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Land Encroachment: India's Disappearing Common Lands

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Abstract

Opportunistic land encroachment, resulting from costly and incomplete enforcement of common land boundaries, is a problem in many less-developed countries. A multi-period model of such encroachment is presented in this paper. The model accounts explicitly for the cumulative effects of non-compliance of regulations designed to protect a finite, non-renewable resource – in this case common land – from private expropriation. Gradual evolution of property rights from common to private – the consequence of encroachment – is demonstrated to be an equilibrium. To prevent the complete loss of common land, full enforcement must be the rule rather than the exception.

Keywords: enforcement, encroachment, dynamic optimisation, India,

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"The raised platforms outside [the houses] had been extended over the years and now took up most of the alley. They epitomized the philosophy of encroachment – when you find empty land on your borders, grab a few feet of it when no one's looking."[1]

1. Introduction

Encroachment, the illegal occupation and cultivation of common land, occurs throughout many less-developed countries. Much of this encroachment has been at the boundaries of common and private land: Farmers with private land adjacent to the common land encroach by gradually moving the boundary marker, incorporating the common land into their own holdings, and farming it as their own to the exclusion of others. The authorities, and even other villagers, do attempt to stop such encroachment through a variety of costly enforcement techniques, yet some encroachment inevitably goes undetected or unpunished. Often this encroachment is followed years later by the *ex post* granting of permanent and transferable property rights to the encroacher, a process known in India as "regularization," the formalization of rights through adverse possession (Miceli and Sirmans, 1995).

Evidently, *de jure* property rights over land, not to mention *de facto* property rights, are not absolute and static but evolve over time, even though much of the property rights literature suggests a fixed allocation of rights in equilibrium.[2] The evolutionary theory of property rights does suggest that land rights will gradually move towards formal private property regimes in response to population growth and market integration (see Feder and Feeny, 1991; Platteau, 1996, for a full discussion). Yet

1 Raag Darbari: A Novel, by Shrilal Shukla (1992, p. 25); translated from the Hindi by Gillian Wright, Penguin Books.

explanatory factors such as population growth are exogenous. Moreover, although no doubt some individuals are driven to encroach by poverty and lack of land, the little data that exist concerning encroachment do not support the claim that it is predominantly the poor who encroach (Jodha, 1986; Nadkarni and Pasha, 1991).

Yet despite evidence that encroachment has been a key mechanism for the conversion of land from common to private hands, little formal recognition or analysis has been undertaken. This paper, building on the law enforcement literature, develops an optimal enforcement model that demonstrates that even when well defined, property rights may well evolve over time because it is costly to protect the boundaries of discrete areas of common land from opportunistic boundary encroachment. That is, the equilibrium itself may be an evolving path of changing land use. The model, pertinent to the patterns of boundary encroachment observed in Karnataka, is then used to explore the equilibrium path of changes in land use and *de facto* land ownership under different assumptions and conditions.

The empirical motivation for this paper comes from Karnataka, a southern Indian state, where encroachment has been extensive. Official data hint at the large scale of this encroachment. For example, in 1990, the state government announced an amendment to the Karnataka Land Revenue Act of 1964 to allow regularization of 725,000 acres of encroached land, equal to 5.5% of the state's remaining *de jure* common land (Karanth, 1992). In 1991, under the provision under section 94A of the same act, over one million applications were made for the regularization of over 2.5 million acres of encroached land, approximately 20% of the state's *de jure* common

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2 A notable exception is Razzaz (1994, p. 13) who writes that non-compliance of laws governing property rights over common land can lead authorities to "reconsider their laws, their sanctions, and their methods of enforcement."

land (personal communication with a state official; see Robinson, 1997).[3] More generally, estimates suggest that in dryland India, encroachment has been responsible for a 20 to 35 percent reduction in the area of common land over the past five decades (Jodha, 1986; Nadkarni and Pasha, 1991; SPWD, 1992). In Karnataka and other states, this encroachment and the subsequent changes in *de facto* land ownership have occurred despite official property rights, both private and common, being well defined at any given point in time over the past half-century, thereby making southern India a particularly interesting place to study the phenomenon of encroachment from an optimal enforcement perspective.[4] Several studies point to opportunistic boundary encroachment, undertaken by those who have access to common land by virtue of an adjacent boundary, as being a key component (SPWD, 1992; Robinson 1997).[5]

The theoretical underpinnings of this paper are found in the law enforcement and property rights literatures in which a general proposition, that typically it is not optimal to prevent all non-compliance with laws and regulations when enforcement is costly, is put forward (including Stigler, 1970; Eckert, 1979; Clark, 1982; Sutinen and Andersen, 1985; Milliman, 1986; Malik, 1990; Shavell, 1991; Sutinen, 1993; Mookherjee and Png, 1994).[6] Studies of fisheries, game poaching, or timber extraction from forests, typically recommend a steady-state static equilibrium comprising a

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3 Although not all the applications for regularization will be granted, the author was told that given the length of time the land had been occupied, it was unlikely that anyone would be evicted.

4 Well-defined *de jure* property rights in Karnataka are in contrast to many other less-developed countries. For example, in Thailand, the great number of different legal land documents, combined with title deeds covering only 15 per cent of private land, attest to the uncertainty and controversy over property rights (Onchan, 1990).

5 Boundary encroachment is more common in dryland areas, “stand alone” encroachments are mostly found in forested areas (Robinson, 1997).

6 Typically either marginal costs exceed the marginal benefits of full enforcement, or criminals are discouraged from committing worse crimes through a reduction in the penalty for lesser crimes, and so some illegal acts occur unpunished. This argument, regarding

positive level of both illegal catch and enforcement (for example, Sutinen and Andersen, 1985, and Milliman, 1986, Coase, 1960; Demsetz, 1964; Helsley and Strange, 1994).[7] The stock remains constant, above the open-access level but below the socially optimal level.

