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**Production, Information and Property Regimes:
Efficiency Implications
in the Case of Economies of Scope**

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Abstract

A conceptual model and numerical example are used to show that private property regimes are not necessarily preferable to common property regimes on efficiency grounds when: (1) agents are risk averse; (2) exogenous enforcement of risk sharing schemes is not feasible; and (3) the associated common property regime is characterized by economies of scope in the production of information. The paper considers a case of idiosyncratic risk in a dynamic grazing context where the marginality of the resource is such that insurance markets are thin or non-existent. The policy implication is that the establishment and maintenance of a common property regime is shown to be a (possibly) reasonable institutional response in the face of difficult and particular circumstances.

Keywords: Economies of Scope, Property Regimes, Transaction Costs, Information, Grazing

JEL Classification: D23, D82, O13, Q24

1 Introduction

Recent work in property rights economics has demonstrated that there are a number of different types of property regimes that could be used to manage environmental resources (Bromley 1991; van den Brink et al. 1995). In general, different property regimes imply different outcomes. Among the outcomes of interest are: (1) the dynamic patterns of resource use; (2) the aggregate net benefits obtained from the resource; (3) the distribution of net benefits obtained from the resource; and (4) the magnitude of the transaction costs associated with each outcome. While some researchers claim that economic efficiency requires thoroughgoing private property relations (Hardin 1968; Demetz 1967), other suggest that alternative property regimes — common property regimes — can work and may be preferable to private property regimes in some settings (Bromley 1991; Ostrom 1990; Park 1993; Thompson and Wilson 1994; Bromley and Cernea 1989; Runge 1992).

The divergence of opinion between members of the property-rights school and common property advocates ¹ seems to turn on their respective claims concerning the severity of the problem of coordinating the appropriators of Common Pool Resources (CPRs) — the ‘traditional common property problem.’ On the one hand, members of the property-rights school build theory illustrating that private property regimes are ultimately superior and preferable in a world of complete markets — a world that probably does not exist. On the other hand, and in complete contrast, common property advocates argue that a common property regime may be the preferable management alternative in a world where the traditional common property problem can be easily or perfectly solved — a world that probably does not exist. It would seem, therefore, that the players in the debate are living in two different worlds; neither of which probably exist.

Consequently, the once fruitful debate concerning the relative merits of common property and private property regimes has deteriorated because each party believes the other party is relying on *faith*. Common property advocates believe that private property advocates have too much faith in markets. Private property advocates believe that common property advocates have too much faith in the ability of people to coordinate and “solve” the traditional common property problem. It is unlikely, therefore, that much headway will be made unless and until the debate can be purged of some of its emotional and ideological elements. Such a purging is one of the principle

¹I should emphasize that, so called, common property advocates do not advocate common property regimes in all circumstances. For my purposes I see common property advocates as researchers who separate themselves from private property advocates by arguing that privatization is not always the appropriate policy response.

aims of the present work. In particular, the paper does this by offering an analysis that considers the issue in the context of a second-best world where: (1) complete markets do not exist and (2) the traditional common property problem is treated as a real (as opposed to hypothetical) problem that may play a part in determining whether or not a common property regime could be considered a reasonable institutional response to a particular production problem. The paper illustrates that, in *some* real world circumstances, a common property regime would be preferable to a private property regime on efficiency grounds in that some informational problems are overcome at a lower cost in the common property regime. This is, of course, the economies of scope argument. Using a similar stochastic environment, a companion analysis suggests that, in some circumstances, common property regimes may be preferable to private property regimes on equity grounds (Steele 1997).

2 Property Rights and Excludability

To have a property right is to have an enforceable claim on a stream of benefits. The crucial feature of a property right, or more generally, a property regime is that it is “a structure of rights and duties characterizing the relationship of individuals to one another with respect to...[a] particular resource” (Bromley and Cernea 1989). Property regimes are social constructs that specify the framework from within which individuals go about their daily routine of individually maximizing.

Private property is the legally and socially sanctioned ability to exclude others — it allows the fortunate owner to force others to go elsewhere (Bromley and Cernea 1989). As such, private property, in general, is characterized by a *strict* form of excludability that may, but need not, exist under alternative property regimes. In the production of food products private property has historically implied a form of strict excludability that prevents access to geographical pieces of land defined by property lines. As a theoretical principle, however, it is unnecessary to develop and enforce this form of strict excludability. For efficiency, all that must actually be achieved is that non-owners be prevented from harvesting the fruits of the property owner’s capital and labor. From such a perspective, private property with strict excludability can be seen to have emerged as the dominant property regime in the production context largely as a result of asymmetric information. Although the property owner may have no use for the fruit that falls off the tree before ripening or the stubble that grows beneath the trees, he/she cannot allow access for fear that the agents who might value such things (given lower opportunity costs of labor) would appropriate — steal — the resource that

the property owner does value — fruit. The upshot is that private property becomes characterized by a strict form of excludability.

On the other hand, common property regimes are rarely characterized by a strict form of excludability where access to a geographical “piece” of land is absolutely prohibited by one person *against* another. In most cases common property is characterized less by excludability and more by rules concerning appropriate use patterns. A well known example of a long-enduring common property regime illustrates the point. The example concerns the grazing of high mountain meadows in Torbel, Switzerland. In that case access to the highland pasture is determined not by strict exclusion but by a stocking rule that indicates that “no citizen could send more cows to the alp than he could feed during the winter” (Netting 1976). This rule, written in 1517, is part of a property regime that provides a context for individual maximizing but does not do so by instituting a form of strict excludability. Additional examples are found in the fisheries literature where “effort” rules specify catch quotas, mesh sizes, boat sizes, and/or fishing access times (Conrad 1995).

Excludability is fundamental in the analysis to follow. In short, the strict excludability embedded in private property regimes plays the role of generating information asymmetries and such asymmetries create a situation where agents are unable to determine the state of the world — the productivity of a resource — that exists on each other’s private land holdings. As such, an efficient risk sharing outcome can only be realized in the private property regime if agents are able to eliminate the informational asymmetry generated by strict excludability. Furthermore, the process of eliminating asymmetric information can be presumed to involve positive costs. It is in this context that one might consider an alternative property regime — one that does not generate as many difficult informational asymmetries.

3 Risk and Risk Sharing in Developing Countries

Many common property proponents claim that common property regimes are valuable and may be preferable to private property regimes because they are a mechanism for providing mutual insurance. Runge, for example, states:

In the face of environmental uncertainty, common property institutions may be created; rather than emphasizing the right to exclude some, these institutions provide instead for the right of

pasture (π_h or π_l) and (2) a cross-agent product transfer (T). A positive cross-agent product transfer for Pastoralist A implies that Pastoralist A is a net gainer. In such a case Pastoralist A is a benefactor of Pastoralist B — T , for B, is negative and equal to the gain (positive T) for A. If agents were in a position to make *binding* contracts the Pareto optimal outcome would yield single period expected utility of $U = .25u(\pi_h) + .25u(\pi_l) + .5u(\frac{\pi_h+\pi_l}{2})$ which, by Jensens inequality ², yields a level of expected utility that is *larger* (given strict concavity of u) than the level of expected utility that is realized in the “go it alone” case. This latter outcome results from the following Pareto optimal contract:

Contract 1

1. If both agents experience identical outcomes — good rain or bad rain falls in both sectors — no cross-agent product transfers are made.
2. If agents experience divergent rain states, the fortunate agent (the agent who experienced good rain) transfers $\frac{\pi_h+\pi_l}{2}$ in product to the unfortunate agent (the agent who experienced bad rain).

If Contract 1 was binding the pastoralists would be better off than if the agents were forced to “go it alone.” Nevertheless, in a world without binding contracts, it is well known that it is not economically rational for agents to sign Contract 1 and then follow through. After the stochastic event occurs, the fortunate agent, if there is such an agent, has no incentive to fulfill his/her obligation. By default, then, agents in the one-off scenario are forced by their own self-interest and rational expectations to “go it alone.” The situation may change, however, if agents happen to interact in repeated settings.

