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The Profits of Power: Land Rights and Agricultural Investment in Ghana

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We examine the impact of ambiguous and contested land rights on investment and productivity in agriculture in Akwapim, Ghana. We show that individuals who hold powerful positions in a local political hierarchy have more secure tenure rights and that as a consequence they invest more in land fertility and have substantially higher output. The intensity of investments on different plots cultivated by a given individual corresponds to that individual's security of tenure over those specific plots and, in turn, to the individual's position in the political hierarchy relevant to those specific plots.

I. Introduction

Institutions matter for growth and development. In particular, it is apparent that investment incentives depend on expectations of rights over

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the returns to that investment and hence on the nature of property rights. In recent years, economists have paid increasing attention to this hypothesis (and brought the argument into the broader public sphere; e.g., De Soto 2000). Economic historians have provided a great deal of the evidence that bears on this hypothesis (North 1981; Jones 1986; Mokyr 2002; Engerman and Sokoloff 2003). Additional evidence has been contributed from cross-country regressions of economic growth on a variety of measures of institutional quality (Hall and Jones 1999; Acemoglu, Johnson, and Robinson 2001, 2002; Easterly and Levine 2003; Pande and Udry 2006). This paper joins a growing microeconomic literature that explores the pathways though which particular institutions influence investment or productivity (Place and Hazell 1993; Besley 1995; Banerjee, Gertler, and Ghatak 2002; Brasselle, Gaspart, and Platteau 2002; Jacoby, Rozelle, and Li 2002; Johnson, McMillan, and Woodruff 2002; Gine 2005; Galiani and Schargrodsky 2006; Field 2007; Ravallion and Van de Walle 2008). Our aim is to examine one particular mechanism through which the nature of the system of property rights in a society can shape its pattern of economic activity. We examine the connection from a set of complex and explicitly negotiable property rights over land to agricultural investment and, in turn, to agricultural productivity.

There are several potential mechanisms through which property rights over land might influence investment in agriculture. Adam Smith focused attention on the possibility that cultivators' fears of expropriation or loss of control over land on which investments have been made might deter such investment.[1] In addition, access to credit might be hindered if property rights are not sufficiently well defined for land to serve as collateral for loans; and an inability to capture potential gains from trade in improved land might reduce investment incentives. Each of these mechanisms has received a good deal of attention in what has become an important literature. With few exceptions, however, these papers "fail to find strong evidence of significant effects of property rights on investment" (Besley 1998, 361).

In much of Africa, explicit land transactions—sales, cash rentals, and

[1] In his discussion of the Act of Ejectment, which provided for compensation for past investments when a tenant was evicted, Smith writes "when such farmers have a lease for a term of years, they may sometimes find it for their interest to lay out part of their capital in the further improvement of the farm; because they may sometimes expect to recover it, with a large profit, before the expiration of the lease. The possession even of such farmers, however, was long extremely precarious, and still is so in many parts of Europe. They could before the expiration of their term be legally ousted of their lease. . . . [But since the act, in England] the security of the tenant is equal to that of the proprietor. . . . Those laws and customs so favourable to the yeomanry have perhaps contributed more to the present grandeur of England than all their boasted regulations of commerce taken together" (Smith 1974, vol. 1, bk. III, chap. 2).

sharecropping—have become more common over recent decades. However, the consensus of the literature is that "the commercialisation of land transactions has not led to the consolidation of land rights into forms of exclusive individual or corporate control comparable to Western notions of private property" (Berry 1993, 104). Instead, land "is subject to multiple, overlapping claims and ongoing debate over these claims' legitimacy and their implications for land use and the distribution of revenue" (Berry 2001, xxi).

The security of farmers' claims over land is important. In an environment in which fertilizer is expensive, land is relatively abundant, and crop returns are sufficiently low, fallowing is the primary mechanism by which farmers increase their yields. A significant portion of the agricultural land in West Africa is farmed under shifting cultivation, so fallowing remains the most important investment in land productivity. We show that farmers who lack local political power are not confident of maintaining their land rights over a long fallow. As a consequence, they fallow their land for much shorter durations than would be technically optimal, at the cost of a large proportion of their potential farm output.

We provide a brief description of land tenure in southern Ghana in Section II. The primary source of land for farming is the allocation to individuals of land controlled by that individual's extended matrilineage, or *abusua*. The agronomics of intercropped maize and cassava, which is the main farming system in the area, is discussed in Section II. In that section, we also describe the data and the survey from which they are drawn. The most important investment that farmers make in their land in the study area is fallowing, so we provide a simple model of efficient fallowing decisions to guide the empirical work in Section III.

In Section IV.A, we show that profits per hectare on maize-cassava farms vary widely across apparently similar plots cultivated by different individuals in the same household and that this variation can be attributed to variation in the length of time that these plots have been left fallow. The essence of our econometric strategy is to examine the effect of an individual's position in local political and social hierarchies on his or her fallowing choices on a plot, conditional on plot characteristics and household fixed effects. In turn, we estimate the productivity effects of (endogenous) fallowing choices, using the individual's political and social position as instruments for the fallowing choice. Our motivation for examining the relationship between fallowing decisions and the political and social position of the cultivator is provided by our review of the literature on land tenure in West Africa. The exclusion restrictions are valid within an efficient household because these variables cannot influence the within-household shadow prices of inputs or outputs.

However, there are potential unobserved variables that are correlated with both productivity and an individual's social and political status. Therefore, in Section IV.B, we examine in depth—and reject—the possibility that within-household variations in fallowing choices and productivity are associated with intrahousehold variations in wealth or bargaining power. In Section IV.C, we show that individuals with powerful positions in local political hierarchies leave their plots fallow for years longer than other individuals do, and this effect is stronger on plots allocated through the prevalent matrilineage allocation process than on plots obtained commercially. In this subsection we also disaggregate officeholding status into inherited versus noninherited offices to examine the hypothesis of reverse causality running from farming choices to officeholding. Perhaps most important, we also show that fallow durations vary across the different plots cultivated by a single farmer, depending on the provenance of the land. Individuals with local political power fallow land that they obtained through the political process of matrilineage land allocation significantly longer than they do land obtained through other means. This permits us to distinguish between determinants of investment that operate at the individual level (such as unobserved ability) and those that operate at the plot × cultivator interaction, such as tenure security.

In Section IV.D, we estimate a model of the annual risk of losing plots while they are fallow as a function of individuals' positions within local political hierarchies and the provenance of the plot. We show that those plots that are fallowed for longer durations are exactly the plots that are more securely held. In Section IV.E, we provide rough estimates of the productivity cost of this tenure insecurity and also derive bounds for discount rates that rationalize the chosen fallow durations, given the estimated productivity of fallowing and the hazard of losing plots while fallow. Section V presents conclusions.

II. Land Rights and the Farming System in Akwapim

The complexity and flexibility of property rights in West Africa are apparent in our study area in Akwapim, Ghana. Most of the land cultivated by farmers in these villages is under the ultimate control of a paramount chief and is allocated locally through the matrilineage (*abusua*) leadership.[2] Each farmer in the area cultivates on average four separate plots. Land is allocated to individuals for use on the basis of their political influence and perceived need.

