Collective action on the commons: the role of inequality

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During the last decades, collective initiatives in matters of common property resource management have been documented in numerous empirical studies. A theme which has received particular attention in this literature is the impact of inequality on collective action capacities. Conclusions from these studies are far from univoqual, as some studies stress the positive role of inequality while others point in the opposite direction (contrast for instance Wade (1988) with Cernea (1989)). One should however avoid the temptation to conclude that nothing definite can then be said about the role of inequality. As a matter of fact, the relations tested differ across the available studies in terms of measurement of the crucial variables, in terms of the interpretation of the results, and in terms of the precise characteristics of the underlying environment.

Regarding the first source of ambiguity, it is obvious that inequality is not unidimensional and, therefore, it is possible that some dimensions of inequality are conducive to collective action whereas others are obnoxious. Moreover, confusion is likely to arise if the dimension of inequality that the researcher is intending to test is in fact combined with some other dimension that does not have the same effect on collective action. To illustrate, two studies assessing the impact of inequality in income or wealth may well reach divergent conclusions because in one case, such inequality is combined with caste polarization or a rigid social polarization, while in the other case, income inequality is accompanied by a rather fluid social structure (Hayami and Kikuchi (1981). Measurement problems can also arise because the type of collective action considered is not the same. Indeed, collective action can be reflected in the willingness of group members to voluntarily contribute to the construction of a collective infrastructure, such as a drain in a watershed or a water control structure in an irrigation scheme (see, e.g., Gaspart et al (1998)), or to the conservation of a resource implying self-restraint behaviour. Or, alternatively, it can take on the form of people's participation in the setting up of a regulatory agency endowed with powers to collect fees, impose contributions on members, lay down rules and punish deviant behaviour (see, e.g., McKean (1986) or Edmonds (2000)). In the latter case, moreover, collective action is sometimes measured by various management actions (existence of management rules, of sanctioning and monitoring activities, incidence of rule-breaking, etc.), sometimes by their impact on efficiency in the use of the managed resource (as measured, for instance, by the rate of deforestation, the progression of sand dunes, the size and maturity of the fish caught,…), and sometimes by both.

An important source of interpretative ambiguity arises when authors infer that inequality is conducive to collective action because they find that richer users bear a larger share of the costs involved. The fact of the matter is that, while an increase in inequality may well enhance the incentives of the rich users to contribute more to collective action, such increase may simultaneously reduce the incentives of the poor. As a result, one cannot be sure that an increased participation of the rich users will better contribute to the efficient management of a resource than a situation in which there is a more balanced pattern of contributions by both the rich and the poor (Baland and Platteau (1999)).

Lastly, most empirical studies about collective management of common property resources implicitly refer to a unitary model of the commons, the archetype of which is the grazing problem depicted by Hardin. This is misleading, however, in so far as collective action outcomes depend on the incentive structure available to the users and the type of interactions among them, which are themselves determined by the characteristics of the resource and the technology used. In particular, it is essential to distinguish between situations in which agents have a predetermined stake in the commons and those in which such stakes are the result of a voluntary decision.

In the following, we consider the impact of inequality in wealth or income abstracting from other forms of inequality that might possibly accompany it. Attention is deliberately focussed on two central issues mentioned above, that is, the necessity to distinguish between various models of the commons on the one hand, and between voluntary contributions and participation in a regulatory structure, on the other hand. These two issues will be examined successively in sections 2 and 3. A short conclusion will close the paper.

2. Modelling the commons

Since in reality there is a wide variety of common property situations, it is impossible to account for all of them in terms of a unique analytical model. Two main models will be considered below. The first model examines a situation where users share the benefits from joint exploitation of a common property resource in direct proportion of the relative amounts of their appropriation efforts which they freely decide. We refer to this case as the appropriation model. In the second model, labelled the common good model, users benefit from the commons in proportion of their share or stake in it which is predetermined.

2. 1 The appropriation model

In many situations, agents jointly exploit a common property resource by individually choosing their individual level of harvesting. Villagers thus decide the number of hours they spend in the forest gathering fuelwood, fishermen decide the number of boats they operate in a common fishery, or, to refer to Hardin's (1968) celebrated example, herders decide on the number of animals to let graze on the common pasture, … In all these situations, the level of harvesting effort decided by an individual agent has an impact not only on the collective level of exploitation of the resource, but also on his share in collective harvest which is usually directly proportional to his effort level.

