ON LOCAL COOPERATION FOR THE CARE OF FORESTS

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CONTENTS

ABSTRACT

This paper presents an analysis of community management of forest resources, using a social custom model of individual behaviour. Agents are sensitive to the reputation which follows from observing social rules, and suffer when they violate the norm. Cooperation may arise out of this process of interdependent decision-making. In particular, it is shown that partial cooperation may be a stable outcome if agents are heterogeneous. Superior cooperative outcomes may exist at the same time as less efficient modes of forest use with no (or less) cooperation. Sustaining cooperation may be more feasible in certain communities than in others.

(JEL classification numbers - D7, O13, P13, Q2, Q23)

I. INTRODUCTION - CONCEPTUALISING COMMONS MANAGEMENT PROBLEMS

The analysis of different institutional arrangements for the care of resources constitutes an important part of current research in environmental economics.[1] Specific rules of each institutional form influence and constrain individual action, which must be guided towards particular patterns of resource utilisation. The problem of allocation becomes complicated because different users have conflicting demands over resources, and struggle to have their demands legitimised. This struggle between interest groups need not necessarily be equitable, and may influence the choice of resource management regime. Natural resource management policy must, then, identify conflicting claims on the use of resources and seek to resolve this conflict by assigning priorities in accordance with some criterion of social choice.[2]

Public policy attempts to secure the cooperation of resource users by providing them with incentives to behave in a manner consistent with particular objectives. Given that all interests cannot be simultaneously accommodated, the conflict arises over the choice of interests which are to be represented in this definition of social objectives. Furthermore, there may be no perfect one-to-one correspondence between the multiple objectives of State policy and the multi-dimensional impacts of alternative institutional structures. The choice of institutional structure may need to compromise particular objectives. Notions of power and relative ability to influence the decision-making process become central to this institutional discourse, and have important implications for the study of resource use patterns.

The structure of property rights is an important component of this institutional framework. Property rights refer to sanctioned and enforceable behavioural "relations" among agents which define the manner in which a benefit stream is under the power of its holder, as well as the restrictions to be observed by all others with respect to the object of

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[1]Two recent contributions to the literature are Bromley (1991) and Stevenson (1991).

[2]It is important to point out that environmental policy inevitably requires such choices to be made among competing uses, even if this is not made explicit. To do nothing is not a welfare-neutral decision, since it implicitly favours the *status quo* allocation over any alternatives.

value. Property rights influence incentives for agents, which determine the nature of their interaction with the resource base, and, as a consequence, the state of the environment. Property rights issues are, thus, of central concern when examining questions of natural resource management. What follows is a preliminary examination of some of the issues which arise in the context of forest care and management under localised, "common property" arrangements.

Environmental resources have been categorised as "common pool resources"[3] or simply as "commons". Hardin (1968) argued that resource users on the commons will tend to over-exploit the resource base, leading to universal "tragedy". This much-quoted article has given rise to an unfortunate stream of literature which implicitly denies the possibility of community management of resources, and recommends privatisation or State management of the commons as a solution. However, a clear and complete definition of private property rights over natural resource systems may involve substantial transactions costs; thus, privatisation may not necessarily be feasible as a solution to "the tragedy of the commons". On the other hand, those who recommend State management implicitly assume that the State will be an altruistic and ecologically-aware guardian of natural resources, while simultaneously suggesting that local users of common-pool resources are likely to be myopic, self-interested and ecologically ignorant. A more comprehensive theory of the State which recognises the processes which underlie policy formulation is required before such conclusions can be accepted.

What Hardin was referring to was a situation of "open access", which is characterised by the absence of any regulations on the use of resources. This is distinct from common property, **in which a clearly defined group of users are allowed to exploit the resource, while all others are excluded.**[4] Hardin's logic applies to the analysis of open access resources, of which the global commons (such as the atmosphere, or the open seas; see Dasgupta and Maler, 1990) are one example. However, local commons (such as

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[3]Wade (1987) defines common pool resources as public goods with finite, or subtractive, benefits.

[4]Ciriacy-Wantrup and Bishop (1975) bring out this distinction between common property (*res communes*) and open access, or no property (*res nullius*).

village ponds, forests or grazing grounds) are often not open access, and may be managed under traditional rules which govern their use. There is substantial evidence which demonstrates the sustained care of local commons under community management (see, for instance, the examples cited in Wade,1988b; Berkes (ed.), 1989; Chopra, *et al*, 1989; Feeny, *et al*, 1990; and Ostrom, 1990, among others). Access to such local commons is usually restricted to a recognisable group, typically those having rights through ties of kinship, community membership, and so on. Monitoring is relatively easy because of the tightly knit nature of the community. What these arrangements share is that individual agents recognise and take account of their interdependence in resource use. Cooperation can be sustained because agents are assured that their restraint will be reciprocated by other members of the community, to the mutual benefit of all.

The logic of Hardin's argument follows from the fact that individual herders are not concerned about the effects of their actions upon the resource, and continue to add animals for grazing in an attempt to maximise private gains. However, the social cost of an additional animal exceeds the private cost. Since each herder uses the commons to the extent dictated by her private cost-benefit calculations, this results in depletion. Hardin's analysis has subsequently been formalised as a Multiperson Prisoners' Dilemma (MPD) game, in which agents face a binary choice between cooperating and defecting from a rule of restraint in the use of resources. The structure of the game gives rise to universal defection as the outcome, which corresponds to Hardin's "tragedy of the commons".[5]

Developments in game theory have formally demonstrated the possibility of cooperation as an outcome of sophisticated behaviour by individuals who recognise their long-term interests. In a repeated game framework, players' strategies can be made interdependent; in particular, players can condition their actions upon the observed actions of other agents in previous iterations of the constituent game. Threats and punishment strategies which penalise defection can be devised, which generate cooperation as the equilibrium of the repeated game. The punishment must be severe enough to outweigh the limited-period benefits from

[5]See Schelling (1978) for a clear exposition of the MPD.

defection. It can further be shown that cooperation represents a subgame perfect equilibrium, which means that the threat of punishment is credible.[6]

Some authors have suggested that the *assurance game* often represents cases of collective action for natural resource management better than the prisoners' dilemma (this is argued by Runge, 1986, and Stevenson, 1991). In the *assurance game* (Sen, 1967), the possibility of strategies being interdependent is explicitly included in the stage game. There is no longer the strict dominance of the non-cooperative strategy which characterises the one-shot prisoners' dilemma. The assurance game seems to be better equipped to capture the notion of strategic complementarity between players in resource use, which may arise because commons users condition their decisions on expectations of others' behaviour.[7] Ideas of a *critical mass* (Schelling, 1978) can be captured more easily, and the fact that agents' decisions may be shaped by the degree of compliance comes out explicitly. In this framework, there is no incentive to defect from the Pareto optimal cooperative solution, once it has been reached. The incentives involved make this solution inherently stable.[8]

The prisoners' dilemma represents situations where each individual is assumed to be making her decision in an isolated environment. Where decision-making is interdependent, the assurance game may be considered more appropriate. It is not possible to make any *a priori* statements about which structure best represents resource management problems; the choice would be determined by the particular characteristics of the situation being analysed. However, the repeated games framework demonstrates that the two models need not be viewed as incompatible. If credible punishment strategies under repetition alter the structure of

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[6]For the details of such models and their application to problems of collective action, see Aumann, 1981; Hardin, 1982; Friedman, 1986; Fudenberg and Maskin, 1986; Sugden, 1986; Taylor, 1987.

