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Common Property Resources: Economic Analytics

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by

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Contents

Abstract

An enormous literature has grown over the past two decades on the subject of common property resources (CPRs). Offering an alternative to impersonal markets and coercive States, the communitarian institutions built around CPRs have looked attractive to scholars in the humanities and social sciences. The literature in consequence has a warm glow to it. Oddly, economic theory has been missing from almost all discussions on CPRs. But without the disciplinary pressure of modern economic theory, it is difficult to judge the status of empirical works, which, in the case of CPRs, have mainly been case studies. In this article, I present a fairly complete economic theory of CPRs. The theory not only identifies circumstances in which communitarian institutions can function well, it also shows when those institutions could be expected to unravel. Recent empirical evidence on the fragility of CPRs is cited to display the robustness of the theory. The theory also identifies an especially dark side of communitarian institutions, namely, their capacity to permit one group to exploit another within long-term relationships.

1 Natural Capital and Economic Development

Twentieth century economics has in large measure been detached from the environmental sciences. Judging by the profession's writings, we economists see Nature, when we see it at all, at best as a backdrop from which resources can be drawn in isolation. Macroeconomic forecasts routinely exclude natural resources. Accounting for natural capital, if it comes into the calculus at all, is an afterthought to the real business of "doing economics".

Official development economics has mirrored the rest of economics in its neglect of the role natural capital plays in economic activity. This should be a puzzle. Development economists, more than anyone else, would have been expected to know that 65 to 75 percent of people in the world's poorest regions live in rural areas. Moreover, they needed only to think of agricultural land, threshing grounds, grazing fields, tanks and ponds, woodlands and forests, rivers and streams, coastal fisheries, mangroves, and coral reefs to recognise the importance of the local natural-resource base in the lives of the rural poor. Nevertheless, apart from agricultural land, natural capital has been absent from the formal models mainstream development economists have used to arrive at policy recommendations. Leading surveys and texts on the economics of development (Stern 1989; Dreze and Sen, 1990, 1995; Ray, 1998) ignore the local natural-resource base and the wide variety of institutions that have evolved for managing them.

Despite that lack of interest, an extensive applied literature has emerged in India on the economics of natural capital. Scholars contributing to that literature have noted that, excepting for agricultural land, the local natural-resource base is often communally owned. They have noted too that access is restricted to people who have historical rights; which, for most intents and purposes are villagers in the locality. There are anomalies and I shall return to a few later in this paper; but the thrust of the literature has been that although the local natural-resource base consists of capital assets that are common property, the assets are not open-access. Among Indian scholars those assets are now called common property resources, or CPRs.

2 Open Access Resources vs CPRs

The economic theory of open access resources has been familiar to economists since Gordon (1954), who noted that an asset that is everyone's property is in fact no one's property. Gordon showed that resources to which access is open are overused, in that it is in the common interest to restrict their use. His reasoning was simple: Given that resources are finite in size, they have positive social worth. But an open access resource is free to all who use it. Moreover, the cost a user incurs isn't merely less than what it ought ideally to be, entry drives the resource rents to zero. The biologist Garrett Hardin later called that overuse "the tragedy of the commons", insisting that "freedom in the commons brings ruin to all" (Hardin, 1968). Hardin must have had in mind the atmosphere and the open seas, where the tragedy he talked of is certainly unfolding today; but he chose a most unfortunate example to illustrate his point: grazing land.

Social scientists haven't been kind to Hardin. Dasgupta (1982) showed in the context of a fully

dynamic model that an open access renewable resource would not be ruined if the cost of extraction was large relative to the value of the resource itself. The motivations behind the finding were that the tropical rainforests had been safe until the chainsaw made its appearance and the fisheries of the open seas were not threatened until the emergence of sophisticated fishing equipments for tracking schools and trawling the sea bottom.

Anthropologists and political scientists took Hardin to task severely. They criticised him for his failure to recognise that geographically localised commons are most often CPRs, not open access, and that local institutions have evolved to forestall the tragedy of the commons. Today one cannot but detect an air of academic triumphalism in those writings.[1] Certainly, it has not been uncommon for articles on CPRs to begin by denigrating Hardin's metaphor and then showing him to have been wrong by means of a case study. Applied economists in India also joined the fray. I have in mind the many articles published in the Economic and Political Weekly since the late 1980s.

In studying CPRs, we are in the realm not only of natural capital, but also of institutions. Economists have traditionally studied markets, while political scientists have studied the State. As CPRs have an academically unfamiliar ring to them, their study has an obvious appeal for social scientists. CPRs are not public nor private property, but are communal property. Unlike the global commons though, they are geographically confined and, as noted above, access is not open to all. Moreover, an emerging parallel literature on social capital hinted that it had something to say about the character of those communitarian institutions that have been built around CPRs. All this was a heady academic cocktail. The literature on CPRs is now enormous, not only in India.[2]

Oddly, economic theory has been missing from almost all of that literature. But without theory as guide, it isn't possible to understand either the institutions that govern CPRs or the policies that would be required if those institutions were found to be wanting. Casual empiricism suggests that communitarian institutions are fragile in the presence of growing markets elsewhere; but without theory one wouldn't know whether the evidence was real. By the same token, one may ask whether communitarian institutions were ever as good as they are made out to be by scholars who believe they are attractive alternatives to impersonal markets and coercive States. But without the disciplinary pressure of economic theory, we wouldn't know whether there is something in that belief or whether it is a mere romantic posture. After all, one can argue that communitarian institutions retard the emergence of more efficient institutions; but is that argument correct?

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[1] See, for example, Feeny et al. (1990).

[2] See, for example, National Research Council (1986, 2002), Agarwal and Narain (1989), Chopra et al. (1989), Ostrom (1990), Stevenson (1991), Bromley et al. (1992), Singh (1994), Baland and Platteau (1996), and Marothia (2002).

In fact, the basic economic theory of CPRs had been created some time ago, in Dasgupta and Heal (1979: ch. 3). At the time I drafted the chapter that presents the theory, I (and probably Heal also) had no idea of the prevalence of CPRs in the contemporary world. I developed the formal model (section 5.1 below) so as to understand the externalities that are present when an asset is an unmanaged CPR. Once the model was constructed, it was but natural to study alternative ways a community could manage the CPR (sections 5.2-5.3 below). However, had I been asked in 1979 whether CPRs form an important class of assets, I wouldn't have been able to answer. In this I was not alone. Judging by the prevailing literature, no one in the development field then knew much about CPRs in the contemporary world. Village commons in modern England are familiar enough; but they are recreational grounds, they are not essential for survival. Economic historians knew of the past importance of CPRs, though, which is why the only illustrations we were able to offer in the book were from early-modern England.[3]

3 Why CPRs?

The trail-blazing empirical study on contemporary CPRs was Jodha (1986), who reported evidence from a number of dry rural districts in India that the proportion of income among poor families based directly on CPRs is in the range 15 to 25 percent. Cavendish (2000) has arrived at even larger estimates from a study of villages in Zimbabwe: the proportion of income based directly on CPRs is 35 percent, the figure for the poorest quintile being 40 percent. Such evidence as Jodha and Cavendish unearthed does not, of course, prove that CPRs in their samples were well managed, but it does show that rural households would have strong incentives to devise arrangements whereby they would be managed.[4]

The economic importance of CPRs, as a proportion of total assets, ranges widely across ecological zones. In India they are most prominent in arid regions, mountain regions, and unirrigated areas; they are least prominent in humid regions and river valleys (Agarwal and Narain, 1989). There is a rationale behind this, based on the mutual desire to pool risks. Woodlands, for example, are spatially non-homogeneous ecosystems. In some year one group of plants bears fruit in one part of a woodland, in another year some other group does in some other part. Relative to mean output, fluctuations could be presumed to be larger in arid regions, mountain regions, and unirrigated areas. If a woodland were to be divided into private parcels, each household would face a greater risk than it would under communal ownership. The reduction in individual household risks owing to communal ownership may be small; but as average incomes are very low in Indian villages, household benefits from communal ownership are large if woodlands are communally owned.

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[3] My friend and colleague Paul David told me what to read on the commons and the enclosure movement. I learnt subsequently that there was an empirical literature on CPRs in Alpine Switzerland (Netting, 1976); but I didn't know of the literature's existence then.

