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Exploiting a Local Common: Egoistic vs. Altruistic Behavior

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Abstract *The paper analyzes the exploitation of a local common where the behavior is steered by altruism rooted in social norms. The analysis is illustrated by using the Gordon-Schäfer model of a fishery. We start by reviewing the standard results when all exploiters are purely egoists; i.e., when own utility depends only on own profit. Under the assumption of identical harvesting efficiency for all owners, we then introduce social norms and find the consequences for the resource utilization and welfare under various degrees of altruism. It is demonstrated that more altruism generally leads to less harvesting effort, less economic overexploitation of the resource stock, and increased resource rent. In a next step, we open up for differences in harvesting technology. It is shown that a high degree of altruism, in addition to a large efficiency gap among the owners, restricts the possibility of an exploitation scheme where all owners participate in the harvesting activity. The possibility of a two-channel efficiency improvement as a result of more altruism is also demonstrated.*

Key words Bioeconomic analysis, local commons, norms.

Introduction

Referring to the ‘conventional wisdom’ among economists about property rights, Bromley (1989, pp.186–87) notes that, “when resource destruction is observed in settings of joint ownership and control it is the institutional arrangements (joint responsibility) that is immediately said to be at fault.” Much in line with Ostrom (1990) he claims that, “in practice, ‘the tragedy of the commons’ metaphor deflects analytical attention away from the actual social arrangements able to overcome resource degradation and make common property regimes viable” (Bromley 1991, pp. 22–23). This flaw in the conventional economic analysis of common property resources can be traced back to the use of very simplistic behavioral and institutional assumptions where, among others, people are supposed to be individually and instrumentally rational, entirely self-interested, and totally unaffected by social norms and the particular institutional arrangement in place. However, empirical and experimental studies suggest that social norms and the prevailing institutional arrangement play a crucial role for individual motivation and behavior in local resource management

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(Bardhan 1993; Ostrom and Gardner 1993; Ostrom 1990; Rabin 1998; Wade 1987).

In the following analysis, we aim to correct for this misconception. Social norms are, therefore, assumed to influence individual behavior. Hence, common property resource management is distinguished from that of the open access. Contextually, the sort of resource management settings we have in mind fall within Ostrom's (1990, p. 26) notion of small-scale, common-pool resources (CPRs), as for instance 'inshore fisheries, smaller grazing areas, groundwater basins, irrigation systems, and communal forests.' These resources are particularly essential for people living in the poor regions of the world (Dasgupta and Mäler 1995), and referring to FAO-statistics, Ostrom (1990, p. 27) maintains that about 90% of the world's fishermen and over half of the fish consumed each year are captured by the small-scale, inshore fisheries. Accordingly, improper understanding and policy failures attached to the management of these resources may have far reaching effects.

Two main features distinguish a local common property regime from open access. Firstly, there is a specified 'small' number of owners that, as a group, has the exclusive rights to appropriate the resource under consideration and, secondly, there is an institutional structure of individual rights and duties within the group of owners in which individual behavior is in compliance (Ciriacy-Wantrup and Bishop 1975; Bromley 1991). Hence, a local common is more than an accidental collection of independent individuals; it is a group of people in which the individual members relate to each other according to specific conventions on cooperation and coexistence, like social norms, group identity, trust, and patterns of reciprocity. These are all part of the social and institutional capital that accumulates over time within well-defined local commons (Baland and Platteau 1996; Ostrom 1990; Seabright 1993). In the same way, we hold that *altruism*, being rooted in these conventions, and in social norms in particular, is a result of the same historical process. Thus, by including altruism in the analysis, we acknowledge the crucial role played by norms and institutions in the economy of local common property management.

Social norms may trigger a variety of behavioral motivations. Our analysis is confined to those fitting along an egoism-altruism axis, on which complete egoism and complete altruism are the polar cases. Basically, there are two ways of addressing the issue of social norms analytically. Firstly, norms may be treated as 'binding constraints limiting the choices of a maximizing self-interested individual,' and secondly, they may 'play an important role in shaping individual preferences' (Baland and Platteau 1996, p. 116). We will adopt the latter in our treatment of altruism rooted in social norms, and the egoism-altruism distinction will be integrated in the preference structure of the individual agents. Based on this concept, our aim is to explore how the level and distribution of altruism among individuals may influence the economy of local common resource management. The various outcomes are evaluated in terms of effort use, resource utilization, and welfare, and the reasoning is illustrated by using the Gordon-Schäfer model of a fishery, where the solution concept all the time is of the Nash-Cournot one-shot game type.[1] We then analyze how the introduction of altruistic preferences eliminates inefficiencies in the resource management of the most pessimistic of all institutional settings, the one represented by static, non-cooperative games based on strict self interests.