[7]This is especially true in the multi-person case, where partial cooperation is a possibility. In Runge's multi-person assurance game, neither cooperation nor defection are strictly dominant, and payoffs are functions of the proportion of the population which cooperates.

[8]This should not be taken to imply that the incentive to cheat is absent from assurance games. It is just that, *given the expectation about other agents' behaviour*, the incentive not to cheat is greater. The interesting question is how such expectations arise and can be sustained.

payoffs to make cooperation dominant (if enough others cooperate), the one-shot prisoners' dilemma can be transformed into a supergame which resembles the assurance game.

A difficulty arises with analysis which is based on a repeated games framework because of the so-called "Folk Theorem". This asserts that any individually rational outcome of the stage game can be supported as an equilibrium of the repeated game. This generates a bewildering multiplicity of possible outcomes, of which cooperation is one.[9] It is equally possible that the community could be locked-in to a historically given pattern of exploitative resource use, which could continue and result in severe environmental degradation. With multiple equilibria, neoclassical instrumental rationality is insufficient to determine the outcome of the game.[10]

It can be argued that choosing the right equilibrium can be viewed simply as a coordination problem, where agents have to select one out of many possible outcomes. Once agents have communicated their intention to cooperate, this will be sustained as the equilibrium. While this may explain the existence of cooperation under certain circumstances, it is unable to account for the failure of cooperation under conditions where coordination should not be expected to be difficult. Ostrom (1990) has evidence of the failure of cooperation in communities which are in long term interaction with each other, and where communication is not a problem. Seabright (1990) shows that varying degrees of cooperative behaviour may be observed in similar communities in a particular region, and suggests that the previous history of cooperative activity in a village may affect the prospects for future successful cooperation.

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[9]In dynamic analyses of resource use, actions of players may depend on the state of the resource, as well as the actions of the other players. The appropriate framework should be a dynamic, differential game with the health of the resource entering as a state variable. Tolwinski, *et al* (1986) show how punishment strategies allow cooperative behaviour to be sustained in such games. Friedman (1990) extends the Folk Theorem to time-dependent supergames. Thus, problems similar to those outlined above persist in this framework.

[10]Abreu and Rubinstein (1988) have a model of bounded rationality which restricts the number of possible equilibria. While they do reduce the set of viable outcomes, there are still a sufficiently large number of possibilities to preclude any predictability.

Clearly, the failure of cooperation may be accounted for by reasons other than coordination failure. The coordination argument denies any role for historical processes which may give rise to non-cooperative social behaviour. A society which has a convention of antagonistic rivalry would probably be less likely to cooperate in the use of common pool resources than one which has a tradition of shared institutional arrangements. The repeated games framework does not allow us to make any predictions about such cases. As Dasgupta (1988, p. 71) observes, "... repeated games need some form of friction to generate predictable outcomes ...". Social norms, moral codes and historical processes could provide us with such friction which would allow us to choose among alternative equilibria.

Some studies of local cooperation for the care of resources have demonstrated that there may be institutional stability even in the presence of some defectors (see Chopra, *et al*, 1989, and Ostrom, 1990). There may exist coalitions within the community who cooperate despite defection by others. However, most theoretical analyses of cooperative behaviour predict all or nothing behaviour, with the outcome being either universal defection or universal cooperation.[11] Schelling (1978) analyses binary choice situations which allow the possibility of partial cooperation, but does not formally specify the assumptions underlying the particular functional forms required to generate such behaviour. Typically, the cooperators benefit less than the free-riders (in terms of flows from the resource); but, if the benefits from partial cooperation are greater than those from universal defection, this may sustain less than full cooperation as the outcome.

Naylor (1989, 1990) introduces heterogeneous agents in a formal model, which is similar to the social custom model of Akerlof (1980). The model explicitly takes account of social relationships as a constraint on individual behaviour, and generates Schelling's results as a special case of his more general analysis. I will be analysing a model of local institutions for the care of forests which follows Naylor and introduces a heterogeneous population. It is assumed that there is a village forest which serves the

[11]Exceptions are Schelling (1978), Sugden (1986) and Taylor (1987), which contain some reference to the possibility of partial cooperation.

fuelwood needs of a local community. There is a community determined rule which regulates the forest, and allocates an amount of wood to each agent (household). The social norm is to abide by the rules of behaviour prescribed by the community. Agents are sensitive to the reputation which follows from observing social rules, and suffer when they violate the norm. Agents differ in their degree of sensitivity to the reputation effect. The model identifies conditions under which cooperative behaviour may be sustained. In particular, partial cooperation is observed to be a stable outcome. The analysis yields some interesting implications for the study of community based management of resources. For instance, institutional shocks which alter the property rights structure may generate incentives for communities to evolve cooperative rules which govern the use of resources. Such processes are more likely to succeed in communities characterised by close social interdependence and a history of previous collective action.

The next section discusses the manner in which community-based norms may affect the incentives for agents to participate in collective action. Section III outlines the model and discusses some comparative statics effects. Schelling's critical mass phenomenon and Hardin's tragedy of the commons outcome are shown to be special cases of this analysis. Section IV contains some tentative hypotheses about the origin of cooperative behaviour, and section V concludes with some remarks about potential implications of such analysis.

II. COMMUNITY AND NORMS

Taylor (1982) asserts that "community" is an open-textured concept, and denies the possibility of an exhaustive definition of the term. He lists some attributes, and suggests that varying degrees of these are observed in all communities. The first is that the set of persons who compose a community have beliefs and values in common; these shared beliefs and values facilitate communication between members of the community. The second characteristic is that relations between members should be direct, and many-sided. Directness here implies the absence of intermediaries, while many-sidedness refers to the interaction of agents at a multiplicity of levels and in a variety of situations. The final characteristic is that of reciprocity, which consists of actions which reflect

"short term altruism" and "long term self interest". Taylor identifies a continuum of reciprocity forms, but focuses his attention on the segment which lies between "balanced reciprocity" and "generalised reciprocity",[12] including the latter but not the former.