3.2 Risk Sharing in Repeated Settings

In repeated settings, it may be possible for households within villages or communities to self-insure against idiosyncratic risk even in the case were binding contracts cannot be established. Given an ongoing relationship, game theoretic analyses of the infinitely repeated prisoners dilemma and the Folk theorem suggest that it may be possible for households in such communities

²Jensens inequality states that for any concave function the expectation of the function is less than or equal to the function of the expectation regardless of the distribution of the random variable (Goldberger 1991).

to establish and endogenously enforce effective risk sharing schemes (Kreps 1990). The Folk theorem, in the context of the infinitely repeated prisoners dilemma, shows that the desired Pareto efficient outcome associated with adherence to Contract 1 can be sustained if agents are not too impatient. In particular, the desired Pareto efficient outcome can be sustained by the ‘tit-for-tat’ strategy which has agents cooperate in the first round, and then follow the actions of their ‘competitor’ in every subsequent round (Bowles and Gintis 1996). The upshot is that there is a good chance that agents will be able to escape, or avoid, the prisoners’ dilemma in repeated interaction settings.³ Nevertheless, this result depends on the assumption that agents are able to inexpensively gather the information that is required to utilize the tit-for-tat type strategy that sustains the Pareto optimal outcome. Coate and Ravallion make the same point that, in the absence of binding contracts, “social insurance is still possible through repeated interaction in an *environment with few informational asymmetries*” (1993, emphasis added). However, the present paper departs from the analysis by Coate and Ravallion by considering endogenously enforced risk sharing in less than ideal situations where agents interact in an environment with, possibly significant, informational asymmetries. The current paper departs from the usual assumptions. “In most theoretical models, where contingent strategies are shown to lead to optimal and stable equilibria, actors are assumed to have complete information about past history...No consideration is given to how this information is generated” (Ostrom 1990). In particular, therefore the current paper aims to consider the more realistic setting where information is difficult and/or costly to obtain.

3.3 Pastoralists in Repeated Settings

Consider the two pastoralists discussed above. In this case, however, Pastoralist A and Pastoralist B are: (1) neighbors in an infinite-horizon setting; and (2) sufficiently farsighted so that endogenously enforced risk sharing is a feasible option. Furthermore, consider that Contract 1 is a *non-binding* contract that simply defines the behaviors that will be considered *cooperative* and *non-cooperative*. Behavior consistent with Contract 1 is regarded as cooperative and any other behavior is regarded as non-cooperative.

If the pastoralists are not too impatient — they do not discount the future excessively — and if pastoralists play a tit-for-tat type strategy, the Pareto efficient outcome associated with Contract 1 will be realized if the pastoralists have *immediate* and *complete* information. That is, the Pareto efficient informal risk sharing scheme can be established and endogenously enforced

³See Coate and Ravallion (1993) for this argument in an informal insurance context.

if pastoralists have the *appropriate* information. In the case considered here, having the appropriate information implies that agents are able to determine immediately and without error if their competitor is ‘cooperating with’ or ‘defecting from’ the informal risk sharing scheme defined by Contract 1. In the scenario spelled out above, to determine defections, the pastoralists must know the type of rain — good or bad — that fell on their competitor’s privately held pasture in the immediately preceding period.⁴ If agents have such information “a defection from cooperation is noticed by the other side immediately and dealt with summarily” (Kreps 1990). As a consequence, it would be relatively easy to establish and maintain the desired risk sharing scheme if the pastoralists: (1) have the appropriate information; (2) interact in an infinite-horizon setting; and (3) are sufficiently farsighted.⁵

3.4 Private Property and Asymmetric Information

Private property regimes are often characterized by *strict excludability* and it is precisely such excludability that may complicate matters in that strict excludability can generate troublesome informational asymmetries. In particular, if the pastoralists are able to exclude each other from their pastures, it may be difficult for Pastoralist A (B) to determine with certainty the rain state that occurred in Pastoralist B’s (A’s) privately held pasture. Given strict excludability, the pastoralists might not be able to ‘identify defections and deal with them summarily.’ As a consequence, if significant informational asymmetries exist, tit-for-tat type strategies cannot be used to endogenously enforce the desired informal risk sharing scheme.

One option at this stage is to implement Contract 1 according to the rain

⁴Nevertheless, it is important to recognize that some level of cooperation can be achieved even in the case of asymmetric information. The general approach in such a situation is to consider that agents employ “trigger” strategies (Kreps 1990). In the case above assume that both agents know that good and bad rain occurs with equal probability. Given this, the pastoralists might employ trigger strategies. Trigger strategies have agents begin by cooperating and continue to cooperate until the other agent behaves in such a way to “trigger” a punishment phase that will last a certain number of periods. For example, the optimal trigger strategy may indicate that punishment is triggered if the one agent claims bad rain for four consecutive periods. But, of course, pastoralists sometimes do experience four consecutive periods of bad rain. Therefore, the punishment phase of the “trigger” strategy introduces, possibly, significant costs. The point to recognize is this: agents may be able to endogenously enforce some cooperation in the asymmetric information case but (1) this will involve costs and (2) full cooperation will not be achieved.

⁵In the scenario above the first-best risk sharing scheme is *implementable* through an informal risk sharing arrangement. Given alternative situations the best implementable risk sharing scheme may not be equivalent to the first-best risk sharing scheme (Coate and Ravallion 1993).

states as *reported* by the pastoralists. Of course, however, this is unlikely to lead to the Pareto optimal outcome because agents have no incentive to report truthfully that they experienced good rain when, in fact, they did. Nevertheless, the pastoralists might be able to develop a direct-revelation mechanism that would induce the pastoralists to report truthfully (Fudenberg and Tirole 1991).⁶ The problem with this solution, however, is that no such direct-revelation mechanism would yield the Pareto efficient first-best outcome associated with Contract 1. Any direct-revelation mechanism must give the fortunate the incentive to report truthfully. To do this, however, requires that the fortunate agent do better, in some period, than the unfortunate agent. But the Pareto efficient outcome requires that identical risk-averse agents realize the same level of utility in each and every period.

So, without a mechanism to provide pastoralists with the appropriate information, it is unlikely that an informal risk sharing scheme could be established and/or maintained. In short, if the pastoralists cannot accurately determine whether or not defections occur, it will be difficult, if not impossible, to get the desired risk sharing scheme “off the ground.”

Consequently, if the private property regime determining relations between the pastoralists generates informational asymmetries, the pastoralists would have an incentive to modify the situation so that either (1) binding contracts could be made, or (2) endogenously enforced risk sharing could be realized. In such circumstances, what steps could the pastoralists take to modify the situation? In the following I briefly consider three options. First, I consider the possibility that the pastoralists could hire a third party enforcer. Second, I consider the possibility that the pastoralists could develop a monitoring scheme. Third, I consider the possibility that the pastoralists could use a common property regime to manage the resource and eliminate (avoid) the informational asymmetry problem generated by the private property regime.

3.4.1 Third party enforcement

Conceptually, the simplest way to enforce a risk sharing scheme is to “hire” a third party to gather information and make the appropriate redistribution when redistribution is necessary. In such a case, the “government” could be hired to fulfill this role. But, as discussed above, we are primarily concerned with endogenously enforced risk sharing schemes precisely because the legal and market foundations necessary to institute *exogenously* enforced risk sharing schemes are not, in general, available to provide this level of service in much of the developing world. In addition, however, even if the third

⁶Thanks to Bill Provencher for making this point.

party enforcement solution had not been assumed away, there are reasons to suspect that the government would not be an effective enforcer. First, the government is liable to have difficulties in accumulating the appropriate information — there is no *a priori* reason to believe that the pastoralists would be more forthcoming with the government than with each other. Second, even if the government could be regarded as an effective contract enforcer, it would likely be an expensive undertaking to establish an agency to develop the legal foundations to effectively provide the desired service. Finally, especially in the context of developing countries, it is appropriate to consider that the government might be too easily corrupted.