To get a vivid idea of the problem, consider a fishery in which a fixed number of fishermen (say, four people) freely decide the number of boats to put out at sea. Each of them has free access to the fishing ground. The fishermen's choice will typically be based on a comparison between the price of entry which they have to bear (say, the rental price of a fishing gear) and the expected income. As long as the net expected benefit on their own gears is positive, they decide to put in an additional unit of fishing effort. Since marginal productivity is decreasing, any such move imposes a negative externality on the other fishermen by reducing the amount of fish caught by pre-existing fishing units (a declining marginal productivity implies a decreasing average productivity). Total net income, or profit, is defined as the difference between the value of aggregate catches and the total operating costs obtained by multiplying the number of boats and their unit price assumed to be equal to one. The relationship between the total number of boats, total output, total profits and average profit per boat, as considered in our hypothetical example, is given in Table 1.

Table 1. Relationship between total level of appropriation efforts and total profit on a CPR with decreasing returns

# of boats	1	2	3	4	5	6	7	8	9	10	11
Total output	2	8	12	15	17	17.5	17.6	17.1	16.3	15.5	11.55
Total profits	1	6	9	11	12	11.5	10.6	9	7.3	5.5	0.55
Profit per boat	1	3	3	2.75	2.4	1.92	1.51	1.12	0.81	0.55	0.05

Given the technology described in the table, the game has a unique Nash equilibrium (2,2,3,3) in which two fishermen put out two boats each while the other two put out three boats. Consider a fisherman with two boats. Given that the three other fishermen operate 8 boats in total, he earns a net income of 0.55 on each of his boats, yielding a total income of 1.10. Putting one more boat would reduce the average income per boat from 0.55 to 0.05, so that his total income would fall to 0.15. On the other hand, if he puts only one boat, he would get an income of 0.81. He therefore decides to put out two boats, which bring him more income than any other alternative. The same reasoning can be made for the three other fishermen, and the conclusion is reached that no one has any interest to change his number of boats. As a result, (2,2,3,3) is a Nash equilibrium. (It can also be shown that it is a unique equilibrium).

However, the total number of boats thus operated in the fishery (10) is clearly in excess to the social optimum which requires that only 5 boats be used to maximize aggregate profits. The problem is that no one, individually, has any interest to deviate from his Nash equilibrium strategy. Let us now introduce inequality among the different fishermen. For instance, consider an external constraint –say, a credit constraint –that has the effect of limiting the number of boats which some fishermen can own. The question is whether such a constraint is susceptible of reducing the extent of overexploitation of the fishery by altering the distribution of access rights.

Typically, rationing on the credit market deprives a number of operators of the funds necessary to acquire as many boats as they would like. In table 2, the first column shows all the possible configurations of a constrained access by fishermen to boat ownership, under the assumption that the total credit available allows the financing of at most ten boats. For example, (1,1,1,7) means that three fishermen can buy only one boat, while the last one can buy up to seven boats. The second column gives the respective values of the Gini coefficients pertaining to all possible distributions of the credit constraints. The resulting Nash equilibria of the instantaneous game where, given his credit constraint, each fisherman has to choose the number of boats to operate are described in the third column. These equilibria are computed in the same way as indicated above with respect to table 1. What is shown in the last column is an efficiency index of the Nash equilibria: it is calculated as the ratio of the total net income obtained in the final situations to the (first-best) optimum.

Table 2. Impact of heterogeneity on the total amount and the distribution of appropriation efforts when increased efforts are impossible

Distribution of credit constraints	Gini index of the distribution of credit constraints	Equilibrium allocation of boats	Index of efficiency in the final allocation (%)	Income of the poorest fisherman
1 1 1 7	.45	1 1 1 4	88.0	1.51
1 1 2 6	.40	1 1 2 3	88.0	1.51
1 1 3 5	.35	1 1 3 3	75.0	1.12
1 1 4 4	.30	1 1 3 3	75.0	1.12
1 2 2 5	.30	1 2 2 3	75.0	0.81
1 2 3 4	.25	1 2 3 3	58.0	0.85
2 2 2 4	.15	2 2 2 3	58.0	1.10
2 2 3 3	.10	2 2 3 3	45.0	1.10

The striking feature that emerges from Table 2 is the following: given the users' inability to reach a binding agreement together, the most desirable situations obtain when the distributions of credit constraints are the most skewed. In these cases, indeed, the value of the efficiency index works out to 88%, which means that maximum inequality leads to an outcome that is remarkably close to the optimum. This represents a significant improvement since the value of this index in the unconstrained Nash equilibrium (2,2,3,3) is as low as 45%. Furthermore, a comparison of the second and fourth columns reveals that there is a perfect rank correlation between the measure of efficiency in the equilibrium situations and the skewness of the distribution of credit constraints (as measured by the Gini coefficient). This is due to the fact that users with larger credit endowments have a strong incentive to exercise self restraint and to leave unused part of their credit capacity, as smaller users, bound by their credit constraints, cannot increase their rates of use.

