University of Wisconsin-Madison

March 1996 No.391

**Indigenous Land Rights in Africa:
Appropriation Security and Investment Demand**

By

Espen Sjaastad & Daniel W. Bromley

AGRICULTURAL ECONOMICS

STAFF PAPER SERIES

March 5th, 1996 No. 391

INDIGENOUS LAND RIGHTS IN SUB-SAHARAN AFRICA:

APPROPRIATION, SECURITY AND INVESTMENT DEMAND

by

Espen Sjaastad and Daniel W. Bromley*

Abstract: This paper discusses the links between rights appropriation, tenure security, and investment demand among farmers in Sub-Saharan Africa. Common assertions of the property rights school regarding indigenous tenure are: (1) insecurity of tenure will lead to suboptimal investment incentives, and; (2) appropriation of land rights in the public domain will be rent-dissipating. It is argued that land use and investment decisions among African farmers often have a dual motive; one of productivity and one of rights appropriation. The two claims of the property rights school may thus seem contradictory. With the aid of a conceptual model, it is argued that indigenous tenure on the one hand may provide equal or higher investment incentives than private land rights, and on the other hand promote modes of rights appropriation which are productive rather than wasteful.

*Espen Sjaastad is a research fellow at the Department of Forestry, Agricultural University of Norway, and a visiting fellow at the Department of Agricultural Economics, University of Wisconsin - Madison. Daniel W. Bromley is a professor at the Department of Agricultural Economics, University of Wisconsin - Madison. The research was funded by the Norwegian Research Council. We would like to thank Ole Hofstad for his helpful comments.

1. INTRODUCTION

Economists have argued that indigenous land rights in the Third World lead to inefficient resource allocation. Inefficiencies are thought to arise because indigenous land rights are ambiguous, are communal, and are afforded insufficient protection in state legislatures, resulting in tenure insecurity which in turn leads to inferior investment incentives, undersupply of credit, and constraints on efficiency-enhancing market exchanges (see e.g. Dorner 1972, Johnson 1972, World Bank 1974). These arguments have been advanced as a justification for government action in land administration matters, and especially conversion to freehold titles in the Western strain. Recently, these views have been challenged on the grounds that: (1) indigenous land rights are often neither communal nor ambiguous; (2) indigenous tenures are flexible enough to cope with increasing land scarcity and to permit a gradual, "autonomous" individualization of rights, and; (3) state intervention in land matters often is more harmful than beneficial (Ault and Rutman 1979, Bates 1984, Bruce 1986 and 1993, LTC 1990, Migot-Adholla *et al* 1991, Bassett 1993, Platteau 1995).

This paper deals with tenure security, and its effects on investment demand, as land becomes scarce and prices — implicit or explicit — rise. The issues are discussed within the context of Sub-Saharan
Africa; specifically one where land initially is abundant and shifting cultivation practices dominate, although the main points of this paper have application beyond this relatively narrow scope.

In the next section we briefly present how these issues have been viewed in main-stream property rights theory, as well as offer some common misgivings. In section three we describe how land rights and land use develop in a typical rural Sub-Saharan African community as land becomes scarce. We also develop a conceptual model which compares investment incentives of indigenous tenure and freehold. In section four, we present a discussion of the central issues, and some concluding remarks.

2. PROPERTY RIGHTS THEORY, TENURE SECURITY, AND INVESTMENT

The property rights school (roughly equivalent to what Bardhan, 1989a, calls the transaction cost approach) can be traced back to, among others, Gordon (1954) and Coase (1960). Using the fishery as an example, and in much the same vein that Hardin (1968) would approach the pastoral commons 14 years later, Gordon showed that unrestricted open access either would lead to overexploitation, or that rents would be dissipated if restrictions were placed on total extraction. In the context of externality problems and zero transaction costs, Coase showed that a clear assignment of rights would lead to Pareto-optimal outcomes, regardless of to whom the rights were assigned. An immediate result of these writings was that private property rights became universally extolled as the only efficient property regime. One reason for this was the confusion of common property and open access; another was the perception that creation and maintenance of private property somehow is costless — a misconception that persists even today.

As early as 1950, Alchian had suggested that institutions were subject to competitive pressures, and that inefficient institutions would perish in the face of such competition. Developing these themes, and introducing the more realistic condition of significant costs of transaction, Demsetz produced a defining and much-quoted thesis of the property rights school:

> "Changes in knowledge result in changes in production functions, market values, and aspirations. New techniques, new ways of doing the same things, and doing new things — all invoke harmful and beneficial effects to which society has not been accustomed. It is my thesis in this part of the paper that the emergence of new property rights takes place in response to the desires of the interacting persons for adjustment to new cost responsibilities. The thesis can be restated in a slightly different fashion: property rights develop to internalize externalities when the gains of internalization become larger than the costs of internalization. Increased internalization, in the main, results from changes in economic values, changes which stem from the development of new technology and the opening of new markets, changes to which old property rights are poorly attuned." [1967, p. 350].

Thus, shifts in relative prices may reverse a situation where transaction costs previously made it undesirable to bring marginal social and private costs into line. On the one hand, the property rights school seeks to explain institutional evolution through changes in economic parameters, primarily relative prices. Where rights are unspecified, rent capture will come about through opportunistic behavior on the part of individual agents, leading to rent dissipation. Changes in relative prices can make it profitable to engage in bargaining and more detailed contractual specification, where such specification earlier was too costly. State intervention may be warranted because the benefits of legislation have grown to a point where they exceed the costs. The costs of opportunistic behavior now exceed the costs of specification and enforcement of rights.[1] When land is abundant it has no price; since there is no shared cost associated with its use, there are no externalities. As capture attempts multiply in response to increasing scarcity, land becomes costlier relative to other factors, rent is dissipated through costly litigation, and it becomes profitable to remove land from the public domain into the hands of groups or individuals with clearly defined rights. The corollary of Demsetz's thesis to land is thus a transition from open access to a situation where all rights to land are specified and enforced. On the other hand, the theory often purports to show the superiority of private — as opposed to common — property regimes, as the former permits less costly contracting and avoids free-rider and hold-out problems.

A number of publications expounded on property rights theory, its application to land in general, and to developing countries in particular. Barzel (1989) has pointed out that certain attributes will always remain in the public domain, either because the gains from rights specification are too small or the costs are too large. Thus, the absolute rights often accorded freehold are an exaggeration, something that even a cursory perusal of Western land law will readily reveal. Platteau (1995) has summarized property rights theory and its more recent developments as they apply to land rights in Sub-Saharan Africa, and dubbed it "The Evolutionary Theory of Land

[1] It is, of course, possible that a change in relative prices may cause the costs of rights specification and enforcement to decrease, thus providing lower costs of internalization — rather than increasing gains — as the motive behind institutional renewal. But since, as Bardhan (1989a) has pointed out, economics does not provide a theory of how (rather than why) institutions change, this notion is not thoroughly treated in the literature.

Rights." Extending Demsetz's thesis on the evolution of institutions, government provision of land titles is here treated as a market response to increasing rural demand. This feature is thoroughly critiqued in the paper by Platteau on both practical and theoretical grounds. North (1990) presents a subtler view of how institutions evolve; acknowledging the role of culture and norms and emphasizing costs of information and rights enforcement, North abandons the concept of an efficient institutional evolution. His focus is not microeconomic, but some of the points regarding the scale of institutions are crucial — in particular how the demands of an increasingly complex economy require more universal institutions in the face of rising information costs. Other convincing misgivings about the theory and its relevance, also considered by Platteau (1995), include a general lack of available intensification technologies (implicit in the theory of induced technical change), the absence of accessible capital to invest in such technologies when they do exist, the persistence of cultural norms that run counter to privatization or its predicted effects, the inseparability of efficiency and equity, and second-best problems whereby the emergence of a single market, e.g. land, in a general market vacuum may increase inefficiencies. The most thoroughly tested hypothesis of the theory is the positive effect that government provision of titles will have on investment demand, credit supply, and productivity. Both supportive (Feder 1987, Feder and Noronha 1987) and critical (Migot-Adholla *et al* 1991, Pinckney and Kimuyu 1994) studies exist. As far as costly rent capture is concerned, the usual example is costly litigation in connection with land disputes, although titling also has been found to increase litigation costs (Coldham 1978).