As a background for the analysis, we start in the next section by reviewing the fairly standard results of the Gordon-Schäfer model when all exploiters are purely egoists, and we have what we will refer to as 'restricted open-access.' In the section that follows, we introduce social norms and analyze the resource exploitation under

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[1] Hence, although conventions on cooperation are indirectly accounted for through the inclusion of altruism in the preferences of the individuals, the game theoretic concept adopted is entirely noncooperative.

various degrees of altruism. In the next section, the special case when the co-owners practice the same degree of altruism and, therefore, have the same preferences, are analyzed. Finally, we study what happens when the exploiters use different harvesting technologies and the harvesting efficiency is different.

The Standard Gordon-Schäfer Model

When the number of exploiters is explicitly considered, the basic relationships of the Gordon-Schäfer model (see, *e.g.*, Mesterton-Gibbons 1993) are given by:

$$dX/dt = F(X) - \Sigma h_j \tag{1}$$

$$F(X) = rX(1 - X/K) \tag{2}$$

and

$$h_i = qe_iX. \tag{3}$$

Equation (1) is the population dynamics of the resource (the fish stock) with X as the stock size at time t (the time index is omitted), $F(X)$ is the natural growth function and h_j is the harvesting of exploiter j, $j = 1, ..., n$ and where n is fixed. The natural growth function [equation (2)] is of the logistic type, where r is the maximum specific growth rate, and K is the carrying capacity. Finally, equation (3) yields the Schäfer harvesting function with e_i as the effort and q as the catchability coefficient. Consequently, in the present setup, all owners are assumed to have identical catchability coefficients, thus being equally efficient in harvesting and homogeneous in endowment (see below). This assumption is relaxed later on.

The current profit of exploiter i is now $\pi_i = (ph_i - ce_i)$, where p is the given market price of the resource and c is the unit effort cost, also assumed to be given and fixed. Combining the above equations when $dX/dt = 0$, gives $X = K[1 - (q/r)\Sigma e_j)]$. When substituting into the harvesting function [equation (3)], we obtain $h_i = qK[1 - (q/r)\Sigma e_j]e_i$. The profit, or the resource rent, of exploiter i under biological equilibrium is, therefore, $\pi_i = pqK[1 - b - (q/r)\Sigma e_j]e_i$, where $b = c/Kpq$. $b < 1$ must hold to secure a positive profit and hence, a positive harvesting activity.

When every fisherman maximizes profit under biological equilibrium and treats the effort of all the $(n - 1)$ other exploiters as given so that the solution concept is of the Nash-Cournot type, we obtain the open-access solution under the assumption of a fixed number of exploiters. The equilibrium effort of owner i is then given as:

$$e_i^{roa} = r(1 - b)/q(n + 1)\,. \tag{4}$$

Equation (4) represents the *restricted open-access* effort (denoted by superscript 'roa'), emphasizing that the property relations between the exploiters are the same as in the traditional notion of open access, except from the constraint imposed on the number of agents. The total effort of the n fishermen follows as $E^{roa} = nr(1 - b)/q(n + 1)$. Substituted into the profit function, the profit of exploiter i reads $\pi_i^{roa} = Kpr(1 - b)^2/(n + 1)^2$, while the total profit is $\pi^{roa} = Kprn(1 - b)^2/(n + 1)^2$. Hence, contrary to the traditional concept of open access, there will always be a positive economic rent in the restricted open access case; *i.e.*, the rent will never be entirely dissipated. The equilibrium stock will be $X^{roa} = K(1 + nb)/(n + 1)$. For more details, see below.