The loss of common land through encroachment is fundamentally different. Theft of fish or timber is from the flow of a renewable resource and so, in general, no long-run multi-period stock effects need be accounted for. Yet if the "theft" is of a finite, non-renewable resource such as land, no static equilibrium comprising positive and constant levels of both theft and enforcement effort each period can exist. If any encroachment, however small, goes undetected and unpunished each period, the allocation of *de facto* ownership changes as the stock of common land decreases. Ultimately, under many scenarios, the static equilibrium is reached where none of the resource remains in its original state.[8] That is, gradual encroachment until no common land remains may be an efficient, if troubling, equilibrium.

Although multi-period enforcement problems have been addressed in the law enforcement literature, the focus has been on the multi-period consequences for the criminal, not the enforcer (for example Leung, 1991, 1995; Nash, 1991; and Polinsky and Shavell, 1996). The emphasis of the literature is appropriate because for many illegal acts that are discussed any cumulative effects that might occur are minor. For example, if people double park in a street, whether or not they are caught they will most

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marginal deterrence, assumes that penalties are capped, typically at the current wealth of the criminal (for example: Shavell, 1991; Mookherjee and Png, 1994).

7 Alternative mechanisms for controlling excessive depletion of a resource have been identified. For example, Homans and Wilen (1997) discuss the use of regulatory instruments such as season-length restrictions to prevent over-fishing.

8 When land encroachment occurs, the resource is not consumed or destroyed but rather is converted, possibly irreversibly, from one state – common land such as forest or grazing – to another – cultivated land.

likely remove their cars at the end of the day. Yet for many environmental problems it is the cumulative effects on the resource that matter, such as the cumulative build up of pollution.

This paper incorporates into its model an additional dimension of multi-period enforcement, the possible use of “stock” enforcement – such as fences and ditches – as an alternative to “flow” enforcement –patrols and punishments. Stock enforcement is defined as one for which enforcement expenditure is incurred in one period, but the benefits are persistent, carrying over into future periods. Such stock enforcements have been used by the forest department in Karnataka, especially in areas where the forest is highly valuable or at particular risk. A high fixed cost is imposed on the encroacher, but the marginal decision of how far to encroach is not affected. In contrast, the costs and benefits of flow enforcement, almost exclusively assumed in the law enforcement literature, concern a single period, affect the marginal decision over how far to encroach in that particular period, and do not exhibit persistence.

The model demonstrates several key points. Firstly, under a broad range of parameters, the complete loss of discrete areas of common land should be expected, because protecting common land from encroachment is costly and hence rarely complete. Either the cost of the stock enforcement, although it could prevent all encroachment, is excessive relative to the benefits. Or even though the use of stock enforcement is optimal in terms of maximizing social welfare, the government agency responsible for the land does not have access to the upfront funds required, and so must rely on the second best solution of period-by-period flow enforcement comprising patrols and fines.

The conclusion that it may be efficient to permit gradually all the land to be encroached is particularly problematic for policy makers in less-developed countries. Boundary encroachment typically results in an *ad hoc*, inefficient, and often inequitable allocation of land. Positive externalities typically are lost. And only a specific group of villagers, those with land adjacent to the common land, has the opportunity to encroach in this way. Yet it is the poor and especially the landless poor who are particularly dependent on the shrinking commons but typically are themselves unable to encroach. Moreover, the path itself is important, because the transition of property rights is slow, often taking many decades. In countries where property rights regimes are still evolving, or where innovations to reduce the costs of enforcement are anticipated, reducing the current rate of encroachment could slow down the irreversible loss of common land until full protection is feasible.

In this paper, both the approach to solving the model and the equilibrium path of encroachment and enforcement depend critically on the "enforcement technology." The model that is solved allows for both stock and flow enforcement, but makes two strong assumptions: that the government only investigates encroachment undertaken in the particular period rather than also investigating possible previous encroachment; and that, if caught, there are no consequences for future opportunities to encroach. The implications of relaxing these assumptions are then discussed, thereby permitting a discussion of alternative approaches to stopping encroachment completely: that is, to achieve full compliance. The law enforcement literature has tended to ignore full-compliance as uninteresting or unlikely, a reasonable conclusion for illegal activities in which cumulative effects are not critical. Hence mechanisms for achieving full compliance have not been a focus. Yet achieving full compliance as the norm rather than the exception is essential if the boundaries between common and private land are to be stabilized.

2. A Multi-Period Model of Encroachment and Enforcement

The model is constructed as a game between a large number of farmers who live adjacent to an area of common land of initial area $\overline{A}$, and the government, which is responsible for the land. Each player has perfect information, is risk neutral, and unconstrained, so that the impact of costly enforcement can be isolated.[9]

2.1 Encroacher and government objective functions

All farmers are assumed to be identical, and so a representative farmer is considered, who "competes" with the government over the *de facto* property rights to the land.[10] The farmer attempts to acquire the land for cultivation through costly boundary encroachment. The government attempts to slow down or prevent altogether this encroachment through costly enforcement activities, using either flow or stock enforcement. Hence the model can be thought of as similar to a model of extraction of a finite resource. However, in this case, two players are competing for the same resource, and, critical for the model, each manages and values the land differently, else the government would not be concerned about the encroachment. Specifically, the farmer is concerned only with his private returns to the land and so prefers to convert the land for farming rather than leave it in its original state. The government takes into

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[9] The simplifying assumptions in the model do not change the key findings, but do introduce biases. For example, an assumption of risk neutrality will over-estimate the area encroached if farmers are indeed risk averse.

[10] Robinson (1997) found that farmers typically do adhere to certain norms when encroaching at the common land boundary, suggesting that they are exploiting what could be termed an implicit pseudo-property right. For example, a farmer will not take land to the left or the right of his own land that could be encroached by her neighbours. Similarly, she would typically not permit a farmer to encroach the common land adjacent to her own because this removes her option to encroach the common land in the future.

account social benefits such as ground water recharge, and may also be concerned about access and equity. The game ends when no more encroachment occurs.

The model is set up as a dynamic Stackelberg game. At the start of each period, the government chooses the level of enforcement, that is, how much to spend on patrols and whether to build a permanent barrier. Knowing the government's decisions, the farmer chooses how much to encroach. From a game-theoretic perspective, the government acts as the Stackelberg leader, the farmer as the follower, and so the farmer's optimisation is considered first.