The propositions of the theory, as regards problems related to tenure security and investment decisions in indigenous tenure regimes, can be summarized as follows. First, the lack of legal title to land reduces its value as collateral, thus increasing the price of capital and reducing the value of investments. Second, high transaction costs in establishing ownership will reduce the value of investments, or, conversely, any residual uncertainty about ownership will have the same effect since future returns may be lost. Third, the absence of a land market means that farmers cannot convert fixed land assets into other asset forms, thus reducing the value of investments to the

farmer and preventing efficiency gains of trade. For the same reason, land becomes less attractive as collateral to the lender, again increasing the price of capital.

This paper specifically critiques the second of these assertions. This critique is based partly on the nature of indigenous rights — that is, whether such rights in fact are communal and ambiguous, and partly on the implied one-way link between security of tenure and investment demand. This, in turn, leads to a critique of the common assertions about opportunism, rent capture, and rent dissipation.

3. INDIGENOUS LAND RIGHTS, SECURITY, AND INVESTMENT: AN ALTERNATIVE VIEW

Land Use and Land Appropriation under Abundance

The types of land use that develop under conditions of land abundance are naturally extensive, given the free availability of land and the associated incentives to substitute it for other factors, notably labor. This substitution is, however, at some point curbed, not only by the increasing physical effort required in utilizing more land at greater distances, but also by the complementary nature of land and labor endemic to many traditional forms of cultivation.

A key feature of traditional systems of shifting cultivation is mobility; when, after a period of cultivation, resources are considered insufficient for further exploitation, the community (family, kinship group, or village) will move to an unsettled area of bush and start over. Associated with mobility is often a paucity and impermanence of material possessions. The essential possession of a household required to move at frequent intervals from one location to another is its own labor power. Another characteristic is the lack of trade. The interlinked features of dispersed population, lack of material possessions, an emphasis on self-reliance and consequent equation of labor power and wealth — these traits often impede fruitful exchange of commodities, and

the situation may be compounded by a general and far-reaching uniformity of the natural environment. The absence of markets in turn influences the egalitarian nature and functions of traditional communities. Villages consisting of relatively small kinship groups and affines need to spread risk through the sharing of resources available within the community, and acute local food shortage is solved through migration to kin settled in a region where food is relatively plentiful.

The impermanence of residence and lack of material possessions, and the associated assignment of values, may in numerous ways inform the manner in which land is viewed. The resource over which a household has absolute and initial right is its labor. Thus, the key to possession of a resource or a good is the labor expended in its acquisition. In a sense, this can be seen as the "swapping" of labor for another benefit, the conversion of rights in labor to rights in the fruits of that labor. The important distinction, however, is not between goods acquired through labor and goods obtained through trade or barter; it is between the ultimate origins of a good. A good thus initially acquired through labor may then in turn be bartered or invested, and the new resource or good obtained will be subject to equally strong rights of ownership.

This might ostensibly be interpreted as commensurate with a Lockean perspective on appropriation of land rights. Two points need clarification in this regard. First, appropriation of a good, and the subsequent assignment of a right, does not materialize in an institutional vacuum; a "social contract" — an agreement, tacit or explicit, on the legitimacy of ownership — must precede individual appropriation of resources (Bromley 1991). Second, shifting cultivators do not perceive land in the established Western manner as geographical points on a grid. Land contains a certain collection of natural resources — resources that are not initially created or acquired through labor — and appropriation applies to these resources in a manner that is often independent of the coincidence of their location. Thus, one does not have rights over land as such; a right to one of the resources on the land is established through the visible expenditure of labor or of other goods thus acquired. The rights to the use of a tree may be established

by planting it, felling it, or perhaps by simply marking it. But none has the rights to a tree if its circumstance cannot somehow be ascribed to human effort.

If land is abundant and freely available — that is, initial rights over it do not exist — land, and the resources upon and within it, have no price.[2] But neither the condition of abundance nor the failure to recognize rights in undeveloped land implies that land is worthless. What is implied is that the potential value of land is realized only by mixing it with labor. Rights to land can be claimed only through the use of land, and only for the duration of that use. A crop field that is left fallow will, when evidence of human activity has faded, revert to the public domain. Land itself, since it is not originally obtained through human activity, cannot be permanently claimed or alienated. Any fruits of human activity, on the other hand, may be sold or exchanged; thus one may observe the frequent sales of crops on a piece of land, or the sale of huts and houses, but not the land itself. This distinction between land itself and the fruits of labor on any given section of land is important analytically, and especially with respect to investment.[3]

Rights in Transition, Security, and Investment

We have observed that rights in land are traditionally established through initial use and maintained through continued use. When land has been abandoned for a sufficiently long time, i.e. when evidence of use has vanished, anyone may claim the land. When land is abundant, however, this poses no problem, at least to the extent that one disregards land variability in quality and distance from dwelling. Since land may equally well be acquired elsewhere, no farmer will have any incentive to claim any particular field, and by the same token, no

[2] It is common, in relation to traditional tenure, to attribute ownership of land to chiefs. But chiefs primarily had rights over their subjects rather than the land on which they farmed, although certain important exceptions exist. The role of the chief was largely political, a role that the modern African state to some extent has filled in the post-independence era.

[3] This distinction, though often ignored, is evident also in the way Western law denies exculsive rights to certain land resources, e.g. mineral rights in the U.S. and rights to minor forest products and recreation in much of Norther Europe.

farmer will fret over its loss. In the language of property rights theory, the negligible externality costs do not justify internalization.

How does land use change, from an initial condition of abundance, as land becomes more scarce? One obvious implication[4] is that the land to labor ratio decreases, and that more land will be under cultivation at any given time. Specific expressions of this in the context of shifting cultivation are a decline in fallow periods and the gradual conversion of swidden land to permanently cultivated land. Theoretically, more permanent land claims appear when fallow periods fall below a critical number — the period between the end of the crop rotation and the point at which a field reverts to the public domain — although the number may itself decrease as land becomes scarce. The logical result of a process where population pressure causes increasing land scarcity, however, is one where more and more farm land is cultivated in such a way — i.e. continuously or semi-continuously — that land does not revert to the public domain.

The fact that indigenous rights to land are contingent upon continued use is often perceived as a major problem. The persistence of the risk of losing land when fallowed hypothetically leads to myopic behavior and disincentives in terms of investments in long-term productivity and sustainability. The fact that proprietary rights may have beneficial incentive effects is often neglected, perhaps because these benefits only appear where markets in land, labor, or capital are imperfect. The possibility of eviction seems sensible, however, if land is scarce and the risk of absentee ownership is high. The requirement that land more or less continuously be used prevents such "waste" of idle land and would seem efficiency-enhancing in the short-term at the very least,[5] with the important caveat that may apply if the institution itself is the cause of market imperfection.

[4] Insofar as population pressure is behind increasing land scarcity.

[5] Such exploitation may of course be undesirable in the long term, if land use is generally unsustainable.

The arrangement thus, in its basic form, may entail a benefit in the form of exploitation, or "coverage," and a cost in the form of long-term insecurity of tenure. If the right to use land is absolutely secure as long as use continues, then the infringement on absolute ownership that this arrangement entails is the inability to simultaneously maintain the right to retain ownership and the right not to cultivate the land.[6] A right to permanent use of land is contingent upon not exercising the right to fallow it, at least not for extended periods of time.

How relevant is this problem of insecurity of tenure in Sub-Saharan Africa? First, the problem of not being able to abandon land might be trivial in the context of a community where land is truly scarce. To the extent that land is the major source of income and subsistence, there would be little incentive not to use the land every year anyway, so security would in effect be ensured. Also, a household which for some reason wished to abandon the land for a period of time but later reclaim it may have other strategies at its disposal, notably leaving the land in trust of relatives. Finally, long-term investments are not likely to be undertaken by people with a propensity for abandoning their land. A proprietary system of land rights may thus in fact help to weed out farmers with an indifferent attitude to farming.

Permanent use is one way to establish claims to land. A method that is perhaps even more powerful is to invest in land. To the extent that the investment represents a visible commitment to the long-term productivity of the land, continued use of the land is implied, and the common assertion that tenure security is necessary to promote investment may in many cases be reversed; investment is necessary to obtain security. Investments in trees, irrigation furrows, buildings, or other fixed structures may provide a litigant in a land dispute with an unassailable case. Thus, although insecurity of tenure is a disincentive to invest, it is — paradoxically — often also an incentive, because investment will itself increase security.