The restricted open-access solution can be compared to the Pareto efficient solution when the total resource rent $\pi = \Sigma\pi_j$ is maximized so that the stock externalities are internalized. The effort use of exploiter i is then given by:

$$e_i^s = r(1 - b)/2qn \tag{5}$$

(superscript 's' denotes overall optimality). The total effort follows as $E^s = r(1 - b)/2q$, which is independent of n because the harvesting function is linear in the effort use. Moreover, we find that the total resource rent reads $\pi^s = Kpr(1 - b)^2/4$, and the equilibrium stock is $X^s = K(1 + b)/2$. E^s is below E^{roa} for all $n > 1$, while X^s is above X^{roa}, and the discrepancy increases when n shifts up because of more stock externalities. All these results are well known (see Mesterton-Gibbons 1993).

Exploitation Under Various Degree of Altruism

The above solution was obtained when the behavior of every exploiter was steered by strict egoism; own utility depends only on own profit. This is the restricted open-access solution because there are no social norms governing the individual exploitation of the resource. However, as discussed in the introduction, a local common property regime is characterized by having a structure of individual rights and duties within the group of owners in which the individual members relate to each other according to specific conventions on cooperation. These social norms are now embedded in the model by changing the assumption of purely egoistic behavior with altruistic behavior.[2]

The various degree of altruism will be reflected by the weight put on the well being of the others relative to own well being. The utility of owner i is, therefore, now a weighted sum of own profit and the profit of the other exploiters. We use the specific functional form $U_i = (1 - \mu_i)\pi_i + [\mu_i/(n - 1)]\Sigma\pi_j$, where $i = 1, ..., n$ and $j = 1, ..., i - 1, i + 1, \ldots, n$. The (exogenous) weight μ_i is assumed to be in the domain $[0, (n - 1)/n]$ and a higher μ_i means more altruism. If the weight is equal to $(n - 1)/n$, we define owner i to be *completely altruistic*, and hence, $U_i = (1/n)\Sigma\pi_j$, where $i = 1, \ldots, n$ and $j = 1, \ldots, n$. On the contrary, the model coincides with the standard Gordon-Schäfer model when $\mu_i = 0$; *i.e.*, when there is *pure egoism* and the preferences are given by $U_i = \pi_i$.[3]

To obtain analytical results, we consider only two exploiters. The utility functions are then:

$$U_1 = (1 - \mu_1)\pi_1 + \mu_1\pi_2 \tag{6}$$

and

$$U_2 = (1 - \mu_2)\pi_2 + \mu_2\pi_1. \tag{7}$$

For owner 1, the utility writes $U_1 = pqK[1 - b - (q/r)(e_1 + e_2)][(1 - \mu_1)e_1 + \mu_1 e_2]$ when using equations (1)–(3), and $U_2 = pqK[1 - b - (q/r)(e_2 + e_1)][(1 - \mu_2)e_2 + \mu_2 e_1]$ for

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[2] Becker (1976; 1981) and Kurz (1978), among others, discuss the underlying individual motives to act altruistically in other contexts (*e.g.*, within the family).

[3] The possibility of 'overaltruism'; *i.e.*, the case when μ_i is in the domain $(n - 1/n,1]$ is therefore ruled out. Neither the case of masochism nor envy are considered (Stark 1995).

owner 2. It can easily be confirmed that the utility functions are strictly concave in own effort under the given restrictions on μ_i. Under the assumption of utility maximization, $\partial U_i/\partial e_i = 0$ (i = 1,2), we obtain the best response functions as:

$$2(1 - \mu_1)e_1 + e_2 = r(1 - \mu_1)(1 - b)/q \quad (8)$$

and

$$e_1 + 2(1 - \mu_2)e_2 = r(1 - \mu_2)(1 - b)/q \quad (9)$$

where equation (8) is for owner 1 and equation (9) is for owner 2. See figure 1.

Solving, the Nash equilibrium comes out as:

$$e_1^* = r(1 - b)(1 - 2\mu_1)(1 - \mu_2)/[4(1 - \mu_1)(1 - \mu_2) - 1]q \quad (10)$$

and

$$e_2^* = r(1 - b)(1 - 2\mu_2)(1 - \mu_1)/[4(1 - \mu_1)(1 - \mu_2) - 1]q \quad (11)$$

Superscript '*' denotes the general case of altruism. The equilibrium will be unique except when both owners are completely altruistic and $\mu_1 = \mu_2 = 0.5$. The best response functions will then coincide and it will be an infinite number of equilibria. It is also seen that the problem has no interior solution when one of the owners is completely altruistic. Hence, when $\mu_1 = 0.5$ ($\mu_2 = 0.5$) and μ_2 (μ_1) is in the domain [0, 0.5), the best response functions will intersect at the e_2-axis (e_1-axis) so the effort of owner 1 (2) is zero, $e_1^* = 0$ ($e_2^* = 0$). However, when μ_i is in the domain [0, 0.5) and the problem has an unique interior solution, it can easily be confirmed that $\partial e_1^*/\partial\mu_1$