[4] The earliest study I have so far been able to locate of communitarian institutions governing CPRs in the poor world is Netting (1985).

CPRs are prominent also because ecosystem constituents are mobile. Birds and insects fly, fish swim, inorganic materials defuse in space, and even earthworms are known to travel. Their mobility integrates an ecosystem's various components. Ecosystem dynamics are generally speaking non-linear, involving positive feedback in a wide range of states, meaning that the system as a whole is greater than the sum of its spatial parts. Ecosystems therefore have an element of indivisibility to them. If you slice off a significant portion for some other purpose, the productivity (e.g., biomass production) per unit area of what remains is reduced.[5] But even if it were decreed that no portion could be converted for another use, parcelling ecosystems into private bits would be inefficient because of the externalities created by the mobile components. Admittedly, private monopoly would avoid the externalties, but it would grant far too much power to one person in the community.

CPRs are sometimes the only assets to which the otherwise disenfranchised have access. This is a virtuous byproduct of the institutions governing CPRs. Economic theory says that even the casual wage rate of unskilled labourers would be higher in villages with more abundant CPRs (Dasgupta, 1993; Barbier, 2004; Pattanaik and Butry, 2004). That said, I am not implying that assetless people featured prominently in community decisions to create the institutions governing CPRs; I am merely drawing attention to a good feature of CPRs.

The local resource base of rural communities consists of extractive, self-renewing capital assets (Dasgupta, 1982). Woodlands, village ponds, and coastal fisheries are prominent examples. Even wetlands, noted for recycling organic pollutants, fit into that category: they provide continuing services at no extraction cost. No doubt investment in those assets can increase their productivity, but what sets them apart from manufactured capital is that they are self-renewing natural assets.

Agricultural land, especially in densely populated areas, is a different matter. Both labour and capital are critical inputs in production. Investment can increase land's productivity enormously. Agricultural land as CPRs would be subject to significant management problems, including those due to the temptations to free ride on investment costs. The lack of incentives to invest and innovate would lead to stagnation, even decay. The fate of collective farms testifies to that. Those regions of sub-Saharan Africa where land has been, or was, held by the kinship were exceptions, but only because land was plentiful and because poor soil quality meant that land had to be kept fallow for extended periods, following only a few years of cultivation. Of course, it may be that agricultural productivity remained low there because land was held by the kinship, not by individuals. As elsewhere in the social sciences, causation typically works in both directions.

4 Plan of the Paper

[5] Steffen et al. (2004) is a technical account of the pervasiveness of non-linearities in natural processes. Dasgupta and Mäler (2004) is a collection of essays that develops the welfare economics of non-linear ecosystems.

In this paper I present a fairly complete economic theory of CPRs. A timeless deterministic model, taken directly from Dasgupta and Heal (1979: ch. 3), is presented in section 5. The asset under study is a piece of grazing land in which owners of cattle herd their animals. Cattle are assumed to be private property. We first identify the externalities that emerge in an unmanaged CPR (section 5.1). We then confirm that an efficient use of the grazing land involves reduction in the number of cattle. Two regulatory regimes for enforcing that reduction are studied (section 5.2): quota restriction on the number of cattle each herdsman is permitted in the CPR and a tax on each cow introduced into the CPR (paid back lump sum to the herdsmen). As the model is deterministic, the two regulatory regimes are found to be equivalent.[6]

Privatization is an alternative system of property rights to communal ownership in those cases where the resource is divisible without productivity loss. Assuming that pastures are divisible without loss in productivity, we confirm (section 5.3) that the grazing land in the model would be used efficiently if it were divided into private lots.

Irrespective of whether the herdsmen rely on taxes or quotas, managing a CPR involves cooperation. Interestingly, it has been uncommon among social scientists who write about CPRs to ask how cooperative agreements are enforced. To say that herdsmen can devise a regulatory regime to implement cooperation (taxes, quotas) isn't enough; we have to ask what incentives the parties have for carrying out their respective sides of the agreement. That raises a far more general question:

Imagine that a group of people have identified a mutually beneficial course of actions. Imagine too that they have agreed to follow that course. In what contexts can the group be sanguine that people will do what they said they will do under the terms of the agreement? To put the question in another way, in what contexts are the promises people make to one another credible? In section 6 we answer that question. The analysis there is based on Dasgupta (1993, 2004). I pay special attention (section 6.6) to the situation where the group faces the problem of cooperation period after period. The theory of repeated games is used to show that agreements can be kept if the parties discount the future benefits from cooperation at a low enough rate. Repeated games are, of course, abstractions. In the world as we know it, the circumstances people face change over time (owing, for example, to changes in the composition of capital assets). However, it can be shown that the conclusions we arrive at from the study of repeated games carry over qualitatively to situations where people face changing circumstances over time.

Writings on CPRs have frequently had a warm glow to them (Bromley et al., 1992). And yet, institutions for managing CPRs have been found to be fragile. Moreover, there is a dark side to the institutions that have been built round CPRs. In sections 7-8 we study those weaknesses.

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[6] Meade (1973) and Weitzman (1974) showed that if the regulator and the herdsmen possess different information, the two regimes are not equivalent. But their finding holds only if the tax is constrained to be constant per cow. The tax-quota alternatives are special cases of non-linear taxes. See Dasgupta et al. (1980) and Dasgupta (1982).

In section 7.1 the theory of repeated games is applied to the timeless model of the CPR studied in section 5 to show that it is possible for the benefits of cooperation to be shared unequally even if community members were equally placed to begin with. Economic theory therefore provides a strong account of an empirical observation, that access to CPRs is frequently unequal. In section 7.2 I review a number of empirical findings concerning the deteriorating fate of CPRs in the contemporary world. The theory of repeated games is then applied to the timeless model of section 5 to explain why CPRs are institutionally fragile.

Section 8 is about a matter that to the best of my knowledge has not been investigated in the literature. I apply the theory of repeated games to the timeless model of section 5 once again, but this time to show that it is also possible for some members of a community to be worse off under cooperation based on long-term relationship than they would have been if the community's members hadn't entered into the long-term relationship. The model offers an account of how one group of people in a community could exploit another even while the latter may mistakenly be thought to be enjoying the benefits of long-term relationship.

Section 9 summarises the main conclusions.

5 CPRs: A Formal Model

There are N herdsmen, indexed by i (i = 1, 2, ..., N). Cattle are private property. The pasture is neither privately owned nor State property, but is communally owned. Outsiders are not permitted to graze their cattle in the pasture, meaning that there is no open access to the land either: the grazing land is a CPR.

The model is timeless. The size of the pasture is S. Cattle intermingle while grazing, so that on average the cows consume the same amount of grass. If X is the size of the herd in the pasture, total output - of milk - is H(X, S), where H is taken to be constant returns to scale in X and S. Assume H(0, S) = 0 for all $S \geq 0$. Assume too that the marginal products of X and S are positive, but diminish with increasing values of X and S, respectively. In short, I take H to be a textbook production function. I am modelling the pasture in an orthodox manner for pedagogical reasons. I want to illustrate how, starting from the most conventional of production possibilities, matters concerning human interactions that go far beyond markets and the State can be analysed. Readers can confirm though that excepting for the analysis in section 5.3, every result that I prove in this article carries over to cases where the CPR in question displays non-linear dynamics, so that time does not merely involve an indefinite recurrence of a single social situation.

As S is fixed and H is constant returns to scale, we may eliminate S by writing H(X, S) = SH(X/S, 1); by letting S = 1 without loss of generality; and by defining $F(X) \equiv H(X, 1)$. From the assumptions made on H, we may conclude that F(0) = 0; $F'(X) > 0$; $F''(X) < 0$; and $F(X)/X > F'(X) > 0$ for all $X \geq 0$. Figure 1 depicts both the functions F(X)/X (the average product curve) and $F'(X)$ (the marginal product curve).

Herdsmen are interested in the profits they are able to earn from their cattle. We normalise by choosing the market price of milk to be one. Let the market price of cattle be p (> 0), which may be

interpreted as a rental price. To have a problem worth studying (see equation (8) below), I assume that $F'(0) > p$.