Therefore, when considering the third party enforcer solution, it must be recognized that: (1) it may be possible to establish and maintain the desired risk sharing scheme by hiring a third party enforcer; but (2) the costs of hiring this enforcer may be large and may indeed surpass the benefits that could be gained by such an enforcer. In fact, from a transactions costs perspective, the reason that this level of government service does not exist in most marginal areas of the developing world is that the associated transactions costs are excessive in comparison to the benefits that would be forthcoming.

3.4.2 Information mechanisms and monitoring

Even without the aid of a third party enforcer, a risk sharing scheme might be possible if the pastoralists could modify the situation in such a way to enable endogenous enforcement. To enable endogenous enforcement the pastoralists would need to “solve” — eliminate — the asymmetric information problem. In particular, if the pastoralists could develop information and/or monitoring mechanisms to ensure the dissemination of accurate information, they would be able to determine cooperation and defection. In such a case, the pastoralists would be in a position to endogenously enforce the desired risk sharing scheme. For example, a technological solution to the asymmetric information problem would involve the use of rain sensors to accurately reveal whether the pastures received good rain or bad rain. If such sensors were in place and if they were impervious to alteration, the pastoralists could determine cooperation and defection and endogenously enforce the desired risk sharing scheme. Barring such a technological solution, the pastoralists might agree to have relatively open pastures where each pastoralist would have access to the other pastoralist’s pasture to allow for manual monitoring of rain states. In this case the pastoralists could go to each other’s pasture and “see for themselves” the rain state that was realized. Of course, however, manual monitoring would seem to require the pastoralist to stop

production during the time that he/she is inspecting.

3.4.3 Many solutions

The brief discussion above suggests that there are at least two and possibly many different possibilities for getting the Pareto efficient risk sharing scheme “off the ground.” The situation can be succinctly characterized. The pastoralists desire risk sharing — it would be first-best if risk sharing could be achieved at zero cost. Risk sharing can be established and maintained by a variety of means that imply non-zero costs. Consequently, the social and economic problem facing the pastoralists is the problem of choosing the best of all possible second-best worlds. In the present context this involves choosing a set of mechanisms, processes, and institutions to establish risk sharing for the lowest possible cost. Once this problem is solved the second-stage problem is to determine whether or not the benefits to be gained from risk sharing exceed the costs. Of course, however, it may also be the case that it is actually preferable to institute a less than complete risk sharing.

3.4.4 The common property solution

An alternative way to solve the informational asymmetry problem is to change the property regime that is used to manage the resource. In particular, the pastoralists could join their individually held pastures into one two-sector common pasture. If such lands were managed as one common pasture then the information needed to establish and maintain the desired risk sharing scheme might be obtainable at almost zero cost. The argument for this relies on economies of scope and is simply this: the marginal cost of producing information on rainfall may be nil when pastoralist share one common pasture because, as the pastoralists move about the common property pasture producing they may be, at the same time, gathering information about rainfall in both sectors of the pasture. The point to recognize in this situation is that the pastoralists are doing two things at once. Agents are producing on the resource and, at the same time, gathering information about rainfall. I submit, then, that if the pasture lands were managed according to a common property regime, the pastoralists could endogenously enforce the desired risk sharing scheme because the informational asymmetry problem generated in the private property regime would cease to exist. Or, in transaction cost terms, the information asymmetry problem generated in the private property regime is solved in the common property regime at almost zero cost (Coase 1937, Williamson 1985).

The question the pastoralists face now is to determine which, of the three solutions proposed, is the preferable second-best solution. Of course, I have suggested here that the marginal cost of producing information in the common property case would be less than in any other case and, therefore, the common property solution would appear to be the preferable option.

3.5 Common Property Regimes and Economies of Scope

Section 3 opened with a brief discussion of the claims made by some common property advocates concerning the benefits of common property in providing a hedge against uncertainty. In many cases such claims are framed in such a way to suggest that common property regimes provide a means for risk sharing that simply is not available in private property regimes. In general, it must be noted that such claims are misleading. The claims are misleading in the sense that *it is not the case that common property regimes provide services that cannot be provided for under well functioning private property regimes* — common property regimes do not provide services that are not available in private property regimes. Nevertheless, in certain circumstances, it may be the case that common property regimes would be such that certain services could be provided at lower costs. The analysis in this section suggests exactly that — that common property regimes may be useful in that they may provide a context whereby risk sharing could be realized at relatively low costs. In particular, the argument suggests that the common property solution may be the most cost effective solution to the information asymmetry problem created by the strict exclusion rules that often characterize private property regimes. In general, the argument can be viewed as an economies of scope argument in that two products are being produced at once. In one action, it is assumed that two things are produced — physical product and information.

4 A Dynamic Grazing Problem

Section 3 was used to develop a very simple model to illustrate that the establishment and maintenance of a common property regime might be a reasonable institutional response and a preferable second-best solution when the first-best solution is unattainable. In that simple case management decisions had no effect on productivity. As a pedagogical device the example was useful. Nevertheless, to show that economies of scope are likely to have further coverage in more realistic and complex settings, it is important to develop the argument in a dynamic context. In this section I present a sim-

ple dynamic grazing model to show that the existence or non-existence of economies of scope may have a significant impact in determining which institutional design would be optimal. The aim is to illustrate that economies of scope may be more significant — have more coverage — when one considers more realistic and complex settings.

Consider the following situation. Pastoralist A and Pastoralist B each individually hold — privately own — one sector of productive pasture.⁷ Consider that the pastoralists interact repeatedly and that they have infinite time horizons. Consider that, in any particular period, a sector of pasture may be highly productive or moderately productive. The productivity of a pasture will be affected by a variety of things including, most significantly, weather and pest infestation. In addition, the probability that the pasture will be highly or moderately productive depends on previous grazing practices. If a sector of pasture was over-stocked in the preceding period it is unlikely that the pasture will be highly productive regardless of whether or not the majority of the *other* factors (weather and pest infestation) favor high productivity. On the other hand, if a sector of pasture was not grazed intensively in the preceding period, it is likely that high productivity will be realized with less than optimal weather and with a moderate level of pest infestation.

Let the probability that a sector of pasture is highly productive in period $t+1$ be

$$\rho_{t+1} = (1 - g_t^2); \quad (0 \leq g_t \leq 1) \quad (2)$$

where g_t is the intensity of grazing in t .

In this simple case the probability that a pastoralist's pasture is highly productive is directly related to the intensity of grazing that occurred in the immediately preceding period.

4.1 The sole proprietor

In an infinite-horizon setting the sole proprietor faces the problem of choosing the grazing strategy that maximizes

$$E_0 \sum_{t=1}^{\infty} \beta^t u(c_t); \quad 0 < \beta < 1 \quad (3)$$

⁷The pastoralists' also privately hold livestock that they can use as they see fit on the sectors of pasture to which they have access.

where c_t is consumption at t , β is the discount factor, E_t is the mathematical expectation operator conditioned on information known to the agent at t , and u is a one period utility function satisfying $u' > 0$ and $u'' < 0$.⁸

For the analysis here I assume that consumption smoothing is not possible in that product produced in the current period cannot be saved and consumed in future periods. When considering poor households in marginal areas this is often a reasonable assumption as any available storage facilities do not, in general, provide adequate protection against damp and pests (Dasgupta 1983). Given such circumstances, pastoralists can only achieve consumption smoothing indirectly by employing the appropriate grazing strategy. Given that the product produced in one period cannot be held over for future consumption, $c_t = \lambda_h g_t$ when the pastoralist's pasture is highly productive and $c_t = \lambda_l g_t$ when the pastoralist's pasture is moderately productive ($\lambda_h > \lambda_l$). λ is simply a weight parameter used to distinguish productivity differences between the states.