There is a rich literature that describes the land tenure systems of

[2] This is not to say that other forms of ownership/contracts over land do not exist. We discuss these less prevalent forms of tenure later.

southern Ghana. The most general principle is that land is “owned” by the paramount chieftaincy (known as the *stool*) and is controlled by a particular *abusua* subject to that *abusua*’s members meeting their continuing obligations as subjects of the *stool*. Individuals, in turn, have rights to the use of farm land by virtue of membership in an *abusua*.[3]

This general principle does not define which individual member of a matrilineage will cultivate which particular plots. Individual claims over land overlap. Who ends up farming a specific plot is the outcome of a complex, sometimes contentious, process of negotiation. Moreover, land rights are multifaceted. The act of cultivating a given plot may—or may not—also be associated with the right to the produce of trees on the land, the right to lend the plot to a family member, the right to rent out the land, the right to make improvements, or the right to pass cultivation rights to one’s heirs. A person’s right to establish and maintain cultivation on a particular piece of land and the extent of her claims along the many dimensions of land tenure are ambiguous and negotiable. The situation is further complicated by the tension between matriliny and patriliny as fathers attempt to transfer land rights to their own children, outside inheritance norms (McCaskie 1995, 77, 277–78; Austin 2004, 174). As a consequence, “people’s ability to exercise claims to land remains closely linked to membership in social networks and participation in both formal and informal political processes” (Berry 1993, 104). To summarize, while “in principle, any individual is entitled to use some portion of his or her family’s land, . . . people’s abilities to exercise such claims vary a good deal in practice and are often subject to dispute. Disputed claims may turn on conflicting accounts not only of individuals’ histories of land use, field boundaries, or contributions to land improvements but also their status within the family, or even their claims of family membership itself” (Berry 2001, 145).[4]

In our sample, there are a number of individuals (about 18 percent of the sample) who hold an office of social or political power in their

[3] There are numerous descriptions of this principle. See Rattray (1923, 224–41), Klingelhofer (1972, 132), Wilks (1993), Amanor (2001, 64–76), Berry (2001, 146–56), and Austin (2004, 100).

[4] This general pattern of negotiated access to land through membership in a corporate group is found elsewhere in Ghana, in many parts of West Africa, and in some other areas of Africa, although there is considerable variation in the details. Some examples can be found in Biebuyck (1963), Benneh (1988), Bromley (1989), Bassett (1993), Bruce and Migot-Adholla (1994), Peters (1994), Binswanger, Deininger, and Feder (1995), Fred-Mensah (1996), Sawadogo and Stramm (2000), and Amanor (2001). Summarizing the conclusions of several studies from across the continent, Bassett and Crummey (1993, 20) state that “the process of acquiring and defending rights in land is inherently a political process based on power relations among members of the social group. That is, membership in the social group, is, by itself, not a sufficient condition for gaining and maintaining access to land. A person’s status . . . can and often does determine his or her capacity to engage in tenure building.”

TABLE 1
Perceptions of Land Rights

	Percent of Cultivated Plots on Which Respondent Claims Right to				Plots Fallowed More than 6 Years (%)
	Determine Inheritance (1)	Rent Out (2)	Lend Out (3)	Sell (4)	(5)
Nonofficeholders	4	15	21	10	18
Officeholders	18	37	42	22	26
t-test for equality	6.39	6.51	5.56	4.36	2.23
Observations	846	847	847	846	813

village or matrilineage. Typical offices include lineage head (*abusua-panyin*), chief's spokesman (*okyeame*), lineage elder, or subchief. These are not formal government positions. They instead represent positions of importance within local political hierarchies. In accordance with the conclusions of other observers, we find in table 1 that such individuals are far more confident than typical farmers of their rights over their cultivated land. Of course, these are their own claims about their rights along a limited number of dimensions; below, we examine the relationships between such political power and output and investment decisions on these plots and the actual hazard of losing plots while they are fallow.

A cultivator's rights over her growing crops, however, are quite secure. Wilks summarizes the principle as "afuo mu yɛ deɛ, asase yɛ ohene deɛ" ("the cultivated farm is my property, the land is the stool's"; 1993, 99).[5] Plots are virtually never lost while under cultivation. The impact of the particular form of tenure insecurity that exists in Ghana on certain types of investment, especially tree planting, therefore, might be quite minimal.[6]

However, in the farming system we consider, the most important investment in land quality is leaving land fallow in order to permit soil fertility to regenerate. It is during this period of fallow that one's rights over a plot can be lost (see Firman-Sellers 1996, 65; Austin 2004, 333–46). "Because of tenure insecurity under traditional land tenure institutions, there is no strong guarantee that the cultivator can keep fallow land for his or her own use in the future" (Otsuka et al. 2003, 78). Accordingly, we investigate the possibility that the chance that land might be lost while fallowed leads farmers to reduce the duration of

[5] This principle is also supported in the formal court system: "Since colonial times, the courts have held that while allodial rights to land belong to the stool, families' rights of usufruct are secure from arbitrary intervention" (Berry 2001, 145; citing Ollenu [1962]).

[6] See Austin (2004) and Pande and Udry (2006) for discussions of the interactions between this land tenure system and the twentieth-century cocoa boom in Ghana.

the fallow period. It is the nexus of a particular form of investment and these complex and negotiable land rights that has dramatic consequences for the overall efficiency of the farming system.

We restrict attention in this paper to the main food crop farming system in the study area, which is an intercropped mixture of maize and cassava. Approximately three-quarters of the plots cultivated in our study area are planted with these crops. This mixture became the focus of agriculture in the Akwapim region by the 1950s, after swollen shoot disease devastated cocoa production. In addition to maize and cassava, farmers in these villages also cultivate pineapple for export as a fresh fruit and a variety of other, more minor, crops.

Soil fertility in the maize and cassava farming system in southern Ghana is managed primarily through fallowing: cultivation is periodically stopped in order for nutrients to be restored and weeds and other pests to be controlled.[7] As a result, this farming system exhibits a particularly regular cycle of fallowing and cultivation. Farms are cleared from a bush fallow and the cleared brush is burned. The newly cleared plot is cultivated for a single cycle of cassava and maize—long enough for one harvest of cassava and two of maize. The cassava harvest often continues over a period of many months, ending approximately 2 years after the initial clearing of the plot. After the cassava is harvested, the plot is returned for another period of fallowing.[8] Of 519 plots in our sample, only 61 have been in cultivation for more than 3 years. In most cases, cultivation continues on these plots because they are primarily orchards with tree crops; in a few instances these are small garden plots under permanent cultivation near the house. We observed no instance of chemical fertilizers being used to maintain soil fertility on maize-cassava plots. People are aware of fertilizer and use it frequently on the pineapple farms cultivated by some of these households. The absence of its use on maize-cassava farms indicates to us that fertilizer is less profitable than fallowing as a means of maintaining soil fertility in this farming system. The fact that no farmer uses fertilizer on maize-cassava plots, of course, implies that we cannot directly test this conclusion.