5.1 An Unmanaged CPR

We first determine the herd size brought into the CPR if the cattle owners have instituted no grazing charges nor any quantity restriction on numbers. Let x_i be the size of i's herd. x_i is taken to be a continuous variable. Since cattle intermingle, $x_iF(X)/X$ is i's output of milk. Therefore, i's net profit, π_i, is

$$\pi_i = x_iF(X)/X - px_i. \tag{1}$$

We wish to compute the non-cooperative (Nash) equilibrium of the resulting timeless game. Since the model is symmetric, we should expect it to posesses a symmetric equilibrium. (It can be shown that equilibrium in this timeless model is unique.)

Without loss of generality, consider herdsman i. If the herd size of each of the other cattlemen is x, equation (1) can be written as

$$\pi_i(x_i, x) = x_iF(x_i+(N-1)x)/(x_i+(N-1)x) - px_i. \tag{2}$$

The profit function $\pi_i(x_i, x)$ reflects the crowding externalities each herdsman inflicts on all others in the unmanaged CPR: π_i is a function not only of x_i, but also of x. Let $\underline{x}$ be the size of each cattleman's herd at a symmetric equilibrium. By definition, $\underline{x}$ would be the value of x_i that maximizes $\pi_i(x_i, \underline{x})$. Therefore differentiate $\pi_i(x_i, \underline{x})$ partially with respect to x_i and equate the result to zero. This yields,

$$F(x_i+(N-1)\underline{x})/[x_i+(N-1)\underline{x}] + x_iF'(x_i+(N-1)\underline{x})/[x_i+(N-1)\underline{x}] - x_iF(x_i+(N-1)\underline{x})/[x_i+(N-1)\underline{x}]^2 = p. \tag{3}$$

At a symmetric equilibrium x_i in equation (3) must equal $\underline{x}$. Now re-arrange terms to confirm that the aggregate herd size in the CPR, which we write as $\underline{X}$, satisfies

$$((N-1)/N)F(\underline{X})/\underline{X} + F'(\underline{X})/N = p, \qquad \text{where } \underline{X} = N\underline{x}. \tag{4}$$

Equation (4) is a beautiful condition. It says that in equilibrium the price of cattle equals the weighted average of the average product of cattle and the marginal product of cattle, with weights (N-1)/N and 1/N, respectively. $\underline{X}$ is shown in Figure 1 as being a point lying between the value of X at which marginal product of X equals p (it is X* in Figure 1) and the value of X at which the average product of X equals p (it is X** in Figure 1). It can be easily confirmed that $\underline{X}$ is an increasing function of N.

Notice that aggregate profit, which I denote by $\underline{\pi}$, is

$$\underline{\pi} = [F(\underline{X}) - \underline{X}F'(\underline{X})]/N > 0, \tag{5}$$

implying that rents are not entirely dissipated. In Figure 1, $\underline{\pi}$ is the area of the rectangle JKLM.

From equation (5) we conclude that profit per herdsman is

$$\underline{\pi}/N = [F(\underline{X}) - \underline{X}F'(\underline{X})]/N^2 > 0. \tag{6}$$

In Figure 2, which depicts the case N = 2, the equilibrium pair of profits ($\underline{\pi}/2$, $\underline{\pi}/2$) is the point A.

Although $\underline{X}/N$ is the equilibrium number of cattle per herdsman, it isn't a dominant strategy for the representative herdsman: CPRs do not give rise to the Prisoners' Dilemma game. This is a fact I make

use of in sections 7 and 8.[7]

If N is large, the unmanaged CPR approximates an open access resource. To confirm, notice that if N is large, equation (4) becomes

$$F(\underline{X})/\underline{X} \approx p. \tag{7}$$

The approximate equation (7) says that rents are dissipated almost entirely. This is the case studied by Gordon (1954).[8]

5.2 Regulatory Regimes: Quotas and Taxes

An unmanaged CPR would be unattractive to the herdsmen: they could increase their profits by cooperating. Imagine that cooperation involves negligible transaction costs (Coase, 1960). What would be a reasonable agreement among the herdsmen? As the model is symmetric, it may seem plausible to assume that they agree to maximise aggregate profit and share that profit equally. We assume that here.[9] Maximising aggregate profit (F(X) - pX) yields the condition

$$F'(X) = p. \tag{8}$$

Equation (8) says that at the optimum the marginal product of cattle equals their price - a familiar result in price theory. Let X* be the solution of equation (8). At the community optimum, aggregate profit, which I denote by π^*, is

$$\pi^* = F(X^*) - F'(X^*)X^* > \underline{\pi} > 0. \tag{9}$$

In Figure 1, π^* is the area of the rectangle JNRT.

From equation (8) we conclude that profit per herdsman is

$$\pi^*/N = (F(X^*) - F'(X^*)X^*)/N. \tag{10}$$

A comparison of equations (4) and (8) shows that $\underline{X} > X^*$. In Figure 2, which depicts the case N = 2, the pair of profits ($\pi^*/2$, $\pi^*/2$) at the community optimum is the point B.

We now study two regulatory regimes for implementing X*.

With a quota restriction the herdsmen agree to practice restraint by limiting each to at most X*/N

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[7] Recall that a game is called the Prisoners' Dilemma if each player has a dominant strategy (a strategy that is best for him no matter what strategies the others choose) and that playing their dominant strategies results in a collectively inefficient outcome.

[8] Gordon (1954) followed a different modelling strategy, but with the same import. He assumed that H is not constant returns to scale; that, in particular, F′(X) is increasing at small values of X, but decreasing at large values of X. He didn't specify the number of herdsmen; instead he postulated that open access would lead to a complete dissipation of land rents: F(X)/X = p. In Gordon's open access model, the number of herdsmen is endogenous and finite (because of the increasing returns to scale in F at low values of X). In contrast, the model here regards the number of herdsmen to be exogenously given. The latter is the correct assumption to make on CPRs. If the number of cattlemen is large in our model, each herdsman introduces small numbers of cattle into the pasture, with the result that rents get dissipated almost entirely.

[9] But see sections 7.1 and 8.

cattle. It is simple to confirm that choosing X*/N is then the dominant strategy for each herdsman. We conclude that a quota can implement the agreement to limit the aggregate herd size to X*.

An alternative regime would be to impose an entry tax on each cow and to share the tax revenue equally as a lump sum income. This is the tax solution to the problem. Let us compute the optimum tax.[10]

In a tax regime the herdsmen are free to graze as many cattle as they like, but have to pay an entry free per cow. The optimum tax corrects for the externalities each herdsman inflicts on all others when introducing a cow in the CPR. If the tax rate is t, the effective price a herdsman pays is (p + t). The idea therefore is to so choose t that equation (4) reduces to equation (8) and the equilibrium herd size equals X*.

Let t* be the optimum tax. Routine calculations show that

$$t^* = [F(X^*)/X^* - F'(X^*)](N-1)/N. \quad (11)$$

Equation (11) is intuitively amiable. The right hand side measures the externality each herdsman inflicts on others. That externality is the difference between the marginal private benefit of introducing cattle in the pasture (the left hand side of equation (4)) and the marginal community benefit (the left hand side of equation (8)). When the tax rate is set equal to that difference (evaluated at the optimum value X*), cattlemen limit their herds to the right size.

5.3 Privatising the CPR

An alternative to a regulatory regime involves a change in the property rights to the pasture. Consider privatising the grazing land. The size of the pasture is S. Imagine that S is divided into N equal parts and awarded as private property to the herdsmen. Suppose too that they are able to protect their property rights costlessly (e.g., fences are costlessly built). What would be the outcome?

Each cattleman owns S/N amount of land after privatisation. If herdsman i were to introduce x_i cows into his own land, his output would be $H(x_i, S/N)$ and his profit would be

$$\pi_i(x_i) = H(x_i, S/N) - px_i. \quad (12)$$

Because H is constant returns to scale, $H(x_i, S/N) = H(Nx_i/S, 1)S/N$. Once again, let us normalise by setting S = 1. Now $H(Nx_i, 1) = F(Nx_i)$ in our earlier notation. Therefore equation (12) reduces to

$$\pi_i(x_i) = F(Nx_i)/N - px_i. \quad (13)$$

Notice that unlike equation (2), which represented herdsman i's profit function in the unmanaged CPR, the profit function in equation (13) harbours no externalities: π_i is solely a function of x_i. Privatisation removes the crowding externalities among cattle. Differentiating π_i with respect x_i and setting the result equal to zero, the profit maximising size of herd is found to be

$$F'(Nx_i) = p. \quad (14)$$

[10] Wade (1988) and Baland and Platteau (1996) have shown how communities do in fact levy user taxes on CPRs.