Given this model, the pastoralists' can solve (3) subject to (2) and derive time-independent grazing strategies given by

$$g^*(s) = \begin{cases} g_h & \text{if } s = h \\ g_l & \text{if } s = l \end{cases} \quad (4)$$

where $s = h$ if high productivity is realized and $s = l$ if moderate productivity is realized. Notice that $g^*(s)$ is not indexed on time — the optimal grazing strategy is time-independent.⁹

Given a particular utility function and set of parameter values for β and λ_i ($i = h, l$), the pastoralists' management problem is easily solved. The optimal grazing strategy — $g^*(s)$ — can be determined and has the following characteristics:

1. For any set of parameters satisfying $0 < \beta < 1$ and $\lambda_h > \lambda_l$; $g_h \geq g_l$. This includes the trivial case where $g_h = g_l = 1$. In such cases, intensive grazing occurs all the time and nothing is gained by employing a less than full-intensity grazing strategy.
2. For non-trivial cases, where $g_i < 1 \exists i$, $g_h > g_l$. This follows because:
 - (1) *current marginal benefits* from grazing are greater when $s = h$ than when $s = l$

$$\frac{\partial u(\lambda_h g_t)}{\partial g_t} > \frac{\partial u(\lambda_l g_t)}{\partial g_t}; \quad (5)$$

⁸This formalization of the problem can be found in Sergeant(1987).

⁹Given the process in Equation (2), where $\rho_{t+1}(g_t)$, the dynamic problem can be solved by choosing the optimal grazing strategy in any two period sequence subject to the constraint that $g_t^*(s) = g_{t+1}^*(s)$

and (2) the *marginal costs* of grazing are identical irrespective of the productivity state realized. Given a particular level of grazing intensity, the probability that the highly productive state will occur in the subsequent period is identical irrespective of the current state. That the marginal costs of grazing in the current period are the same irrespective of the current state can be noted by examination of Equation (6) which gives pastoralists' expected lifetime utility beginning at period $t + 1$.

$$U_{t+1} = \rho_{t+1}u(\lambda_h g_{t+1}) + (1 - \rho_{t+1})u(\lambda_l g_{t+1}) + E_{t+1} \sum_{t=2}^{\infty} \beta^t u(c_t) \quad (6)$$

where, $c_t = \lambda_h g_t$ if $s_t = h$, and $c_t = \lambda_l g_t$ if $s_t = l$. The first (second) term on the right-hand-side of Equation (6) is the product of: (1) the probability that the high (moderate) productivity state will be realized in $t + 1$, and (2) the utility that will be realized if that state occurs. The third term on the right-hand-side of Equation (6) gives the pastoralist's expected lifetime utility beginning at period $t + 2$. Given that expected lifetime utility from period $t + 2$ is invariant to g_t , the third term can be treated as a constant in determining the marginal costs of choosing a particular level of grazing in the current period. Substituting Equation (2) into Equation (6) and taking the partial derivative with respect to g_t we find that: (1) there are positive marginal costs, expressed in terms of reductions in expected life-time utility, to current period grazing; and (2) marginal cost are identical irrespective of the state that was realized in t . It follows, therefore, that $g_h \neq g_l$; and, furthermore, that $g_h > g_l$ because the marginal benefits of grazing are *lower* in the moderate productivity state.

Once the optimal grazing strategy is determined, the pastoralists' expected lifetime utility can be calculated.

4.2 Binding contracts

Just as was the case in Section 3, the pastoralists could do better if binding contracts were a legitimate option. For illustrative purposes, assume, for the moment, that binding contracts could be made and enforced at zero cost. In such instances it should be clear that a Pareto optimal contract will spread risk equally across the risk averse pastoralists — this is required of any first-best arrangement. Going further, one can solve for the optimal grazing strategy in a world with binding contracts by designing and solving the appropriate social planner's problem. In this context the social planner's

problem is to choose a grazing strategy that maximizes

$$E_0 \sum_{t=1}^{\infty} \beta^t u(c_t); \quad 0 < \beta < 1 \quad (7)$$

where, in this case,

1. $c_t = \lambda_h(g_{hh}^A + g_{hh}^B)$ if both sectors of pasture are highly productive (an event that occurs with probability .25)
2. $c_t = \lambda_l(g_{ll}^A + g_{ll}^B)$ if both sectors of pasture are moderately productive (an event that occurs with probability .25)
3. $c_t = \frac{\lambda_h g_{hl}^A + \lambda_l g_{hl}^B}{2}$ if sector A is highly productive and sector B is moderately productive (an event that occurs with probability .25).
4. $c_t = \frac{\lambda_h g_{lh}^A + \lambda_l g_{lh}^B}{2}$ if sector A is moderately productive and sector B is highly productive (an event that occurs with probability .25).

Although Equation (7) is identical to Equation (3), the results differ as c_t takes on different values in the different cases.

The solution to the above social planner's problem is given by the following optimal grazing strategy

$$g^*(s) = \begin{cases} g_{hh}^i & \text{if } s = hh \\ g_{ll}^i & \text{if } s = ll \\ g_{hl}^i & \text{if } s = hl \\ g_{lh}^i & \text{if } s = lh \end{cases} \quad i = A, B \quad (8)$$

where, $s = hh$ if both sectors of pasture are highly productive, $s = ll$ if both sectors of pasture are moderately productive, $s = hl$ if sector A is highly productive and sector B is moderately productive, and $s = lh$ if sector A is moderately productive and sector B is highly productive. For a given utility function, and set of parameters, this problem can be solved using successive approximation or any dynamic programming technique. In this model, the optimal solution requires that $g^{*A} = g^{*B}$ when identical productivity states are realized.¹⁰

In the above formulation, an important feature of the social planner's problem is assumed away. To this point $g^*(s)$ only gives the optimal grazing

¹⁰An alternative forms of Equation (2) may require the identification of a "main producer" even in the symmetric productivity cases. In such cases the main producer would do the majority of production and then make a cross-agent product transfer.

strategy without explicitly considering the cross-agent product transfers that must occur if the pastoralists are to achieve the first-best outcome. Let a first-best solution be characterized by the following Pareto optimal contract:

Contract 2

1. If the same level of productivity is realized in both sectors; (1) the pastoralists graze their pastures at intensity level g_{hh}^i and g_{ll}^i ($i = A, B$) and no transfers are made.
2. If one sector of pasture is highly productive and the other is moderately productive: (1) the pastoralist with the highly productive pasture grazes his/her pasture at the appropriate high intensity level, g_{hl}^A or g_{lh}^B ; (2) the pastoralist with the moderately productive sector grazes his/her pasture at the appropriate low intensity level g_{ih}^A or g_{hl}^B ; and (3) if $s = hl$ a cross-agent product transfer of $\frac{1}{2}\lambda_h g_{hl}^A - \frac{1}{2}\lambda_l(g_{hl}^B)$ is made from the fortunate agent (Pastoralist A) to the less fortunate agent (Pastoralist B). In state $s = lh$ a cross-agent product transfer of the same magnitude travels in the opposite direction.

The point to recognize is that the pastoralists would be better off in a world where binding contracts were possible. Unlike the case in Section 3, this improvement in expected lifetime utility can be attributed to *two* factors. First, the risk-averse pastoralists are in a better position as a simple result of risk-spreading — Contract 2 specifies that the pastoralists realize identical levels of utility in all t . Second, given the existence of binding contracts, pastoralists in a first-best world would be able to improve their situation by optimizing from *within* a context where binding contracts are established and enforced at zero cost. Following the game theory literature the solution $g^*(s)$ can be regarded as the *collusive* solution.

4.3 Joint ventures in a second-best world

We are faced with the same question as before. How can the pastoralists modify the situation so that a Pareto optimal contract — Contract 2 — could be endogenously enforced? Or similarly, how can the pastoralists modify the situation so that they might approach the first-best outcome in a second-best world? What is the cost minimizing way to make Contract 2 endogenously enforceable?