Soil scientists working in the area argue that fallow durations of approximately 6–8 years are sufficient to maintain soil fertility in this farming system (de Rouw 1995; Nweke 2004). Ahn (1979, 21) argues that "under forest conditions, both soil organic matter changes and the transition from thicket of young secondary forest re-growth suggest that, in many areas, a fallow of 6–8 years is a desirable practical minimum: below

[7] Amanor (1994, chap. 6) has a useful discussion of fallowing and soil fertility in Krobo, near our study area.

[8] This corresponds to the "short fallow" system with one cycle of cultivation described by Nweke, Spencer, and Lynam (2002). This is the dominant system for cassava cultivation in Africa.

this the soil will be maintained by successive fallows at a lower organic matter level and level of productivity."

The median duration of fallow in the plots in our sample is 4 years; the 90th percentile of fallow durations is 6 years. To anticipate results that follow, column 5 in table 1 shows that plots cultivated by individuals who hold local offices are more likely to have been fallowed for more than 6 years than plots cultivated by others.

To examine this differential and the attendant productivity effects, we use data from a 2-year rural survey in the Akwapim South District of the Eastern Region of Ghana.[9] Our sample consists of four village clusters (comprising five villages and two hamlets) with a variety of cropping patterns and market integration. Within each village cluster we selected 60 married couples for our sample. Each head and spouse was interviewed 15 times during the course of the 2 years. Every interview was carried out in private, usually by an enumerator of the same gender.

In southern Ghana, as in many African societies, agricultural production is carried out on multiple plots managed separately by individuals in households, so each plot in our sample can be identified with a particular individual who controls that plot. The survey was centered around a core group of agricultural activity questionnaires (plot-level inputs, harvests, sales, credit) that were administered during each visit. The purpose of this high frequency was to minimize recall error on reports of plot-level inputs and outputs. In addition, about 35 other modules were administered on a rotating basis. We also administered an in-depth plot rights and history questionnaire and mapped each plot using a global positioning system. We supplemented this with data on soil fertility: the organic matter and pH of approximately 80 percent of the plots was tested each year. We also make use of data on education and individual wealth. It is possible to collect the latter because of the quite separate accounts that are kept by husbands and wives.

Table 2 reports summary statistics on the variables we use in this paper's analysis. Plot profits are calculated with household labor valued at gender-village-survey round specific median wages. Given that we are examining the role of political power in tenure security, we have separated the summary statistics by the officeholding status of the individual. Average per-hectare profits and yields are comparable on the plots cultivated by office holders and nonofficeholders, but officeholders cultivate larger plots. Inputs and measured soil organic matter and pH of plots are similar across officeholding status. The average duration of the last fallow period is almost a year longer for officeholders, and officeholders have had control over their plots for much longer than nonofficeholders. Officeholders are significantly more likely to be cul-

[9] The data and documentation are available at http://www.econ.yale.edu/cru2.

TABLE 2
SUMMARY STATISTICS

Variable	Officeholders Mean	Officeholders Standard Deviation	Nonofficeholders Mean	Nonofficeholders Standard Deviation	$\|t\|$
Plot-level data:					
Profit × 1,000 cedis/hectare	649.10	2,374.87	580.59	6,864.34	.11
Yield × 1,000 cedis/hectare	1,490.32	2,850.93	1,615.14	7,353.06	.18
Hectares	.48	.62	.31	.30	4.26
Labor cost × 1,000 cedis/hectare	651.39	1,155.59	883.14	2,223.01	1.11
Seed cost × 1,000 cedis/hectare	282.12	612.24	243.08	719.98	.45
pH	6.36	.71	6.34	.75	.22
Organic matter	3.22	1.06	3.13	1.08	.67
Last fallow duration (years)	4.83	4.23	3.93	2.65	2.60
Length of tenure (years)	16.13	16.10	7.32	9.47	7.26
Plot same *abusua* as individual	.66	.47	.56	.50	1.79
Plot obtained via commercial transaction	.25	.43	.30	.46	1.17
Observations	122		484		
Individual-level data:					
Gender (1 = female)	.11	.32	.40	.49	3.73
Age	51.92	13.47	40.08	12.21	5.41
Average assets × 1,000 cedis	1,475.52	1,767.18	620.39	902.57	4.71
Years of schooling	7.56	6.98	7.09	4.92	.50
1 if mother was a trader	.09	.29	.24	.43	2.23
1 if mother was a farmer	.89	.32	.72	.45	2.35
1 if father was a farmer	.82	.39	.79	.41	.46
1 if father was an artisan	.07	.25	.11	.31	.76
1 if father was a civil servant	.09	.29	.09	.29	.02
1 if father was a laborer	.00	.00	.00	.07	.46
1 if first in village of family	.11	.32	.23	.42	1.82
Years family or respondent has been in village	64.80	41.63	53.50	39.44	1.72
Number of wives of father	2.82	1.71	2.14	1.20	3.18
Number of children of father	12.04	7.32	10.84	6.51	1.10
Parity of mother in father's wives	1.71	1.47	1.30	.64	2.94
1 if fostered as a child	.58	.50	.69	.46	1.46
Size of inherited land	.62	.83	.13	.39	6.10
1 if mother had any school	.04	.21	.12	.32	1.43
1 if father had any school	.16	.37	.31	.46	2.09
Observations	45		207		

tivating plots that come from their own matrilineage than others. There is some indication that officeholders cultivate fewer plots obtained through commercial transactions. Approximately half of these commercial transactions are sharecropping contracts, and half are based on fixed rent.

Officeholders are much more likely to be male and are older, richer, and better educated than other farmers in their villages. Their mothers were more likely to be farmers, and their fathers had more wives. They are less likely to be the first of their family to settle in the village, and their families have lived in the village longer. They claim to have inherited more land (although we are skeptical about the accuracy of this particular variable because we were not able to physically measure the area claimed to be inherited, and farmer estimates of the areas of the plots they do cultivate were extremely inaccurate [Goldstein and Udry 1999]). The parents of officeholders were less likely to have been educated than others in the village, perhaps reflecting the age of the officeholders.

III. Productivity in a Fallow Farming System

An individual's decisions regarding the optimal time path of fertility and of agricultural output from a given plot in such a system depend, among other things, on the opportunity cost of capital to that individual and his or her confidence in the ability to reestablish cultivation on the plot after fallowing.

Consider an individual i (in household h) with control over a set P_i of plots of land (indexed by p). We assume that i's aim is to manage fertility to maximize the present value of the stream of profits she can claim from this land.[10] The salient decision facing this individual is the length of time she should leave each plot fallow before cultivation. Considered in a stationary environment, this corresponds precisely to the optimal harvest problem solved long ago by Faustmann ([1849] 1995).

Suppose that the profit (per hectare) that can be generated from cultivating a plot depends on the time that the plot has been left fallow according to the strictly concave and increasing function $\pi_p(\tau)$, where τ denotes the number of years the plot has been left fallow. Denote by ρ_h the household-specific annual discount rate. Let the (constant) likelihood of losing plot p during a year in which it is fallow be ω_p. The discussion in Section II implies that ω_p may vary according to i's status in local political hierarchies and according to the manner in which i acquired plot p.