Comparison of equations (8) and (14) shows that each herdsman introduces X*/N cows into his private parcel of land. But this is the cooperative outcome in the case where the pasture is a CPR. Thus privatisation also solves the resource allocation problem facing the N herdsmen.

6. Trust and Credibility

Both privatisation of the grazing land and cooperation over the use of that land as a CPR involve trust. If the allocation defined by equation (14) is to be realised, the herdsmen have to trust the "legal system" to enforce private property rights to their parcels of land. Similarly, if cooperation over the use of the pasture as a CPR is to be achieved, they have to trust one another to enforce the agreement to limit each herd size to X*/N either by means of quota (eq. (8)) or a tax (eq. (9)).

We now use the problem of trust facing our cattlemen to ask a question that goes far beyond the management of CPRs:

Imagine a group of people who have discovered a joint course of actions that would lead to a mutually beneficial outcome. Imagine too that they have agreed to cooperate and share the resulting benefits in a specified manner. If the parties don't trust one another, what could have been mutually beneficial transactions won't take place. But what grounds could they have for trusting one another to do what they have undertaken to do?

They would have grounds if promises were credible. So a general question arises: Under what circumstances are promises credible? Five come to mind.

6.1 Mutual Affection

Promises would be credible if the parties care about one another sufficiently. Innumerable transactions take place only because the people involved care about one another and rationally believe that they care about one another (i.e., each knows that the others know that they care about one another, each knows that the others know that each knows that they care about one another, and so on) and therefore trust one another to carry out their obligations. Economists model the situation as one where group members have interdependent utilities. The household best exemplifies institutions based on care and affection. As monitoring costs within the household are low (a group of people who cohabit are able to observe and to get to know one another), the institution harbours fewer problems of moral hazard and adverse selection than many other institutions. On the other hand, being few in number, members of a household, as a group, are unable to engage in those enterprises that require large numbers of people of varied talents and locations.

6.2 Pro-social Disposition

Promises would be credible if it was common knowledge that those making the promises were

trustworthy, or that they reciprocated by keeping their promise if others displayed trust in them.[11] Evolutionary psychologists have argued that, because of selection pressures operating among our hunter-gatherer Pleistocene ancestors, we are adapted to have a general disposition to reciprocate. Others have argued that such a disposition is to a greater or lesser extent formed through communal living, role modelling, education, and receiving rewards and punishments, and that the process begins at the earliest stages of our lives.[12]

For our purposes here, we don't have to choose between the two theories; either would do. In any event, they are not mutually exclusive. Thus, evolutionary psychologists have argued that our capacity to have such feelings as shame, affection, anger, elation, reciprocity, benevolence, and jealousy has emerged under selection pressure. No doubt culture helps to shape preferences and expectations (thus, behaviour), which are known to differ widely across societies. But cultural coordinates enable us to identify the locus of points upon which shame, affection, anger, elation, reciprocity, benevolence, and jealousy are put to work; they don't displace the centrality of those feelings in the human makeup. The thought I am exploring here is that, as adults, we not only have a disposition for such behaviour as paying our dues, helping others at some cost to ourselves, and returning a favour; we also practise such norms as those which prescribe that we punish people who have hurt us intentionally; and even such higher-order-norms as shunning people who break agreements, on occasion frowning on those who socialise with people who have broken agreements; and so forth. By internalizing specific norms, a person enables the springs of her actions to include them. She therefore feels shame or guilt in violating the norm, and this prevents her from doing so, or at the very least it puts a break on her, unless other considerations are found by her to be overriding. In short, her upbringing ensures that she has a disposition to obey the norm, be it moral or social. When she does violate it, neither guilt nor shame would typically be absent, but frequently the act will have been rationalized by her. For such a person, making a promise is a commitment, and it is essential for her that others recognise it to be so.[13]

Often enough, the disposition to be honest would be toward members of some particular group (clan, or neighbours, or ethnic group), not others. This amounts to group loyalty. One may have been raised to be suspicious of people from other groups, one may have even been encouraged to dupe such others if and when the occasion arose. Society as a whole wastes resources when the disposition for honesty is

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[11] The new behavioural economics emphasises this aspect of human character. See, for example, Rabin (1993) and Fehr and Fischbacher (2002).

[12] See, for example, Hinde and Groebel (1991), which contains accounts of what is currently known of the development processes through which people from their infancy acquire prosocial dispositions; for example, by learning to distinguish accidental effects from intentional effects of others' actions.

[13] In an innovative work, Sethi and Somanathan (1996) have constructed a formal model to ask when pro-social disposition of the kind I have just sketched in the text is locally stable under selection pressure.

restricted to particular groups.

Runge (1981, 1986) has asserted that village life in the world's poorest regions involves such close interactions, that people develop pro-social dispositions toward one another. His arguments imply that the timeless CPR game of section 5 would be better modelled as a game where not only is $\underline{X}$ an equilibrium herd size, but so is X*, because if the herdsmen say to one another they will each introduce X*/N cattle into the CPR, then they will do just that. A word, or so Runge imagines, is a person's bond; period.[14] But the evidence Runge deploys is not at all transparent. To me his interpretation of villagers' motives is a pleasant assumption, not much more. It may of course be that villagers develop pro-social dispositions toward one another; but it may be that social sanctions are in place on those who break agreements and is the reason why villagers trust one another and their own selves to do what they said they will do (section 6.6). Simply to ask people to declare their reason for trusting one another is not enough. Anthropologists have discovered that visitors can easily be misled by the answers inhabitants give about the workings of their local communities. Moreover, Runge's reformulation of the timeless CPR game doesn't seem to be capable of explaining why cooperation over the use of CPRs has broken down in so many instances in recent decades; whereas the modelling I pursue in section 7 is able to do so.

In the world as we know it, the disposition to be trustworthy at both the personal and impersonal spheres exists in varying degrees. When we refrain from breaking the law, it isn't always because of a fear of being caught. When an employee in an unorganised sector works overtime, it may simply be a gesture of benevolence, helping out an employer in unexpected need. Recent work in behavioural economics has re-affirmed that benevolence isn't alien to human nature. On the other hand, if say, relative to the gravity of the misdemeanour the pecuniary benefits from malfeasance were high, some transgression could be expected to occur. Punishment assumes its role as a deterrence because of the latter fact.

6.3 The Need for Incentives to Keep Promises

When the temptation to break one's agreement is so large that neither mutual affection nor pro-social disposition is enough, there is need for socially constructed incentives. The promises the parties have made to one another to keep to their agreement would be credible if they could devise an institution in which keeping those promises would be in the interest of each party if everyone else kept theirs. The problem therefore is to devise an institution where keeping the agreement is an equilibrium strategy.

A strategy is a sequence of conditional actions. It involves counterfactuals. Strategies assume the forms, "I shall choose X if you choose Y", or "I shall do P if Q happens", and so on. If promises are to be credible, it must be in the interest of those making promises to carry them out if and when the relevant occasions arise. It would follow that the concept we need to track is that of <u>equilibrium beliefs</u>, by which

[14] Technically, Runge's belief is that CPRs, even when studied in a timeless framework, should be modelled as "coordination games".

I mean a set of beliefs about one another, one for each party, such that it would be rational for each party to hold his or her belief if everyone else were to hold their respective beliefs.

Societies everywhere have constructed solutions to the credibility problem, but in different ways. What all solutions have in common, however, is their insistence that those failing to comply with agreements without cause will suffer punishment. Broadly speaking, there are three types of situation where parties to an agreement could expect everyone to keep their words.[15] Each gives rise to a set of institutions that capitalize on their particular features. (In practice, of course, the types would be expected to shade into one another.) In what follows we study them.

6.4 External Enforcement

It could be that the agreement is translated into an explicit contract and enforced by an established structure of power and authority. This is to rely on an external enforcer. We must now assume that whether agreements have been carried out is verifiable, otherwise the external enforcer would have nothing to go on when adjudicating disputes.