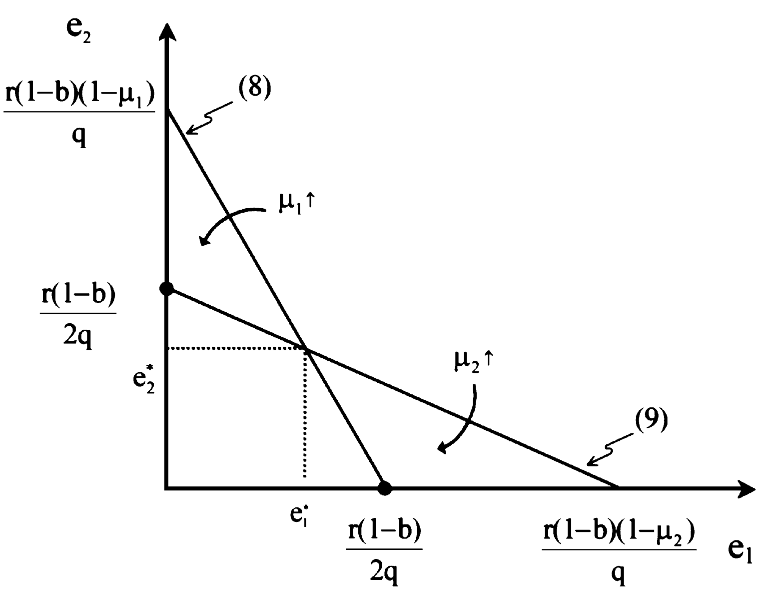

Figure 1. The Best Response Functions Under Various Degree of Altruism

< 0 and $\partial e_2^*/\partial\mu_1 > 0$, and $\partial e_2^*/\partial\mu_2 < 0$ and $\partial e_1^*/\partial\mu_2 > 0$ hold (see figure 1). Increased altruism works, as expected, in the direction of less own effort and more effort of the other owner. Combining the equilibrium conditions, it is also seen that $e_1^*/e_2^* = (1 - 2\mu_1)(1 - \mu_2)/(1 - 2\mu_2)(1 - \mu_1)$ holds; *i.e.*, the relative harvesting effort is only contingent upon the various degree of altruism.

Having characterized the equilibrium, we proceed to show how altruism influences the exploitation of the local common resource. From equations (10) and (11) it follows directly that the total effort will be $E^* = r(1 - b)[(1 - 2\mu_1)(1 - \mu_2) + (1 - 2\mu_2)(1 - \mu_1)]/[4(1 - \mu_1)(1 - \mu_2) - 1]q$, and E^* will be reduced when altruism increases, $\partial E^*/\partial\mu_i < 0$ ($i = 1,2$). Less effort of one owner must, therefore, outweigh more effort of the other. Moreover, when there is some degree of altruism among at least one of the exploiters, $E^* < E^{roa}$ must hold. Because the stock size of the resource is decreasing in the total effort use, $X^* = K(1 - qE^*/r)$, we will also have that $\partial X^*/\partial\mu_i > 0$ ($i = 1,2$). A strengthening of social norms, leading to increased altruism, works unambiguously in the direction of less effort and less overexploitation of the resource.

The next question is, what happens to the resource rent when there is a movement in the direction of more altruism? The profit of owner 1 will be $\pi_1^* = pqK[1 - b - (q/r)E^*]\,e_1^*$, which after some rearrangements can be written as $\pi_1^* = Kpr(1 - b)^2(1 - \mu_1 - \mu_2)(1 - 2\mu_1)(1 - \mu_2)/[4(1 - \mu_1)(1 - \mu_2) - 1]^2$. It can be confirmed that $\partial\pi_1^*/\partial\mu_1 < 0$ will hold. Finding the corresponding equilibrium profit of owner 2 and differentiating, we obtain $\partial\pi_2^*/\partial\mu_1 > 0$. The total profit is $\pi^* = Kpr(1 - b)^2(1 - \mu_1 - \mu_2)[(1 - 2\mu_1)(1 - \mu_2) + (1 - 2\mu_2)(1 - \mu_1)/[4(1 - \mu_1)(1 - \mu_2) - 1]^2$ and hence, $\partial\pi^*/\partial\mu_i > 0$. The total profit increases when one of the owners becomes more altruistic. The conclusion is that when individuals become more altruistic oriented, own effort and own profit will be reduced. At the same time, this ensures that total effort decreases and overall profit increases.