[6] Rights of transfer (as opposed to price) are not necessarily linked to permanence of ownership.

This leads to a related issue. A common definition of security — or rather insecurity — of tenure is the perceived probability of losing ownership of the land. In communities where land is seen as a bundle of resources rather than a geometric area, and where multiple tenure determines the access to these resources, the above definition is inadequate. Barrows and Roth (1990, p. 292) state that tenure security "can also be defined more broadly as the perception of the likelihood of losing a specific right to cultivate, graze, fallow, transfer, or mortgage." One such right is the right to recover the returns on any investment made on a given parcel of land. Any two rights may or may not be interlinked. For example, the right to harvest the fruit from a tree may be linked to the right to cut it down; or the right to bequeath land may be linked to the right to sell it. One action may be sufficient to claim several rights that need not otherwise be related; or one behavioral code or norm may inform the rules regarding several different rights. The right to recover an investment need not, however, be related to the right to retain land. This is hardly a radical notion; in most western countries, the loss of property in an ownership dispute is typically tempered by compensation for any fixed investments in the property that the loser of such a dispute has undertaken, at least as long as that property was not initially acquired illegally.

Similarly, when an African farmer loses an ownership dispute, that farmer may be compensated for any trees planted, buildings erected, or furrows dug. The rule is, of course, far from absolute. The law itself is often not written down; local African courts do not always follow the prescribed codes of procedure; decisions are often affected by the stature and authority of the litigants. Nevertheless, in cases where the loser in an ownership dispute has not clearly obtained the land through swindle, investments may be compensated. And even in cases of blatant fraud, compensation has been known to be given.

If one accepts that certain types of investment in land are a legitimate way of claiming more secure rights to land, and that investments may be recovered even when land is lost, the assertion that insecurity of land rights in indigenous tenure systems is a serious impediment to investment seems less convincing. The question of whether

investment is more attractive under freehold or under the conditions outlined above is equivalent to the following question: will the increased expectation of retaining the natural land rent offset the risk of losing the investment, when the latter is a function of both the increased security in land and the expected recovery of investment even when land is lost?

The Model

Consider a simple model of a farmer with the "absolute" rights afforded by freehold tenure. Net productivity prior to investment, termed rent, is a_0. The gains from an investment that gives a perpetual, annual increase in agricultural productivity from a_0 to a_1 at an interest rate of *r* will have a present value of

$$S_F = \frac{a_1 - a_0}{r} \qquad [1]$$

Investment costs are here ignored since, from a present value perspective, they do not have any bearing on the relative advantage of the two tenure regimes. For simplicity, if the investment is in a fixed asset, it is assumed that a_1 includes a premium deducted from the productivity increase large enough to cover capital consumption. The corresponding gains for a farmer with user rights of the type described above, hereafter simply called "indigenous tenure," will consist of two distinct parts. First, there is the direct productivity gain from the investment itself, which, in addition to the above variables, will be a function of the probability of eviction after the investment and the likelihood of recovering all or part of the investment if evicted. This will be called the "recovery effect." The second effect is the increased expectation of rent capture resulting from the lower probability of eviction generated by the investment. This is equal to expected rent after investment minus rent prior to investment, and will be called the "rent effect." Let *d* be the product of the probability and level of recovery of investment returns — that is, the discounted, perpetual increase in annual flows generated by the investment — even if evicted; p_1 is

the probability of eviction after the investment, and p_0 is the probability of eviction before investment. Boundaries for p are given by $0 \leq p \leq 1$ and $p_1 \leq p_0$.

The expected total returns for a farmer with indigenous tenure is given by the equation[7]

$$S_I = \underbrace{\frac{a_1 - a_0}{r}}_{[2a]} \cdot \underbrace{\frac{r(1 - p_1) + p_1 d}{r + p_1}}_{[2b]} + \underbrace{\frac{a_0}{r}}_{[2c]} \cdot \underbrace{\frac{r(p_0 - p_1)(1 + r)}{(r + p_1)(r + p_0)}}_{[2d]} \qquad [2]$$

The first product, [2a]·[2b], is the recovery effect; the second, [2c]·[2d], is the rent effect. If p_0 and p_1 are both 0 (no risk of eviction before or after investment) [1] and [2] become identical — both tenures provide equal investment incentives. Another expected corollary of the model is that if p_0 and p_1 are equal (no gain in tenure security from investment) and d is 0 (no possibility of recovery after eviction), then [2] reduces to $(a_1 - a_0)(1 - p_1)/(r + p_1)$, the standard formula for discounted perpetual annual flows under tenure insecurity, and the higher investment incentive of freehold is directly related to this insecurity.

Looking at the two effects in isolation reveals something of their relative power. If $d = 1$ (full investment recovery is guaranteed), and the worst-case scenario in terms of tenure security is assumed ($p_0 = p_1 = 1$; absolute certainty of eviction before and after investment), then [2] becomes

$$\frac{a_1 - a_0}{r(1 + r)} \qquad [3]$$

[7] See the appendix for elaboration of this formula.

The inferior incentive of indigenous tenure compared to freehold, even with certain immediate eviction, is merely a one-year discount of the capitalized investment gains, since the compensation is given only after the period (year 1) when land is lost. In general, if full recovery is guaranteed and investment does not reduce the risk of eviction ($p_0 = p_1$), [2] reduces to

$$\frac{a_1 - a_0}{r} \cdot \left(1 - \frac{rp_1}{r + p_1}\right) \qquad [4]$$

The minimum of [4] is given by [3], the maximum is given by [1], when, as noted above, there is no risk of eviction before or after investment (in this case, level of recovery is irrelevant). The recovery effect cannot by itself render indigenous tenure equal to freehold in terms of investment incentives. On the other hand, even when investment does not improve tenure security, a high level of recovery or a small level of tenure insecurity will entail very small differences between the two tenure regimes. Figure 1 describes the recovery expectancy required to make the two tenures equal in terms of investment incentive for various changes in eviction probability, given an initial eviction probability of 20%. The discount rate is set at 10%.