The farmer, if not caught and evicted in the period of encroachment, gets *de facto* permanent rights to the land. The punishment is eviction from the most recently encroached land, loss of the crop and any associated input costs, and possibly some additional fine. That is, in this model the probability of detection and the punishment is a function only of current period encroachment.[11] Given this model specification, the farmer maximizes expected returns to encroaching period-by-period:

$$\max_{L_t} E[V_t] = \max\left[\left((1-p_t)\frac{1+r}{r}\left(R^P(L_t)-w(L_t)\right)-p_t w(L_t)\right)-p_t\left(M+N(L_t)\right)-\delta_t kB\right]$$

$$\text{s.t } L_t \geq 0 \qquad [1]$$

The first term on the right hand side is the net present expected revenues from encroaching a distance L_t into the commons, given that there is a probability p_t of being caught and evicted in the period of encroachment, but the land is kept in perpetuity if the farmer is not caught.[12] $w(L_t)$ are the variable costs of encroaching

[11] Two key characteristics of punishments in Karnataka are that they are rarely punitive, and tend to be a function only of recent encroachment (Robinson, 1997; Abbot and Mace, 1999).

[12] In common with the enforcement literature, in the model the "flow of returns can be aggregated into a lifetime … income" that is realized if the crime is not detected in the period of encroachment (Leung, 1991, p. 252).

such as labor, which are incurred whether or not the farmer is caught. The second term represents a fine, $N(L_t)$, that is proportional to the distance encroached, is fixed exogenously, and incurred only if the farmer is caught.[13] The final term is the cost of penetrating any fixed barrier such as a wall or fence if one has been erected, in which case δ =1, else δ =0. For ease of exposition, and without loss of generality, let R^P be constant, $w(L_t)=wL_t$, and $N(L_t)=NL_t$.

The Kuhn-Tucker conditions for the farmer's maximization are:[14]

$$V'(L) \leq 0,\ L \geq 0,\ L\,V'(L) = 0$$

Where $V'(L) = \frac{1+r}{r}\left(R^P - w\right) - \left(p(L^*) + p'(L^*)L^*\right)\left(\frac{1+r}{r}\left(R^P - w\right) + \left(w + \overline{N}\right)\right)$ [2]

The forward-looking government maximizes net present returns to land:

$$\max_{F(.)} Q = \max \sum_{t=1}^{\infty} \frac{1}{(1+r)^t}\left[R_t^C\left(A_t^C\right) - c(F_t) + \theta\left(R^P - w\right)\left(\overline{A} - A_t^C\right) - \delta_t B\right] \quad [3]$$

The first term on the right hand side is the returns to the remaining area of common land at the end of period *t*, R_t^C (A_t^C).[15] The second term is the per-period cost of enforcement effort F_t. In the third term, a parameter θ is introduced whereby if the government's objective is to maximize returns only to the remaining common land,

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13 If the expected punishment does not increase with the severity of the illegal activity, in this case the distance encroached, there is no effective method of deterring encroachers from encroaching the maximum distance. Hence the fine is assumed to be proportional to the distance encroached. And without limits to the amount that someone can be punished, any desired pattern of deterrence "could be achieved at minimal cost by combining arbitrarily low monitoring with sufficiently steep penalties," (Mookherjee and Png, 1994, p. 1049), as proscribed by Becker (1968). In less-developed countries, fines tend to be small or negligible, given in part the low levels of disposable income for most rural inhabitants, and so it is reasonable to assume that the fine is not a choice variable in this paper.

14 The time subscript is suppressed for clarity.

15 Critical to the model is the assumption that individual farmers and the government value the common land differently, due for example, to positive externalities such as ground water

θ=0, such that the returns to (illegally) encroached cultivated land A_t^E are excluded from its objective function. If the government's objective is to maximize total social returns to the land, returns to all land are included and so θ=1. The inclusion of the parameter θ reflects Milliman's (1986) concern that some weight be attached to the benefits of illegal activity (see also Clarke et al., 1993, Robinson, 1997). In most of the law enforcement literature, it is assumed that the enforcer maximizes overall social welfare, implying a value for θ of 1 (an assumption criticized in Stigler, 1970). The final term allows for the possibility that the government constructs a barrier at a cost *B* in period *t*, in which case δ=1, else δ=0. Consistent with the optimal enforcement literature, from the perspective of the government fines are simply transfers and so do not show up in the government's optimization.

2.2 Equilibrium interaction

The key issues addressed in solving for the equilibrium are: whether and if so how the government can prevent all encroachment without erecting a barrier; when if at all the government chooses to erect a barrier; and if not, what is the equilibrium path of encroachment and hence loss of common land. The Kuhn Tucker conditions for the farmer and the Euler equation for the government characterize the equilibrium.

To solve the model, first, the government's optimization is re-written as an optimal control model that can explicitly account for both stock and flow enforcement. The state variable is the area of common land remaining, and the government's control variable is the amount of enforcement effort. Given that the barrier imposes a fixed cost to encroaching and does not affect the villager's marginal decision over how far to

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recharge that cannot be captured fully by the individual farmer. Else the tension between government's preference and farmer's is lost.

encroach, the government will only choose to erect the barrier if it stops encroachment entirely.[16] Hence the game ends if a barrier is erected.[17]

Second, because farmers optimise period-by-period, their actions can be incorporated via the equation of motion that links the area of common land remaining each period to the area encroached in the previous period. The optimal distance encroached by the farmer for a given level of enforcement effort is determined from the Kuhn-Tucker conditions above. If a barrier has been built then no encroachment occurs for all future periods. If there is no barrier, the farmer's optimal encroachment for a given level of enforcement effort F_t, $L_t^*(F_t)$, is determined from the first order condition shown in Equation 2.