The above results were obtained when it was an interior solution for effort use. When owner 1 is purely altruistic and, therefore, indifferent to whether the resource rent is obtained through own harvesting activity or the activity of others, $\mu_1 = 0.5$, while μ_2 is in the domain [0, 0.5). Equations (10) and (11) reduce to $e_1^* = 0$ and $e_2^* = r(1 - b)/2q$, respectively. In this case, the harvesting activity of owner 2 is independent of the degree of own altruism, and the effort use coincides with the total effort under overall optimality; *i.e.*, $e_2^* = E^s$. This result is obvious; when harvesting takes place by only one agent there will be no stock externalities.[4] We will also have $\pi_1^* = 0$ and $\pi_2^* = \pi^* = \pi^s$, and the complete altruist renounces his personal profit. Hence, being indifferent about who obtains the profit, the complete altruist will keep away from own harvesting because the stock externalities are neutralized, and the total resource rent is maximized.

A Special Case: The Same Preferences of the Owners

We now look at the special case when the degree of altruism rooted in social norms is the same among the owners so that $\mu_1 = \mu_2 = \mu$ holds. The solution is then symmetric and the equilibrium effort will be:

$$e_i^* = r(1 - b)(1 - \mu)(1 - 2\mu)\big/\left[4(1 - \mu)^2 - 1\right]q; \quad i = 1, 2 \tag{12}$$

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[4] This is, however, not a general result. When there are three or more owners and just one is completely altruist, harvesting will take place by the other two. Stock externalities will, therefore, be present, and the total effort use will be above that of the overall optimum.

As above, the solution will obviously be as in the standard Gordon-Schäfer model when $\mu = 0$; $e_i^* = e_i^{roa}$ and $E^* = E^{\mathrm{roa}}$. It also follows that $\partial e_i^* / \partial \mu < 0$; *i.e.*, the effort of each owner decreases when there is a general movement in the direction of more altruism. Moreover, by using L'Hopitals rule, it can be demonstrated that e_i^* approaches $e_i^s (i = 1,2)$, and hence, E^* approaches E^s, when μ approaches 0.5. When we are close to the strict altruistic case, each owner uses approximately the same effort as under overall optimality. See figure 2.

The equilibrium stock size can now be written as $X^* = K\{1 - 2(1 - b)(1 - \mu)(1 - 2\mu)/[4(1 - \mu)^2 - 1]\}$, while the total profit is $\pi^* = 2Kpr(1 - b)^2(1 - \mu)(1 - 2\mu)^2/[4(1 - \mu)^2 - 1]^2$. Hence, more altruism means less ecological and economic overexploitation. In the limiting case when μ approaches 0.5, the stock size will also approach the stock size under overall optimality. This will also be so for profit. Being altruists, the owners maximize total resource rent and thus internalize the stock externalities; they reduce harvesting effort to avoid imposing high unit harvesting costs on their co-owners.

Differences in Efficiency

We now study what happens when there are differences in harvesting efficiency among the owners. According to Baland and Platteau (1996), the focus is then directed to the twin issues of group size and homogeneity. The conventional argument is that social norms are more likely to appear in homogeneous groups of small numbers. Moreover, it is supposed that homogeneity is more likely to be present in small groups, indicating that the effect of group size partly works through the homogeneity factor. Baland and Platteau (1996, p. 301), however, argue that, "too often, heterogeneity is blamed as a matter of principle without enough effort being devoted to spelling out the precise conditions under which it undermines collective action." To correct for this misconception, they separate between three main sources of hetero-