As in the previous case, there are a variety of things that could be done to induce enforcement of Contract 2. First, although it is always a theoretical possibility to hire a third-party enforcer, such an option is not liable to be economically prudent or practically feasible in many marginal areas of the developing world. This point was discussed above. Second, the pastoralists would consider the possibility of developing monitoring mechanisms to modify the situation to enable the endogenous enforcement of Contract 2. Although it may be relatively inexpensive to develop mechanisms to monitor productivity, it might be quite difficult and expensive to monitoring the intensity of grazing with remote sensors or the like. Given this, I submit that the common property solution to the management information problem may be preferable on efficiency grounds. The *two* pieces of information that are necessary to enable endogenous enforcement of Contract 2 might be produced at low costs if access to the pastures was determined on the basis of a common property regime.

First, consider the difficulties that the pastoralists would face in enabling endogenous enforcement of Contract 2 if access to the pastures was determined by a private property regime. In such a case getting Contract 2 “off the ground” requires: (1) mechanisms to relate information on productivity; and (2) mechanisms to monitor management practices. As discussed above, it might prove very difficult/expensive to monitor management practices in the private property regime. This, of course, opens the door for the pastoralists to consider alternative options.

Consider an alternative institutional regime where the pastures are held and managed according to a common property regime. In such a case, due to economies of scope, it may be relatively less expensive to produce the necessary information to get Contract 2 “off the ground.” Pastoralists in a common property regime might be able to do (produce) many things at once thus reducing the total costs of achieving the desired outcome. In particular, as agents produce on the common pasture they might be able to simultaneously monitor, at low or zero costs, (1) pasture productivity and (2) management practices. Therefore, due to the economies of scope that may exist in a common property regime, it might be less expensive to enable endogenous enforcement of Contract 2 when access to productive resources is determined by a common property regime as opposed to the case when access to the resource is determined by a private property regime. This is, of course, the same point made in Section 3. Nevertheless, it is in the current more complicated dynamic setting where the value of common property regimes and the economies of scope embedded therein can be shown to affect the optimal mix of technologies, processes and institutions to be used to guide productive activities.

It is readily admitted that the information problem in Section 3 was not overbearing and that it would be relatively simple/inexpensive to solve the rain-state information problem to enable efficient risk sharing from within a private property regime. In that case, economies of scope in the common property regime were only based on the fact that production and rain-state information gathering could occur at the same time. Given that it would likely be inexpensive to monitor productivity in any regime, the potential benefits of a common property regime are not large. However, the world is rarely this simple. In the realm of productivity the world is often very complicated with many informational asymmetries at a variety of levels. The point here is to consider a world that is slightly more complex to illustrate that the introduction of further complexities can increase the potential coverage of economies of scope. If such potential coverage is actual, it becomes more likely that the potential benefits of a common property regime would be sufficient so that the common property regime would be the preferable option.

4.3.1 Searching for economies of scope

The above example does not show that it is *preferable* that privately held pastures be joined and managed according to common property relations. While this is a possibility, careful attention must be given to: (1) the costs associated with solving the traditional common property problem; and (2) the question of whether or not the hypothesized economies of scope actually exist. The traditional common property problem is considered below. The issue concerning the existence of economies of scope is introduced here.

It is not the case that the suggested economies of scope will always exist — each particular situation must be examined on its own merits. To illustrate, consider some of the questions that must be asked in the above setting to determine whether or not the common property regime has the suggested cost saving characteristics. In the above setting, the most significant information asymmetry concerns the inability of agents to determine with certainty whether each other is pursuing the appropriate management program as specified by $g^*(s)$. It must be asked, therefore, if casual observation is sufficient to determine if pastoralists are employing the management program $g^*(s)$.

There is not, however, a general answer to the above question. Depending on what behavior is required by the pastoralists to pursue the appropriate management program, casual observation — the observation that would likely take place in the common property regime — may or may not be sufficient

to determine 'cooperation with' or 'defection from' $g^*(s)$. If, for example, a particular intensity level of grazing requires something akin to constant movement throughout the pasture, then it seems that casual observation *would* be sufficient. On the other hand, if the appropriate management practice only requires movement when the resource exhibits certain subtle characteristics that happen to indicate possible resource damage, it may be much more difficult to determine defections from $g^*(s)$ by mere casual observation. That is, when *subtle* action is required for adherence to $g^*(s)$, it may be difficult to determine adherence or non-adherence through casual observation. In the latter case, the common property solution may do very little in terms of eliminating the management-practices information problem thought to be caused by the strict excludability embedded in private property regimes. In the former case, however, where casual observation was thought to be sufficient to determine adherence to $g^*(s)$, the common property solution might be useful as it eliminates, at relatively low costs, an information problem that would exist if access to the resource was determined by private property relations.

There are, however, a number of additional issues to consider. First, if casual observation is sufficient to accurately observe management practices, is 'road-side' casual observation equally sufficient to determine adherence or non-adherence to $g^*(s)$? That is, would it be possible to determine the other agent's management practices by casual observation from *outside* of the individually held pasture. In such a case the private property regime might not generate an information gap that is difficult or expensive to overcome. In the case at hand, if 'road-side' casual observation is sufficient, the pastoralists would not need to occupy the same common pasture — nothing would be gained from milling about on the same pasture because identical information could easily be gathered from afar. In general, the issues considered here are empirical and situation specific. The pastures may be large, for example, so that 'road-side' casual observance is impossible. But, at the same time, this would seem to imply that accurate and useful observation in the common property regime would also be difficult — pastoralist would be milling about in a very large pasture. Nevertheless, even in a large pasture, pastoralists in a common property regime are liable to meet one another with positive probability and this may be useful in creating a context to induce the appropriate management program.

There is one final issue that may be significant in determining whether or not economies of scope exist in a particular setting. Again, the issue concerns the nature of the appropriate management practice. Is $g^*(s)$ accomplished by a single punctuated event? Although this seems unlikely in the grazing example, it may be important in other settings. If management practice is determined by a punctuated event, then snap-shot observation — the type

of observation likely to be practical in the private property regime — will not, in general, be sufficient to determine if the appropriate management practices are in use. That is, of course, unless the snap-shot occurs at the exact same time that the punctuated event determining management practice occurs. On the other hand, appropriate management might require constant and on-going behavior. In that case it may be important to have rather constant monitoring — the type of monitoring that might be realized at relatively low costs in a common property regime.

Such a discussion could no doubt continue. The variety of social, economic and environmental conditions that exist in production activities is simply too great and every possibility cannot be considered. The point to recognize is that the suggested (hypothesized) existence of economies of scope is not a universal principle. In some instances a common property regime will be characterized by significant economies of scope in the production of information. In some instances the hypothesized economies of scope will not exist or be so minor as to be trivial. Furthermore, even if significant economies of scope do exist, the value of such economies must be compared to the losses associated with management by common property regimes through the traditional common property problem.

4.3.2 Approaching the first-best world with a private property regime

Given that the first-best world is unattainable, what is the best outcome that the pastoralists can achieve under a private property regime? Consider the possibility that: (1) it is inexpensive to establish and maintain a technology or process to monitor sector productivity; and (2) that it is costly to develop and maintain mechanisms or processes to monitor grazing practices. In such a case, the pastoralists will likely establish a rain-contingent contract. Such a contract will go some way in spreading risk but will, in general, fail to produce the first-best outcome associated with Contract 2. This follows because the pastoralists are not in a position to make credible commitments concerning their individual management practices. Given such a situation, the pastoralists face a problem of *optimal contract design*. Consider a rain-contingent contract of the following form:

Contract 3

1. If identical levels of productivity are realized in both sectors, no cross-agent product transfers are made.

2. If Pastoralist A's sector is highly productive and Pastoralist B's sector is moderately productive ($s = hl$), a cross-agent product transfer of z is made from the fortunate agent (Pastoralist A) to the less fortunate agent (Pastoralist B). If the opposite state occurs ($s = lh$), the product transfer goes in the other direction.