Equally noticeable is the fact that the poorest fishermen earn a higher income in the most inequitable situation (1.51) than in the most equitable one (2x0.55) although they operate fewer boats. Rather paradoxically, therefore, constraints or factor market imperfections that limit the access of some users to capital or other critical inputs may thus allow inequitable distributions of endowments to increase the incomes of the most constrained users.

There is actually a wide array of constraints that can yield the above effect. The administrative distribution of harvesting licences by a central authority provides an interesting application of our central argument. Indeed, if the state distributes the available licences in an unequal way among the operating fishermen, it would create a situation in which the bigger licence-holders have an incentive not to use all their licences, which can even lead to an improvement of the incomes of the small licence-holders.

The above argument can be generalized as follows. Consider *n* agents who jointly exploit a common property resource and share their benefits in direct proportion to the relative amount of appropriation efforts they have chosen to put in. Let g_i stand for the appropriation effort of agent *i*. Total output can then be written as:

$$G = G\left(\sum_j g_j\right)$$

where $G''>0$ and G' can be positive or negative. For the sake of notational simplicity, we assume that costs are nil, so that the profit accruing to agent i is simply:

$$\Pi_i = \left(g_i \Big/ \sum_{j=1}^{n} g_j\right) G\left(\sum_j g_j\right)$$

In a Nash equilibrium, each agent maximizes his profit by choosing his own level of effort, taking the level of effort provided by the others as given. Raising the level of effort has two separate effects on profits: it may increase (or reduce) the aggregate output to be shared by all users, and it increases the individual's share in aggregate output. This is expressed in the first-order condition:

$$\frac{\partial \Pi_i}{\partial g_i} = \left(\sum_{k \neq i} g_k \Big/ \left(\sum_{j=1}^{n} g_j \right)^2 \right) G\left(\sum_j g_j \right) + \left(g_i \Big/ \sum_j g_j \right) G'\left(\sum_j g_j \right) = 0$$

In the above equation, the first term is always positive. In equilibrium, the second term must therefore be negative, which implies that at the Nash equilibrium agents set the total amount of effort in such a way that its marginal productivity is negative (or, if costs were positive, below marginal cost). Inefficiency arises because, at the efficient point where marginal productivity is nil, agents have an incentive to increase their effort level since it increases their share in aggregate output[1].

Consider the situation under which the distribution of wealth translates into a distribution of the maximal amount of effort that an agent can choose. While the constraint is not binding for wealthier agents in the choice of their effort level, it is binding for poorer ones. Consider a disequalizing transfer from (i) an agent who was previously unconstrained and is now constrained, or (ii) from an agent who was previously constrained. Such a transfer has the effect of reducing the aggregate level of effort, thereby making the use of the common resource more efficient.

To show this result, consider the first-order condition above. Suppose that the transfers benefitted an unconstrained agent[2] (we leave to the reader the discussion of the case where such transfer benefits a constrained agent). The constrained user, who lost from the transfer, reduces his own level of effort (by an amount equal to the change in his constraint). If after the transfer, the benefitting user, who is unconstrained, increases his effort level so that the aggregate level remains unchanged, the derivative of the profit function given above

[1] Note that, if the users on the commons are simultaneously Cournot competitors on the output market, there exists an optimal number of users such that the commons is efficiently used (see Cornes et al, 1986)

would be negative: the first term on the R. H. S. would be smaller, and, bearing in mind that *G'* is negative at the Nash equilibrium, the second term would be more negative. Hence, the post-transfer level of effort chosen by this agent will never be such that the aggregate level (increases or) remains constant. As can be checked from the F.O.C. above, he does increase his level of effort (i.e., efforts by the agents are strategic substitutes in this model), but this increase is smaller than the reduction in the effort levels of the loosing agent. It should be moreover noted that, in some circumstances, a disequalizing change in the distribution of wealth may have such an impact on the aggregate level of effort that the welfare of all users is increased.