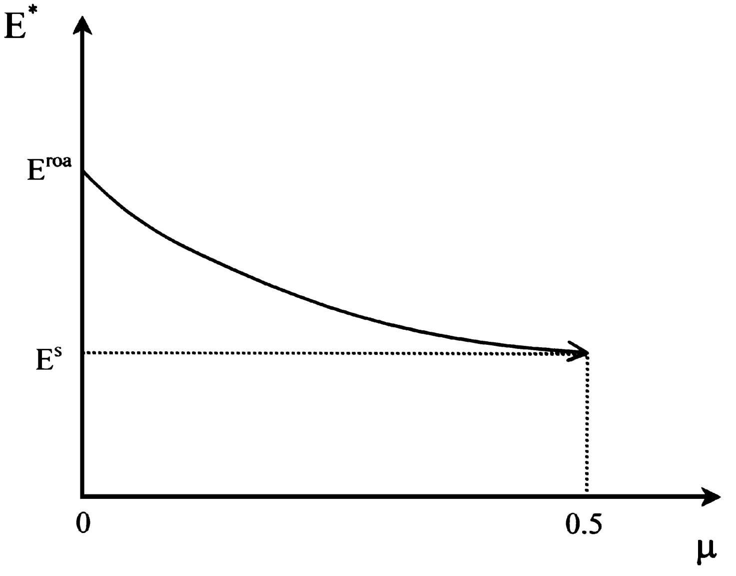

Figure 2. Overall Effort Use Under the Same Degree of Altruism

geneity; those of culture, interests, and endowments. From their empirical studies, they conclude that heterogeneity of endowments, quite contrary to those of culture and interests, may enhance co-operation and stimulate collective action. As skills are included in their endowments category, our notion of differences in efficiency falls within this category.

Hence, to analyze the above issues within the present setting, the assumption that technical skills or the efficiency in harvesting are identical, is relaxed. We still consider only two owners and restrict the analysis to the situation where the agents have the same weights in their utility functions, $\mu_1 = \mu_2 = \mu$. The utility functions under biological equilibrium when the catchability coefficient q varies are then $U_1 = (1 - \mu)pq_1K[1 - b_1 - (1/r)(q_1e_1 + q_2e_2)]e_1 + \mu pq_2K[1 - b_2 - (1/r)(q_1e_1 + q_2e_2)]e_2$ for owner 1, $U_2 = (1 - \mu)pq_2K[1 - b_2 - (1/r)(q_1e_1 + q_2e_2)]e_2 + \mu pq_1K[1 - b_1 - (1/r)(q_1e_1 + q_2e_2)]e_1$ for owner 2, and where $b_i = c/pq_iK < 1$ (i = 1,2). Under the assumption of utility maximization and an interior solution, $\partial U_i/\partial e_i = 0$ (i = 1,2), the Nash-equilibrium will now be given by:

$$e_1^* = r(1 - \mu)\left[2(1 - \mu)(1 - b_1) - (1 - b_2)\right]/\left[4(1 - \mu)^2 - 1\right]q_1 \tag{13}$$

and

$$e_2^* = r(1 - \mu)\left[2(1 - \mu)(1 - b_2) - (1 - b_1)\right]/\left[4(1 - \mu)^2 - 1\right]q_2 \, . \tag{14}$$

To obtain an interior solution with positive harvesting efforts, more restrictions on the ecological and economic parameters have to be imposed. $e_1^* > 0$ will hold when $(1 - b_2)/(1 - b_1) < 2(1 - \mu)$, while $e_2^* > 0$ holds when $(1 - b_2)/(1 - b_1) > 1/2(1 - \mu)$. The feasible set for an interior solution is, therefore, determined by the relative efficiency together with the degree of altruism, and is represented by the shaded area in figure 3. The feasible set shrinks when the degree of altruism increases. Hence, a 'high' degree of altruism accompanied by a 'small' efficiency gap means that one of the owners will refrain from harvesting because of stock externalities, while the other one takes the total catch; say, $e_1^* = 0$ and $e_2^* = r(1 - b_2)/2q_2 = E^s$. The same happens under a modest degree of altruism accompanied by a large efficiency gap.[5]

The result that a large efficiency gap causes the most efficient (or the most efficient ones in a general setting with more agents) to take all the catch is earlier demonstrated by, among others, Mesterton-Gibbons (1993). What is new here, is that a similar outcome is generated under the assumption of a small efficiency gap if combined with a high degree of altruism. Altruism rooted in social norms adds a new channel to a more efficient exploitation of the common as it reallocates harvesting effort from the least efficient to the most efficient by making the least efficient owner stop fishing altogether, thus leaving only one owner left in the fishery. Hence, total rent of the fishery is increased, firstly, due to the elimination of stock externalities as only one owner will be left in the fishery and, secondly, due to the fact that