[10] In general, of course, this assumption is consistent with utility maximization only if factor and insurance markets are complete (Krishna 1964; Singh, Squire, and Strauss 1986). However, we will focus on comparisons across plots within households and also across different plots cultivated by the same individual. If households are Pareto efficient (as in Chiappori [1988]), then by the second welfare theorem there exist (household-specific) shadow prices such that fertility management decisions correspond to those that maximize the present discounted value of the stream of profits at those shadow prices. Similarly, when we examine fertility decisions across plots of a particular individual, we will be assuming that the allocation of resources across plots cultivated by that single individual is Pareto efficient. In this case, there are individual-specific shadow prices such that the present discounted value of the stream of profits from each of the individual's plots is maximized.

Suppose for the moment that cultivation itself takes no time. Then the expected present discounted value of profits from i's plots is

$$\sum_{p \in P_i} \pi_p(\tau_p) \sum_{n=1}^{\infty} \left(\frac{1-\omega_p}{1+\rho_h} \right)^{n\tau_p} = \sum_{p \in P_i} \pi_p(\tau_p) \frac{[(1-\omega_p)/(1+\rho_h)]^{\tau_p}}{1-[(1-\omega_p)/(1+\rho_h)]^{\tau_p}}. \quad (1)$$

The individual maximizes (1) with respect to τ_p. Let $\pi_p'(\tau)$ denote the first derivative of the profit function. The concavity of $\pi_p(\cdot)$ ensures a unique optimal fallow duration for each plot (τ_p^*), which is defined implicitly by

$$\frac{\pi_p'(\tau_p^*)}{\pi_p(\tau_p^*)} = -\frac{\ln [(1-\omega_p)/(1+\rho_p)]}{1-[(1-\omega_p)/(1+\rho_h)]^{\tau_p^*}}. \quad (2)$$

The optimal fallow duration falls with increases in the likelihood that the individual will lose the plot and with the discount rate. It is apparent from (2) that for any two plots p and q cultivated by the same individual, if they are similarly securely held ($\omega_p = \omega_q$) and have similar physical characteristics ($\pi_p(\tau) \equiv \pi_q(\tau)$), then the optimal fallow durations are the same on each plot ($\tau_p^* = \tau_q^*$). The same holds for any two plots within a given household if the household is Pareto efficient.[11]

We supposed "for the moment" that cultivation occurred instantaneously. In fact, as we discussed above, the cultivation cycle in this farm-

[11] This general message is robust to imperfect markets that provide an incentive for individuals to adjust harvest periods to smooth factor demand. Consider, e.g., a simple discrete-time model and a household with two plots. In any given year, if the household cultivates one plot that had been fallowed the previous year, it earns Y. If it cultivates both plots, each having been fallowed, it earns only θY from each plot, $\theta < 1$. This reflects the costs of extending cultivation beyond the single plot where labor or other input markets are imperfect. If a plot was not left fallow the previous year, it yields δY, $\delta < 1/2$ (so fallowing is potentially productive). If two unfallowed plots are cultivated, total return is $2\delta\theta Y$; if one unfallowed and one fallowed plot are cultivated, the return is $\theta Y(1+\delta)$. Let the state variable $s \in (0, 1, 2)$ denote the number of plots fallowed last period. The discount factor is β, and the household is risk neutral and maximizes the discounted stream of future returns. The value functions v_s are

$$v_2 = \max\{\beta v_2,\ Y + \beta v_1,\ 2\theta Y + \beta v_0\},$$

$$v_1 = \max\{\beta v_2,\ Y + \beta v_1,\ \theta Y(1+\delta) + \beta v_0\},$$

$$v_0 = \max\{\beta v_2,\ \delta Y + \beta v_1,\ 2\delta\theta Y + \beta v_0\}.$$

The choices in each maximand correspond to fallowing two, one, or zero plots, respectively. Depending on parameter values, there are a number of possible equilibria. The interesting case is the two equilibria

$$0 \rightarrow 2,\ 1 \rightarrow 1,\ 2 \rightarrow 1$$

$$0 \rightarrow 0,\ 1 \rightarrow 1,\ 2 \rightarrow 1.$$

In the first pattern, the equilibrium of cultivating one of the two plots each year rapidly emerges, regardless of the initial state of fallowing. However, for sufficiently low β, the second pattern emerges. If the cultivator starts with none of her plots fallowed ($s = 0$), she is sufficiently impatient that she does not ever begin fallowing. The key point is that in the steady state of any equilibrium, each similar plot is treated identically.

ing system occurs over a period of 2 years. During the period of cultivation, there is no chance that the plot will be lost. This fact does not change the essence of this argument. Accounting for the 2-year period during which cultivation occurs changes the expected present discounted value of profits of the plots cultivated by i to

$$\sum_{p \in P_i} \pi_p(\tau_p) \frac{(1-\omega_p)^{\tau_p - 2}/(1+\rho_h)^{\tau_p}}{1 - [(1-\omega_p)^{\tau_p - 2}/(1+\rho_h)^{\tau_p}]}. \tag{1$'$}$$

Equation (2) becomes considerably more complex without changing the comparative static conclusions at all.

Given imperfect financial and labor markets in rural Ghana, it is unlikely that the opportunity costs of capital or labor are identical across plots cultivated by individuals in different households. However, they will be the same across plots cultivated by the same individual, and if households allocate resources efficiently across household members, then they will be identical across plots within households. These observations form the basis of our initial empirical work.

We begin by supposing that households allocate resources efficiently. If so, the marginal value products of inputs used on farm operations are equated across plots within households. We do not assume that input costs or the opportunity cost of capital is similar across households. Within the household, plots of similar fertility should be cultivated similarly. Moreover, we have seen in (2) that the optimal fallowing period does not vary across plots within the household, except as a function of their physical characteristics or of the security with which they are held.

So we can define profits on plot p cultivated by individual i in household h at time t as a function only of the characteristics of that plot:

$$\pi(\tau_p^*(\mathbf{X}_p, \omega_p), \mathbf{X}_p), \tag{3}$$

where $\mathbf{X}_p$ is defined as a vector of fixed characteristics of plot p and τ_p^* is the duration of the last fallow on plot p. A first-order approximation of the difference in profits across plots within a household is

$$\pi(\tau_p^*, \mathbf{X}_p) - \pi(\bar{\tau}_{h_p}, \overline{\mathbf{X}}_{h_p}) \approx \frac{\partial \pi}{\partial \tau}(\tau_p^* - \bar{\tau}_{h_p}) + \frac{\partial \pi}{\partial \mathbf{X}}(\mathbf{X}_p - \overline{\mathbf{X}}_{h_p}), \tag{4}$$

where h_p is the household in which the cultivator of plot p resides, and bars indicate averages of characteristics over the plots cultivated by household h_p.