Taylor makes no claim about the universal applicability of this attempt to define "community" or about the exhaustiveness of this definition. What is relevant for the present purposes is the suggestion that social relations among small and relatively stable groups of people may display such characteristics in different forms, and at differing levels of complexity. Customs and norms arise out of this interaction; for them to be social, they must be shared by other people and partly sustained by their approval and disapproval. Thus, Akerlof (1980, p. 749) defines a social custom as "... an act whose utility to the agent performing it in some way depends on the beliefs or actions of other members of the community ...". Ostrom (1990) also emphasises that social norms must be defined with respect to a shared belief. Dasgupta (1988) suggests that agents who interact with each other repeatedly develop "bonds". Presumably, this repeated interaction could be over time or at multiple levels. Elster (1989, p. 105) asserts that a norm "...is the propensity to feel shame and anticipate sanctions by others at the thought of behaving in a certain, forbidden way...".

Elster's definition allows us to identify two levels at which social norms act as a constraint on economic behaviour, either by inducing psychological effects or by the anticipation of sanctions by other people (and usually because of a combination of both). Varoufakis (1990) refers to the former as resulting from guilt at having betrayed the cause, while the latter reflects the desire among individuals to be accepted socially and held in regard by their peers. I will call these the *guilt effect* of violating social norms, and the *reputation effect* of conforming, respectively.

Guilt from violating a social norm can be thought to follow as a result of the "internalisation" of these norms. Taylor (1982) stresses the role of socialisation and education in shaping these attitudes. Religious beliefs and notions of sacredness and profanity also influence an individual's subconscious, psychological attitude towards norms. Gadgil and Vartak

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[12]Taylor borrows these terms from Sahlins (1974).

(1974) have an interesting study of the reservation of forests in India by village communities as "sacred groves". The religious aspect may in part have moulded individual perceptions so that agents would experience feelings of guilt at violating the sanctity of such a forest. Such feelings may deter behaviour which violates social norms; this is what I shall refer to as the "guilt effect".

The guilt effect is independent and distinct from the reputation an agent can hope to gain by following socially sanctioned behaviour. The reputation effect arises out of an agent's long-term interest in being part of a community. One reason for this is that social interaction in a community typically takes place at a multiplicity of levels. Since relations among agents are multi-faceted, the observance of a norm may serve a number of different ends. In most villages, interlinking of various activities implies that agents are involved in collective action at many levels. Sharing irrigation water, common grazing grounds, cooperative institutions for the provision of credit, fertiliser and other inputs, and cooperative marketing institutions are just a few examples of this multidimensional interaction. Cooperation at any level may have a positive effect because the agent would acquire a reputation for such behaviour and be allowed to participate in other collective institutions. Reciprocal arrangements such as food sharing and pooling and exchanging of labour also contribute to the benefits of acquiring a reputation for conformism.

The reputation effect may also arise because of a fear of punishment of non-cooperators by the community. This could take the form of ostracism, even to the extent of exclusion from everyday social intercourse, excommunication, and the prohibition of particular individuals from participation in community rituals or functions.[13] Agents, thus, may value a reputation for abiding by norms in order to be included in social interaction at other levels. Agents need not necessarily attach equal importance to the reputation to be gained from participation in

[13]The point about punishment strategies is that the threat must be credible. Thus, if defection is observed, it must be in the interests of other agents to carry out the punishment. Hirshleifer and Rasmusen (1989) have a model of cooperation in a repeated Prisoners' Dilemma game with ostracism as a credible punishment strategy.

community activity, and it is not unreasonable to expect to observe a distribution of this characteristic among the population.

Notice that the reputation effect depends directly on the level of observability of behaviour. If defection can go undetected, the agent will not suffer any loss of reputation. This has implications for the need for effective monitoring systems to ensure compliance with social norms. On the other hand, the guilt effect is independent of the level of monitoring, since it arises out of an internalised characteristic of each agent.

The introduction of these effects is a preliminary attempt to bridge the gap between economics and other social disciplines, in the hope of developing a more accurate description of the real world. However, notice that the departure from traditional microeconomic approaches is not very significant. As Field (1984) argues, the framework of microeconomic analysis implicitly assumes logically anterior rules within which transactions take place. Thus, he asserts that "... the assumption that some system of rules, norms or structures persists is an analytical necessity if microeconomic theory or game theory is to be undertaken within the empirical context of stable political and social orders ..." (Field, 1984, p. 685). In order to model stable social orders, one must posit certain rules and norms which help identify the constraints under which strategic interaction takes place. Microeconomic analysis can be interpreted as the study of the results of behaviour of self-interested agents acting within the constraints determined in part by technologies, resources and the preferences of others, but also in part by the system of rules or norms confronted or participated in. In this sense, social norms can be interpreted as constraints which define the limits within which interaction between members of a community can be studied.[14]

The present analysis **does not** claim that **all** norm-based behaviour can be reduced to that which is dictated by an individual's valuation of the guilt and reputation effects. I acknowledge the importance of sociological and

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[14]A valid objection at this stage would be my "functionalist" justification for the existence of social norms. I will attempt to discuss some of the issues which arise in this context later in the present paper. However, this assumption is no more arbitrary than the assumption that a state of nature can be represented as a repeated game, underlying which there must be an overall structure of rudimentary non betrayal interaction.

psychological motivations, and recognise that the present framework tells only part of the story. People often observe norms for their own sake, without considerations of selfish optimisation.[15] The attempt here is simply to demonstrate how the incorporation of social customs as an additional constraint on individual behaviour can generate interdependence in decision-making. This gives rise to certain theoretical predictions which conform more closely to empirical analyses of cooperative behaviour.

III. THE MODEL

The problem being addressed is that of effective collective action in the control of resources. I will attempt to identify conditions under which collective action may be sustainable with local, community-based resource management.[16] The present concern is to examine situations in which individuals have a binary choice, between not cooperating and participating in collective action. The outcome of the collective action is the adequate maintenance of resources, as desired by the community. Free-riding by all leads to the degradation of the forest.