The problem the pastoralists face is to choose z in such a way to maximize expected lifetime benefits. In general, z will not be equal to the cross-agent product transfer specified in Contract 2. If the unfortunate agent were to receive this level of transfer, he/she would actually be better off than the fortunate agent because he/she would chisel away at the collusive agreement and graze at a higher level than is specified by $g^*(s)$.

Although the problem in this case becomes moderately sophisticated, it is not intractable. First, one must determine how agents respond to the actions of one another and the level of z . In particular, each pastoralist will have a reaction function of the form $r^i(g^j, z)$ ($i = A, B; j = A$ or B not i) that specifies the optimal level of grazing as a function of a particular level of grazing by the other pastoralist and the level of z . A Cournot-Nash equilibrium is determined as the point where, for a given level of z , grazing strategies are mutual best responses: Pastoralist A's choice of grazing intensity must maximize expected lifetime utility given Pastoralist B's choice of grazing intensity, which in turn must maximize Pastoralist B's expected lifetime utility given Pastoralist A's choice of grazing intensity (Gravelle and Rees 1992). Conceptually, the optimal contract design problem is then solved by incorporating the reaction functions into Equation 3 (3) and choosing z to maximize. A two-period version of this problem is solved below.

The first-best solution defined by Contract 2 and the second-best solution defined by Contract 3 and the competitive Cournot-Nash equilibrium differ on two fronts. First, the optimal second-best contract is one that induces less than perfect risk spreading. Less than perfect risk spreading emerges because, as is often the case, risk spreading and incentive provision work in opposite directions. Second, as grazing practices are unobservable (momentarily assumed), the (Cournot-Nash) equilibrium characterizing the situation yields higher grazing intensity levels and has the effect of increasing the probability that $s = ll$ will occur. This, in turn, reduces the pastoralists' expected lifetime utility. It is clear and unsurprising, therefore, that in moving from the first-best world to the real world, the pastoralists lose in terms of expected lifetime utility. It must be asked, however, if the rain-contingent contract above yields the *best* second-best solution.

In fact, even if the private property regime remained intact, it is likely that the above solution could be improved upon. I briefly consider the

most relevant possibility. Although it may be too expensive to solve the grazing-practices information problem completely, it might be the case that mechanisms, processes, or institutions could be established that would go *some way* in reducing the pastoralists tendency to chisel away at the collusive solution. If, for example, a reasonably “priced” noisy monitoring scheme could be used to correctly determine, with some positive probability, the grazing practices of the *other* pastoralist, it might be optimal to institute such a scheme and modify Contract 3 to included specifications on *appropriate* management practices. Given such a possibility, the marginal benefits of introducing monitoring schemes would need to be compared to the marginal costs of introducing such schemes. Although it is not likely that it would be optimal to introduce monitoring up to the point where perfect monitoring takes place, it might be optimal to introduce *some* monitoring. Consequently, by introducing some monitoring, the pastoralists will likely be able to improve upon their situation and move in the direction of the collusive solution. When the theoretical dust has settled, the pastoralists will likely find themselves in a second-best world where resources are spent on monitoring and where the outcome, even ignoring monitoring costs, is less than optimal and yet better than what could be realized under Contract 3. In the “real-world” the pastoralists will not be able to achieve the first-best outcome when the monitoring of grazing practices involves significant positive costs.

As a general rule we can presume that as situations become more complex (realistic) the difference between the first-best outcome and the *best* second-best outcome will likely increase. Furthermore, the above discussion and analysis should make clear that situations become more complex (realistic) as the burden of information increases — it is *information*, or the lack thereof, that makes a particular situation complex and realistic. Consequently, in circumstances where particular institutional arrangements imply large informational burdens (burdens that would need to be overcome if the first-best solution was to be approached), it is reasonable to consider alternative institutional arrangements that: (1) fail to generate significant informational asymmetries; or similarly, (2) reduce the costs of gathering (producing) information. It is in this context that I submit that, in some circumstance, it might be preferable, on efficiency grounds, to replace the hypothesized private property regime with a common property regime.

4.3.3 Approaching the first-best world with a common property regime

This section does not aim to show that a common property regime is unambiguously superior to a private property regime. It will be shown, however, that the converse does not necessarily hold. The aim of this section is to articulate a moderate position concerning the efficiency implications of common property regimes in particular circumstances. The position is simply this: It might be the case that a common property regime would be preferable to a private property regime in certain cases where (1) asymmetric information is problematic and (2) the common property regime in question has the characteristic of being able to overcome informational asymmetry problems at relatively low costs. The section proceeds by setting up the situation and considering two polar cases.

Consider a situation where Pastoralist A and Pastoralist B are considering the possibility of replacing the status quo private property regime with a common property regime that gives the pastoralists the right to graze livestock in any sector they see fit — the pastoralists are simply not excluded from any particular part of the common pasture. By adopting such an institutional regime, the pastoralists hope to approach the first-best outcome. Will the pastoralists succeed?

First, consider the *ideal* second-best situation — the first polar case — where the informational problems associated with private property and strict excludability can be solved perfectly and at irrelevant costs by removing the private property regime and replacing it with a common property regime. For the ideal situation to pertain it must be the case that the pastoralist could perfectly monitor productivity and grazing practices at very low costs. As such, the appropriate grazing strategy ($g^*(s)$) must be such that compliance or non-compliance could be determined easily by the type of casual observation that would take place as the pastoralists go about producing on the common pasture. In such a case, expected lifetime utility at $t = 0$ is

$$E_0 \sum_{t=1}^{\infty} \beta^t u(c_t) - \delta \tag{9}$$

where, in this case, $c_t = c(g^*(s))$ and δ is the loss in terms of expected lifetime utility associated with the process of producing perfect information on productivity and grazing practices. In the ideal second-best situation it is assumed that δ is arbitrarily small; consequently, the ideal second-best situation yields an outcome that is arbitrarily close to the first-best outcome.

The scenario in the ideal case seems to ignore an important problem that has been the focus of the bulk of the literature on common property since Hardin

(1968) popularized the *traditional common property problem* of achieving coordination among the appropriators of CPRs. Where, in the above case, could one find the ‘tragedy of the commons’? Re-interpreting the ‘tragedy of the commons’¹¹ we find that the traditional common property problem is, fundamentally, an information and enforcement problem and that resource degradation is not, necessarily, an *inevitable consequence* of joint ownership. Assuming that the resource held in common is not open-access and that there are rules determining use and access of the resource, the traditional common property problem concerns the difficulty of monitoring to ensure compliance with the rules of use and access. In the ideal second-best case, however, the traditional common property problem is assumed solved in that compliance or non-compliance with any particular set of use rules is observable. In the ideal second-best world endogenous enforcement is possible as it is assumed that the pastoralists interact with infinite time horizons and are sufficiently patient. So, in the ideal second-best case the traditional common property problem is not ignored; it is solved.

For the second polar case, however, assume that information on grazing practices is difficult or expensive to obtain. Refer to this as the worst-case common property scenario. In the worst-case common property scenario, even though access to the resource is unrestricted, it is not possible to solve the grazing-practices information problem through casual observation. As in the private property case above, assume that the information problem associated with sector productivity is trivial and rectified at irrelevant costs.