Third, the probability function p is specified. The function captures the essential nature of enforcement – the greater the distance encroached, or the greater the level of enforcement, the greater the probability that the encroacher will be caught and punished. That is, $p_t = p_t(F_t, L_t)$.[18] Finally, the width of the encroachment is chosen to be the numeraire, the number of encroaching farmers is *n*, and it is assumed that the common land can be recovered after eviction. Hence the area of common land

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16 In any one period the government uses either stock or flow enforcement but not both. In practice, if an enforcement agency does erect a barrier, it will also need some level of maintenance and patrol activities each subsequent year. However, from the model perspective, these on-going variable costs can be capitalized in the value of the fixed cost *B* of the barrier, and so there is no loss of generality in this model. In practice *B* could be endogenous to the model, but given that the model is comparing stock and flow enforcement, and that including an additional choice variable adds complexity to the model without adding additional insights, *B* is assumed to be exogenous and sufficient to stop all encroachment.

17 Conceptually, a two-part fine could also be introduced, a combination of a fixed fine, and a fine that was proportionate to the distance encroached. In which case the fixed fine, if sufficiently large, would have the same effect as the barrier, but at much lower cost. However, such a scenario is improbable, as argued in footnote 13, and so not considered further in this paper.

remaining at the end of period t is $A^{C}{}_{t-1} - n(1-p_t)L_t^{*}$, and the total area of encroached land is $\overline{A}$ -($A^{C}{}_{t-1} - n(1-p_t)L_t^{*}$).

The optimal control model is written:

$$W_t^C\left(F_t, A_t^C\right) = R_t^C\left(A_t^C\right) - c(F_t) + \theta\left(R^P - w\right)\left(\overline{A} - A_t^C\right) - \delta_t B + \beta W_{t+1}^C\left(F_{t+1}, A_{t+1}^C\right) \quad [4]$$

$A_t^C = A_{t-1}^C - n(1-p_t)L_t^{*}$; $p_t = p_t\left(F_t, L_t^*\right)$ and $L_t^* = L_t^*\left(F_t\right)$ if no barrier

$A_t^C = A_{t-1}^C$ if a barrier has been erected

$A_0^C = \overline{A}$

If it is optimal for the farmer to make some non-zero level of encroachment in some period t, the first order condition governing her actions is written:

$$p\left(L^*\right) + p'\left(L^*\right)L^* = \frac{\frac{1+r}{r}\left(R^P - w\right)}{\left(\frac{1+r}{r}\left(R^P - w\right) + \left(w + \overline{N}\right)\right)} \quad \text{for } L^* > 0 \quad [5]$$

If a barrier is erected in period t (that is if δ_t =1), then:

$$W_t^C\left(F_t, A_t^C\right) = \frac{R_t^C\left(A_t^C\right)}{r} \quad [6]$$

The Euler equation governing the government's actions, determined by taking the first derivative of the value function with respect to the government's choice of enforcement effort F_t, is written:

[18] The probability of being caught could also depend on the actions of the farmer's neighbours, or the proportion of the common land remaining that is encroached in the period. The implications of these alternative specifications are discussed later.

$$\frac{\partial W_t^C}{\partial F_t} = \frac{\partial R_t}{\partial F_t} + \frac{\partial R_t}{\partial L_t}\frac{\partial L_t^*}{\partial F_t} - c'(F_t)$$
$$+ \left(R^P - w\right)\left(-n(1-p_t)\frac{\partial L_t^*}{\partial F_t} + nL_t^*\left(\frac{\partial p_t}{\partial F_t} + \frac{\partial p_t}{\partial L_t}\frac{\partial L_t^*}{\partial F_t}\right)\right)$$
$$+ \beta\left(\frac{\partial W_{t+1}^C}{\partial F_t} + \frac{\partial W_{t+1}^C}{\partial L_t}\frac{\partial L_t^*}{\partial F_t}\right) \qquad [7]$$

Although the Euler equation is a powerful tool to describe some of the key features of the equilibrium, analytical solutions can only be obtained if the functional forms are sufficiently simple such that the model's inherent non-linearities are removed. Moreover, given that the optimum may be a path with the gradual loss of common land, or the construction of a barrier such that there is no further encroachment, simply using the Euler equations does not give adequate insights into the model.

However, a numerical simulation model with appropriate functional forms and calibration captures the path of endogenous variables that vary non-linearly over time as the area of common land decreases, and so can, for example, illustrate discrete changes in policy regime within a single run of the model. The simulation model employed in this paper accommodates explicitly the structural equation that represents the forward-looking enforcer, and changes over time of equilibrium enforcement policy.

Before solving the model numerically to demonstrate different equilibrium paths of encroachment, a general discussion of the model provides some insights into the equilibrium path of encroachment.

The equilibrium path of encroachment depends on assumptions over the relative value of common and private land, whether it is cost effective to construct a barrier, and whether the encroachment can be reversed. If $R_t^C = R^C$ for all *t* – that is, the returns to the common land are neither a function of the area remaining nor of time – then $\partial W_{t+1}^C / \partial L_t^*$ is zero, and the problem is simple. If $R^C < R^P - c$ and θ=1, then the government allows all the common land to be encroached in period one since the social returns to cultivated land are greater than to common land. If θ=0, or $R^C > R^P - c$, then, assuming that the length of the boundary remains constant, the government simply chooses between constructing a barrier straight away, or relying on a constant level of flow enforcement each period and accepting a constant area of encroachment each period until the common land disappears. The rate of loss depends on the relative cost of enforcement effort. Of more interest and often more realistic, and hence the scenario used in this paper, is when the marginal social returns to the common land increase as its area decreases (Panayotou and Parasuk, 1990; Robinson, 1997).

Proposition 1: If there are no fixed costs to encroaching, then each period, so long as some common land remains, and for all but the most extreme calibrations of the model, in equilibrium there will be a positive amount of encroachment each period.

The intuition behind this proposition is as follows. So long as there are no fixed costs to encroaching, if the enforcer increases his spending on flow enforcement and hence, *ceteris paribus,* increases the probability of detection, the farmer can reduce the probability of being caught simply by reducing the distance she encroaches. Given that flow enforcement is costly, the value of the common land must be extremely high, or the cost of enforcement effort extremely low, for it to be optimal for the government to prevent all encroachment. Hence, to stop all encroachment, the government must introduce some fixed cost to encroaching, such as a barrier, which itself is costly.