Consider a village forest under the control of the local community. There is assumed to be a prescribed social rule governing the use of the forest, which requires individuals to meet only a part of their demands from the village forest. For simplicity, assume a single demand, fuelwood. The free-riders do not observe the norm, so the amount of wood extracted by free-riders exceeds the amount available to those who cooperate. Further, there is an additional cost of participation in collective action. This cost can be thought of as effort expended on obtaining alternative fuels. This may involve looking further afield to make up the deficiency, or, alternatively, purchasing some amount of a substitute (e.g., kerosene) for fuelwood. This

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[15]For instance, Elster (1989) defines norms mainly by their intrinsic nature and not by their causes and effects, i.e., they are not outcome oriented.

[16]The analogy with the "free-rider" problem in the theory of the provision of public goods is clear. Notice one important difference between the problem of contribution to the provision of public goods, and the present discussion. While the former involves an act of "giving", restraint in resource use requires agents to refrain from "taking". The two situations need not be viewed identically by agents, because of the way the problems are "framed" (Kahnemann and Tversky, 1979). People may evaluate losses and gains foregone differently, with implications for the feasibility of collective action.

is a private cost borne by the agent when she chooses to observe the social norm, and is independent of the behaviour of others or the degree of participation in collective action.

Assume further that there is a reputation effect, which follows from recognition of the individual's cooperation in the regulated use of the forest. Since I am considering a community in which agents can be expected to interact at many different levels, this effect may be fairly strong.[17] Furthermore, in general, not all agents would value reputation equally. The distribution of this characteristic across a heterogeneous population allows us to distinguish between resource users. For instance, members of a community who own no cattle would not need to participate in common grazing arrangements, or be part of a milk marketing cooperative. They can be expected to value a reputation for cooperation less than another member of the community who is involved at many different levels, including cattle raising. The greater the level of involvement of an agent in community activity, the more he can be expected to value the reputation of "being a cooperator".

Further, I assume that agents suffer guilt consequent upon violation of the social norm. This guilt captures the feelings of "shame" which accompany defection. These are essentially psychic effects. It is not unreasonable to expect that all members of the community suffer "equal" guilt from defection, since the norm is defined as a commonly shared social belief. If agents differ in their belief about the social custom, this would introduce further heterogeneity in the population. This may occur, for instance, in a community which encompasses a number of diverse sub-cultures. In a more closely integrated community, however, we should not expect to observe significant differences in the attitudes of agents towards the norm. For the present purposes, I will assume that the guilt effect is identical for the entire population, although this assumption can probably easily be relaxed.

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[17]Dasgupta (1988, p.62) suggests that reputation can be thought of as a capital asset; thus "...one can build it up by pursuing certain courses of action, or destroy it by pursuing certain others...". A dynamic analysis could endogenise reputation formation in a learning model.

The formal model derives largely from the analysis in Naylor (1989 and 1990).[18] Consider the following individual payoff functions

$$B_i^0 = Y_0 - g \tag{1}$$

and

$$B_i^1 = Y_1 - c + r_i\mu, \tag{2}$$

where

B_i^0 is individual i's net payoff or **benefit** from defecting;

B_i^1 is individual i's net payoff or **benefit** from cooperating;

Y_0 is the individual's **income** from the forest if she defects from the social norm, and everybody else cooperates;

Y_1 is the individual's **income** from the forest if she cooperates, and so does everybody else. As outlined above, $Y_0 > Y_1$, since defectors extract a larger amount of fuelwood than those who adhere to the norm;

μ is the fraction of the population which cooperates and exercises restraint in the use of the forest. Multiplication by this variable captures the nature of interdependence in the decision making process;

c is the private **cost** to the individual of participating in the collective action. This captures the additional effort required to acquire additional fuel in order to make up the deficiency which results from observing the norm;

r_i represents the individual's valuation of the **reputation** derived from obeying the social custom, i.e., cooperating, if everybody else cooperates. The greater the proportion of the population which cooperates, the more the agent values her reputation;

g is a measure of the **guilt** which follows from the act of violating the social norm;

An individual will cooperate whenever $B_i^1 > B_i^0$, i.e.,

$$Y_1 - c + r_i\mu > Y_0 - g \tag{3}$$

which gives us

$$r_i\mu > Y_0 - Y_1 + c - g \tag{4}$$

or,
$$r_i > \frac{(Y_0 - Y_1) - g + c}{\mu}. \tag{4'}$$

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[18]For analytical simplicity, the functional form which I will consider is extremely elementary. However, it can probably be made fairly complex without severe damage to the results.

Thus, cooperation occurs where the reputation effect from participating outweighs the loss of utility which follows from observing the prescribed social norm. The right-hand side of equation (4) captures the level of guilt an agent is willing to suffer in order to capture the social benefits which follow from a reputation for cooperation. It can be interpreted as a measure of the value an agent imputes to her social standing; she will "sell her soul" (i.e., defect), the moment the right hand side exceeds $r_i\mu$. This relationship can be shown diagrammatically as follows (Figure 1).

FIGURE 1

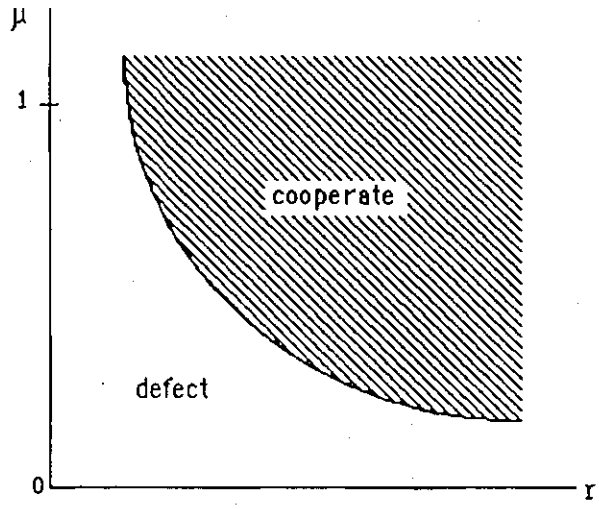


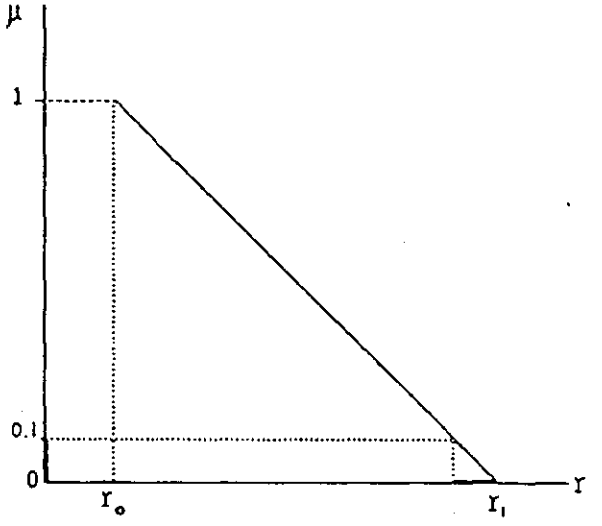
Figure 1 is a decision schedule which represents the level of the reputation effect required to induce cooperation. As the proportion of cooperators increases, the level of the reputation effect required for each individual to cooperate falls. Individuals who value reputation more than the threshold level represented by the schedule can be expected to cooperate.