In the worst-case scenario each pastoralist must *independently* determine how intensively to graze each of the two sectors taking into account the behavior of the *other* pastoralist. Again, then, the outcome is liable to be characterized by a Cournot-Nash equilibrium. Solving such a problem will yield, for each agent, two reaction functions that give the optimal intensity level of grazing for each sector of pasture as a function of: (1) a given level of grazing on each sector for the *other* pastoralist and (2) one’s own intensity level of grazing on the *other* sector. For example, for Pastoralist A the set of reaction functions is given by

$$r^{A*}(\cdot) = \begin{cases} r_A^A = r_A^A(g_A^B, g_B^B, g_B^A) \\ r_B^A = r_B^A(g_A^B, g_B^B, g_B^A) \end{cases} \quad (10)$$

where r_i^A gives Pastoralist A’s optimal level of grazing on sector i ($i = A, B$), g_i^B gives Pastoralist B’s level of grazing on sector i ($i = A, B$), and g_i^A

¹¹Hardin’s (1968) ‘tragedy of the commons’ is more accurately viewed as a ‘tragedy of open-access’ when the resource: (1) is positively valued; (2) can be degraded by over-use; and (3) is open-access in that access is completely unrestricted. See Bromley and Cerena (1989) and Ostrom (1990).

gives Pastoralist A's level of grazing on sector i ($i = A, B$). Simultaneously solving the *four* reaction functions (A's and B's) gives the Cournot-Nash equilibrium. Let expected lifetime utility under such circumstance be given by

$$E_0 \sum_{t=1}^{\infty} \beta^t u(c_t) \quad (11)$$

where, in this case, $c_t = c(r^{A^*}(\cdot), r^{B^*}(\cdot))$. Combining (7) and (11) and substituting in for c_t , the loss associated with the traditional common property problem (L) is given by:

$$L = E_0 \sum_{t=1}^{\infty} \beta^t u(c(g^*(s))) - E_0 \sum_{t=1}^{\infty} \beta^t u(c(r^{A^*}(\cdot), r^{B^*}(\cdot))) \quad (12)$$

Equation (12) is simply the difference between the first- best outcome and the outcome in the worst-case common property scenario where appropriators are unable to coordinate to achieve anything better than the outcome characterized by the competitive Cournot-Nash equilibrium.

The solution in the worst-case scenario will, by default, yield perfect risk sharing in that the pastoralists will always realize identical outcomes. As there is no exclusion and neither pastoralist is given an *a priori* advantage, the Cournot-Nash equilibrium is such that $r^{A^*}(\cdot) = r^{B^*}(\cdot)$. Nevertheless, the fundamental problem in this case is the same as in the second-best private property case — coordination is not possible — too much grazing takes place.

If grazing practices cannot be observed by mere *casual* observation, are the pastoralist destined to realize the outcome associated with this worst-case scenario? The short answer is 'probably not.' There are two distinct possibilities to consider. First, consider the possibility of maintaining the common property regime but introducing more than casual observation. Just as in the second-best private property case, the pastoralists might be able to introduce some monitoring to reduce the tendency for the pastoralists to chisel at the collusive solution. Such additional monitoring will require resources and, therefore, the pastoralists would need to determine the optimal level of monitoring by comparing marginal benefits and marginal costs. Second, the pastoralists could privatize the common pasture and proceed to choose the optimal level of monitoring from within that regime. The ultimately preferable solution can then be determined by a simple comparison.

The economies of scope argument I am making is a simple argument based on the fact that the *marginal monitoring costs will be lower* in many common property regimes (those characterized by economies of scope) than in the corresponding private property regimes. Consequently, if monitoring has a

similar affect in both regimes in that it reduces the pastoralists tendency to chisel at the collusive outcome, it might be the case that the common property regime would be preferable on efficiency grounds in that more monitoring will occur in the common property regime and the pastoralists will emerge closer to the collusive outcome.

4.3.4 Taking stock

It is instructive to take stock of the developing argument. There are now three general outcomes to consider. First, there is the outcome associated with the optimal rain-contingent contract. Let U_{pp} give the pastoralists' expected lifetime utility in such a case. Second, there is the outcome associated with the ideal common property situation. Let U_{cp+} give the pastoralists' expected lifetime utility in such a case. Third, there is the outcome associated with the worst case common property scenario. Let U_{cp-} give the pastoralists' expected lifetime utility in such a case.

In general, it must be the case that U_{cp+} yields the best second-best outcome as it is arbitrarily close to the first-best outcome. Consequently, if the situation was such that U_{cp+} were to hold (a seemingly unlikely event), it is obvious that the common property regime would be preferable to the private property regime. On the other hand, given a particular set of circumstances, if U_{cp-} were to hold, it is likely that the private property regime would be the preferable option ($U_{pp} > U_{cp-}$) in that private property regimes have particularly desirable incentive properties. As is well known private property regimes function nicely to internalize costs. In marginal areas of the developing world, however, where insurance markets are lacking and inter-temporal saving is ineffective, private property regimes are not necessarily superior to all other property regimes. Yet, if the loss associated with the traditional common property problem (L from equation 12) is large, as in the worst-case scenario, it is presumably likely that the private property regime would dominate the common property regime.¹²

While we have some preliminary results, the point of considering the two polar cases in the common property regime is to suggest that, in general,

¹²In some cases, however, it happens that $U_{cp-} > U_{pp}$. This unanticipated result arises because the rain-contingent contract induces less than perfect risk sharing while the common property regime ensures perfect risk sharing by default. Further research must be conducted to draw out the implication of this finding. Nevertheless, for the present purposes, to put forth the economies of scope argument, I wish to put this result aside and consider cases where $U_{pp} > U_{cp-}$. In the numerical example in Section 5 the former case occurs when λ_h was much larger than λ_l . In such a case the incentive properties of the private property regime were dwarfed by the risk sharing that arises in the common property case.

neither case is likely to hold. In the ideal second-best case it is assumed that the traditional common property problem is not a problem — L is zero. In the second polar case, L takes on its largest possible value and no consideration is made of introducing monitoring. Furthermore, the polar cases provide a formal means of distinguishing between the private property advocates and the common property advocates. To crystallize the distinction, one might view private property advocates as taking the position that all common property regimes would be plagued by the traditional common property problem and that the losses from such a problem would be as large as theoretically possible — hence the outcome would always be U_{cp-} . On the other hand, common property advocates can be viewed as taking the position that the losses from the traditional common property problem would be as small as theoretically possible — the outcome would always be U_{cp+} . Is it any wonder that in recent years the two schools have found little common ground?

4.4 Choosing the best second-best world

This section is used to summarize the general economies of scope argument. Formally, I am suggesting that the pastoralists might be able to achieve a better outcome if they dismantled the assumed private property regime and replaced it with a common property regime. I am arguing that this might be the case if the marginal costs of monitoring grazing practices are lower in the common property regime than in the private property regime.

Assume the following:

1. the marginal benefits of monitoring are the same irrespective of the existing property regime;
2. the monitoring of management practices has a simple affect on the outcome in that monitoring pushes the behavior of the pastoralists away from the competitive Cournot-Nash equilibrium and towards the optimal collusive solution; and
3. movements away from the competitive Cournot-Nash equilibrium and towards the collusive outcome function to unambiguously and constantly increase the pastoralists' expected outcomes.

It follows that, if the marginal costs of monitoring are lower in the common property regime than in the private property regime, more monitoring will take place in the common property regime. But, there is still the issue of the

traditional common property problem. While it is true that more monitoring will take place in the common property regime it is not necessarily true that the common property regime would be preferable. It depends on the magnitude of the traditional common property problem and, more explicitly, the initial competitive equilibria. I claimed, initially, that $U_{pp} > U_{cp}$ —given that more costs are internalized in the private property regime. Consequently, the common property regime is left with some ground to make up. If the traditional common property problem is severe and if the economies of scope embedded in the common property regime are not large, it is unlikely that a common property regime would be preferable on efficiency grounds. On the other hand, if the traditional common property problem is not severe and there are significant economies of scope, a common property regime is likely to be preferable on efficiency grounds. The following section provides a numerical example.

5 Numerical Illustration

The argument above can be illustrated by considering a numerical example. For simplicity, I consider a two-period world. Qualitatively similar results would arise if the infinite-horizon problems were solved. The only disconcerting aspect of using a two-period example in an infinite-horizon setting is that endogenously enforceable risk sharing schemes could not arise in a two-period world. As such, the numerical example is not concerned with determining how patient agents would need to be to endogenously enforce a risk sharing scheme — it is assumed that the case we are considering is one where agents are sufficiently patient and the losses from current actions are large enough so that endogenous enforcement would be possible if the agents had the appropriate information.