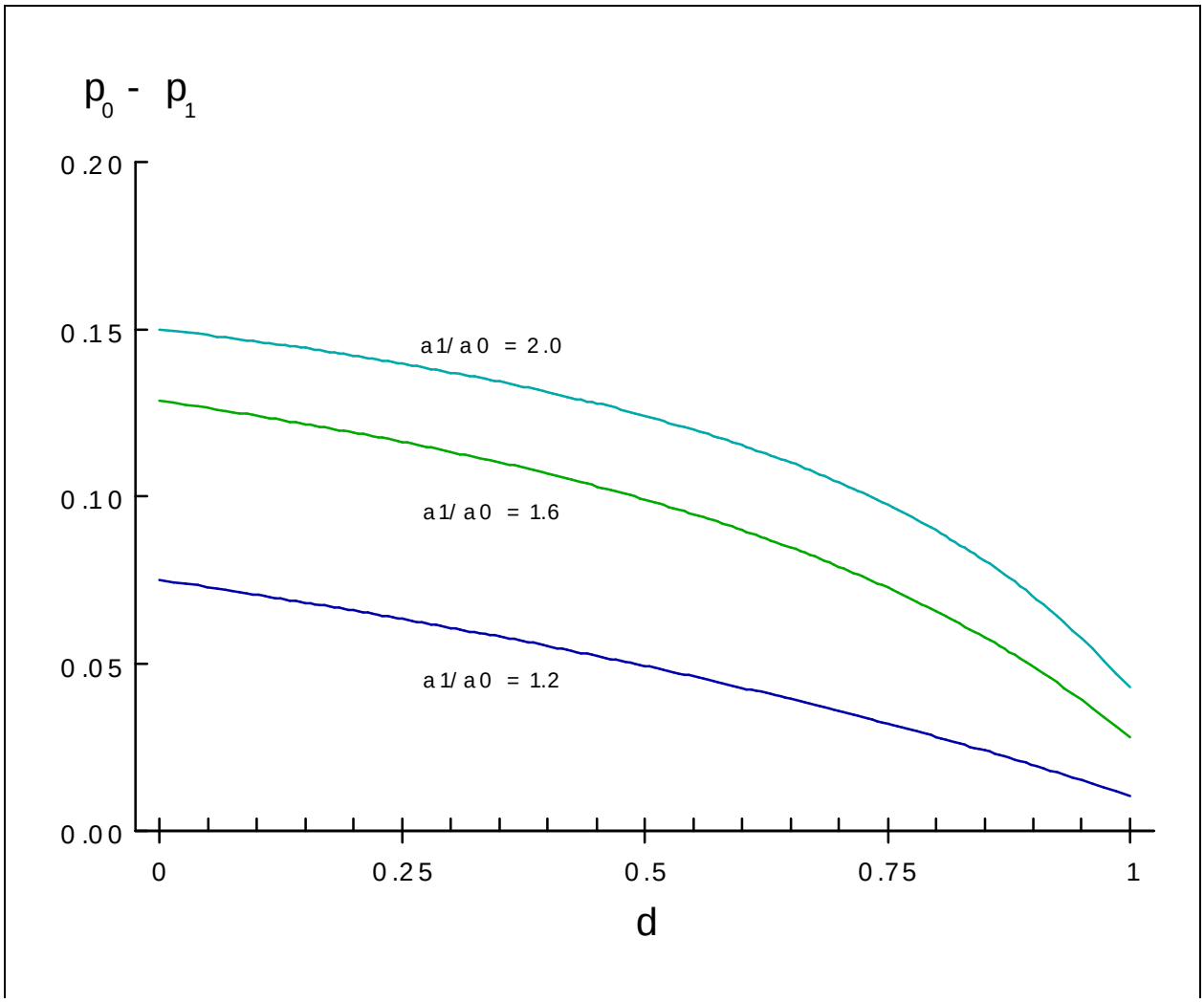

Figure 1: the percentage decrease in probability of eviction, $p_0 - p_1$, required to provide indigenous tenure with investment incentive equal to that of freehold for different levels of expected investment recovery, d, when evicted. Initial probability of eviction, p_0, is 20%, and the discount rate, r, is 10%.

The effect of increased tenure security is more complex. To isolate it, assume that recovery after eviction is infeasible; $d = 0$. Since $p_1 \leq p_0$, two extremes are provided by the cases $p_1 = 0$ and $p_0 = 1$. In the former case, when there is no residual uncertainty after investment (level of recovery after eviction is irrelevant), there is no loss of

direct investment returns compared to freehold, and the higher investment incentive provided by indigenous tenure is given by the expected increase in rent capture. This is equivalent to the final segment in the new expression for total gains from investment under indigenous tenure:

$$S_I = \frac{a_1 - a_0}{r} + \frac{a_0}{r} \cdot \frac{1 + r}{1 + rp_0^{-1}} \qquad [5]$$

This expected gain is again described in terms of rent multiplied by a ratio between 0 and 1, depending on the perceived likelihood of eviction prior to investment, p_0. The corresponding case when $p_0 = 1$ yields the following equation:

$$S_I = \frac{(a_1 - a_0)(1 - p_1)a_0}{r + p_1} + \frac{r(1 - p_1)}{r} \cdot \frac{a_1(1 - p_1)}{r + p_1} = \frac{a_1(1 - p_1)}{r + p_1} \qquad [6]$$

When both extremes occur, $p_1 = 0$ and $p_0 = 1$, [5] and [6] both reduce to

$$S_I = \frac{a_1 - a_0}{r} + \frac{a_0}{r} = \frac{a_1}{r} \qquad [7]$$

and the higher investment incentive of indigenous tenure is [7] — [1] = a_0/r, the entire rent. A transition from absolute certainty of immediate eviction to absolute tenure security because of an investment is, perhaps, an unlikely scenario. In general, the difference in investment incentive between the two tenure regimes is given by [2] — [1], and the result is sensitive to small variations in the stated variables.

One striking feature revealed by the model is that if p_0 (initial probability of eviction) is small, even small changes in p will generate substantial increases in expected rent capture, whereas if p_0 is substantial, a small increase in p will entail a negligible rent effect. This can perhaps best be illustrated by an example. Assume recovery of investment returns after eviction is infeasible; $d = 0$. Consider three farmers who have identical land endowments in terms of both size and productivity, who have a discount rate of 20 percent, and who all face an identical investment decision that will increase agricultural production by 20 percent. One farmer has freehold tenure, and faces no insecurity before or after investment. A second farmer initially faces a five percent risk of eviction, which will be reduced by one percent after investment, so that p_1 is 0.04. The third farmer's tenure insecurity will be reduced by 20 percent — from an initial value of 50 percent to a residual value of 30 percent. Which of these farmers has the greater incentive to invest? From a present value criterion, they all have approximately the same incentive. Although the values of p here are sensitive to changes in interest rates and productivity increases, the general pattern holds: if initial insecurity is high, large changes in p are needed for indigenous tenure to provide equal investment incentives to freehold; if initial insecurity is low, very small changes are required. Which scenario is realistic? Although there are inherent problems in treating eviction risk as a fixed parameter, low rates are more relevant than large ones; a farmer who faces, say, a 30% annual risk of eviction is hardly likely to bother with land preparation at all. A farmer who faces an eviction rate of 30% has only a 17% chance of still owning his land after five years. And, as mentioned, if initial eviction rates are low (smaller than 10%) and rent is at all substantial, the rent effect will be substantial for even small changes in p. This can be seen from figure 2, where the percentage decrease in eviction probability required to render the two tenure regimes equal in terms of investment incentive is plotted against initial eviction probability. The stipulated productivity increase is 20%, and the recovery effect is assumed to be 0. The figure also reveals that the likelihood of indigenous tenure providing higher investment incentive generally will increase with the discount rate.

