Karna (2003)	Chitwan District, Nepal	Yes	No	23	75–1327	Buffer-zone forests had greater reforestation and lesser deforestation than community forests. Size of groups did not differ between these two kinds of forest institutions, but the size of the group as a ratio of forest area was significantly higher for buffer-zone forests.

Table A1. (continued)

Study	Location	Group Size Studied	Heterogeneity Studied	No. of Groups	Range of Group Sizes (households)	Findings
Varughese (1999, 2000)	Middle Hills, Nepal	Yes	Yes	18	26–404	High population size and growth rates were not correlated with forest condition. Higher levels of collective action within the Village Development Committees were correlated with better forest condition. Various forms of heterogeneity (locational, wealth, gender, sociocultural) on collective action were not related to higher levels of collective action.
Varughese and Ostrom (2001)	Middle Hills, Nepal	No	Yes	18	26–404	Supports and further elaborates on the heterogeneity results of Varughese (1999).

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