Proposition 2: If the ratio of the length of boundary between the common and private land to the area of common land does not decrease, then a government which is not credit constrained will either construct a barrier in the first period or not at all.

If the government values only the common land (θ=0) it will compare the net returns to the optimal path of gradual encroachment (determined by solving the dynamic optimisation model, assuming δ_t=0 for all *t*) with the net returns to erecting a barrier in period one and enclosing all the common land immediately.

If the government values all land, (θ=1), then similarly it will compare the returns to the optimal path of gradual encroachment when θ=1 and δ_t=0 for all *t* with the net returns to enclosing the efficient area of common land in period one. This efficient area is given by the condition $\frac{\partial}{\partial A_c}\left(R^C\right)= R^P$. That is, where the marginal returns to the area of common land are equal to the marginal returns to encroached land. Not surprisingly, given that a barrier does not affect the marginal decision on how far to encroach, this is the same condition as for costless enforcement. The government would then privatise the extra land, either explicitly, or by permitting rapid encroachment up to the barrier.

3 A numerical example

3.1 Calibration and functional forms

The specific functional forms and calibration are chosen to illustrate some of the more interesting equilibrium paths that can arise from the model. For the probability function, a simple exponential function, parsimoniously parameterised, is chosen, $p_t = \min[1, F_t(\exp(\gamma L_t) - 1)]$, implying unlimited encroachment when the enforcement effort is zero.[19] Hence any gradual encroachment is not merely a function of farmers being constrained by the model's construction. The function relies on just one parameter, γ, set at 0.9 for the numerical simulation, which can be interpreted as a measure of the effectiveness of enforcement effort: The higher the value of γ the more effective a specific level of enforcement. Higher values of γ might be associated with an efficient judicial system, or with areas where encroachment is easier to see (Robinson, 1997).[20]

Private and social net returns to cultivated land, R^P, are equal and fixed at 960 rupees per acre of land per year, at the time of the fieldwork the approximate net returns to *ragi* – finger millet – the staple food crop in Karnataka (Nagaraj, 1995; Robinson, 1997). The variable costs, *c*, typically land preparation and seed, are set at 400 rupees per acre.[21] The marginal social returns to the common land are inversely related to the area of common land remaining, $R_t^C = -k_1 \cdot A_t^C + k_2$, where k_1 and k_2 are chosen to be 8.0 and 1800 respectively. The initial area of land, $\overline{A}$, is set at 90 acres. Hence the marginal social returns to the common land are initially lower than to cultivated land, implying that some conversion of land from common to farmed would

19 The problem of specifying a functional form and calibrating a probability function is recognized in the law enforcement literature (Nash, 1991). For examples of efforts to specify and parameterise fully the probability function see, for example, Block *et al*. (1981), and McCormick and Tollison (1984).

20 It is assumed that the value of γ itself is not a function of the area of common land remaining.

21 Though in practice villagers can and do choose the extent to which they invest in land preparation and chemical inputs to reduce the upfront costs of investing on recently encroached land, thus reducing the risk of encroaching.

be optimal. The extent to which an individual encroacher values the common land does not come into her optimisation and so need not be considered.[22]

As is common in dynamic optimisation models, the choice of terminal condition itself influences the model's outcome. For this model the two extreme terminal conditions are: one, that any common land remaining in period T has zero value for the government; and two, that any remaining common land can be kept for free by the government for all future periods. If comparing a myopic and forward-looking government, it is perhaps more interesting to use the terminal condition in which the common land has no value, biasing the results towards the more rapid loss of the common land, so as to emphasize that even though the land eventually has no value, the government still slows down considerably the rate of encroachment for many years. Choosing a terminal condition in which the land is retained costlessly by the government, implying for example that in the future enforcement is much more effective, would bias the results towards conservation of the common land in anticipation of the improved enforcement. Alternatively, an intermediate value of the common land can be chosen to mimic an infinite period game. However, by incorporating a sufficient number of periods, the sensitivity of the model to the terminal condition, particularly in the early periods, is reduced.

3.2 Equilibrium paths

If no fixed barrier is erected, when $\theta=1$, three broad stages can be identified in the equilibrium transition of property rights from common to *de facto* private. In the first stage, when the marginal social returns to the common land are initially well below

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[22] If villagers were to cooperate over managing the common land and chose between "defecting" –that is encroaching, and cooperating – that is protecting the common land and not encroaching, this private valuation would matter.

the returns to cultivated land, the rate of encroachment is rapid and the level of enforcement is low. In the second stage the rate of encroachment is lower, and enforcement levels higher. The increased enforcement effort begins even when the marginal social returns to the common land are below those to the cultivated land because the forward-looking government anticipates future encroachment and so restricts encroachment in the early periods even when the marginal returns to cultivated land are higher than to common land. However, as more land is encroached the marginal returns eventually increase above those to the cultivated land, implying excess encroachment relative to a zero-cost enforcement scenario. In the third stage no further encroachment occurs, because no common land remains to be encroached.[23]

Figure 1 shows such an equilibrium path of encroachment, enforcement effort, and marginal returns to the land when $\theta=1$, for the particular model calibration. The figure also, for comparison, shows the equilibrium path for a myopic government and the equilibrium path if a barrier is constructed (the latter path equivalent to the path for costless enforcement). If the government is myopic the common land is encroached much more rapidly than if the government were forward looking. In the first period the government, not anticipating future encroachments, permits the statically efficient level of encroachment (such that the marginal returns to common and private land are equal). Then in future periods, the rate of encroachment slows down as the marginal returns to the common land increase above those to the private land, though still more rapid than for the forward-looking government.

[23] As discussed earlier in the paper, under extreme calibrations it is possible that an equilibrium could be achieved in which there is a finite area of common land remaining and zero encroachment. This would be most likely if the variable costs of encroaching were extremely high, the returns to encroaching extremely low relative to very high marginal returns to the common land, or the cost of enforcement very low.