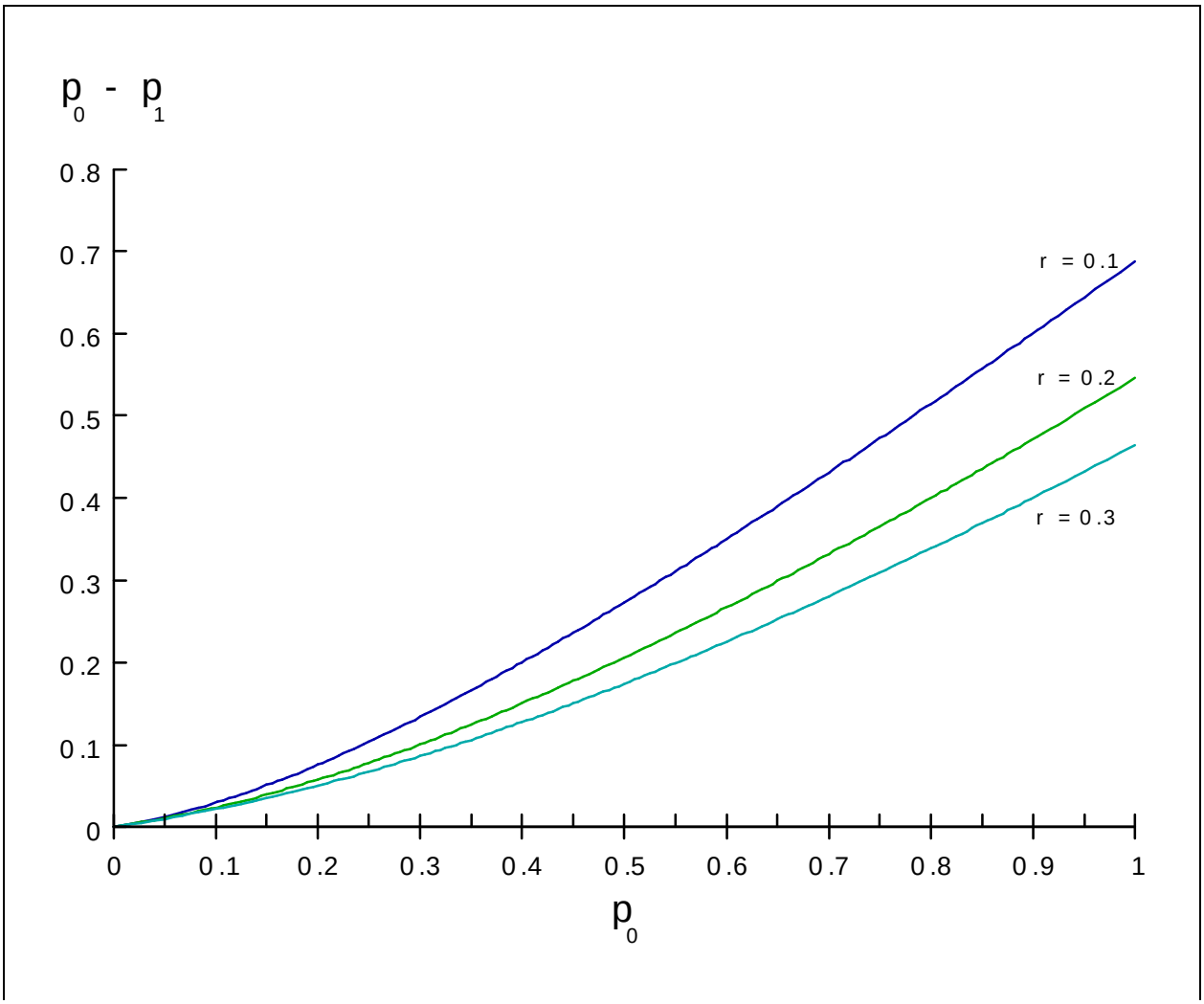

Figure 2: reduction in probability of eviction, p_0 — p_1, required to provide indigenous tenure with investment incentive equal to freehold for different values of initial eviction probability, p_0. Productivity increase is 20% and expected recovery if evicted is zero.

Another aspect is that, in general, in situations where the rent effect is negligible, the recovery effect will be important and vice versa. For example, the rent effect will decrease with an increase in p_1 (residual insecurity), whereas the recovery effect will increase with p_1. And if the productivity increase from the investment is large

compared to rent (if $(a_1 - a_0)/a_0$ is large), the rent effect will be small but the recovery effect will be large. Thus, if both effects are valid — and the thesis of this paper is that they often are — then investment incentives are unlikely to be significantly smaller under indigenous tenure than under freehold.

The size of the increase in productivity, relative to rent, is of general interest. The higher this ratio, $(a_1 - a_0)/a_0$, the lower the rent effect will be, and the more likely freehold is to provide higher investment incentives. As this ratio approaches 0, the rent effect becomes increasingly important, and it is thus possible that an "investment" will be undertaken even if it gives no productivity increase. Since in this case [2a]·[2b] = 0, such a scenario simply requires that the rent effect, [2c]·[2d], exceeds cost. This would no longer be considered a conventional investment, though. We have here arrived at what is termed opportunistic behavior, where rent is dissipated in the capture of resources in the public domain. The significant impact of the relative productivity increase is illustrated in figure 3, where the relative investment incentive of the two tenure regimes, given as a fraction with indigenous incentive divided by freehold incentive, is plotted against residual productivity divided by initial productivity. Again, the recovery effect is assumed to be 0. The discount rate is set at 10% — the function is fairly robust against variations in the discount rate. Note that the points at which incentives are equal (the points where the curves cross the line where [2]/[1] = 1) will not be influenced by including positive costs; the slope of the curves will, however, increase with positive costs, thus accentuating the differences in incentive.

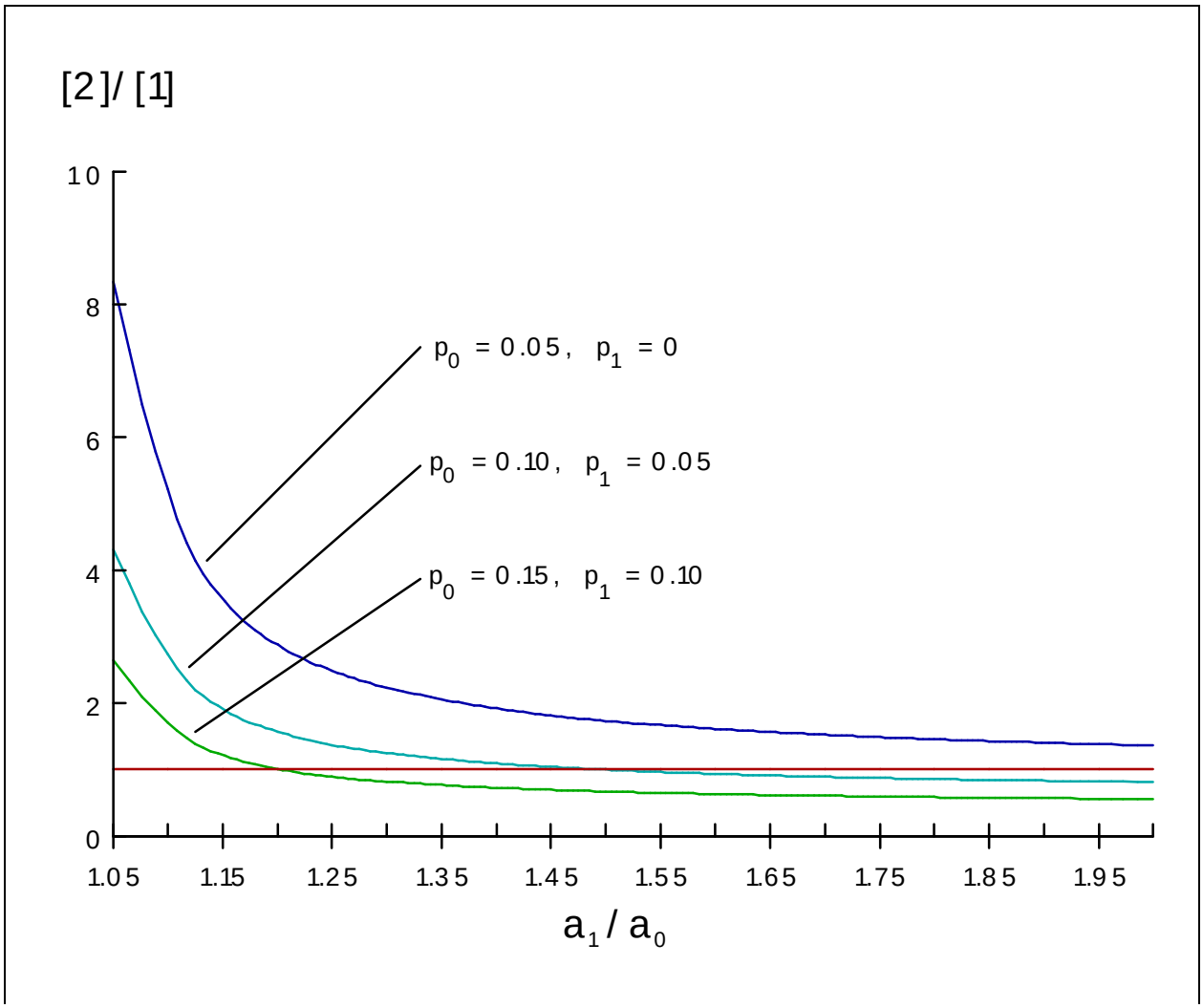

Figure 3: the vertical axis is relative investment incentive of the two tenure regimes; a fraction where indigenous incentive, [2], is divided by freehold incentive, [1]. The horizontal line with a value of 1 represents equal investment incentive — values higher than 1 denote situations where incentive is higher for indigenous tenure; values lower than 1 denote lower investment incentive for indigenous tenure. The horizontal axis describes changes in productivity resulting from the investment, given as a fraction with residual productivity divided by initial productivity, a_1/a_0. The discount rate, r, is 0.10 and expected investment recovery if evicted, d, is zero.

4. DISCUSSION

Types of Investment and Optimal Investment

At this point, a partial return to reality seems warranted. The above model investigates incentives in the context of a single investment, given variations in certain key parameters. But an investment may possess a number of different attributes. A model of such a general description as that in the previous section begs the question of what an investment actually is, and how investment attributes influence the variables of the model — in particular the probability of eviction. A farmer may face a number of investment opportunities; the tenure regime which he is under is likely to influence both the sequence in which he chooses them, and the amount of resources he commits to each one. Specifically, a farmer with indigenous tenure will choose an investment schedule which maximizes the combined effects of productivity increase and security increase; a farmer with freehold will be concerned only with productivity.