Assume, for the moment, that the reputation effect, r_i, is uniformly distributed across the population, between a lower bound, r_0, and an upper bound, r_1. This distribution is depicted in Figure 2.[19] Notice that if $\mu = 0.1$, the agents most likely to cooperate will be the top decile of the characteristic distribution, i.e., the decile which most values the reputation

[19]Alternative distributions will generate different results. What is important for the present analysis is that heterogeneity of the population will lead to stable cooperative outcomes without universal participation.

effect and probably has most at stake in maintaining cooperative arrangements.

FIGURE 2



A necessary condition for equilibrium is that those cooperating (defecting) cannot make themselves better off by defecting (cooperating), i.e., no agent should wish to change her action in equilibrium. Define a function Z_i as

$$Z_i = B_i^1 - B_i^0 \tag{5}$$

Z_i is a "surplus" function, and is equal to the difference in the net benefit from cooperating and the net benefit from defecting. An equilibrium with cooperation (possibly partial) can be defined as a proportion of the population, μ^*, such that $r_i > \frac{(Y_0 - Y_1) - g + c}{\mu^*}$ for every member of the population who cooperates and, simultaneously, the proportion of such cooperators is exactly equal to μ^*. This is simply a consistency requirement, so that all those who cooperate have no incentive to defect, and all those who defect have no incentive to cooperate, given the level of cooperation defined by μ^*. Clearly, in this situation, the marginal agent is indifferent between the two actions, i.e., $Z_i = 0$. We can examine conditions under which such an equilibrium exists in this model. Consider, first the situation of universal defection, i.e., $\mu = 0$. For universal defection, the benefit from cooperation must not exceed that from defection for any agent, or $Z_i < 0$. Since Z_i is continuous, for an

equilibrium with cooperation to exist, we must have $Z_i \geq 0$, for some $\mu^* > 0$, i.e.,

$$Z_i = Y_1 - Y_0 - c + r_i\mu^* + g \geq 0$$

$$r_i\mu^* + g \geq Y_0 - Y_1 + c \qquad (6)$$

On the left hand side of equation (6) are the reputation effect and guilt effect which follow from the existence of the social norm. If the norm did not exist, the left hand side would be zero. The right hand side is the increased benefit from defecting, due to greater extraction of fuelwood and the saving in costs of acquiring of alternative fuels. Clearly, for an agent to cooperate, the loss in benefit from violating the social norm must offset the gain in benefit from defecting. The tragedy of the commons arises because, without the social custom, the incentive structure drives agents to defection. The social custom allows users to overcome the tragedy by providing net benefits from cooperative behaviour.[20]

We can now superimpose the two figures to examine the possible equilibria in the model. Figures 3.1 to 3.4 show possible outcomes, which depend on the relative positions of the two schedules.

Consider Figure 3.1 (overleaf). At point **b**, μ_b of the population are cooperating. For these individuals, $r_i > r_b$. Cooperation can be sustained for all individuals for whom $r_i > r_b^*$. This implies that a larger proportion, μ_b^*, of cooperators can be sustained. As the arrow indicates, the number of cooperators should be expected to grow until the proportion is μ_a, which corresponds to the intersection of the two curves at point **a**. At any point below **c**, the proportion of cooperators is too low to sustain any cooperation, even by those who value reputation very highly, and μ falls to 0.[21] Conversely, at points above **a**, the reputation effect for some of the

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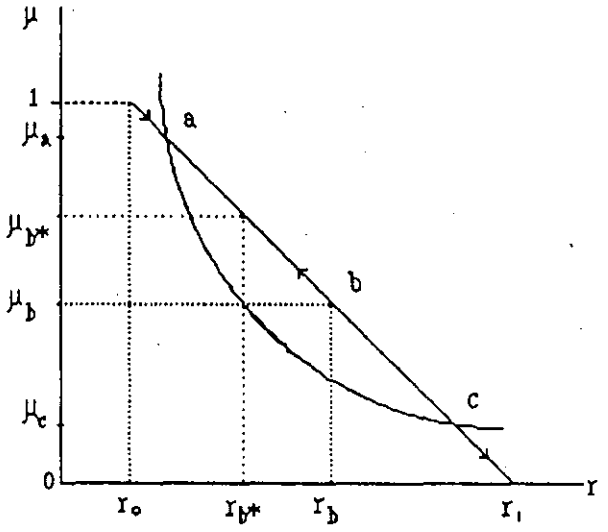
[20]Equation (7) represents an example of a possible payoff structure from an assurance game. What is of interest, and merits further research, is what underlies the reputation and disutility functions which are driving this result. As suggested earlier, repetition of a stage game which is a MPD may be one possibility. This does not exclude other stories which may generate similar payoff structures. However, it is probably difficult to theorise generally about the nature of these functions, which can be expected to vary under different empirical conditions.

[21]This corresponds to the critical mass or threshold level of cooperation, as defined by Schelling (1978). Naylor (1990) shows that Schelling's model is a special case of his analysis.

cooperators is insufficiently large to offset the losses from cooperation, and μ falls to μ_a.

FIGURE 3.1



There are three equilibria; $\mu = 0$, $\mu = \mu_a$, $\mu = \mu_c$.[22] Of these, the first two are locally stable, while the third is unstable. At any level of cooperation above μ_c, the proportion of cooperators increases to μ_a, while at levels below μ_c, cooperation collapses and everyone defects. μ_c represents the minimum coalition whose expectations must be coordinated in order to achieve a cooperative outcome. This can have important implications for the evolution of cooperative behaviour. If the behaviour of this critical proportion of the population, which values reputation most highly, can be coordinated, cooperation may be sustainable.[23] Notice that it is not necessary to direct the expectations of all agents, only those of a critical minimum number. Further, notice that the stable equilibrium level of cooperation does not require universal participation, which conforms to empirical observation. In a heterogeneous population, cooperation will be observed from those agents for whom reputation yields the greatest utility; those who do not expect to benefit sufficiently cannot be expected to participate in collective action.