If θ=0, land encroachment is more gradual and the path of land transfer from common to private relatively smooth. This slower rate of encroachment comes at a cost. Enforcement costs each period are much higher and the total social returns to land are lower because land allocation is less efficient.

To determine whether or not it is optimal for the forward-looking government to construct a barrier, the net returns using flow enforcement are compared with the returns assuming costless enforcement. If the difference is greater than the cost of the barrier, then building the barrier is efficient.

Changing patterns of, and acceptance of, encroachment can be identified in southern India over the past century and appear to be reflected in state-level legislation. The rapid conversion of land from common to cultivated land was commonplace in southern India at the turn of the century, constrained only by the availability of labour for land preparation, and encouraged by the 1894 Indian Forest Act which implicitly recognizes that it is in the country's interest for people to farm more of the forest. In effect, the government was acting as if the weight, θ, on returns to illegal encroachment were non-zero. As common land became scarcer and correspondingly more valuable, actions that were once encouraged were deemed illegal. Subsequent changes in the law suggest that farmers who had been perceived as pioneers were now seen as encroachers stealing the common land. In Karnataka this second phase was reached during the 1970s when the Karnataka Land Reform Act of 1974 was passed. The state government did not punish those who had encroached earlier when it was considered acceptable, but announced that further encroachment would be punished with fines and eviction. Though illegal, encroachment continued, but at a slower pace.

More recently, evidence of the third phase can be found. In many villages in Karnataka, discrete areas of common land have disappeared completely (gradually absorbed into private land holdings despite often remaining common on official land records: Nadkarni and Pasha, 1991; Nagaraj, 1995; and Robinson, 1997). In Kolar district, 500 of the 4479 original tanks – small reservoirs constructed to retain run-off water above surface level – have disappeared, due either to neglect or encroachment. In Kodagu district, only 346 of the original 755 sacred groves – protected forests – that existed in 1900 remain; most of this loss has been attributed to encroachment (Nagaraj 1995). In one specific village in Karnataka visited by the author, all twelve acres of government revenue land – typically scrub land – had been encroached over the past four decades, the original five acres of *gomal* land – grazing land – had been reduced to half an acre to which there was no longer public access, much of the ninety or so acres of forestland had been assimilated into the private holdings of those with bordering land (Robinson, 1997).

4. Alternative model scenarios

4.1 Alternative enforcement strategies

Although this paper has focused on just two "enforcement technologies", other approaches could be taken to slow down encroachment. For example, investigation of an individual's history of encroachment if they are caught can increase the deterrence effect of being caught to the point at which the individual chooses not to encroach after a number of years, even when the probability of detection is relatively low. However, certainly in much of India, even though no statute of limitations *per se* exists, frequent changes in land laws and the difficulty in proving where an original boundary was, or when encroachment occurred (the latter important for anticipated *regularization* of land) suggest that although theoretically appealing, such an approach likely would not be practicable.

From a modelling perspective, the encroacher's problem would be modelled as an optimal stopping problem (a spatial analogy can be found in Robinson et al, 2000). If individuals recognize that being caught for an illegal activity undertaken in the current period implies being punished for all previous illegal activities, then the expected cost of encroaching increases considerably more than the expected marginal benefits each time the villager encroaches. At some point it becomes optimal to encroach no further because the expected cost of being caught and losing all previous encroachment is higher than the expected benefits from further encroachment. The equivalent scenario in the law enforcement literature would be one in which an individual caught committing a crime would have all his past investigated for earlier illegal activities and punishment would be based on all previous detected criminal acts in addition to the present crime.[24]

A further punishment structure, explored in Robinson (1997), is to prevent farmers from encroaching again if they are caught. That is, a farmer would be out of the "game" permanently if caught. Such an outcome could be achieved by continuously patrolling the boundary of those caught such that the probability of being caught in the future was one. Or, more practically, local villagers could be extra vigilant of those neighbours known to encroach. A forward-looking encroacher would now recognize consequences over and above losing the land encroached in that period; the cost of being caught would be the expected returns to all future encroachment attempts, not just to encroachment in that period. From a modelling perspective, the encroacher's optimisation could no longer simply be incorporated period-by-period into the equation of motion. Rather, a stochastic model must be solved. The threat of being out of the game permanently if caught acts as a tax on a farmer's encroachment decision, and so each period she encroaches less than if she were not at risk of being excluded permanently from the game.

4.2 Irreversibilities

The optimal enforcement technology also depends on the extent to which the government can, in practice, reverse the effects of encroachment. In the base-case model, when a farmer is evicted the land is recovered back to its original state at zero cost. Yet in practice, the ability of the government to recover the common land depends on both physical irreversibilities – such as when primary forest is cut down – and institutional irreversibilities – in India it is not uncommon for a court case to take over ten years within which period the land laws could have changed.

From a modelling perspective, to isolate the impact of such irreversibilities, the farmer, rather than being evicted, is fined an amount equal to the net present value of the land encroached in that period. Hence, period-by-period, farmers are indifferent as to whether they are evicted or fined but allowed to keep the land. Whether or not encroachment is irreversible is accommodated in the equation of motion. If encroachment is not reversible, the equation of motion is written $A_{t+1} = A_t - nL_t^*$. Not surprisingly, both the rate of loss of common land and the enforcement costs are higher when irreversibilities are present (see Figure 2). *Ceteris paribus*, the ability of the authorities to reverse the effects of encroachment has cumulative benefits over time.

[24] Such a rationale is behind the so-called "three strikes and you are out" legislation in California.

In reality, the equilibrium response of the authorities to encroachment will depend on the relative costs of different punishment regimes (for example, it tends to be cheaper to impose a fine than to evict a farmer), the benefits, and the feasibility of each punishment strategy. If more than one punishment regime is possible, the choice of punishment should be endogenous to the model.[25] Further, whether or not encroachment is irreversible has implications for the type of enforcement strategy adopted by the government. If encroachment is irreversible, then there should be more emphasis on prevention rather than detection and eviction, and hence more likelihood that a permanent barrier is erected.