We rewrite (4) as

$$\pi_{pt} = \alpha\tau_p^* + \mathbf{X}_p\boldsymbol{\beta} + \gamma G_p + \lambda_{h_p,t} + \varepsilon_{pt}, \tag{5}$$

where π_{pt} is the profit measured on plot p in year t, α is $\partial\pi/\partial\tau$, $\boldsymbol{\beta}$ is

$\partial\pi/\partial\mathbf{X}$, and G_p is the gender of the individual who cultivates plot p. The term $\lambda_{h_p,t}$ is a fixed effect for the household-year, and ε_{pt} is an error term (that might be heteroskedastic and correlated within household-year groups) that summarizes the effects of unobserved variation in plot quality and plot-specific production shocks on profits. An exclusion restriction of the model is that $\boldsymbol{\gamma} = 0$. In an efficient household, the identity of the cultivator is irrelevant for profits.

Within the vector $\mathbf{X}_p$ we include a variety of plot characteristics: size, toposequence, direct measures of soil quality (the soil pH and organic matter content), and the respondent-reported soil type classified into clay, sandy, or loam. These soil types might affect profits and inputs through their different nutrient and moisture retention capacities, among other factors.

Equation (2) implies that τ_p^* is chosen optimally. We can expect τ_p^* to be correlated with ε_{pt}, even conditional on $\lambda_{h_p,t}$, because it may respond to the same unobserved attributes of the plot that influence profits. From (3), we see that the appropriate instrument for τ_p^* is ω_p—the security of tenure over that plot. However, ω_p is unobserved. Therefore, on the basis of the discussion of Section II, we collected a set of variables that represent the cultivator's position in local social and political hierarchies. These variables might influence her tenure security and thus her choice of optimal fallow duration, and we estimate (5) using these as instrumental variables.

IV. Results

A. *Fallowing and Within-Household Productivity Variation*

We begin with what we expect is the counterfactual assumption that there is complete tenure security on all plots in our sample, which implies that $\omega_p = 0$ for all plots. In this case, equation (2) implies that optimal fallow duration τ_p^* is a function only of $\mathbf{X}_p$ and household-specific shadow prices. Equation (3) becomes $\pi_t(\tau(\mathbf{X}_p), \mathbf{X}_p)$, where $\tau(\cdot)$ is defined implicitly by (2) evaluated at ρ_h. Within-household differences in plot profits (4) depend only on differences in plot characteristics, so we modify (5) and estimate

$$\pi_{pt} = \mathbf{X}_p\tilde{\boldsymbol{\beta}} + \tilde{\boldsymbol{\gamma}}G_p + \tilde{\lambda}_{h_p,t} + \tilde{\varepsilon}_{pt}. \tag{6}$$

In (6) $\tilde{\boldsymbol{\beta}}$ is

$$\frac{\partial\pi}{\partial\tau}\frac{\partial\tau}{\partial\mathbf{X}} + \frac{\partial\pi}{\partial\mathbf{X}};$$

that is, it captures both the direct and the indirect (through fallowing choice) effects on plot profits of variation in plot characteristics. The

TABLE 3
PROFITS AND GENDER
Dependent Variable: Profit × 1,000 Cedis/Hectare

	OLS (1)	OLS (2)	OLS (3)
Gender: 1 = woman	−913 (365)	−985 (468)	−1,683 (380)
Plot size decile:			
2	198 (486)	1,049 (571)	1,646 (265)
3	689 (507)	1,239 (590)	749 (265)
4	655 (508)	1,806 (591)	1,557 (364)
5	25 (502)	883 (583)	923 (147)
6	377 (489)	1,447 (581)	819 (222)
7	−79 (494)	1,206 (548)	628 (252)
8	−389 (520)	593 (594)	−180 (259)
9	46 (513)	705 (633)	420 (261)
10	−383 (597)	−17 (693)	−693 (338)
Soil type:			
Loam	629 (342)	35 (396)	−21 (151)
Clay	226 (381)	−58 (463)	122 (321)
Toposequence:			
Midslope	−364 (1,110)	339 (1,581)	−705 (493)
Bottom	−45 (1,104)	661 (1,569)	−722 (552)
Steep	−800 (1,153)	−83 (1,610)	476 (695)
pH		−122 (247)	−202 (78)
Organic matter		−26 (150)	135 (49)
Observations	888	614	575
Fixed effects	Household × year	Household × year	Spatial (250 meters) and household × year

NOTE.—Standard errors are in parentheses.

exclusion restriction $\tilde{\gamma} = 0$ remains in force, under the joint null hypothesis that the household is Pareto efficient and that there is no variation in tenure security across plots.

We present estimates of (6) in table 3. Recall that the results are interpreted in terms of deviations from household-year means for cassava-maize plots. We do not expect returns to be equalized across households or years because of imperfect factor markets within villages. Column 1 presents ordinary least squares (OLS) results.[12] The most striking result concerns gender: women achieve much lower profits than their husbands. Conditional on household-year fixed effects and on the observed characteristics of their plots, women get 900,000 cedis less in profits per hectare then their husbands. Average profits per hectare are approximately 600,000 cedis, so this is a very large effect. Given diminishing returns, a systematic difference in the cassava/maize profits on similar plots of men and women *within* a household in a given year rejects our joint null of Pareto efficiency within households and the assumption that tenure security is the same across plots within a household. The literature contains similar results in some other West African contexts (Udry 1996; Akresh 2005); those papers have interpreted it as a violation of the null hypothesis of within-household Pareto efficiency. Here, we raise the possibility that the within-household dispersion in yields on similar plots may arise from the land tenure system.

Another possible explanation for the gender differential in farm profitability is that women farm plots that are of lower exogenous quality than those of their husbands. In column 2, we add additional information on soil quality, in the form of data on the soil pH and organic matter content measured on most plots.[13] Differences in this dimension of measured soil quality do not help explain the gap in profits between husbands and wives.

It is possible that the plots of husbands and wives are physically systematically different from each other along dimensions that we do not observe. The different profitability of their plots might be a consequence of these unobserved differences in fundamental plot characteristics. These unobserved differences in physical characteristics might have to do, for example, with variations in soil physical structure or quality that are finer than we observe or with differences in moisture or patterns of water runoff. In the Akwapim region, these relatively fine physical characteristics of land tend to vary gradually over space. Plots close to each other (within a few hundred meters) are more likely to be very similar than plots separated by larger distances. This can be seen in

[12] The standard errors in all our specifications use limiting results for cross-section estimation with spatial dependence characterized by physical distance between plots. Spatial standard errors are calculated using the estimator in Conley (1999) with a weighting function that is the product of one kernel in each dimension (north-south, east-west). In each dimension, the kernel starts at one and decreases linearly until it is zero at a distance of 1.5 kilometers and remains at zero for larger distances. This estimator allows general correlation patterns up to the cutoff distances.

[13] We lose some plots because of the administrative difficulties of conducting such a large number of soil tests. In addition, soil pH and organic matter content are likely to respond to fallowing decisions; hence, in most of the results that follow these variables are excluded.

figure 1, which is a map of the plots in one of the villages. This map also shows houses (as stars) and paths. The other villages are organized similarly.