By an external enforcer we may imagine the State. (There can, of course, be other types of external enforcement agencies; e.g. tribal chieftains, warlords, and so forth.) Consider, as an illustration, that the rules governing transactions in the formal market-place are embodied in the law. So markets are supported by a legal structure. Firms, for example, are legal entities. Even when you go to a shop, your purchases (paid in cash or by card) involve the law, which provides protection for both parties (the shopkeeper, in case the cash is counterfeit or the card is void; the purchaser, in case the product turns out on inspection to be sub-standard). The law is enforced by the coercive power of the State. Transactions involve legal contracts backed by an external enforcer, namely, the State. It is because you and the shopkeeper are confident that the State has the ability and willingness to enforce contracts that you and the shopkeeper are willing to transact. The same confidence would be required among our herdsmen if they are to transact in the market for cows (price p), for milk (price unity), and are to exercise their property rights in the case where the pasture has been privatised.

What is the basis of that confidence? After all, the contemporary world has shown that there are States and there are States. Simply to invoke an external enforcer for solving the credibility problem won't do; for why should the parties trust the State to carry out its tasks in an honest manner? A possible answer is that the government worries about its reputation. So, for example, a free and inquisitive press in a democracy helps to sober the government into believing that incompetence or malfeasance would mean an end to its rule, come the next election. Knowing that they worry, the parties trust them to enforce

[15] Of course, none may be potent in a particular context, in which case people would find themselves in a hole they cannot easily get out of, and what could have been mutually beneficial agreements will not take place. The behaviour reported in the Mezzogiorno by Banfield (1958) is an illustration of this possibility. See below.

agreements. Even if senior members of the ruling party are getting on in years and therefore don't much care what happens in the future, younger members would worry that the party's reputation would suffer if the government were not to behave.[16]

The above argument involves a system of interlocking beliefs about one another's abilities and intentions. Consider that millions of households in many parts of the world trust their government (more or less!) to enforce contracts, because they know that government leaders know that not to enforce contracts efficiently would mean being thrown out of office. In their turn, each side of a contract trusts the other not to renage (again, more or less!), because each knows that the other knows that the government can be trusted to enforce contracts. And so on. Trust is maintained by the threat of punishment (a fine, a jail term, dismissal, or whatever) for anyone who breaks a contract. We are in the realm of equilibrium beliefs, held together by their own bootstraps.

Unfortunately, cooperation isn't the only possible outcome. Non-cooperation can also be held together by its own bootstrap. In a non-cooperative equilibrium the parties don't trust one another to keep their promises, because the external enforcer cannot be trusted to enforce agreements. To ask whether cooperation or non-cooperation would prevail is to ask which system of beliefs are adopted by the parties about one another's intentions. Social systems have multiple equilibria.

6.5 Reputation as Capital Asset

Political parties are not the only entities that view reputation as capital asset. Individuals and firms view it that way too. Even someone who doesn't care what his reputation will be after death would care to build a reputation for honest dealing if he could cash in on that reputation at the time of retirement. Brand names are created and maintained thus. The persons who own the brand name no doubt change over time, but the name itself remains. People can have a strategic reason for creating a reputation for honesty because of life after retirement. Consider a firm whose current owner can choose either to be honest or to be dishonest. Imagine that dishonest behaviour enables the owner to enjoy additional profits in the short term. Imagine, however, that dishonest behaviour would ruin the firm's reputation - thereby future prospects - because customers deal only with firms that have an unsullied reputation. On retirement, the owner of a dishonest firm would find no buyer. Knowing this in advance, the owner may well wish to maintain the firm's reputation by behaving honestly. If the owner cared sufficiently about his quality of life after retirement, honesty would then be an equilibrium strategy, just as boycoting ill-reputed firms would be a corresponding equilibrium strategy for customers.[17] Of course, even in situations where reputation can be a capital asset, there is an equilibrium where reputation is not maintained. It cannot be repeated often enough that social systems possess multiple equilibria.

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[16] Przeworski (1991) has explored this argument.

[17] A formal analysis of reputation as capital asset is to be found in Kreps (1990).

The formal analysis of reputation as capital asset is similar to one involving parties who expect to face transaction opportunities repeatedly in the future. I turn to a study of such situations.

6.6 Mutual Enforcement in Long-term Relationships

Suppose the group of people in question expect to face similar transaction opportunities over and over again indefinitely. As an example, imagine that the N herdsmen of section 5 face the same CPR management problem year after year. I take it that, living as they do in proximity and being as they are a small community, the size of each cattleman's herd is observable by all others. Imagine that the parties aren't able to depend on the law of contracts because the nearest courts are far from their residence. There may even be no lawyer in sight. In rural parts of sub-Saharan Africa, for example, much economic life is shaped outside a formal legal system. Even though no external enforcer may be available, people there do transact. But why should the parties be sanguine that the agreements won't turn sour on account of malfeasance? Returning to our example, why should the herdsmen trust one another to comply with the agreement that each is to limit his herd size to X*/N in every period?

They would be sanguine if agreements were mutually enforced. The basic idea is this: A credible threat by members of a community that stiff sanctions would be imposed on anyone who broke an agreement could deter everyone from breaking it. The problem then is to make the threat of stiff sanctions credible. The solution to the credibility problem in this case is achieved by recourse to social norms of behaviour.

By a social norm we mean a rule of behaviour (or strategy) that is followed by members of a community. For a rule of behaviour to be a social norm, it must be in the interest of each person to act in accordance with the rule if all others were to act in accordance with it. Social norms are equilibrium rules of behaviour.

To see how social norms work in general contexts, imagine that the private gain to someone from breaking the agreement unilaterally during a period is less than the losses he would suffer if all others were to punish him subsequently in specific ways. The condition can, of course, only hold if the parties discount future benefits at a low rate; otherwise future losses wouldn't look significant when compared to the instantaneous gain from breaking the agreement. Inflicting a punishment could involve refusing to engage in any transactions with the erring person in the following period, shunning him in other ways for suitable numbers of periods, and so on. Call a person conformist if he cooperates with those who are conformists but punishes those who are non-conformists. This sounds circular, but it isn't, because we assume the social norm requires all people to start the process by keeping their agreement. It would then be possible for anyone in any period to determine who is a conformist and who is not. For example, if ever someone were to break the original agreement, he would be judged to be non-conformist. So, the norm would require everyone to punish the non-conformist - perhaps at some costs to themselves. Moreover, the norm would require that punishment be inflicted not only upon those in violation of the original agreement (first-order

violation); but also upon those who fail to punish those in violation of the agreement (second-order violation); upon those who fail to punish those who fail to punish those in violation of the agreement (third-order violation); and so on, indefinitely. This infinite chain makes the threat of punishment for errant behaviour credible because, if all others were to conform to the norm, it would not be worth anyone's while to violate the norm. Keeping one's agreement would then be mutually-enforcing.[18]

All traditional societies appear to have sanctions in place for first-order violations. That sanctions against higher-order violations haven't been documented much may be because they aren't needed to be built into social norms if it is commonly recognised that people feel a strong emotional urge to punish those who have broken agreements. Anger facilitates cooperation by making the threat of retaliation credible.[19]

How would the idea of social norms apply to groups wishing to cooperate over the use of CPRs? To answer, let us return to the model of N herdsmen. Denote time by t, where t = 0, 1, 2, ... We take it that the game studied in section 5.1 - which we now call the stage game - repeats itself every period. I assume that the herdsmen discount their future profits at a low rate. (Below we confirm why this is necessary for cooperation.)

Imagine that at t = 0 the herdsmen agree to limit each of their herds to X*/N cattle, where X* is the optimum herd size. Under the agreement each herdsman's profit in each period is π^*/N (equation (10)). The question arises as to how the agreement can be enforced.

Consider the following strategy for the representative herdsman: Begin by introducing X*/N cattle into the pasture and continue to bring in X*/N so long as no herdsman has broken the agreement; but introduce X/N cattle into the pasture in every period following the first violation of the agreement by someone, where X/N is the herd size per cattleman in the unmanaged CPR (equation (4)). Game theorists have christened it the "grim strategy", or simply grim, because of its unforgiving nature.