[5] The present notion of relative efficiency should, however, be interpreted with care because the vertical axis on figure 3 refers to the ratio $(1 - b_2)/(1 - b_1)$, and not q_2/q_1. The simplest way to illustrate this point is when altruism is absent. When $\mu = 0$, $e_1^* > 0$ if $(1 - 2a) + a/q_2 > 0$, and $e_2^* > 0$ if $q_2 > 2a(1 + a)$. b_i is here replaced, and we have $a = b_iq_i = c/pK$. In addition, the catchability coefficient of owner two is normalized to one, $q_1 = 1$. Accordingly, we must have $a < 1$. Depending on the value of a, which can be interpreted as the cost-price ratio, it can be easily shown that the conditions for obtaining an interior solution are fulfilled for a wide range of values of q_2. Hence, when $\mu = 0$, an interior solution can take place for small as well as large gaps in efficiency among the harvesters. This is also the case when $\mu > 0$.

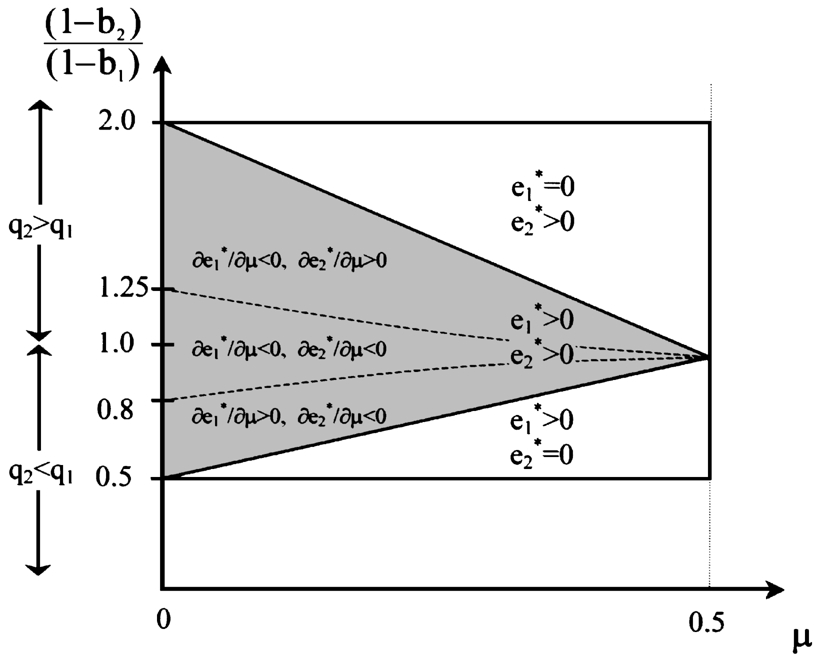

Figure 3. The Feasible Set for an interior Solution Under Different Degree of Altruism and Efficiency.

Note: Both owners harvest (the shaded area) and only one harvest (the non-shaded area). Outside the box, the least efficient is forced to leave harvesting regardless of the prevalence of altruism.

the one remaining will be the most efficient. Notice also that altruism triggers a voluntary withdrawal from harvesting, compared to a coerced withdrawal in the conventional model; that is, withdrawal and reduction in the number of exploiters take place because individual preferences are more in accordance with the interests of the collective. The co-owners of the local common can then reap the fruit of labour division, where the most efficient fishermen harvest, while the least efficient find alternative work at the prevailing opportunity cost, *c*. Our theoretical reasoning on heterogeneity fostering cooperation is, therefore, in line with the above mentioned empirical findings of Baland and Platteau (1996).