The significance of this can be seen by considering investment in movable and tradable assets. A farmer with freehold tenure will use the same productivity criterion when evaluating different types of investments. Since, however, increased tenure security is inextricably linked to investments affixed to the land, a farmer with indigenous tenure will evaluate differently. The advantage of investing in movable and exchangeable assets, such as tractors or oxen, is that even if evicted, the farmer will retain his investment; this must be weighed against the advantage of increased tenure security that attends an investment in a fixed land asset such as irrigation structures or trees. If the recovery effect is substantial, it will nullify or reduce the advantage of investment in movable assets, and, *ceteris paribus*, create a bias towards investment in fixed land assets on the part of farmers with indigenous tenure.

An investment is often regarded as the acquisition or creation of productive physical assets, and this is the manner in which investments are understood in the model. More generally, however, investment can be understood as the swapping of current consumption opportunities for increased future consumption opportunities. Thus, two investments which have similar effects are longer fallows in order to enhance soil productivity, and planting leguminous trees for nitrogen-fixing purposes. It should be clear from earlier discussions, however, that the two will have opposite effects on tenure security. The former may be labelled an "inconspicuous" investment, as it does not involve the change or acquisition of an asset through labor or trade, but rather the "passive" enhancement of an asset through its return to a natural state. Such investments will reduce rather than increase security, and thus violate the model's assumption that investment enhances security. In a sense, tenure insecurity here causes land and farmer to part ways; what represents an investment in the land is no investment to the farmer. This point is particularly important where sensitive ecosystems — and thus long-term sustainability considerations — are concerned. Such "inconspicuous" investments will, however, also go against the general grain of changes in land use implied by a process where land becomes scarce and rights are in transition. Unless one considers population pressure an endogenous variable, land-extensive cultivation methods at some point become untenable under either tenure regime. Indigenous tenure, by inducing conspicuous rather than inconspicuous investment, may in fact accelerate land use intensification.

Assuming that the effect on eviction probability is the same, the lower the productivity increase generated by the investment (relative to initial productivity; not to cost), the more likely indigenous tenure is to provide a higher investment incentive. Thus, it is possible to construct an example where, given otherwise identical conditions, a farmer with freehold will choose a productive investment such as terracing whereas a farmer with indigenous tenure will choose a non-productive investment such as the construction of a house. If the degree of increased tenure security is linked to the extent to which the investment is seen as a commitment to the long-term productivity of the land, which it might well be, this will tend to negate the influence of productivity increase.

Economics is, however, not necessarily particularly concerned with how high investment demand is — at least not in the sense that higher is better. Excessive investment is as inefficient as underinvestment. Thus, if investment demand under freehold is efficient, and barring the unlikely event that a chance combination of circumstances should render indigenous and freehold tenure identical in all aspects of investment demand, indigenous tenure is inefficient regardless of the direction in which investment incentives diverge. The problem here, though, is the assumption that freehold incentives are socially optimal in rural African communities. What are the more realistic conditions, and in which ways are the lessons from the model likely to be relevant?

As the size of direct investment returns increases relative to rent, the rent effect decreases, and the likelihood that indigenous tenure will provide higher investment incentives decreases. Under which conditions is the productivity increase from an investment likely to be large relative to rent? One possibility is that rent is very low, and this may occur e.g. when soils have been mined after repeated clearings. On severely degraded lands, indigenous tenure is therefore more likely to provide inferior investment incentives; farmers with any type of tenure may, however, be reluctant to engage in — or find it difficult to identify — viable investment opportunities on such land. If, on the other hand, rent is significant, investments that generate relatively large returns will probably also be capital-intensive; budget constraints may render investments of this type infeasible under all circumstances. And if inexpensive investments with high returns are available, these are likely to be undertaken by farmers regardless of tenure.

The key lessons of the model are as follows: (1) as the discount rate increases, the likelihood of indigenous tenure providing the higher investment incentive increases; (2) as the productivity increase of an investment becomes smaller relative to rent, the likelihood of indigenous tenure providing the higher investment incentive increases; (3) as the initial probability of eviction decreases, the likelihood of indigenous tenure providing the higher

investment incentive increases, and; (4) if the probability of recovering the investment even when evicted is high, a very small decrease in eviction probability is required to render investment incentive higher under indigenous tenure. The model is admittedly rudimentary, and conclusive statements about which regime provides the higher investment incentive cannot be given without measuring the variables for each specific case. When matched with a realistic view of conditions in Sub-Saharan Africa, however, it seems to us that these effects increase the possibility that investments which would require low costs or low discount rates under freehold tenure may be undertaken with higher costs or discount rates under indigenous tenure. In particular, the possibility that the prospect of increased tenure security will lead a farmer with indigenous tenure to continue to commit resources to land improvements beyond the point where marginal costs and benefits normally would converge is important. And to construe this as an incentive for overinvestment would fly in the face of the almost universal consensus that myopic behavior is one of the most critical obstacles to rural development in Sub-Saharan Africa.

Rent Capture and Rent Dissipation

As we have seen, it is possible that an "investment" will be undertaken under indigenous tenure conditions even when no productivity increase results, because the rent effect may exceed cost. In some examples of open access, the entire rent is dissipated, as in Gordon's (1954) portrayal of the fishery, and in the example given by Mendelsohn (1991) for rent capture from land in frontier areas. The solution to this problem was initially seen to be the provision of private property rights — in the fishery, tradable quotas; for land, freehold tenure. Private property rights would allow all costs to be internalized, and were conveniently assumed to be both "absolute" and costlessly supplied. The work of economists within the transaction cost genre have since dispelled these notions, by recognizing that more detailed specification and more rigorous enforcement of rights is linked to increasing costs. The notion that still persists is that the problem reduces to a simple comparison of two types of costs: on the one hand, the cost of strictly rent-dissipating opportunistic behavior generated by the absence of certain rights, and on the other hand the cost of rights specification and enforcement sufficiently elaborate to avoid such rent

dissipation. In the context of increasing land scarcity, it is merely a matter of *when* it becomes economically efficient to specify rights of increasing detail in response to the change in relative prices.[8]

Mendelsohn's example of a recently opened frontier area is useful in examining some of these claims, although it should be noted that he does not claim universal validity for his models, which are tailored towards Latin American conditions:

> "Suppose, however, that property rights over this new frontier have not yet been defined. Suppose that it is decided that each person's share of land at each distance will depend on the amount of some x_i that the person invests in defending or creating his property right. For example, each person can prematurely develop by building roads or clearing land before the land is profitable to use. Or possibly each person can pay guards to keep the other people away from the land. Or the person may destroy parts of the land (by cutting valuable forest cover) to secure ownership of the rest. [...] The Model reveals that individual maximizing behavior will lead competing colonists to spend as much money creating their property rights as the land is worth. Development will be physically sustainable but society will reap zero net benefits." [1991, p. 7].

Clearly, for the entire rent to be dissipated in the manner of this example, the following conditions must be fulfilled: (1) all feasible capture activities are strictly wasteful (have no beneficial effects); (2) costlier capture activities are always superior to less costly ones and are available to the point where cost equals rent, and; (3) no prior rights exist. It is possible that all of these conditions occasionally may hold for the fishery. Some of the conditions, in particular (2) and (3), may be closely matched in frontier areas in some parts of Latin America and Asia. None of these conditions is likely to hold in a rural African scenario; even "frontier" areas where no prior land *use* exists will be subject to the established custom of the tribe. Rights are essentially instrumental in nature (Bromley 1991). Agreement on rights which are detrimental to the community will not be reached. In the development of acceptable forms of claiming property, then, one would assume that wasteful strategies will not gain approval, at least not in the long run in communities with a relatively old and cohesive social structure. As

[8] It is a paradox that the ideological origin of the private property lobby is liberal and anti-state when the corollary of the theory itself in most cases is state intervention in property matters. This paradox rests perhaps on the aforementioned confusion of common property and open access, but mostly on the belief that free markets and the property assignments on which they depend are costless. As North (1990, p. 66) has put it, "...when economists talk about efficient markets, they have simply taken for granted an elaborate framework of constraints."

for individual incentives, why would a farmer "invest" unproductively if a productive investment can achieve the same objective?

The point we are trying to make here is that rational, individual capture of resources in the public domain — opportunistic behavior — is not necessarily rent-dissipating; if continuous cultivation or investment in land assets enhance tenure security, then rent capture may generate tangible benefits. And even if these benefits are smaller than those that would be generated under freehold, the relevant comparison is between the *difference* in benefits and the costs of rights specification and enforcement; not between the simple costs and benefits of freehold as such. It is important to note here that even an "investment" which has no productive effect, as denoted in the model by $a_1 = a_0$, is not necessarily wasteful. The example where the erection of a building increases tenure security is pertinent; although the building has no effect on productivity, it still obviously provides benefits.