Therefore, we generalize (6) to permit a local neighborhood effect in unobserved land quality that could be correlated with gender and the other regressors. With some abuse of notation, let N_p denote both the set of plots within a critical distance of plot p and the number of such plots. We construct a within estimator by differencing away these spatial fixed effects:

$$\pi_{pt} - \frac{1}{N_p}\sum_{q\in N_p}\pi_{qt} = \left(\mathbf{X}_p - \frac{1}{N_p}\sum_{q\in N_p}\mathbf{X}_q\right)\tilde{\beta} + \tilde{\gamma}\left(G_p - \frac{1}{N_p}\sum_{q\in N_p}G_q\right)$$
$$+ \tilde{\lambda}_{h_pt} - \frac{1}{N_p}\sum_{q\in N_p}\tilde{\lambda}_{h_qt} + \tilde{\varepsilon}_{pt} - \frac{1}{N_p}\sum_{q\in N_p}\tilde{\varepsilon}_{qt}. \qquad (7)$$

In column 3 of table 3 we define the geographical neighborhood of each plot using a critical distance of 250 meters. If the component of unobserved land quality that is correlated with the regressors in (7) is fixed within this small neighborhood, then the spatial fixed-effect estimator removes this potential source of bias. Wives achieve much lower profits than their husbands, even on plots that are within 250 meters of each other.

Husbands and wives achieve very different profits on plots that share very similar fundamental characteristics. However, these estimates neglect the anthropogenic differences in soil fertility that emerge as a result of the varying fallowing histories of their plots. If tenure security is not the same on all plots and this variation is correlated with gender, then fallowing choices might systematically vary across plots that otherwise look similar. Hence, in table 4 we present estimates of equation (5).

In column 1 we present OLS estimates that ignore the potential endogeneity of τ^*. Unsurprisingly, given the discussion of soil fertility in Section II, we find that longer fallow durations are strongly associated with higher profits. Perhaps more important, the coefficient on gender falls by more than half and is statistically insignificant. Conditional on fallow duration, we can no longer reject the hypothesis that profits are similar on men's and women's plots within a household-year.

The optimal duration of fallowing on a plot depends on unobserved plot and individual characteristics and so is treated as endogenous in columns 3, 4, and 6. We use a set of variables based on the social and political family background of the cultivator as instruments for the duration of the most recent fallow. In Section II, we saw that an individual's security of tenure on a given plot is influenced by his or her position in local social and political hierarchies. Conditional on the assumption

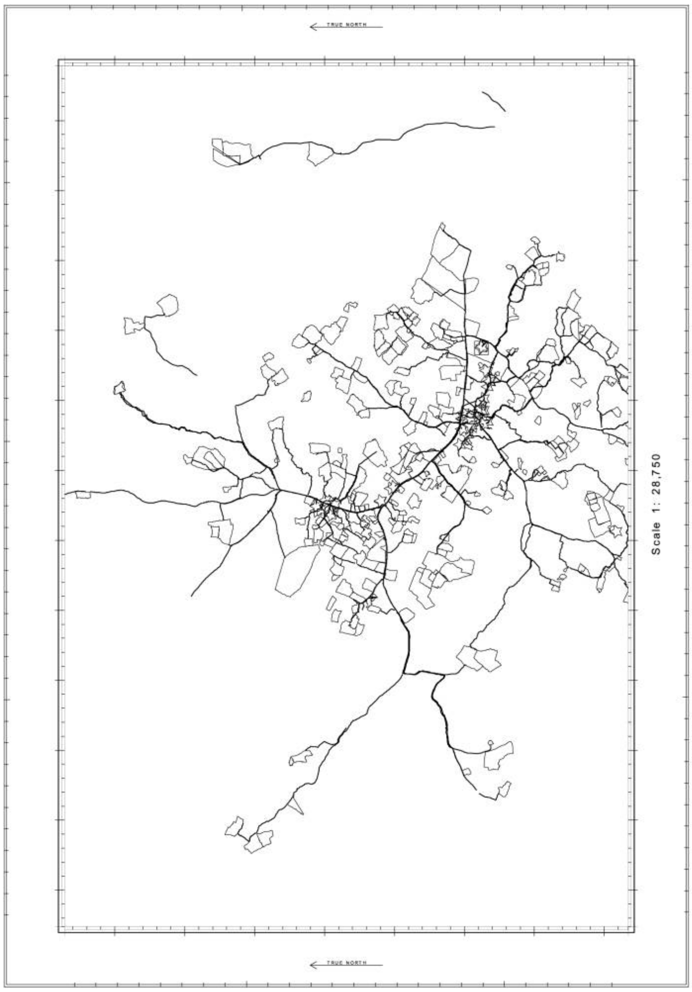

FIG. 1.—Plots of sample members in one village

TABLE 4
Profits and Fallow Duration

	OLS DV: Profit × 1,000 Cedis/Hectare (1)	OLS DV: Fallow Duration (2)	IV DV: Profit × 1,000 Cedis/Hectare (3)	IV DV: Profit × 1,000 Cedis/Hectare (4)	OLS DV: Fallow Duration (5)	IV DV: Profit × 1,000 Cedis/Hectare (6)
Fallow duration (years)*	145		541	662		326
	(48)		(233)	(261)		(58)
Gender: 1 = woman	−473	−.58	130	−688	−.34	328
	(393)	(.67)	(555)	(732)	(.24)	(148)
Age				−118		
				(62)		
> 6 years of school				−286		
				(720)		
1 if first of family in town		−.44			.30	
		(.66)			(.19)	
Years family/respondent lived in village		−.01			.01	
		(.01)			(.00)	

	(1)	(2)	(3)	(4)	(5)	(6)
1 if respondent holds traditional office		3.91			1.82	
		(1.11)			(.33)	
Number of wives of father		.39			.50	
		(.35)			(.13)	
Number of father's children		−.08			−.01	
		(.07)			(.02)	
Parity of mother in father's wives		−.44			−.43	
		(.41)			(.32)	
1 if fostered as a child		.86			.37	
		(.74)			(.34)	
Size of inherited land		−.29			−.45	
		(.63)			(.21)	
1 if mother had any education		−.87			1.18	
		(1.17)			(.61)	
1 if father had any education		−.13			−1.16	
		(.80)			(.31)	
Observations	760	755	755	672	609	609
Fixed effects		Household × year			Spatial (250 meters) and household × year	
J-statistic of overidentifying restrictions			$\chi^2(16) = 10.25$	$\chi^2(9) = 2.25$		$\chi^2(9) = 2.43$
F-test of instruments		$F(10, 415) = 2.10$			$F(10, 272) = 20.83$	

NOTE.—All regressions include the plot characteristics used in table 3, col. 1. Standard errors (in parentheses) are consistent for arbitrary spatial correlation.
* Treated as endogenous in cols. 3, 4, and 6. Instruments are as indicated in cols. 2 and 5.

of Pareto efficiency within the household, these variables cannot influence the shadow price of factors of production or output and hence do not enter (3) except via ω_p, the security of tenure. We test the overidentifying restrictions implied by this assumption in table 4 and relax the household efficiency assumption by moving to a within-individual procedure in Section IV.C.