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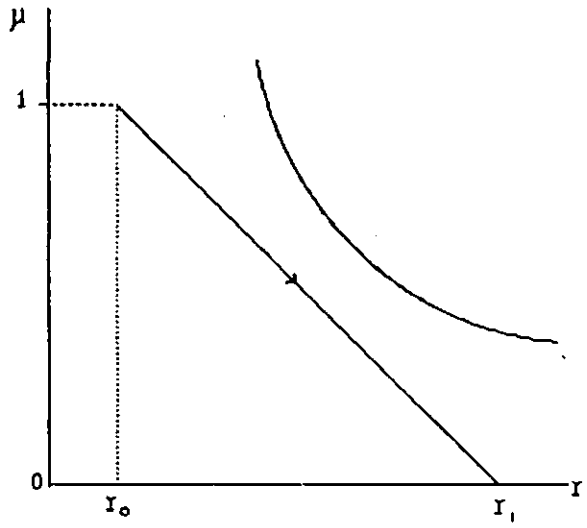
[22]The particular functional forms I have adopted yield these three possible equilibria. However, with different formulations of the relationships, the curves may intersect more often, and generate other possibilities. This would not damage the essential results of the present analysis.

[23]Clearly, in this case, coordination can be an effective mechanism for generating cooperation. Failures of cooperation can occur in this framework, despite perfect coordination, if the two curves do not intersect.

FIGURE 3.2



In Figure 3.2, the two schedules do not intersect and the only stable equilibrium is universal defection. In terms of the above analysis, $Z_i < 0$, for all μ. Nowhere does the payoff from cooperation exceed that from defection. In Figure 3.3, the two schedules are tangentional at **a**. Here, too, the only stable equilibrium is universal defection. μ_a does represent an equilibrium, but this is clearly unstable.

FIGURE 3.3

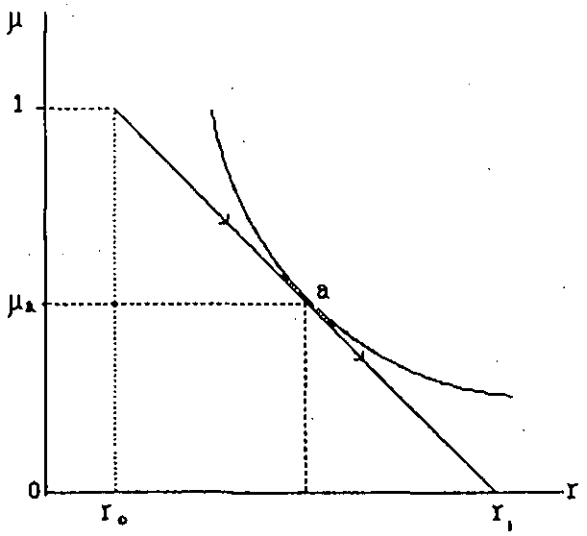
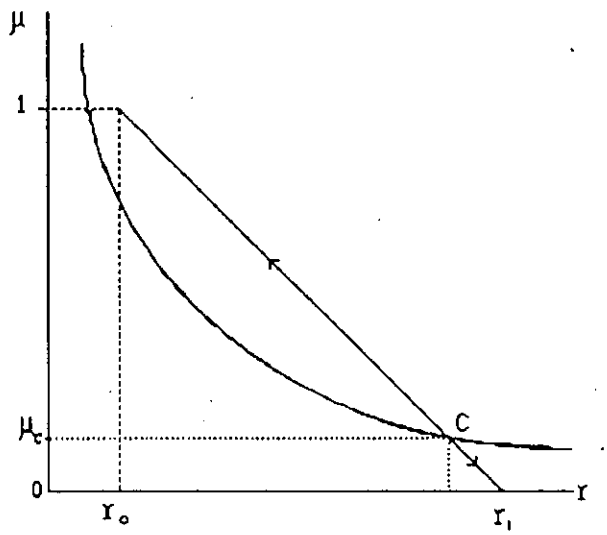


Figure 3.4 shows the possibility of universal cooperation once the critical level, μ_c, has been achieved. However, we need to restate the decision rule more precisely to sustain this outcome. Our decision rule stated that individuals would cooperate so long as the payoff from doing so was at least as great as that from defecting. In this case, $\mu = \mu_c$ would not be an

equilibrium, since all individuals will cooperate once $r_i^* = \frac{(Y_0 - Y_1) - g + c}{\mu}$.

Thus, we assume that when two payoffs are equal, agents continue with their previous actions. This allows μ_c to be sustained as an equilibrium, although this is unstable. For any proportion greater (less) than μ_c, the game collapses to universal cooperation (defection). Above μ_c, we observe universal cooperation, with r_i greater than the critical r for all individuals.

FIGURE 3.4



Clearly, the possibility of cooperation depends on the shape and relative position of the two schedules. As the private cost of cooperation, c, rises, the decision schedule shifts to the right, through the cases described by Figures 3.3 and 3.2 respectively, and the stable equilibrium level of cooperation falls to zero. Thus, as the cost of obtaining alternative fuels increases (possibly due to greater effort), we can expect the level of sustainable cooperation to fall.

As the difference between the return from defection and that from cooperation, $(Y_0 - Y_1)$, increases, the decision schedule shifts to the right, lowering the sustainable level of cooperation. This may be caused in part by previous degradation of the forest, which forces the adoption of a more stringent rule. This suggests that the feasibility of enforcing a sustainable community-based sharing rule is related to the extent of sacrifice members are required to make. If the rule involves a severe reduction in flows from the forest, one would expect the cooperative outcome to be more difficult to achieve.

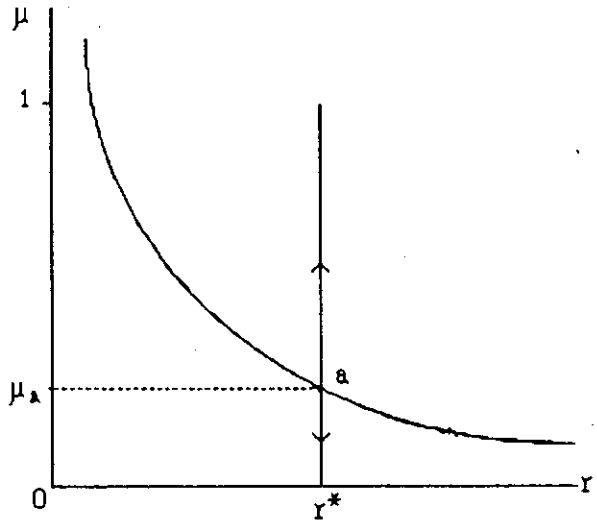
An increase in internalisation of the norm increases the guilt effect, g, and shifts the decision schedule to the left, increasing the level of cooperation. This could incorporate historical influences and the effects of learning; if a community has a history of cooperative behaviour, the extent of socialisation of its members is expected to be greater, which increases guilt from defection. The guilt effect can be thought of as a reduced form of a dynamic variable. Just as with capital assets, previous actions can add to (or take away from) the "stock" of guilt which exists at any time.