Just as capture attempts do not have to be rent-dissipating, some forms of capture may in fact dissipate more than rent. This can again be seen as an effect of the incongruity between the income potential from a given piece of land and the income potential for a given household, given insecurity of tenure; an investment in the context of the household may be a divestment if considered per unit land. "Destructive" investments — investments that entail costs over and beyond complete dissipation of rent, and thus represent a net reduction in social wealth — may be rational if no other means of capture are available. Such "investments" not only dissipate rent in the manner modelled by Mendelsohn, but also permanently reduce or destroy the income potential from the land. Conversion of tropical rainforest to wasteland may indeed fit such a description.

Finally, a note on land disputes: costly litigation is the predominant example of how rent is dissipated when rights are inadequately specified. But disputes do not always lend themselves to a simple tenurial analysis. First, although tenure insecurity will increase the uncertainty of the outcome of any given dispute, a typical conflict still

requires "irrational expectations" in that "Disputants go to court only if they are optimistic about the outcome (indeed, between them, they must err in the direction of excessive optimism)" as Barzel (1989, p. 70) has pointed out. Second, insofar as a dispute is between heirs to an estate, tenure regime is relevant only to the extent that it incorporates laws of succession.

Concluding Remarks

The land market, or the lack of such, is not treated in detail here. Corollaries do exist. Under most traditional African tenures, land cannot be sold but improvements can, so as far as investments are concerned, these are tradable for both tenure regimes, although "rent" is tradable only under freehold. If rent goes down, land value will increasingly be congruent with investments (improvements), and indigenous tenure may approach freehold in this respect. Strategies that subvert the traditional norm that prohibits land sales exist, e.g. rules specifying that the surrounding land accompanies any house that is sold. As land becomes scarce, its value will to an increasing degree be incorporated into such transactions. However, since land cannot be moved, an activated land market implies an increasing intermix of different people and peoples, with consequences for the tight and largely self-governing communities that are found throughout much of rural Africa. As North (1990) has noted, increasingly impersonal transactions will lead to higher information costs and a greater need for government regulation. Although state intervention may not be required to establish markets, the transactions facilitated by markets may themselves generate a need for state control. This is perhaps especially true of land markets. On the other hand, markets for agricultural land are in general slow, even in most Western countries, due to the complexity and variability of land, associated high information costs, and a lack of "interim markets" (Basu 196).

Another issue not considered here is the possibility that the tenure regime itself is the cause of market imperfections. In general, we believe the causality runs the other way; tenures arise to cope with the prevailing economic conditions, and will not profoundly influence markets. An important reservation in this regard is, perhaps, the credit market. It could be, and has been, hypothesized that the issuing of land titles will generate the

emergence of a financial market and thus more capital-intensive investment, since a deed will provide the necessary security that lending institutions require. Norms that dictate that land is essentially a common heritage may resist such moves — codes that prevent farmers from seeking permanent claims to land also prevent them from taking that land to the bank as collateral. Many other reservations apply, including rationing rather than supply effects of land registration, with associated inequities (Carter 1988) and the general second-best problems that attend an emerging market in a wider market vacuum (see e.g. Jaynes 1984).

This paper is, however, primarily concerned with the effects of tenure on investment demand, rather than on redistribution or credit supply. We argue that: (1) most African farmers do not face a high risk of eviction; (2) continuous use and "conspicuous" investments in land-based resources will further reduce this risk; (3) even if land is lost in e.g. a dispute, the investment may be partially or completely recovered, and; (4) the more feasible investment alternatives among farmers in Sub-Saharan Africa are inexpensive ones with modest absolute returns on at worst moderately degraded land.

Under these conditions, indigenous tenure is likely to provide significantly higher investment incentives than freehold, and very unlikely to provide significantly lower investment incentives. Also, we highlight the paradox that whereas tenure security — as such, or in its conventional tenurial guise of freehold — is routinely seen as a prerequisite for investment and prudent land use, the reverse link may be just as important; investment or prudent use may be a prerequisite for tenure security. The fact that land-based investment is low in rural African communities is not due to the incentive structure of the indigenous tenure regime but to the general lack of investment opportunities as determined by the cost and availability of agricultural technology.

The propositions that indigenous tenure on the one hand provides insufficient investment incentives and on the other leads to rent dissipation are contradictory; each may have some merit on its own, but both cannot hold at the same time. The very act of rent-dissipating capture is largely analogous to overinvestment — in the extreme case,

an investment which yields no direct returns but only more secure rights to land. For Sub-Saharan Africa, we argue that most cases are not extreme; the key to understanding this is to see that many of the activities related to farming have a dual function — one that is productive and one that is tenurial. If the general investment climate of a rural community is overly cautious — because of market failure, risk aversion, or for other reasons — it is possible that indigenous tenures may provide investment incentives that are superior to freehold, as well as a path towards tenure security more efficient than state intervention.

In a dynamic context, the comparison of tenure regimes may seem contrived; at each stage of a transition process a farmer faces a set of opportunities unique to the rights defined by that stage. The merit of counterfactuals — questions such as "what would productivity have been under a different tenure regime?" — shrinks as theory is superimposed on reality. The point here has been to illustrate that in that set are opportunities which, if taken, will push the process itself into a subsequent stage, and that these opportunities may be profitable in both a static and a dynamic context. Indigenous tenures may contain intrinsic mechanisms and incentives that, if allowed to unfold, trigger and sustain a transition to tenures that resemble the familiar Western institution of freehold. Thus, indigenous tenures may initially provide investment incentives that on the one hand may be equal to freehold, and on the other hand — and by these very incentives — propel them towards freehold. Tenure security may be a result, as well as a trigger, of land use decisions.

REFERENCES:

Alchian, A. A., 1950, "Uncertainty, Evolution and Economic Theory," *Journal of Political Economy*, 58, 211-221.

Ault, D. E. and G. L. Rutman, 1979, "The Development of Individual Rights to Property in Tribal Africa," *Journal of Law and Economics*, 22, 163-182.

Bardhan, P., 1989a, "Alternative Approaches to the Theory of Institutions in Economic Development," in Bardhan (Ed.), 1989b.

Bardhan, P., 1989b, *The Economic Theory of Agrarian Institutions*, Oxford: Oxford University Press.

Barrows, R. and M. Roth, 1989, "Land Tenure and Investment in African Agriculture: Theory and Evidence," *The Journal of Modern African Studies*, 28, 265-297.

Barzel, Y., 1989, *Economic Analysis of Property Rights*, Cambridge: Cambridge University Press.

Basset, T. J., 1993, "Introduction: The Land Question and Agricultural Transformation in Sub-Saharan Africa," in Basset, T. J. and D. E. Crummey (Eds.), 1993.

Basset, T. J. and D. E. Crummey (Eds.), 1993, *Land in African Agrarian Systems*, Madison, Wisconsin: University of Wisconsin Press.

Basu, K., 1986, "The Market for Land: An Analysis of Interim Transactions," *Journal of development Economics*, 20, 163-177.

Bates, R. H., 1984, "Some Conventional Orthodoxies in the Study of Agrarian Change," *World Politics*, 26, 234-254.

Bromley, D. W., 1991, *Environment and Economy*, Cambridge, Mass.: Blackwell.

Bruce, J. W., 1986, "Land Tenure Issues in Project Design and Strategies for Agricultural Development in Sub-Saharan Africa," Land Tenure Center, LTC Paper No. 128, University of Wisconsin - Madison.

Bruce, J. W., 1993, "Do Indigenous Tenure Systems Constrain Agricultural Development?" in Basset, T. J. and D. E. Crummey (Eds.), 1993.

Carter, M. R., 1988, "Equilibrium Credit Rationing of Small Farm Agriculture," *Journal of Development Economics*, 28, 83-103.

Coase, R. H., 1960, "The Problem of Social Cost," *Journal of Law and Economics*, 3, 1-44.

Coldham, S., 1978, "The Effect of Registration of Title upon Customary Land Rights in Kenya," *Journal of African Law*, 22, 91-111.

Demsetz, H., 1967, "Toward a Theory of Property Rights," *American Economic Review*, 57, 347-359.

Dorner, P., 1972, *Land Reform and Economic Development*, Harmondsworth: Penguin.