2.2 The common good model

A good point of departure for analyzing the common good problem is the public good model in which all agents derive an identical benefit from the (pure) public good that their contributions generate. An important result regarding the impact of inequality is that obtained by Bergstrom, Blume and Varian in their seminal paper (1986). According to them, the (inefficient) amount of public good produced is independent of the extent of inequality among contributing users. The intuition behind this apparently paradoxical result is the following: when deciding the amount of his contribution, an agent considers the existing level of the public good contributed by the others and, by choosing his contribution, he actually determines the final level of the public good that will be made available. The budget constraint of agent i is : $c_i + g_i = w_i$, where c_i stands for his private consumption, g_i for his voluntary contribution to the public good, and w_i for his income. It can be rewritten as $c_i + G_i = w_i + G_{-i}$, where G_{-i} is the amount of the public good provided by the other agents, and G_i is

[2] If more than one agent benefits from the transfer, one can always decompose the transfer as the sum of

the final amount of the public good, including agent i's contribution : $G_i = g_i + G_{-i}$. In other words, the amount of public good provided by the others directly enters as a source of income for agent i, as long as he makes a positive contribution. Consider now a transfer of 1$ from agent j to agent i. If agent j reduces his contribution by exactly 1$, agent i's budget constraint can now be written as : $c_i + G_i = w_i + 1\$ + (G_{-i} - 1\$)$. His budget constraint is unaffected, and he will make the same choice regarding the final level of the public good as before. His contribution therefore increases by exactly 1$. (Conversely, for agent j, if agent i increases his contribution by 1$, his best reply is to reduce his contribution by exactly 1$). The equilibrium aggregate level of the contribution thus stands unaffected by (small) transfers between contributing agents. By contrast, when some agents choose not to contribute, a transfer from non-contributors to contributors will increase the level of the public good produced (provided it is a normal good).

In the same logic, any change in the distribution of income that increases the aggregate wealth of the contributing agents increases the equilibrium amount of public good provided (see proposition 4 in Bergstrom et al (1986)). This holds true for simple transfers of wealth from a non-contributor to a contributor, but it also applies to more complicated redistributions of income, which, for instance, involve that a former contributor has become too poor to continue contributing. The critical factor in this result is that the aggregate wealth of the set of contributors is increased. As the preceding result has made clear, the way this increase is distributed among them is of no consequence.

However, as consumers can differ in their preferences, the redistribution of income discussed here cannot be directly related to inequality. Indeed, nothing so far prohibits a situation in which poor consumers, who have a 'strong' preference for the public good, contribute while the rich consumers, with other preferences, do not have an income high enough to prompt them to contribute. In such a situation, redistributions of income that would increase the aggregate provision of the public good are equalizing.

Let us now consider the general case in which agents draw unequal benefits from the resource due to different endowments in the relevant asset. Think of the harvesting of immature fishes by means of small mesh nets in a common fishery, or the building and maintenance of anti-erosive barriers in a hilly area, or else the collective maintenance of irrigation channels. In all these situations, the benefits of the 'public good' provided are not enjoyed by all agents in the same proportion. Clearly, it is the fisherman with the largest fleet, and therefore the largest share in total fish catches, who benefits most from the protection of juveniles through the adoption of appropriate mesh sizes. In these circumstances, the agents benefit from the public good produced (or the public 'bad' avoided) with the help of their aggregate contribution in proportion to their share or their 'interest' in the good (which is called common good in what follows). This share is often directly related to their ownership of the relevant factors of production. Thus, in the case of a fishery composed of n fishermen, the share of fisherman i, s_i, can be thought of as being equal to the number of boats he owns, B_i, in proportion to the total number of boats in the fishery, if we assume that only one type of boat technology is available. Similarly, the share of peasant i in the collective irrigation system, s_i, is (at least for the sake of many of the relevant issues) equal to the ratio of his landholdings to the total service area operated under this system. The question considered here is thus the voluntary contributions of agents who draw benefits in proportion of their interest, s_i, which is predetermined. We assume that the common good is a strictly normal good, and that the production technology of the common good is well-behaved.

In these circumstances, the model is identical to the pure public good model. The difference of shares between two agents can indeed be simply reinterpreted as a difference in preferences, which the model of public good analyzed above allowed for. The effects of changes in the distribution of income, w_i, are then identical to those implied by the neutrality result obtained by Blume, Bergstrom and Varian (1986) reported above. In particular, any change in the distribution which increases the aggregate income of the contributing agents increases the provision of the public good.