To see how grim would work, note that since X/N is the equilibrium herd size per cattleman in the unmanaged CPR, the threat by someone to switch permanently to X/N following the first defection by anyone is credible if all other herdsmen play grim. Since the herdsmen discount their respective profits at a low rate, no one can do better than to choose grim if all others choose grim. We conclude that grim is a Nash equilibrium of the repeated game, meaning that it can function as a social norm.

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[18] For a rigorous proof of this proposition, see Fudenberg and Maskin (1986).

[19] However, on a riverboat ride in Kakadu National Park, Australia, in the summer of 2004, my wife and I were informed by the guide, a young aborigine, that his tribe traditionally practised a form of punishment that involved spearing the thigh muscle of the errant party. When I asked him what would happen if the party obliged to spear an errant party were to balk at doing so, the young man's reply was that he in turn would have been speared. When I asked him what would happen if the person obliged to spear the latter miscreant were to balk, he replied that he too would have been speared! I asked him if the chain he was describing would go on indefinitely. Our guide said he didn't know what I meant by "indefinitely", but as far as he knew, there was no end to the chain.

How low does a herdsman's discount rate have to be if grim is to function as a social norm? Suppose r (> 0) is the rate at which the herdsmen discount their private profits. The date is t = 0. Consider any one of the N herdsmen. Suppose all others play grim. Our herdsman now wonders whether to break the agreement or to keep to it. As all the others play grim, he knows they each will introduce X*/N cattle into the CPR at t = 0. Let w be the maximum gain in one-period profit he could enjoy by breaking the agreement. (In seeking w, he would be bringing more than X*/N cattle into the CPR at t = 0.) Obviously, w > 0, which is why he is wondering whether to break the agreement. But our herdsman knows that the others are playing grim. He knows therefore that if he were to break the agreement now, they will each bring $\underline{X}$/N cattle into the CPR from t = 1 onward. He also knows that the moment they switch to $\underline{X}$/N cattle, he himself will find it in his own best interest to switch to $\underline{X}$/N cattle (because $\underline{X}$/N is a Nash equilibrium of the repeated game that begins at t = 1). But if everyone switches permanently to $\underline{X}$/N from t = 1, our herdsman's profit flow from then will be $\underline{\pi}$/N. The loss he will suffer from t = 1 onward will be $(\pi^*-\underline{\pi})$/N per period; the present discounted value of which, when evaluated at t = 0, is $(\pi^*-\underline{\pi})$/Nr. It follows that our herdsman will not find it to his advantage to break the agreement if $w < (\pi^*-\underline{\pi})/Nr$; or, if

$$r < (\pi^*-\underline{\pi})/Nw. \qquad (15)$$

It is equally easy to confirm that if $r > (\pi^*-\underline{\pi})/Nw$, cooperation by means of grim is impossible. Readers can confirm too that it isn't possible to enforce cooperation by means of a social norm - grim or otherwise - if $r > \pi^*/Nw$.[20]

Notice how the community's size enters the picture. Inequality (15) says that if N is large, cooperation is possible only if the herdsmen's discount rate is correspondingly low, other things being the same. Notice also the interesting way the productivity of the CPR enters the picture. Inequality (15) says that if $(\pi^*-\underline{\pi})/w$ is small, cooperation is possible only if the herdsmen's discount rate is correspondingly low, other things being the same. We return to these important facts in section 7.2.

Even when cooperation is a possible equilibrium (e.g., by means of the grim social norm), non-cooperation is an equilibrium too. If everyone was to believe that all others would break the agreement from the start, then everyone would break the agreement from the start. Non-cooperation would involve each herdsman selecting the strategy, "choose $\underline{\pi}$/N at all times". Notice that a failure to cooperate could be due simply to a collection of unfortunate, self-confirming beliefs, nothing else. We usually reserve the term "society" to denote a collective that has managed to equilibrate at a mutually beneficial outcome, whether by using reputation as an enabling capital asset (as in sections 6.2 and 6.5) or by relying on social norms (as in this sub-section).

7 The Dark Side of CPRs

After revewing the economic theory of CPRs (section 5), we went on in section 6 to ask a general

[20] To do so, use the argument deployed in Section 8 below.

question: in what contexts can parties be sanguine that the promises they have made to one another will be kept? Having studied the good news about communitarian institutions, I return to CPRs to report two pieces of bad news in this section. The first concerns inequalities within communities in the access to CPR benefits (section 7.1); and the second records deteriorations in the CPRs themselves (section 7.2).[21]

7.1 Inequalities

The first piece of disturbing news about CPRs is a general finding, that entitlements to their products are frequently based on private holdings: richer households enjoy a greater proportion of the benefits. Beteille (1983), for example, drew on examples from India to show that access to CPRs is often restricted to the elite (e.g., caste Hindus). Recently, Cavendish (2000) has reported that, in absolute terms, richer households in his sample in Zimbabwe took more from CPRs than poor households. In her work on coastal fisheries and forests products, McKean (1992) noted that benefits from CPRs are frequently captured by the elite. Agarwal and Narain (1996) have exposed the same phenomenon in their study of water management practices in the Gangetic plain. That women are excluded has also been recorded (for example, in communal forestry: B. Agarwal, 2001). Molians (1998) has noted the way gender inequalities are woven into local collective action in the contemporary setting. In a wider context, Ogilvie (2003) has reported striking differences between the life chances of women in 17th century Germany (embedded in dense networks of social relationships) and the life chances of women in 17th century England (not so embedded in dense networks): English women were better off.

It is an interesting theoretical fact that inequality in groups can emerge even in circumstances that are symmetric to begin with; meaning that you don't need to assume inequality among users of a CPR (e.g., elites and non-elites) in order to explain inequality in access to it. To confirm this, we return to the model of herdsmen grazing their cattle in a CPR. The argument that was deployed in section 6.6 can now be used to demonstrate how inequality in the distribution of benefits from the CPR can be sustained under cooperation.

In order to simplify the exposition, I suppose N = 2. Assume that the stage game is played indefinitely. Denote time by t, where t = 0, 1, 2, ... As before, I take it that the herdsmen discount their future profits at a low rate.

Consider an agreement at t = 0 that says that in each period, herdsman 1 is permitted to introduce upto αX^* cattle and herdsman 2 upto $(1-\alpha)X^*$ cattle, where α is such that $1 > \alpha > 1/2$ and $(1-\alpha)\pi^* > \underline{\pi}/2$. If the agreement were kept, the herdsmen's profits in each period would be $\alpha\pi^*$ and $(1-\alpha)\pi^*$, respectively.

[21] In a recent letter Elinor Ostrom has remarked to me that all institutions would be expected to have a dark side; that markets and the State have dark sides as well. True enough, but economists have long studied the dark side of markets (witness the enormous literature on "market failure") and political scientists that of the State. In contrast, CPRs have enjoyed a relatively comfortable ride in the humanities and social sciences.

Notice that under the agreement herdsman 2 earns less than herdsman 1 ($\alpha > 1/2$), but more than what he would earn if the CPR were unmanaged (because $(1-\alpha)\pi^* > \underline{\pi}/2$). Thus, even though the agreement is to share the benefits of cooperation unequally, both parties gain from cooperation. In Figure 2, C denotes the pair of profits, $(\alpha\pi^*, (1-\alpha)\pi^*)$, the herdsmen earn in each period under the agreement. C lies to the northeast of A. The question arises as to how the agreement could be enforced.

Let us look at the grim strategy again, but now applied to the unequal division of benefits from the CPR. Let the strategy read: begin by abiding by the agreement and continue to abide by it so long as neither herdsmen has broken it; but introduce $\underline{X}/2$ cattle into the pasture forever following the first violation of the agreement by either herdsman.

To see how grim would work in the social environment of our two herdsmen, notice that $\underline{X}/2$ is the equilibrium herd size for each party in the stage game (section 5.1). The threat to switch permanently to $\underline{X}/2$ following the first defection by either of the herdsmen is therefore credible if the other herdsman plays grim. Since the pair discount their respective profits at a low rate, neither herdsmen can do better than choose grim if the other chooses it.[22] We conclude that grim is an equilibrium of the repeated game, meaning that it can operate as a social norm.