When there are interior solutions and both owners harvest, a changing degree of altruism yields:

$$\partial e_1^*/\partial\mu = r\left\{4(1-\mu)(1-b_1) - \left[5-4\mu(2-\mu)\right](1-b_2)\right\}\Big/\left[4(1-\mu)^2-1\right]^2 q_1 \quad (15)$$

and

$$\partial e_2^*/\partial\mu = r\left\{4(1-\mu)(1-b_2) - \left[5-4\mu(2-\mu)\right](1-b_1)\right\}\Big/\left[4(1-\mu)^2-1\right]^2 q_2 \quad (16)$$

We have the suspected result $\partial e_1^*/\partial\mu < 0$ when $(1-b_2)/(1-b_1) > (1-\mu)/[5/4-\mu(2-\mu)]$, and $\partial e_2^*/\partial\mu < 0$ when $(1-b_2)/(1-b_1) < [5/4-\mu(2-\mu)]/(1-\mu)$. This case is given in the middle of the shaded area in figure 3. Hence, as long as there is a small initial degree of altruism and a small efficiency gap, we obtain the same result as in the previous section. On the other hand, if there is a large initial degree of altruism or a large efficiency gap, we obtain other results and only the least efficient owner will reduce harvesting, while the most efficient, in fact, will increase harvesting effort. These cases take place in the upper part of the shaded area when owner 2 is most efficient, $\partial e_2^*/\partial\mu > 0$ and $\partial e_1^*/\partial\mu < 0$, and in the lower part when 1 is the most efficient harvester, $\partial e_1^*/\partial\mu > 0$ and $\partial e_2^*/\partial\mu < 0$.

A general movement in the direction toward more altruistic behavior when the efficiency gap is large (but small enough to secure an interior solution) so that the harvesting activity of the most efficient increases, while the activity of the other shrinks, leads to a major reallocation of effort use. However, for the outcomes taking place in the upper and lower parts of the shaded area, we demonstrate that total effort will decrease, ensuring a reduction of the economic overexploitation of the resource stock and an increase in the total resource rent, $\partial E^*/\partial\mu < 0$, $\partial X^*/\partial\mu > 0$ and $\partial\pi^*/\partial\mu > 0$.[6] More altruism promotes more efficient exploitation through a neutralization of the stock externalities. However, under these regimes an additional channel for efficiency improvement is present as the harvesting activity of the most efficient expands, while the activity of the least efficient shrinks. Efficiency improvement is achieved through redistribution of the harvesting shares as well.

Concluding Remarks

In this paper, we have studied the exploitation of a local common natural resource with a structure of individual rights and duties within the group of co-owners in which individual behavior is in compliance. Sharply in contrast to conventional economic analysis, the study is based on the assumption that the behavior of each owner is steered by altruism rooted in social norms. By introducing altruistic preferences, the role played by social and institutional capital are acknowledged. We have also used the term ‘restricted open access,’ pertaining to the traditional notion of open access, except with the assumption of a limited number of agents.

The analysis has been illustrated by using the Gordon-Schäfer model of a fishery, and where the exploitation takes place through a one-shot game with an equilibrium concept of the Nash-type. The main results can be summarized as follows. More altruism leads to less harvesting effort, less economic overexploitation of the resource, and a higher rent. In the limiting case when all owners are completely altruistic, the exploitation of the common takes place as under overall optimality; *i.e.*, as in a situation where the stock externalities are internalized. The present one-shot game model with altruistic behavior produces qualitatively the same results as the Nash equilibrium of an infinitely repeated game using trigger strategies and where individual utility is based strictly on self interests; *i.e.*, own utility depends only on own profit (the so-called Folk-theorem, see Gibbons 1992). More importantly, we have demonstrated that when there are differences in harvesting efficiency among the exploiters, altruism combined with efficiency gaps restricts the possibility of obtaining an exploitation scheme where all owners participate in the harvesting activity. Altruism in combination with efficiency gaps adds a new channel for efficiency improvement as it reallocates effort from the less efficient to the more efficient harvesters. In the boundary solution where exploiters voluntarily withdraw from exploitation due to altruistic preferences, our analysis also concludes that heterogeneity,

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[6] We have not been able to show these results analytically. They are confirmed by numerical experiments.

indeed, may stimulate collective action. This conclusion challenges the conventional belief that group homogeneity is unambiguously positive for common property management, and it applies to the case of heterogeneity in technological skills.

As long as the owners are not completely altruistic, the model presented in the paper joins conventional theory in concluding that economic inefficiencies are less severe when the group of owners is small. More importantly, however, the model indicates that the presence of social and institutional capital may be more crucial for the well functioning of common property regimes than the size of the group. In fact, it is shown that the adverse effects of large numbers may be partly or completely neutralized by social norms either through a coordinated internalization of stock externalities or through a voluntary withdrawal from harvesting in the case of heterogeneity in efficiency and skills.

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