4.3 Community involvement

Encroachment is a highly complex phenomenon that, like most resources, is influenced by the interaction of formal and informal mechanisms and social norms that influence behavioural patterns (Berkes et al., 1989). In the villages of rural southern India land is *de jure* covered by formal property rights regimes. However, the extent to which the common land is managed and protected depends both on the efficacy of the official regime and the ability or will of the local community to take on the role of management of the commons in the absence of formal enforcement. Village customs and norms are a critical factor in determining the rate of encroachment. For example, Nagaraj and Chandrakanth (1995, p.14) write that in Coorg, a region of Karnataka, norms of protecting and sustaining *Devara kadu* "have been practiced for years by the village community". An expectation exists that people will neither encroach nor cut the trees and these expectations are maintained in part through annual rituals linked to religious norms. Punishment for violating the village norms involves open confession,

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[25] Few papers have considered multiple punishment instruments. One that has is Polinsky and Shavell (1994), which compares the use of fines and imprisonment to deter harmful

apology, and the payment of a fine. They further write that the village community in Coorg itself provides a 'social fence' to the Devara Kadu. That is, the enforcement of the boundary between common and private land can be physical or social. Yet even these lands are being encroached, suggesting that social norms are eroding.

The extent to which villagers are willing to protect an area of common land from encroachment will be influenced by their own access to the commons, use of the commons, and their own ability to encroach. Encroachment typically worsens income distribution within a village, suggesting that many farmers – those who rely on the commons and are themselves unable to encroach – should have a strong incentive to prevent encroachment even without the help of the authorities. Such a pattern, concerning access to and theft from canals in northern India, was found by Ray and Williams. Inevitably, income inequalities and political influences often go hand in hand, with the richer and more influential farmers more likely to get away with encroaching. Hence even if villagers get positive utility from the commons and so might be expected to group together to protect the commons themselves they may not feel empowered to use informal channels to prevent more influential farmers from encroaching.

5. Concluding comments

Formal enforcement typically involved a combination of preventative measures, such as patrols to deter and detect encroachment, and fines and sometimes eviction for those caught. Informal enforcement included shunning, dumping mud on the encroached land, or simply taking back the land once the illegal encroachment had been proven by the villagers (Robinson, 1997). The fear of being ostracized or made to

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activities.

apologize in public could be enough to deter some people from encroaching (Robinson, 1997). The threat of a prison sentence might be needed to deter others. Yet despite the multitude of enforcement regimes encountered by the author, the fundamentals remain the same. From an enforcement perspective, protecting common lands is costly, and so may not be complete. From the encroacher' perspective, individuals weigh up the relative expected costs and benefits, whether financial or emotional, when determining whether and how much to encroach. The underlying assumption behind this paper, based on empirical evidence, is that encroachment is an opportunistic action. An individual gets an economic benefit from encroaching, and is deterred by the possibility of social or financial penalties.

The dynamic framework developed in this paper demonstrates that the definition and realization of property rights depends on both current and future enforceability of the rights, and that when enforcement is costly, the state's *de facto*, and eventually *de jure*, property rights can erode over time. Whenever boundaries are costly to enforce, a paradigm of absolute and static property rights may no longer hold: a gradual transition in *de facto* property rights from common to private may be a natural equilibrium resulting from the interaction between costly enforcement and opportunistic encroachment.

As Jodha (1990) writes, in rural India, 'privatisation is carried out either (i) through the formal distribution of common lands to landless and other groups under different welfare or development schemes, or (ii) through the legalization of illegal grabbing of CPR lands by people'. When enforcement is costly, and an area of common land suffers from boundary encroachment, the government could be tempted simply to privatise the land straight away. In this way, they would prevent the snatching of land that rewards those with land adjacent to the commons with yet more land. But official privatisation is costly for policy makers, whereas people who encroach bear the burden themselves of defining and protecting their land.

Faced with continuing encroachment and insufficient budgets, solutions to protect common lands are not simple. Most likely the solution is not simply to dig deeper ditches, or increase the patrol frequency, the cost of which is often beyond the reach of local departments in LDCs. Rather, the government might work to strengthen local institutions, encourage more rapid detection to reduce eviction and land recovery costs, improve the definition and documentation of boundaries thereby lowering the costs of proving where boundaries are, and strengthen legal institutions. However, none of these solutions are simple, and many are costly and will take time to implement.

Sequential decision-making leads to the possibility of dynamically inconsistent policy. Although the law enforcement literature tends to ignore this possibility, state government actions in response to encroachment in Karnataka do suggest that the government has not always committed credibly to its enforcement policies.[26] Examples of dynamically inconsistent policy include frequently changing government policy and the willingness of the state government to permit farmers caught encroaching to remain on the land despite stated policy.

Encroachment differs from most other illegal activities in that it tends to be highly visible, and hence relatively easy to detect. Razzaz (1994) writes of illegal land markets that “the openness of the process brings into question the nature and the limits of law enforcement and efficacy of various forms of government intervention.” Policy makers often give mixed signals to those who have encroached or who intend to encroach. Although it is *de jure* illegal, those who are caught encroaching may not be punished but rather rewarded. This may be explicit, the justification being that encroachers who improve the land should be rewarded for their entrepreneurialism, or implicit, when the tacit acceptance of encroachment is a cheap – though invariably inequitable and *ad hoc* – method of privatisation.

Cumulative effects of non-compliance can be found in many different areas. In Thailand, boundary encroachment of forests has been a pervasive problem compounded by the fact that the illegal felling of trees is often irreversible (Panayotou and Parasuk, 1990; MIDAS, 1991). Pollution by factories adjacent to lakes can lead to a gradual accumulation of toxins in a finite body of water, even with optimal enforcement of enforcement of environmental legislation, let alone lax enforcement. The illegal excessive sinking of wells for irrigation results in a gradual decline in the water table, which in time can result in irreversible land subsidence or saltwater incursion. Modelling the equilibrium management of such non-renewable resources when enforcement is costly necessarily requires a multi-period dynamic framework. Only by shifting the focus away from a static steady-state equilibrium can the cumulative effects from incomplete enforcement be studied.