It is important to distinguish a social norm from the state of affairs that is sustained by means of an application of that norm. In those circumstances where grim is an equilibrium strategy in repeated interactions, it can serve as a social norm. But the agreement grim sustains is not uniquely given. In fact we have confirmed that grim can support an infinity of agreements. It can support not only an agreement to share the benefits of cooperation equally (section 6.6), but also a wide range of unequal divisions of that benefit (as just above). The theory I am exploring in this paper doesn't offer an account of how an agreement is reached; what the theory offers is an account of the way agreements that have been reached can be implemented. Bargaining theory explores the former problem. That pretty much any sharing of the benefits of cooperation can be implemented in long-term relationships is an implication of the Folk Theorem in game theory.[23] For example, any point to the north-east of the origin and in the triangle OMN in Figure 2 can be implemented, provided each herdsman's discount rate is small enough. (See Section 8.)[24]

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[22] What counts as a "low" discount rate depends on the choice of α: the greater is the value of α (i.e. the greater is the proposed inequality), the lower is the rate the herdsmen must be assumed to use for discounting future profits if the proposed sharing rule is to be enforced by grim. Readers can confirm this by deploying the corresponding argument in section 6.6.

[23] See Fudenberg and Maskin (1986).

[24] It may seem odd that one should pay attention to potential agreements over unequal sharing of benefits in a model that is patently symmetric across the parties. How, one may ask, could the parties have unequal bargaining powers in a world that has been modelled as one where the parties are equally placed to begin with? The answer is that the model reflects only one aspect of the herdsmen's lives; namely, their options as herdsmen. Presumably though, those lives are embedded in a wider set of lives, where the

7.2 Deterioration of CPRs

The second piece of bad news regarding CPRs is that they have degraded in recent years in many parts of the poor world. Why should this happen now in those places where they had previously been managed in a sustainable manner?

One reason is the kind of deterioration in external circumstances that lowers both the private and collective profitability of cooperative behaviour. There are many ways in which circumstances can deteriorate. Increased uncertainty in property rights is a prime example. You and your community may think that you together own the forest your forefathers passed on to you, but if the community doesn't possess a deed to the forest, its rights to the asset are insecure. In a dysfunctional state of affairs, the government may confiscate the property. Political instability (in the extreme, civil war) is another source of uncertainty: a community's CPR could be taken away from it by force. An increase in such uncertainties as those above translates into an increase in the rate at which people discount the benefits from cooperation. In the context of the CPR we studied in section 6.6, it amounts to an increase in r. But from inequality (15) we know that if r increases sufficiently, cooperation ceases.

Political instability is also a direct cause of environmental degradation: civil disturbance all too frequently expresses itself through the destruction of physical capital. In the context of the grazing land of section 6.6, this amounts to a lowered value of $(\pi^*-\underline{\pi})/w$, which, as we noted from inequality (15), makes cooperation more difficult to maintain, other things being the same.

More generally, when people are uncertain of their rights to a piece of property, they are reluctant to make the investments necessary to protect and improve it. If the security of a CPR is uncertain (owing to whichever of the above reasons), the risk adjusted returns from collective investment are low. The influence would be expected to run the other way too, with growing resource scarcity contributing to political instability, as rival groups battle over resources. The feedback could be "positive", exacerbating the problem for a time, reducing private returns on investment further. Groups fighting over spatially confined resources are a frequent occurrence today (Homer-Dixon, 1999). Over time, the communitarian institutions themselves disintegrate.

The second reason is rapid population growth, which can trigger resource depletion if institutional practices are unable to adapt to the increased pressure on resources. The CPR then erodes owing to a weakening of cooperation. In Côte d'Ivoire, for example, growth in rural population has been accompanied by increased deforestation and reduced fallows. Biomass production has declined, as has agricultural productivity (Lopez, 1998). Moreover, rapid population growth in itself can be the cause of battles over

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herdsmen are engaged in other projects and purposes and relationships. For example, it could be that the herdsmen are equally placed as herdsmen, but unequally placed as regards their status in society. Unequal bargaining power could be a reflection of that, unmodelled, inequality in status.

resources (Homer-Dixon, 1999). In our analysis of the CPR in section 6.6, it was noted that cooperation is more difficult when community numbers (N) increase (inequality (15)). Since profits decline, whether in the managed CPR (π^*/N) or the unmanaged one ($\underline{\pi}/N$), the individual temptation to take over the land as private property increases. Economic theory is so much in line with empirical observations that those observations should be believable.

However, rapid population growth in the world's poorest regions in recent decades itself requires explanation. Increased economic insecurity, owing to deteriorating institutions, is one identifiable cause: children yield a higher return in such circumstances than other forms of capital assets (Bledsoe, 1994; Guyer, 1994; Heyser, 1996). This means that even if rapid population growth is a proximate cause of environmental destruction, the underlying cause would be expected to lie elsewhere. When positive links are observed in the data between population growth, environmental degradation, and poverty, they should not be read to mean that one of them is the prior cause of the others. Over time, each could in turn be the cause of the others.[25]

The third reason for a deterioration of CPRs is that management practices at the local level are sometimes overturned by central fiat. In recent decades a number of states in the Sahel, for example, imposed rules that in effect destroyed communal management practices in the forests. Villages ceased to have the authority to enforce sanctions on those who violated locally-instituted rules. There are now several enumerations of the ways in which State authority can damage local institutions and turn CPRs into open-access resources (Thomson et al., 1986; Somanathan, 1991; Baland and Platteau, 1996).

And the fourth reason is that social norms of behaviour, founded as they are on reciprocity (section 6.6), can be fragile. Institutions based on reciprocity are especially fragile in the face of growing opportunities for private investment in substitute resources (Dasgupta, 1993, 2001; Campbell et al., 2001). This is a case where an institution deteriorates even when there is no deterioration in external circumstances, nor population pressure. But when traditional systems of management collapse and aren't replaced by institutions that can act as substitutes, the use of CPRs becomes unrestrained or are transformed for other uses. In the context of our model of the grazing land in section 6.6, improved economic opportunities elsewhere amounts to a reduction in the worth of CPR as a pasture; meaning that both $\underline{\pi}$ and π^* decline, relative to the profitability of other forms of activity on the CPR. In a recent study, Balasubramanian and Selvaraj (2003) have found that one of the oldest sources of irrigation - village tanks - have deteriorated over the years in a sample of villages in southern India, owing to a gradual decline in collective investment in their maintenance. The decline has come about because richer households have invested increasingly in private wells. Since poor households depend not only on tank water, but also on

[25] For the theory, see Dasgupta (1993, 2003); for a recent empirical study on South Africa that tests the theory, see Aggarwal et al. (2001).

the fuelwood and fodder that grow round the tanks, the move to private wells on the part of richer households has accentuated the economic stress experienced by the poor.

History tells us that CPRs can be expected to decline in importance in tandem with economic development (North and Thomas, 1973). Ensminger's (1990) study of the privatization of common grazing lands among the Orma in northeastern Kenya established that the transformation took place with the consent of the elders of the tribe. She attributed this to cheaper transportation and widening markets, making private ownership of land more profitable. The elders were from the stronger families, and it did not go unnoted by Ensminger that privatization accentuated inequality within the tribe.

The point is not to lament the decline of CPRs; it is to identify those who are likely to get hurt by the transformation of economic regimes. That there are winners in the process of economic development is a truism. Much the harder task is to identify the likely losers and have policies in place that act as safety nets for them.

8 Exploitation in Long-Term Relationships

As noted earlier, empirical studies have uncovered inequalities in the distribution of benefits from cooperation. Such inequalities as have been uncovered are however consistent with the possibility that all parties have benefitted from cooperation. In the context of cooperation over the use of a CPR, we confirmed in section 7.1 that inequalities in the distribution of the benefits from cooperation can emerge in long-term relationships even if the underlying stage game is symmetrical. However, in the example we studied there, all herdsmen were better off under the agreement than they would have been if the CPR had been unmanaged.

8.1 A Question

Is it possible that someone is worse off in a long-term relationship than he (or she) would have been if the group of which he (or she) is a member hadn't embarked on the long-term relationship? In other words, can there be exploitation in long-term relationships? Empirical studies of communitarian institutions haven't investigated such a possibility.