Let the pastoralists receive utility from consumption according to the following:

$$u = \sqrt{c_1} + \sqrt{c_2} \quad (13)$$

where c_1 gives consumption in period 1 and c_2 gives consumption in period 2. Table 1 gives the result for the following cases: (1) the sole proprietorship; (2) the perfect information case; (3) the optimal rain-contingent contract case; and (4) the worst-case common property scenario. The parameter values for this example are $\lambda_h = 3$, $\lambda_l = 1$, and $\beta = 1$. The numerical examples were solved using GAMS.¹³

The first columns of Table 1 give the grazing intensity levels (Period 1)

¹³The GAMS programs can be accessed on my Web page at www.ucg.ie/ecn/.

for the pastoralists in the different sectors of pasture given alternative productivity states. State 'Good Good' indicates that high productivity was realized on both sectors of pasture while state 'Good Bad' indicates that high productivity was realized on sector A (owned by Pastoralist A in the private property cases) and moderate productivity was realized on sector B. Given a two-period world, it is assumed that pastures are grazed at full intensity in Period 2. The fifth column gives the pastoralists' expected lifetime utility given the state that is realized in Period 1. The bold numbers give the pastoralists expected lifetime utility in Period zero before any stochastic outcomes are realized. Assume that the pastoralist must choose a property regime based on expected lifetime utility at Period zero. The last column gives the level of the cross-agent product transfer when such a transfer is required. In the first three cases pastoralists are assumed to only have access to their own individually held pastures. In the common property case the pastoralists have access to the entire resource and choose how much to graze on each sector.

It is clear that the pastoralists do the worst when they are in a sole proprietorship and are forced to "go it alone." On the other hand, in the perfect information case — the first-best world — the pastoralists are as well off as they theoretically could be. Given that grazing-practice information is difficult or expensive to obtain, however, the agents will be faced with a second-best world initially characterized by the rain-contingent contract case or the worst-case common property scenario. Comparing the expected outcomes in the *initial* second-best worlds, we find that agents would do better if the pastures were privately held. This results follows because, in the symmetric cases, a larger portion of the costs of grazing are internalized so that aggregate grazing levels on the individual sectors are lower when agents individually own pastures and utilize a rain-contingent contract. Consequently, the expected outcomes in the symmetric cases in the private property regime yield outcomes that are superior to those outcomes that would be realized in the worst-case common property regime. Nevertheless, the incentive provision associated with the private property regime creates a problem in the asymmetric cases. In the asymmetric cases, the pastoralists do better in the common property regime as it is irrelevant which particular sector is highly productive — in the common property regime perfect risk sharing is realized by default. In aggregate, however, the second-best world in the private property case yields a superior outcome.

While this is all fine, I have suggested that, in general, this is not the end of the analysis. Although the first-best outcome could never be reached, the situation in both second-best situations might be improved upon by introducing some monitoring that would function to reduce the pastoralists' incentive to chisel away at the collusive solution. In many cases, given

economies of scope, the costs of monitoring will be lower in the common property regime than in the private property regime. Consequently, it will be optimal to employ more monitoring in the common property scenario than in the private property scenario. It might be the case, therefore, that the common property regime would yield a superior outcome to the private property regime. This result would occur if the economies of scope in a particular common property regime were sufficiently large that the common property regime could eventually overcome the initial advantage of the private property regime. This is not to say, however, that the ideal common property situation will prevail and that the pastoralists would emerge arbitrarily close to the perfect information outcome. Nevertheless, once monitoring is accounted for, it is reasonable and necessary, if we are to avoid bad policy, to consider the possibility that the common property regime would be preferable to the private property regime on strict efficiency grounds.

On the other hand monitoring might be excessively expensive in both regimes so that it would not be optimal to monitor very much (or at all), consequently, the best second-best world would require utilizing a private property regime and a rain-contingent contract. It is largely an empirical matter to determine which case will prevail in particular circumstances. Nevertheless, it is an important theoretical result to recognize that the traditional common property problem is not necessarily so large to dwarf all other considerations — otherwise unabated and uncritical privatization might occur.

6 Conclusion

The general debate concerning the relative merits of common property and private property regimes is important because a large part of development policy concerns the defining and redefining of rules of access and property rights. For too many years many “development experts” have been guided by the belief that private property is the preferable property regime in all circumstances. In bringing such a perspective to the policy table, development agencies may increase the likelihood, and the pace, at which common property regimes are supplanted by private property regimes. Most obviously, development agencies may influence the situation by offering to defray the costs of privatizing various resources. There are many issues that must be considered when examining the role that development policy plays, or should play, in inducing changes in property regimes.

As the analysis in this paper indicates, privatization may generate informational asymmetry problems that may significantly affect the situation. For example, development agencies may offer to help privatize the resource

and then depart letting the people and emergent markets do any remaining work. In such a case, the users of the resource may be strapped with the costs of eliminating information asymmetry problems if they are to sustain a desirable risk sharing scheme. The fundamental point is this: “development experts” may be overly enthusiastic to take a single step — to privatize. And, while privatization may be useful in “solving” the traditional common property problem, it may generate a handful of other problems. It appears, therefore, that “development experts” may be too engrossed with the traditional common property problem to recognize the work that common property regimes may be doing on other fronts. This paper has explicitly considered the work that common property regimes might be doing in the reduction of costs for the gathering of information.

From an intellectual standpoint the analyses in this paper provide some ammunition to common property advocates. At the same time, however, the paper is critical that the common property advocates have not provided sufficient support for their claims. If common property advocates are going to claim that common property regimes may be preferable to private property regimes — they provide a hedge against uncertainty — these advocates must provide support for their claims. What is it, precisely, that may make a common property regime preferable to a private property regime in some stochastic settings? The implication is that common property advocates need to show the mechanisms through which common property regimes are thought to provide the suggested service. The paper has suggested one important possibility — common property regimes may be beneficial in that they may contain economies of scope that reduce the cost of achieving a desired outcome. Nevertheless, even the hypothesized economies of scope that may exist must be given due attention. It is not the case that economies of scope will always exist. And, even if economies of scope do exist, the cost savings associated with such economies of scope may be insufficient to overcome the costs associated with the traditional common property problem. In short, if common property advocates are to promote common property regimes on efficient grounds, then they must show, in a particular case: (1) that the costs of solving the traditional common property problem are not excessively high and (2) that the hypothesized economies of scope that might exist, do exist, in the particular situation at hand.

Table 1

Pastoralists Decision Making, Transfers and Expected Utility

	Pastoralists Actions on Particular Sectors of Pasture -- Period One				Expected Lifetime Utility	Cross-agent Product Transfer
	A on A	A on B	B on A	B on B		
Sole Proprietorship					2.539	
Good Good	0.705	0	0	0.705	2.823	
Bad Bad	0.489	0	0	0.489	2.256	
Good Bad	0.705	0	0	0.705	Irrelevant	
Perfect Information					2.613	
Good Good	0.705	0	0	0.705	2.847	
Bad Bad	0.510	0	0	0.510	2.121	
Good Bad	0.936	0	0	0.251	2.665	1.2785
Optimal Rain-Contingent Contract $\lambda = 3$					2.573	
Good Good	0.813	0	0	0.813	2.824	
Bad Bad	0.577	0	0	0.577	2.262	
Good Bad	0.887	0	0	0.452	(2.769,2.439) 2.604	0.4
Worst Case Common Property Scenario $\lambda = 3$					2.555	
Good Good	0.500	0.500	0.500	0.500	2.732	
Bad Bad	0.382	0.382	0.382	0.382	2.202	
Good Bad	0.500	0.229	0.500	0.229	2.642	

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