We can now examine the distribution of shares, s_i. Assume that agents differ only in their shares in the common good (and have the same preferences, and face the same constraints). In this setting, individual contributions, at equilibrium, will always be higher for agents with larger shares and it is of course possible that the poorest users make no contribution at all. Not surprising, therefore, is the oft-observed result in the empirical literature that richer users (big landowners, fishermen owning many boats and nets, etc…) contribute significantly more than poorer ones to the management of common property resources or to the construction and maintenance of collective infrastructures.

In the same setting, a disequalizing transfer of shares from a non-contributor to a contributor increases the overall provision of the public good[3]. From here, it is tempting to infer that greater inequality is more conducive to collective action. This is not a correct inference because the impact of transfers between contributors is in fact ambiguous. It will actually depend on whether the increased contribution by the winning agent outweighs the reduction by the loosing agent. However, it remains true that the largest and most efficient voluntary provision of the public good obtains when all the shares are concentrated in the hands of a single agent, in conformity with Olson's (1965) well-known contribution.[4]

In all what has been said above, it has been implicitly assumed that the unit price of the voluntary contributions is uniform across all agents: one unit contributed costs one unit of

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[3] The above results also hold true if the distribution of income closely follows the distribution of shares, so that agents with higher shares have a higher income as well.

[4] In the simple case where agents maximize their profits, that is the difference between their gross benefits, proportional to their shares, and the costs of contributing, assumed to be identical across agents, the income effects are ruled out, and the distribution of income, w_i, becomes irrelevant. In this setting, it is noteworthy that the Nash equilibrium is such that only the largest user contributes. All other users choose not to contribute

income. In many realistic settings, however, the unit cost of contribution is variable. Thus, when contributions take on the form of labour time spent in the production or maintenance of the common good, one expects them to be costlier for the rich since the opportunity cost of their time is higher. Under such conditions, one can no more be sure that the larger users will contribute more than the poorer users to the production of the common good. If the distribution of the shares, s_i, is correlated with that of the opportunity costs of time, the two effects run in opposite directions: larger shares provide more incentives to participate in the collective undertaking, while a higher opportunity cost of time discourages such participation.[5]

Labour inputs are not the only possible form of contributions, though. When contributions can be made in cash, the expectation is that agents with a higher opportunity cost of time will prefer this form of contribution. It is revealing that cash contributions are usually propounded by richer users while labour contributions are the preferred option of the poor. It is revealing that in many schemes richer users are allowed to send wage labourers in their place to contribute to the collective undertaking. When the type of contributions is thus left free, the effect on participation of differential costs of contributing is neutralized (see Sengupta (1991))

In the foregoing discussion, we have also assumed the absence of non-convexities. Indeed, we considered that the production function which transformed the aggregated individual contributions into the common good was (weakly) concave. However, there exist a number of situations related to common property resources where technology displays non-convexities and threshold phenomena[6], for instance because of set-up costs in the building of

because the marginal cost of their contributions always exceeds their marginal benefit (see Baland and Platteau (1997b: 458-61)).

[5] If the opportunity costs of time are perfectly correlated with the shares, and if individuals maximize their net incomes (or profits), equilibrium contributions will be identical among them.

[6] See in particular Baland and Platteau (1997a) for a discussion of non-convexities in the realm of common

a common infrastructure, or because of a minimum threshold level beyond which the resource cannot reproduce itself and disappears. To discuss the impact of non-convexities, consider a situation where aggregate contributions must reach a critical level for the public good to yield any benefit: agents decide to contribute an amount g_i to the building of a common infrastructure, such that $G(\Sigma_j\ g_j) = 1$ if $\Sigma_j\ g_j$ is greater or equal to a constant C, and $G=0$ otherwise. If no share in the benefits of the common good is large enough for an agent to have the incentive to produce alone ($s_i < C$), there is a Nash equilibrium under which no agent contributes. Non-convexities thus give rise to coordination failures, and therefore to more complex possibilities than those yielded by the simple representation of free-riding as a Prisoner's Dilemma. Moreover, as only a limited number of contributions are needed, there is in fact a continuum of Nash equilibria under which the common good is produced, where some agents may contribute more or less depending on the others' contributions. While it is true that agents with larger shares will tend to appear more frequently in the possible equilibria, and that their equilibrium contributions will on average be more important, no further precise prediction can be inferred from this setting (see Gaspart et al (1998)). In particular, one can easily construct examples of equilibria in which only the smallest agents contribute to the public good. Also, given the multiplicity of equilibria, it is hard to get meaningful comparative statics results.