One reason why they haven't may be that the question is empirically very hard to answer, involving as it does a counterfactual. I believe however that there is another reason. The examples that have motivated thoughts on communitarian institutions in general and CPRs in particular have mostly been conceptualised as the N-person Prisoners' Dilemma, where such a possibility as I am raising here can't arise. However, as we noted in section 5.1, CPRs don't give rise to the Prisoners' Dilemma. I now show that someone could indeed be worse off when engaged in a long-term relationship with others than if the parties had not entered into a long-term relationship.

Lest readers think that one needs only to point to bad marriages to provide an affirmative answer to the question posed in this section, we should remind ourselves that people don't enter marriages expecting them to be bad. Marriages go sour because circumstances change in particular ways or because

the partners discover aspects of their character they had not recognised before or because they were forced into a bad marriage against their will or desire. The example below is not about such situations. It involves an indefinite repetition of an unchanging, CPR game (sections 6.6 and 7.1).

8.2 The Model

Recall the idea of a player's min-max value in a game. It is the largest payoff a player can guarantee for himself, meaning that he can guarantee it for himself even if the other parties are malevolent toward him. For completeness, I define min-max values in the Appendix.

The min-max value of a herdsman in the CPR game of section 5.1 is zero. To confirm this, let X** be the herd size at which the average product of cattle equals their price; that is,

$$F(X^{**})/X^{**} = p. \qquad (16)$$

Equation (16) says that at X** profits from cattle grazing are zero. That the min-max value of a herdsman in the CPR game is zero now follows from two observations: (i) each herdsman can avoid earning negative profit by not grazing cattle in the CPR; and (ii) it is impossible for a herdsman to earn positive profit if some other herdsman introduces X** cattle into the CPR. In Figure 2, which represents the case N = 2, the origin represents the pair of min-max values of the two herdsmen in the CPR game.

As in section 7.1, I simplify the exposition by supposing the number of herdsmen to be two. Assume that the stage game is played indefinitely over time. Denote time by t, where t = 0, 1, 2, ... As before, I take it that the herdsmen discount their future profits at a low rate.

Consider an agreement at t = 0 that says that, in each period, herdsman 1 is permitted to introduce upto αX^* cattle and herdsman 2 upto $(1-\alpha)X^*$ cattle, where α is now so chosen that $(F(\underline{X}) - p\underline{X})/2 > (1-\alpha)(F(X^*) - pX^*) > 0$. (The above inequality implies that $1 > \alpha > 1/2$.) In our earlier notation, $\underline{\pi}/2 > (1-\alpha)\pi^* > 0$. If the agreement were kept, the herdsmen's profits in each period would be $\alpha\pi^*$ and $(1-\alpha)\pi^*$, respectively. Notice that under the agreement herdsman 2 not only earns less profit than herdsman 1, but earns less profit than he would if the CPR were unmanaged. Cooperation involves exploitation here, in that herdsman 2 is worse off under cooperation than he would be if there was to be no cooperation over the use of the CPR. In Figure 2 the pair of profits $(\alpha\pi^*, (1-\alpha)\pi^*)$ is depicted as D. Observe that D is to the southeast of A. So the question arises: how can such an exploitative agreement be enforced via a long-term relationsip?

Notice first that grim cannot be deployed for the purpose in hand (why?). So some other social norm has to be devised. In section 6.6 a conformist was defined as one who cooperated with, and only with, conformists. In our present example, consider the strategy that says that if in any period a cattleman's herd size were not to conform to the agreement, the other party would push him to his min-max value (by introducing X** number of cattle) for a sufficiently large number of periods. If that other person were not to punish the errant, then he would be min-maxed for a suitable number of periods by the person who ought first to have been min-maxed; and so on. The trick now is to choose the periods of punishment to

be sufficiently large, so that it would not be in the interest of either herdsmen ever to be a non-conformist. When the numbers of periods (for first-order, second-order, and higher order violations) are so chosen, the strategy can serve as a social norm, meaning that it is in the self interest of each herdsmen to accept the norm if the other accepts it. Exploitation of one by the other is then enforced mutually.

9 Morals

The literature on CPRs has had a warm glow about it. That relationships matter for a person's well-being is no doubt a trite observation; but people writing on communitarian institutions have claimed more. In countries where the law doesn't function well, where officials regard the public sphere to be their private domain, where impersonal markets are often absent, communitarian relationships are what keep people alive, if not well. This probably explains their attraction for many contemporary development economists. But we need to bear counterfactuals in mind. It could be that communitarian relationships prevent impersonal transactions from taking place. Moreover, it may be that personal obligations inherited from the past prevent public officials from acting dispassionately. What appears as corruption in the North could well be social obligation in the South.

In this paper I have offered the economic theory underlying communitarian management of CPRs. The theory is sturdy enough to reveal both the good and bad sides of long-term relationships. More importantly, the theory tells us what to look for when we study the ways in which CPRs are treated. More importantly, the theory tells us what to look for when we study the way people treat one another.

Appendix

Let X_1 and X_2 be the set of strategies available to individuals 1 and 2, respectively, in the stage game of a repeated game. Strategies themselves are denoted by x_1 and x_2 for the two individuals. The payoff function for 1 is denoted by $\pi_1(x_1, x_2)$, for 2 it is denoted by $\pi_2(x_1, x_2)$. Recall that a pair of strategies $(\underline{x}_1, \underline{x}_2)$ is an equilibrium of the stage game if:

$$\pi_1(\underline{x}_1, \underline{x}_2) \geq \pi_1(x_1, \underline{x}_2) \quad \text{for all } x_1 \in X_1$$

and $$\pi_2(\underline{x}_1, \underline{x}_2) \geq \pi_2(\underline{x}_1, x_2) \quad \text{for all } x_2 \in X_2.$$

The min-max values for individuals 1 and 2, which we write as π_1^{**} and π_2^{**}, respectively, are defined as:

$$\pi_1^{**} = [\min_{x_2 \in X_2} \max_{x_1 \in X_1} \pi_1(x_1, x_2)],$$

$$\pi_2^{**} = [\min_{x_1 \in X_1} \max_{x_2 \in X_2} \pi_2(x_1, x_2)].$$

In the CPR game of section 5, $\pi_1^{**} = \pi_2^{**} = 0$.

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Figure 1

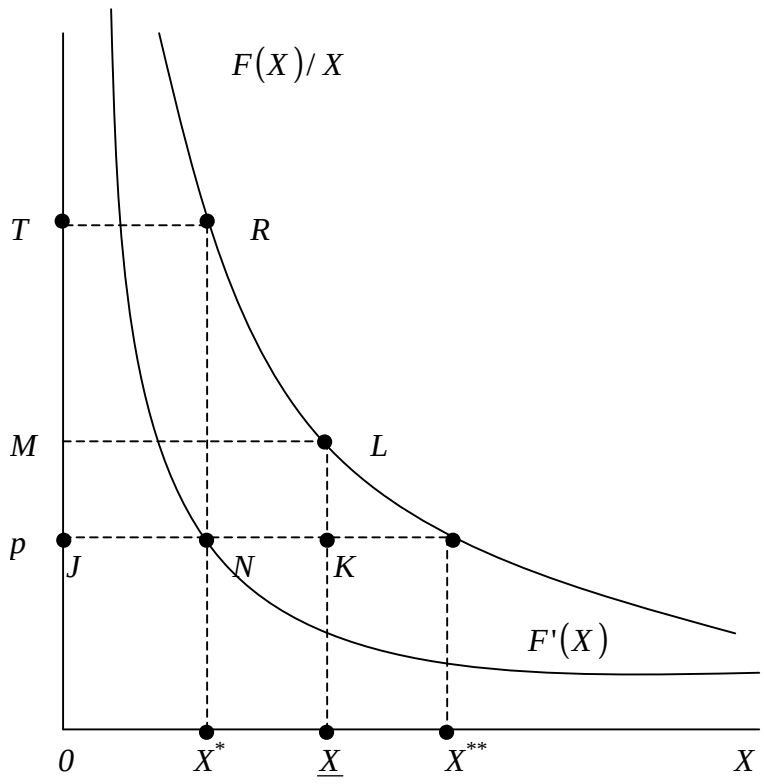

Figure 2