Feder, G., 1987, "Land Ownership Security and Farm Productivity: Evidence from Thailand," *Journal of Development Studies*, 24, 16-30.
Feder, G. and R. Noronha, 1987, "Land Rights Systems and Agricultural Development in Sub-Saharan Africa," *Research Observer*, 2, 143-169.

Gordon, H. S., 1954, "The Economics of a Common Property Resource: The Fishery," *Journal of Political Economy*, 62, 124-142.

Hardin, G., 1968, "The Tragedy of the Commons," *Science*, 162, 1243-1248.

Jaynes, G. D., 1984, "Economic Theory and Land Tenure," in Binswanger, H. and M. R. Rosenzweig (Eds.), *Contractual Arrangements, Employment, and Wages in Rural Labour Markets in Asia*, New Haven: Yale University Press.

Johnson, O. E. G., 1972, "Economic Analysis, the Legal Framework and Land Tenure Systems," *Journal of Law and Economics*, 15, 259-276.

LTC, 1990, *Security of Tenure in Africa*, Land Tenure Center, University of Wisconsin - Madison.

Mendelsohn, R., 1991, "Property Rights and Tropical Deforestation," paper prepared for the 1990 AEA meetings in Washington, D.C.

Migot-Adholla, S., P. Hazell, B. Blarel and F. Place, 1991, "Indigenous Land Rights Systems in Sub-Saharan Africa: A Constraint on Productivity?" *World Bank Economic Review*, 5, 155-175.

North, D. C., 1990, *Institutions, Institutional Change and Economic Performance*, Cambridge: Cambridge University Press.

Pinckney, T. C. and P. K. Kimuyu, 1994, "Land Tenure Reform in East Africa: Good, Bad or Unimportant?" *Journal of African Economies*, 3, 1-28.

Platteau, J. P., "The Evolutionary Theory of Land Rights As Applied to SubSaharan Africa: A Critical Assessment," Namur: Facultes Universitaires Notre-Dame de la Paix.

World Bank, 1974, "Land Reform," Washington, D. C.: World Bank Development Series.

APPENDIX: ELABORATION OF INVESTMENT DEMAND MODEL FOR INDIGENOUS TENURE

An investment increases annual productivity from a_0 to a_1 (a_1 includes a capital consumption premium) and reduces annual risk of eviction from p_0 to p_1. Even if evicted, the farmer has a chance to recover all or part of the capitalized value of investment returns. The capitalized value of the perpetual increase in annual flows is:

$$\frac{a_1 - a_0}{r}$$

where r is the discount rate. The product of the probability and level of recovery, even if evicted, is termed d.

1. RETURNS FROM PRODUCTIVITY INCREASE

The first part of the formula concerns the gains from the productivity increase, $a_1 - a_0$, that the investment generates. After the investment has taken place, the probability of eviction is p_1. The expected benefit in terms of direct investment returns in year 1 is:

$$(a_1 - a_0)(1 - p_1)$$

In the year 2, the corresponding expression is:

$$(a_1 - a_0)(1 - p_1)^2$$

And in year n:

$$(a_1 - a_0)(1 - p_1)^n$$

But even if evicted, the farmer may recover a part of the capitalized value of investment returns. Since the likelihood of being evicted after one year is p_1, and the expected level of recovery is d, then the expected benefit in year 1 is:

$$\frac{(a_1 - a_0)dp_1}{r}$$

In year 2 account must be taken of the probability, $1 - p_1$, that eviction already occurred in year 1. The expression for year 2 is thus:

$$\frac{(a_1 - a_0)(1 - p_1)dp_1}{r}$$

And in year n:

$$\frac{(a_1 - a_0)(1 - p_1)^{n-1}dp_1}{r}$$

The present value of expected returns from the productivity increase generated by the investment for any given year is the sum of the two expressions, discounted to the present by multiplying with $(1 + r)^{-n}$. In year one, this is:

$$[(a_1 - a_0)(1 - p_1) + \frac{(a_1 - a_0)dp_1}{r}] \cdot (1 + r)^{-1}$$

And in year n:

$$[(a_1 - a_0)(1 - p_1)^n + \frac{(a_1 - a_0)(1 - p_1)^{n-1}dp_1}{r}] \cdot (1 + r)^{-n}$$

Now, define:

$$X = (a_1 - a_0) + \frac{(a_1 - a_0)dp_1}{r(1 - p_1)}$$

Then the present value of the string of expected returns from year 1 to year n, termed S_A, can be written as:

$$S_A = \frac{X(1 - p_1)}{1 + r} + \frac{X(1 - p_1)^2}{(1 + r)^2} + ... + \frac{X(1 - p_1)^{n-1}}{(1 + r)^{n-1}} + \frac{X(1 - p_1)^n}{(1 + r)^n} \qquad [1]$$

Multiply both sides of the equation by $(1 + r)/(1 - p_1)$:

$$S_A(\frac{1 + r}{1 - p_1}) = X + \frac{X(1 - p_1)}{1 + r} + ... + \frac{X(1 - p_1)^{n-2}}{(1 + r)^{n-2}} + \frac{X(1 - p_1)^{n-1}}{(1 + r)^{n-1}} \qquad [2]$$

Now subtract equation [1] from equation [2]:

$$S_A(\frac{1 + r}{1 - p_1} - 1) = X - \frac{X(1 - p_1)^n}{(1 + r)^n} \quad \Rightarrow$$

$$S_A = \frac{X(1 - p_1)}{r + p_1} \cdot (1 - \frac{(1 - p_1)^n}{(1 + r)^n})$$

The productivity increase is perpetual; when n approaches infinity, the expression becomes:

$$\lim_{n \to \infty} S_A = \frac{X(1 - p_1)}{r + p_1} \cdot (1 - 0) = \frac{X(1 - p_1)}{r + p_1}$$

Substitute for X:

$$S_A = [(a_1 - a_0) + \frac{(a_1 - a_0)dp_1}{r(1 - p_1)}] \cdot \frac{1 - p_1}{r + p_1} \quad \Rightarrow$$

$$S_A = \frac{a_1 - a_0}{r} \cdot \frac{r(1 - p_1) + dp_1}{r + p_1} \qquad [3]$$

2. RETURNS FROM INCREASED TENURE SECURITY

The second effect arises because the the investment will reduce the probability of eviction from p_0 to p_1 and thus increase the expectation of retaining the rent from the land, a_0.

The present value of expected rent from the land from years 1 through n before investment is:

$$\frac{a_0(1 - p_0)}{1 + r} + \frac{a_0(1 - p_0)^2}{(1 + r)^2} + \ldots + \frac{a_0(1 - p_0)^{n-1}}{(1 + r)^{n-1}} + \frac{a_0(1 - p_0)^n}{(1 + r)^n}$$

The math here is analogous to that in the previous section — the above formula is identical to that in equation [1] except that a_0 has been substituted for X and p_0 has been substituted for p_1. Thus, when n approaches infinity, the present value of expected rent before investment is:

$$\frac{a_0(1 - p_0)}{r + p_0}$$

The same math applies exactly to the present value of expected rent from the land after the investment, except that the new probability of eviction, p_1, is substituted for the earlier probability, p_0. Thus, this can be expressed as:

$$\frac{a_0(1 - p_1)}{r + p_1}$$

The returns from increased tenure security, termed S_B, is the difference between the two:

$$S_B = \frac{a_0(1 - p_1)}{r + p_1} - \frac{a_0(1 - p_0)}{r + p_0} \quad \Rightarrow$$

$$S_B = \frac{a_0}{r} \cdot \frac{r(p_0 - p_1)(1 + r)}{(r + p_1)(r + p_0)} \qquad [4]$$

3. TOTAL INVESTMENT INCENTIVE

The total gain from the investment, S_I, is simply the sum of the two effects, $S_A + S_B$:

$$S_I = \frac{a_1 - a_0}{r} \cdot \frac{r(1 - p_1) + dp_1}{r + p_1} + \frac{a_0}{r} \cdot \frac{r(p_0 - p_1)(1 + r)}{(r + p_1)(r + p_0)} \qquad [5]$$

[a] · [b] + [c] · [d]

[a] and [c] are expressions for discounted perpetual annual flows — [a] for productivity increase and [c] for rent. [b] and [d] are ratios with boundaries of 0 and 1.