Lastly, it bears emphasis that we have so far focussed on Nash equilibria in games of finite duration. While this may adequately represent a large number of field situations, there also exist cases where the game played by users on the commons is more realistically depicted as an infinitely repeated game, or as an interlinked game. In infinitely repeated games, as is well known, there is a plethora of equilibrium strategies and, in particular, the efficient outcome can be possibly sustained in equilibrium (see e.g. Abreu (1986, 1988), and Sethi and Somanathan (1996)). Interlinked games, on the other hand, are more likely to arise in small village communities in which people are related through dense and multiplex relationships. In such circumstances, defection in one sphere of social or economic life is punishable in other spheres, which also makes 'cooperative' outcomes more likely to be established.

3 Regulating the commons

3.1. Wealth inequality and the formation of a regulatory authority

In the previous section, agents interacted in a completely decentralized manner. In numerous field situations, however, there often exists a local authority charged with laying down and enforcing rules for the use of the CPRs (for more details, see Baland and Platteau (1996: chap. 12)). The question then immediately arises as to how the cost of collective regulation, that is, the cost of initiating and performing regulatory task, is borne within the group of users.

The logic of the argument here is the same as that underlying our discussion of non-convexities. Indeed, in most instances, the creation of a regulatory authority can be interpreted as a public or common good for which costs have to be incurred. These costs partly consist of the time and other resources devoted to collectively organize regulation and to ensure its proper implementation (mobilization of the users, monitoring and sanctioning activities, dispute settlements, rule revision, etc). Moreover, for collection action to succeed, a minimum aggregate amount of effort must be put in, lest individual efforts should be spent in vain. Benefits from such action can be thought of as increasing with intensity of use of the resource, which is itself related to wealth endowment. Therefore, the incentives to bear the above costs can be considered as rising with wealth. Inequality may thus play a useful role by giving the better-endowed members sufficient incentives to incur the costs involved (see also Bardhan (1993: 638)).

There is abundant evidence to support the hypothesis that the costs of initiating collective action are largely borne by the economic elite. Thus, in his in-depth study of irrigation systems in South-Indian villages, Wade cogently argues that the effectiveness of a local irrigation council "depends on its councillors all having a substantial private interest in seeing that it works, and that interest is greater a larger a person's landholding" (Wade (1987: 230)). The claims that big landowners can make "are sufficiently large for some of them to be motivated to pay a major share of the organisational costs" (Wade (1988:190)). To take another example, in Ha Nchele, a lowland village in Lesotho, rotational grazing has been successfully introduced on village grazing lands as an alternative to taking animals to a cattle post in the mountains, mainly because the village chief held the greatest number of livestock, and thereby took a predominant part in the development of the project (Swallow and Bromley(1195); in the same vein, see Braverman et al (1991), Laitos (1986), Garcia-Barrios and Garcia-Barrios (1990), Menzies (1994), Heckathorn (1993), Peters (1993) and Gaspart and Platteau (chapter … in this book)).

As has already been emphasized in another context, the fact that better endowed agents tend to be more involved in the collective action process does not imply that increased wealth inequality necessarily increases the likelihood of successful emergence of regulatory mechanisms. It indeed narrowly depends on the political or social ‘technology’ of collective action. For example, if the starting of regulation requires the personal commitment of a single individual user (or of a few of them), it is crucial for the success of collective action that this (these) user(s) can internalize a sufficiently large share of the expected benefits.

Conversely, if the active support of all users is socially needed, reduced incentives for the smaller users to participate may undermine regulation. Interestingly, many empirical studies document cases in which collective action fails because some users are so small or attach so little weight to their resource endowment that they have no real stake in participating in it. Defecting users are often wealthy agents who enjoy access to rewarding alternative opportunities (Zufferey (1986)). Their lack of interest in the commons has serious consequences insofar as they do not, or do not any more, perform their expected leadership role required to coordinate collective action among all users.

A remarkable illustration of this possiblity concerns the arid areas of Western Rajasthan. Before independence, communal grazing lands used to be under the effective control of big landlords known as *jagirdars*. By virtue of their dominating position, they could appropriate a large share of the benefits accruing from the exploitation of the common property resources (the best pastures were indeed earmarked for the animals owned by them). It is therefore not surprising that they took upon themselves the task of deciding and implementing "conservation measures which ensured considerable stability to these resources" (Shanmugaratnam (1996: 172)). Such measures had the effect of conserving perennial grass species and trees and of allowing effective rotational grazing thanks to proper maintenance of water points (Jodha (1987, 1989)).