The more sensitive are individuals to reputation effects, the further to the right is the r-distribution, with the consequence that the stable equilibrium level of non-zero membership (μ_a) is higher, and the critical mass level (μ_c) is lower. The reputation effect depends upon the level of monitoring in the community, and upon the nature and frequency of social (both economic and non-economic) interaction. As the size of the community increases, we can expect monitoring to become more difficult, reducing the value of reputation. Further, an increase in community size may give rise to increased specialisation, which may reduce the multi-layered structure of social relations. The returns from reputation will fall correspondingly. As mobility increases and exit from the community becomes possible, reputation (the "voice" option) becomes less important. What this implies is that, since reputation is likely to be more highly valued in small, stable communities which are in continued interaction with each other at a multiplicity of levels, we should expect cooperative behaviour to be easier to sustain in such situations.

The slope of the r-schedule reflects the degree of heterogeneity of the population. There is no prior reason to assume that the reputation effect will necessarily be uniformly distributed across the population. For instance, the distribution could be considerably skewed if only a small proportion of the population value the reputation effect very highly, while others attach low importance to the benefits from participation. Clearly, different distributions would generate alternative equilibria; however, the substantive analysis should not be expected to alter. Consider, for instance, the case where all individuals are identical, i.e., $r_i = r^*$, for all i. The r-schedule then collapses to a vertical line, as shown in Figure 4 (overleaf). Here, the only possible outcomes are either

universal cooperation or universal defection, with μ_a defining the critical mass. The analysis is similar to that for Figure 3.4.

FIGURE 4



It is easy to get the "Tragedy of the Commons"/ Multiperson Prisoners' Dilemma-type outcomes in the present analysis. What Hardin was referring to was a one-shot game among resource users who shared no binding ties or commitment to each other. Clearly, then,

$$r = g = 0,$$

and the payoffs are reduced to

$$B_i^0 = Y_0$$

and

$$B_i^1 = Y_1 - c.$$

Since $Y_0 > Y_1$, $B_i^0 > B_i^1$.

Thus, defection will always be dominant, and the forest will get degraded due to over-use. However, as argued earlier, in most cases of local management of resource use, modelling players in this manner seems unrealistic. The long term nature of their interaction at multiple levels implies that they value reputation, and suffer some guilt from violating prescribed norms of social behaviour. If these effects are sufficiently strong, the analysis above shows that cooperation may be sustainable.

IV. THE ORIGIN OF COOPERATION

The discussion so far has been within a static framework of agents interacting with, and responding to, a given structure of rules and social institutions. To complement this discussion, what is required is an understanding of the dynamic process by which this framework of norms may be created and sustained. In particular, analysts must attempt to identify conditions which may be conducive to local cooperation in the care of forests, and suggest mechanisms which may generate such institutional arrangements.

The present model should not be viewed as one in which agents cooperate simply because they derive utility from cooperating. The mere presence of a possible benefit from collective action does not ensure that society will organise to obtain it. As the discussion above shows, universal defection may be a stable outcome, even where the potential for a cooperative outcome exists. The model highlights the interdependent nature of decision-making in such situations, and demonstrates that the theoretical existence of a potentially superior outcome does not guarantee that it will be achieved. If a society is locked-in to an exploitative, but stable, mode of resource use, this could be self-sustaining.[24] In terms of our analysis, this may be because the benefits of norm-based behaviour are insufficient to overcome the costs of cooperative behaviour (see Figures 3.2 and 3.3). Alternatively, the beliefs of the required critical mass of agents may not be coordinated, and society may be locked-in to an inferior equilibrium (Figures 3.1 and 3.4).

What distinguishes social structures from one another is their degree of resilience to shocks. Referring back to the analytical structure outlined above, a shock may shift the positions of the decision schedule, or the distribution of the reputation effect; alternatively, it may serve to coordinate the beliefs of a critical minimum number of agents, and shift society from an inferior non-cooperative equilibrium to a superior cooperative outcome. In the present context, an attempt to change

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[24]Thus, I am not suggesting that stable institutional structures *must* be efficient. Inefficient structures may well be self-perpetuating.

property rights structures with respect to forests may represent one type of shock which can potentially affect the system.

The imposition of State monopoly holding rights in many countries has implied that a number of local communities have been denied common access to forests. Monitoring the use of such reserved forests and ensuring the exclusion of local villagers are difficult tasks for a centralised agency. As Repetto and Gillis (1988) show, State forestry may lead to substantial misuse of the forests. On the one hand, private contractors from outside the territory typically have few long-term stakes in the health of the forest; this often results in indiscriminate felling in violation of state regulations. On the other hand, locals have no guarantee that they will reap the benefits of stinting; hence, they have no incentive to restrict their use of resources. The value of the reputation effect from cooperating in such situations is likely to be fairly low. In the absence of effective monitoring and enforcement by the State, the result may be substantial depletion and reduction of the resource to open access.

The introduction of common property rights may generate two types of effects. Firstly, local users will realise that they have a long term interest in the state of the forest; the guarantee that they will reap the benefits of cooperative behaviour will greatly increase the value attached to the reputation effect. Second, the local community will have the power to exclude outside contractors; even if they are permitted, the incentives and ability of locals to effectively monitor and regulate use is likely to be far superior to that of the central agency. These two effects imply that a property rights shock may serve to shift a society from an inferior and exploitative mode of forest use to a more prudent and superior regime.

While this has clear implications for policy, a word of caution is in order. As suggested above, societies differ in their degree of resilience to shocks. Thus, introduction of common property management of forest resources is to be advocated only in communities where it is expected that such a shock will be sufficient to shift society to a cooperative mode of resource use. It would not be advisable to introduce such a property rights regime under all circumstances; communities where conditions are more conducive for cooperative behaviour are clearly more likely to succeed in common property management of their forest resources. On the other

hand, it could be counter-productive to introduce common property arrangements where there is little expectation of their success in regulating resource use. What is stressed here is that firm conclusions can be drawn only after careful analysis of the particular empirical situation.