The instrument set includes the indicator that the individual holds an office of local social or political power as in table 2. In addition, we include more subtle dimensions of the individual's status within the village and matrilineage. These include two indicators of the length of time the cultivator's household has been resident in the village. Newer migrants to the village have a shorter history of local land use, and we saw in Section II that the history of land allocations can play a role in the security with which an individual holds a plot. We also include the number of wives of the individual's father and the parity of the individual's mother in that set of wives. In a polygamous union, the position of a wife in the order of marriages is important for her children's claims over property, among other things. We also include the number of children of the individual's father and an indicator of whether the individual was fostered as a child. Each of these variables is an attempt to capture an aspect of the individual's place within his or her matrilineage, which the literature implies would influence ω_p. Finally, we include measures of the education of the individual's parents as the most important indicator of the parent's social status.

The results of the first-stage regression are presented in column 2 of table 4. The instruments are jointly significant determinants of the duration of fallow on a plot. Officeholders fallow their plots much longer than others. We interpret this first-stage regression as preliminary evidence that the local social and political status of individuals does influence their security of tenure and that this in turn permits them to leave plots fallow for longer periods of time. This hypothesis is examined in more detail below in Sections IV.B–D.

The entire difference between profits on husbands' and wives' plots is attributable to the longer fallow periods on men's plots. In column 3, we show that conditional on fallowing choices, there is no gender differential in profits within households. Instead, we find a strong positive correlation between fallow periods and profits: each additional year of fallowing is associated with about 550,000 cedis of additional profits per hectare. This is a very large effect, given a standard deviation of fallowing of about 3 years. The instrumental variable (IV) estimate of the effect of fallow duration on profits is more than thrice that obtained via OLS, implying that fallowing is negatively correlated with other unobserved determinants of profitability on plots. Farmers appear to compensate for worse plot conditions by extending fallow durations.

Within-household variations in age and education are not driving the variation across plots in fallow durations or profits. We saw in table 2 that officeholders tended to be older than other cultivators. However, in column 4 of table 4, we show that neither age nor education accounts for any of the difference in profits per hectare on plots that have longer fallow durations.

As before, there is a potential concern with unobserved variation in exogenous plot characteristics. If these unobserved characteristics are correlated with the social and political status of the cultivator, then the IV estimator is inconsistent. It is possible, for example, that officeholders get land that is better than average and that output is higher on those plots. If it is also the case that these plots are left fallow for longer periods (perhaps for reasons orthogonal to productivity), then we could see the pattern of results displayed in columns 2 and 3. Therefore, we estimate (5) with spatial fixed effects as well in columns 5 and 6. The strong effect of fallow durations on plot-level profits remains apparent conditional on these spatial fixed effects, and we now find that wives achieve even larger profits than their husbands once we condition on fallow duration.

B. Bargaining, Wealth, and Fallowing Decisions

In this subsection we examine more carefully the determinants of this variation in fallowing choices across plots within households. First, we consider the possibility that inefficient fallowing is a consequence of an inefficient bargaining process within the household. Second, we examine the hypothesis that individuals (within a household) of different social and political status face different opportunity costs of capital and that these differences induce them to choose different fallow durations.

We see in columns 2 and 5 of table 4 that, within households, individuals fallow longer if they have political office. When we control for spatial effects, the length of fallow is associated with the number of wives of their father, their land inheritance, and their parents' education. These indicators of social and political status could be associated with intrahousehold bargaining power. Perhaps the variation in fallowing is a consequence of some inefficient bargaining process within the household (inefficient because an efficient allocation within the household would equalize fallow durations across similar plots). We will address this possibility in three steps. First, in table 5, we show that the wives of officeholders do not have characteristics that distinguish them from the wives of nonofficeholders along the dimensions that determine fallowing, aside from having an officeholder as a spouse. Nor are their attributes vis-à-vis the wives of nonofficeholders those typically associated with diminished intrahousehold bargaining power in the West African

TABLE 5
CHARACTERISTICS OF WIVES OF OFFICEHOLDERS AND NONOFFICEHOLDERS: INDIVIDUAL-LEVEL DATA

	Officeholders		Nonofficeholders		
Variable	Mean	Standard Deviation	Mean	Standard Deviation	$\lvert t \rvert$
Age	45.52	12.86	36.17	13.01	3.65
Average assets × 1,000 cedis	720.48	1,202.12	324.46	243.01	3.27
Years of schooling	2.85	3.92	5.11	4.31	2.70
1 if mother was a trader	.18	.39	.26	.44	.93
1 if mother was a farmer	.82	.39	.69	.46	1.42
1 if father was a farmer	.76	.44	.79	.41	.45
1 if father was an artisan	.09	.29	.06	.23	.71
1 if father was a civil servant	.15	.36	.13	.34	.30
1 if father was a laborer	.00	.00	.01	.10	.55
1 if first in village of family	.52	.51	.25	.44	2.91
Years family or respondent has been in village	38.36	32.81	48.78	41.43	1.32
Number of wives of father	2.09	1.01	2.13	1.10	.19
Number of children of father	8.85	4.95	11.71	7.57	2.04
Parity of mother in father's wives	1.33	.60	1.30	.74	.24
1 if fostered as a child	.76	.43	.72	.45	.48
Size of inherited land	.12	.33	.04	.23	1.58
1 if mother had any school	.03	.17	.18	.38	2.16
1 if father had any school	.26	.45	.41	.49	1.50
Observations	38		118		

context. For example, wives of officeholders are older and wealthier than wives of other men. Second, the fact that their husbands are officeholders may imply that the wives have relatively low weight in some inefficient intrahousehold bargaining process. Therefore, in Section IV.C, we will show similar magnitudes of variation in fallowing choices across plots cultivated by individuals, where inefficient bargaining does not arise as a possible explanation. Third, in Section IV.D, we estimate a hazard model that provides direct evidence of land tenure insecurity that coincides with these results.

An alternative hypothesis is that officeholders fallow their plots more than others because they face a lower opportunity cost of capital. It is plausible that (within a household) relatively wealthy individuals are less credit constrained and therefore choose longer fallow periods. We are able to measure individual wealth holdings because in West Africa most nonland assets are held by individuals rather than by households. Wealth in this exercise is defined as the value of individual holdings of financial assets, stocks of agricultural inputs and outputs, stocks of goods for trading, physical assets and working capital of individual businesses, livestock, farm equipment, and consumer durables.

Of course, individual wealth may be correlated with unobserved characteristics of the plots cultivated by the individual. Therefore, we estimate the determinants of the duration of the last fallow period treating current wealth as endogenous, using the occupational background of the cultivator's parents as instruments for wealth. The relevant conditioning information includes all the measures of the social and political background of the cultivator that appeared in table 4, including the amount of inherited land, traditional officeholding status, and migratory history. The identification assumption is that conditional on these other dimensions of the cultivator's background, parental occupation influences fallowing decisions only through its effect on wealth. The justification for this assumption is that information about the technical properties of fallowing in this farming system is well distributed given its long dominance in the region. The estimates in Section IV.C are robust to deviations from this assumption.