After independence, following a land reform that resulted in the privatisation of a large part of the village grazing areas and in the dissolution of the *jagirdari* rule and its replacement by the *panchayat* system, collective maintenance of the commons was discontinued. Degradation followed as evidenced by poor growth of grass, spread of sand dunes and death of trees. The problem is that in the new circumstances the biggest land owners are able to produce a large part of their fodder needs on their private land (crop residues are privatised since farms are opened after harvest only after the owner's livestock has grazed the bulk of the crop residues) and have the wherewithal to buy from the market the supplementary feed needed. Given their high degree of self-sufficiency in fodder, they tend to be uninterested in the management of the remaining common. In contrast, poorer farm owners highly depend on these commons for access to fodder yet prove unable to coordinate their actions so as to prevent resource degradation (Gupta (1986:312), Shanmugaratnam (1996:173-8)).

Wealthier users can not only refrain from participating in resource-preserving collective actions, but they may also attempt to undermine such actions in order to further their own private interests. In Mali, for example, the emergence of absentee herd owners with outside economic opportunities appears to be a major stumbling block on the way towards pastoral institution-building for sustainable rangeland management. This was a result of the great Sahelian droughts in the seventies when pastoralists were forced to sell their livestock to farmers or, more generally, to wealthier town-dwellers like traders and civil servants. According to a recent evaluation study of the Mopti Area Development Project, "Absentee herd owners favour open access rangelands so that their herds can graze anywhere. They may even use their political influence to prevent pastoral associations receiving legally defensible land rights" (Shanmugaratnam *et al* (1992:20)).

3.2. Regulation through transfers, quotas and taxes

The impact of inequality on collective regulation has been little discussed in the literature on appropriation. There are however a number of arguments to support the view that wealth or skills inequality between users makes regulation less efficient.

First, the economic elite may decide to participate with a view to influencing the collective action in a direction suitable to their private interests. Thus, in their analysis of sugar cooperatives in Maharashtra, Banerjee et al.(2001) show how the weight of wealthy and influential users in collective decision-making tends to distort collective regulation towards their interest, at the cost of efficiency. Their empirical estimates show that distortions (and inefficiency) in collective regulation tend to be highest when inequality was high among users. Likewise, a number of empirical studies of irrigation schemes in developing countries conclude that higher inequality in landholdings (or farm income) tends to reduce the overall level of maintenance, even though it simultaneously induces larger agents to support a bigger share of the collective costs (see Tang (1991), Dayton-Johnson (1998) and Bardhan (2000)).

Second and most importantly, in the presence of inequality regulation is more difficult to design and implement because regulatory instruments are imperfect[7] and often limited to uniform quotas, or constant tax rates (see Baland and Platteau (1998a), Kanbur (1992)). The problem with such instruments is that they cannot be tailored to the particular situation of each user, and must be calibrated for average characteristics. Consequently, the second-best regulated outcome tends to deviate all the more from the first-best (with individual-specific regulation) solution as resource users are more heterogeneous. Absent compensatory transfer schemes, it is also more likely that some of the users will be hurt by the regulation proposed. Therefore, if we require the regulated solution to Pareto-dominate the ex ante unregulated situation, the Pareto-dominating regulation tends to be all the less efficient as inequality or heterogeneity is greater among users.

That the regulated outcome may not be efficient is an important conclusion that should prompt us to critically assess field experiences with resource management schemes. This is all the more so as there is a general tendency in the empirical literature to confuse the means with the end by inferring from the simple existence of regulatory instruments that the resource concerned is properly managed or conserved. Field enquiries typically focus on the question as to whether rules have been laid out and whether they are effectively enforced (what are the detection and monitoring methods used, what is the incidence of rule violation, etc.). For example, studies dealing with forestry or irrigation schemes have a tendency to describe in considerable detail the various rules established by a user community to regulate access to the forest or water as well as the monitoring and sanction systems created towards the purpose of enforcing them (see Ostrom (1990, 1992) and Baland and Platteau (1996)). An effort is then generally undertaken to identify the characteristics of those user communities that have shown their ability to devise and apply membership or use rules as though these rules were necessarily conducive to efficient management of local-level resources. Typically, the possibility that rules do support an efficient outcome or that they are infringed because they are considered to be inefficient or hurting the interests of violators is rarely contemplated.