Finally, location often matters: farmers who encroach at the boundaries are in effect exercising what can be termed a quasi-property right to encroach by virtue of owning a boundary with the common land. The farmers exercise their right through excluding others from the common land adjacent to their own land and converting that land to cultivated land. Likewise, only those farmers whose land is directly above an

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[26] Reinganum and Wilde (1986), Kleit (1990, 1992) and Boadway *et al.* (1994), have addressed the problem of dynamically inconsistent regulation.

aquifer can extract the water by sinking a well. They too have a quasi-property right to exploit, perhaps illegally, the aquifer.

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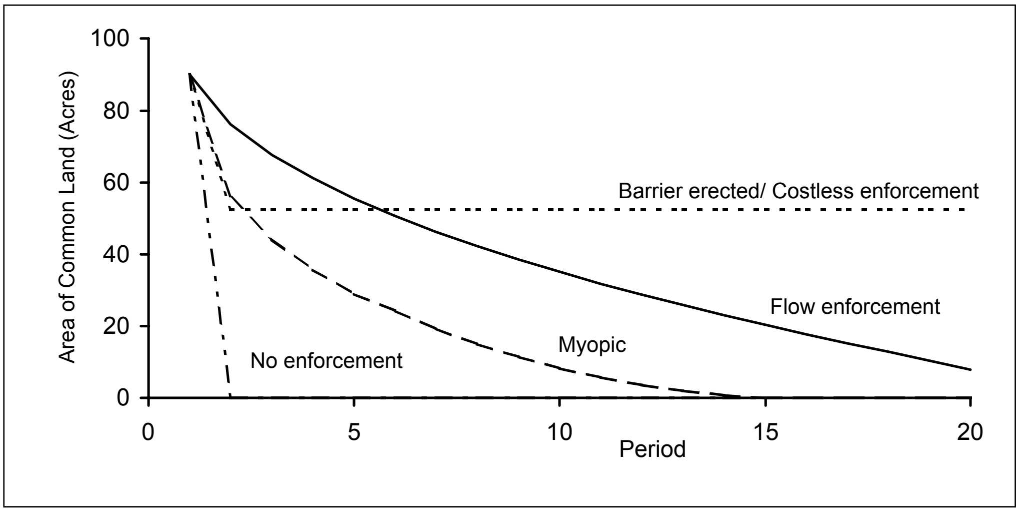

Figure 1a. Area of common land remaining, period by period, when the government's objective function includes production from encroached land (θ=1)

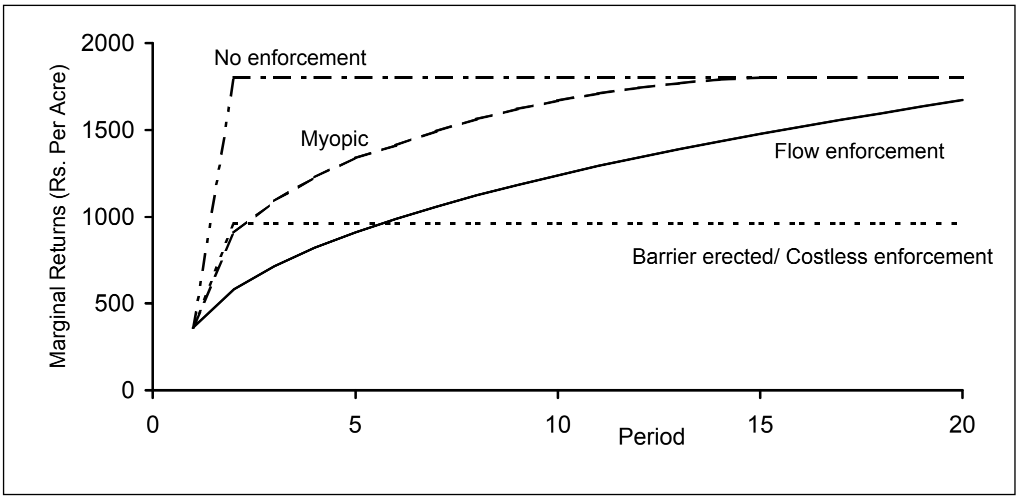

Figure 1b: Marginal social returns to the common land, period by period (θ=1)

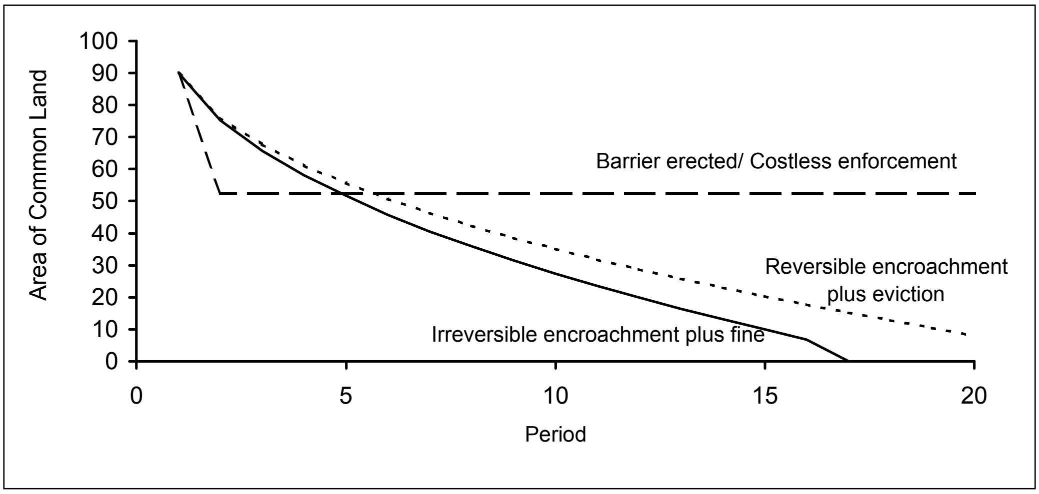

Figure 2. Impact of imposing a fine versus eviction on remaining area of common land, period by period