We can draw some tentative conclusions by relating property rights to values; each institutional structure generates certain values, which may, over time, be internalised by individuals. Thus, markets give rise to "negative freedoms", in the sense that agents have the right to exit from undesirable relations. On the other hand, more personalised interactions in non-market situations (as may occur under collective rights) may be associated with positive freedoms; i.e., participants may have the right to act in order to promote the value of their entitlement, or to exercise voice. If a community is characterised by a mixture of positive and negative freedoms, the property rights shock may tip the balance and promote collective action if it encourages the exercise of voice. On the other hand, shocks (property rights, technology, exogenous - the availability of fruitful outside employment) may encourage exit and give rise to more individualistic behaviour. Thus, the extent of internalisation of the norm can be linked to the existing structure of rights, which may (or may not) reinforce the norm. A shock may generate different norms, which may or may not be stable.[25]

Cooperation may not necessarily arise because of a shock to the system. A dynamic process of learning may generate a cooperative outcome. Chopra *et al* (1989) suggest that the commonly-shared perception of an impending threat may generate sufficient interest in community action to mobilise the community, or a critical number of its members.[26] For instance, the presence of external exploiters may heighten the conflict over resource use and distribution, and serve as a catalyst for collective action. The history of

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[25]The change of values may result from a number of exogenous shocks, of which a restructuring of property rights is one. Other mechanisms which can generate changes in behaviour are the arrival of new technology (which, for instance, may reduce interdependence among water users in traditional irrigation) or the availability of fruitful outside employment (which may encourage greater mobility and, consequently, less dependence on community-based activity).

[26]They have studied a group of North Indian villages where such a process has been observed. A previously degraded resource base has been considerably rejuvenated as a result of cooperative action, which they term "participatory development".

forest movements in India is an example of such a learning process (see Guha, 1989, for an account). The role of education in shaping the perceptions of the population can be quite significant, since it serves to internalise norm-based behaviour and heightens the guilt effect which follows defection. In this context, the role of outside influences, such as social workers and voluntary agencies, is potentially very important.

The sociobiology literature[27] suggests that evolutionary mechanisms of reciprocity, kin selection and group selection converge towards norms of cooperative behaviour. Such characteristics are less likely to be found in highly mobile, developed, specialised and atomistic industrial societies. Cultural and biological selective pressures towards cooperation are more likely to be found in small communities with extended social interaction at a multiplicity of levels. However, it is important to stress that no claim is being made about the efficiency of structures which emerge from these processes of selection.

Theories which are based on self-interest maximisation are an incomplete explanation of the emergence of norms. Enforcement of social norms is not individually rational; higher order norms must exist to enjoin agents to punish violators. If we are to avoid problems of meta reasoning, we must allow for the internalisation of norms, without subjecting them to the utilitarian calculus. Important influences in this process which can be identified are psychological factors, social fitness, history, intentional social design and conflict over the recognition of rights. These, however, are only preliminary speculations, and more thorough analysis is required before any conclusions can be drawn.

V. Concluding Remarks

The above discussion represents an initial attempt to integrate some aspects of social behaviour into the economic analysis of collective action. In particular, I have examined the possibilities of local cooperation in the care of forests. The introduction of social customs allows us to derive cooperative outcomes under particular conditions. Agents are modelled as heterogeneous in their valuation of the reputation which follows from

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[27]See Dawkins (1976). Axelrod (1984) has a discussion of some relevant issues.

participation in collective action; this permits partial cooperation to be sustained as a stable equilibrium. Homogeneous agents are a special case of the present analysis; this generates either universal cooperation or universal defection as the only possible outcomes of the game, which conforms with much of the existing literature on cooperative behaviour.

In the more general case, the particular functional form determines the number and type of possible equilibria. Superior, stable cooperative outcomes may exist at the same time as less efficient equilibria with no (or less) cooperation. It may be possible for the community to be locked-in to an inefficient mode of forest use, despite the possibility of a superior solution. The question then becomes one of coordinating the beliefs of agents, or changing their perceptions of the potential payoffs from cooperation, so that society may shift from a lower level of participation to an outcome with more cooperation. This may be more feasible in certain communities than in others. History (especially of previous collective action), distribution of assets, size of the community, degree of social mobility, the nature of economic and social interaction, and the existence of shared social beliefs and customs have been identified as possible determinants of the success or failure of cooperation. Attempts to promote local management of resources must bear in mind these influences; where cooperative behaviour cannot be expected to be sustained as a stable outcome, it is necessary to examine alternative institutional arrangements for the care of resources.

The preliminary results of the present study suggest that cooperative behaviour is more likely to be sustained in small and closely knit local communities, which share a multiplicity of interactive social relations and exhibit less mobility. Where the pecuniary gains from defection are expected to be relatively high, a greater level of socialisation of the community is required so that these may be offset by the value of the reputation effect and the psychic benefits which follow from cooperative behaviour. Where the pecuniary gains from defection are not significantly greater than those from cooperation, collective action can be sustained with a lower degree of socialisation. This framework can explain the relative success or failure of cooperation in communities with broadly similar social structures by perceived differences in relative pecuniary returns from cooperation (Wade, 1988a, has a similar argument). Where

pecuniary returns are of similar magnitudes, the differences can be attributed to the size of social returns expected from cooperative behaviour; as suggested above, historical processes and cultural norms and conventions play an important part in determining the degree of socialisation of different societies.

The model has some advantages over previous work in that it can generate similar results as those of earlier theoretical studies, while at the same time explaining a fair amount of observed behaviour under community-based resource management regimes. The applicability of the present framework is certainly more general, and it can probably be extended to analyse other problems of collective action. A dynamic analysis must take into account the effects of shocks which shift the system from an inferior stable equilibrium to a superior cooperative outcome; at the same time, it must incorporate the effects of learning and the study of evolutionary processes. Further work must also attempt to generate a more formal analysis of the origins of cooperative behaviour, along the lines suggested in the discussion above.

The implications of this analysis for policy discussions are important. Clearly, collective action must be promoted in communities where conditions are more conducive to such behaviour. On the other hand, where social relations suggest that cooperation is less likely to succeed, it is necessary to devise alternative institutional arrangements which will promote the care of resources. Policy must reflect a sensitivity to the needs of local populations, and the present paper outlines some conditions under which community management of resources may be a feasible alternative. However, it must be stressed that such theoretical discussions cannot substitute for careful empirical analysis of the particular problem under consideration. Policy makers must recognise that there is no universal formula which can guarantee the emergence of successful local institutions for commons management under all circumstances.

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