That regulation tends to be more difficult to implement in the presence of inequality is supported by the well-known analysis of shrimp fishery in Texas by Johnson and Libecap (1982):

> 'Contracting costs are high among heterogeneous fishermen, who vary principally with regard to fishing skill. The differential yields that result from heterogeneity affect the willingness to organize with others for specific regulations…regulations that pose disproportionate constraints on certain classes of fishermen will be opposed by those adversely affected. (…) Indeed, if fishermen had equal abilities and yields, the net gains from effort controls would be evenly spread, and given the large estimates of rent dissipation in many fisheries, rules governing effort or catch would be quickly adopted. (…) For example, total effort could be restricted through uniform quotas for eligible fishermen. But if fishermen are heterogeneous, uniform quotas will be costly to assign and enforce because of opposition from more productive fishermen. Without side payments (which are difficult to administer), uniform quotas leave more productive fishermen worse off' (Johnson and Libecap (1982: 1006-10)).

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[7] For a thorough discussion of the limitations in the use of such instruments in the case of common property

Evidence from Senegal artisanal fisheries confirms that fishermen are reluctant to differentiate fishing quotas according to individual skill levels or performance. As noted by Gaspart and Platteau (see chapter… in this book), many fishermen actually denied that skill differentials exist in their community and they 'actually took pains to explain that better performances on the part of some fishermen are only transient phenomena likely to be reversed as soon as luck turns its back on them to favour other fishing units' (p. 14). The difficulty of measuring relative skill levels in a way that would be accepted by everybody undoubtedly explains why the only feasible regulatory system is one of skill-neutral quotas.

Note that uniform quotas do not necesarily run counter to the interests of the rich insofar as they can be set as per unit of physical assets owned. Thus in the fishing communities studied by Gaspart and Platteau (see chapter … in this book), effort regulation is achieved by fixing a number of sea trips or a quantity of fish landings per boat unit and not per fishing household. Moreover, if uniform quotas may hurt the interests of the rich, uniform costs may work to their advantage. Such a simple rule of cost-sharing is often applied for the maintenance of irrigation systems, whether individual contributions are expressed in kind (typically in the form of labour obligations) or in cash (see, e.g., Sengupta, 1991: 142, 182). At least, this is true when inequality of landholdings is not too high. When inequality is substantial, if we follow Bardhan's aforementioned study of irrigation systems in India (2000), the proportional cost-sharing rule is more likely to be observed.

4. Concluding remarks

By distinguishing between two central models of the commons, on the one hand, and between voluntary contributions and participation in a regulatory structure, on the other hand, we have been able to differentiate the impact of inequality on efficiency in the use of the commons. Economic analysis thus allows us to clarify the conditions under which different effects of inequality on the use of the commons occur.

In particular, we find that inequality is more likely to encourage efficient use of common property resource when it facilitates the establishment of a regulatory authority, and in appropriation problems, when increased inequality reduces the aggregate level of use of the resource, by placing constraints on the individual harvesting efforts of the smaller users. By contrast, when the gamut of available regulatory instruments is limited, inequality between users makes collective agreement and effective enforcement of regulatory schemes more difficult to achieve. In games of voluntary contributions to a common good, the impact of inequality is more ambiguous: while it is generally true that larger users tend to contribute more to the common good, increased inequality also reduces the incentives of small users to contribute.

An important merit of economic analysis lies precisely in the fact that it directs our attention to particular factors that impinge upon the direction of the effect of inequality on resource management. Among those factors highlighted by our discussion are the incentive structures facing participants in their peculiar management problem, the nature of the constraints that limit individual behaviour, the technology of production in the common property, the range of available regulatory instruments (themselves influenced by the prevailing social structure) and the degree of repetition and complexity in the interaction among users.

Poverty is an important dimension which has not been touched upon. It is generally argued that poverty drives people to contemplate short term strategies, with heavy consequences for the future state of the resource (Baland and Platteau (1996), Ternstrom (2001) Paggiola (1993), Perrings (1996)). Typically, poor people do not have access to the capital market. They also tend to be more prone to adverse income shocks, with little ability to self-insure. When their income is low, they would be willing to dissave, that is to transfer income from future periods to the present, but they cannot. They will therefore use alternative and inefficient ways to dissave, as a substitute to their access to the capital market. One such means is to over-exploit the commons. Poverty, when it implies poor access to credit and insurance, may be an additional factor of inefficiency in the use of the commons. However, insofar as poor people have few alternative income opportunities available to them, they also tend to have more stakes, and thus more incentives, to take measures to protect common property resources.

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