The first-stage estimates of the determinants of current wealth are reported in column 1 of table 6. The instruments are jointly highly significant determinants of current wealth. Current wealth is much lower if the cultivator's mother was a farmer rather than the excluded category of trader (or a few other miscellaneous occupations). Current wealth is much higher if the cultivator's father had an office job and somewhat higher if the cultivator's father was a farmer, relative to the excluded category of laborer/artisan. Several of the conditioning variables are also strongly related to current wealth: current wealth is strongly positively correlated to the number of wives of the father and to the parity of one's own mother in that set and negatively related to the number of children of one's father. Individuals whose families have recently migrated to the village tend to be wealthier, and those who were fostered as children poorer. As we saw in the summary statistics, officeholders tend to be wealthier than others.

Current wealth is well determined by the occupations of one's parents but in turn has nothing to do with fallowing decisions. In column 2 we present the fixed-effect (spatial and household) IV estimates of the determinants of fallow duration with current wealth treated as endogenous. The coefficient on current wealth is quite precisely estimated to be near zero: the point estimate implies that individuals with 1 million cedis in additional wealth (mean wealth is 700,000 cedis) reduce the fallow duration on their plots by about a month, and the coefficient is not significantly different from zero. Moreover, the estimated impact of officeholding on fallowing decisions is unchanged from our earlier spatial fixed-effect specification. These results provide no support for the hypothesis that variations within the household in the cost of capital lie at the root of variations in fallowing across the plots cultivated by household members.

TABLE 6
FALLOW, WEALTH, AND LAND OWNED

	OLS DV: Wealth ($\times$1,000 Cedis) (1)	IV DV: Fallow Duration (2)	OLS DV: Fallow Duration (3)
Wealth ($\times$1,000 cedis)*		−.001	
		(.001)	
Gender: 1 = woman	32	−.01	−.27
	(107)	(.20)	(.23)
Area on other plots (hectares)			−.16
			(.07)
1 if first of family in town	145	.06	.22
	(89)	(.32)	(.28)
Years family/respondent lived in village	8	.01	.01
	(1)	(.01)	(.00)
1 if respondent holds traditional office	497	2.35	2.01
	(174)	(.56)	(.36)
Number of wives of father	128	.46	.33
	(36)	(.18)	(.17)
Number of father's children	−46	−.05	.00
	(10)	(.04)	(.02)
Parity of mother in father's wives	141	−.16	−.40
	(64)	(.29)	(.34)
1 if fostered as a child	−152	.20	.38
	(86)	(.30)	(.34)
Size of inherited land	−262	−.69	−.33
	(118)	(.25)	(.23)
1 if mother had any education	−318	.18	.67
	(239)	(.50)	(.52)
1 if father had any education	−84	−.76	−.83
	(91)	(.42)	(.41)
1 if mother was a farmer	−658		
	(232)		
1 if father was a farmer	357		
	(111)		
1 if father had an office job	696		
	(168)		
Observations	413	413	413
Fixed effects	Household and spatial fixed effects (250 meters)		
J-statistic of overidentifying restrictions		$\chi^2(2) = 1.40$	
F-test of instruments	$F(3, 409) = 6.51$		

NOTE.—Standard errors are in parentheses.
* Treated as endogenous. Instruments are as indicated in col. 2.

In column 3, we examine another dimension of wealth: the total land area controlled by the individual (minus the area on the plot under consideration). We find that fallow durations are decreasing in the total area controlled by the individual. The standard deviation of area on other plots is approximately 1 hectare; increasing area by that magnitude is associated with a relatively small but statistically significant decline in fallowing of approximately 2 months. This result should be treated with

TABLE 7
FALLOW DURATION AND PLOT ORIGIN
Dependent Variable: Fallow Duration

	OLS: ALL PLOTS			
	(1)	(2)	(3)	(4)
Gender: 1 = woman	−.35	−.36	−.28	−.48
	(.20)	(.20)	(.22)	(.24)
1 if officeholder	1.73		.68	
	(.49)		(.59)	
1 if holds inherited office		2.28		1.49
		(.93)		(.65)
1 if noninherited office		1.29		−.52
		(.53)		(.95)
Plot in same *abusua* as cultivator			.25	.36
			(.21)	(.27)
Cultivator holds office × Plot in same *abusua* as cultivator			3.24	
			(.89)	
Cultivator holds inherited office × Plot in same *abusua* as cultivator				1.63
				(1.57)
Cultivator holds noninherited office × Plot in same *abusua* as cultivator				2.92
				(1.01)
Observations	402	402	402	402
Fixed effects	Household and spatial fixed effects (250 meters)			

NOTE.—Standard errors are in parentheses.

caution because it is plausible that the total area cultivated by an individual is correlated with unobserved variables that influence fallowing choices. Unfortunately, we cannot construct a theoretical argument for the existence of variables that influence the area of land cultivated by each individual that do not also influence that individual's tenure security and thus fallow duration. However, we can see from these results that the strong effect of officeholding on fallowing durations is not a simple consequence of officeholders having more land and therefore mechanically fallowing land for longer.

C. *Political Power, Tenure Security, and Investment in Fertility*

The strongest and most consistent of our results is that those who hold a local social or political office fallow their land longer than others in their households and, as a consequence, achieve higher profits. The remainder of the paper focuses on the relationship between officeholding and investment in land fertility. Column 1 of table 7 provides the baseline result: conditional on household and spatial fixed effects and on the same plot characteristics included in table 3, officeholders leave their plots fallow for almost 2 years longer than others in the same household. This result is very similar to that shown in column 5 of table 4.

We treat officeholding status as exogenous to fallow duration on farmers' plots. It is possible, though, that offices are awarded to individuals in part on the basis of their decisions as farmers. In nearby northern Nigeria one common office is *sarkin noma*, "chief farmer," which is often awarded to a particularly innovative or successful farmer. One might not want to treat such an office as exogenous in a regression such as that reported in column 1 of table 7. As a first step, therefore, we divide the offices reported in our data into two categories: the first is the set of offices that are typically inherited (e.g., *abusuapanyin*, or lineage head). The second are offices that are not inherited (e.g., village youth chief). We estimate the coefficients of these two types of office separately in column 2. In both cases, there is a statistically significant positive relationship between officeholding and fallow durations. The point estimate is stronger for inherited offices than for noninherited offices, although the difference is not statistically significant. This exercise provides no evidence that the strong positive relationship between officeholding and fallow durations is being driven by a simple reverse causality between farming performance and ascent to office. The more subtle worry that officeholders have unobserved characteristics that might be associated with longer fallow durations is addressed in the within-individual analysis that follows in table 8. For the remainder of the paper, we will report results both for the aggregate set of officeholders and disaggregated by type of office.

All land in our sample can be traced to a specific matrilineage, whether it was allocated through the matrilineage-based political process of land allocation or not. Approximately 60 percent of the plots in our sample are controlled by the matrilineage of the cultivator (table 2). There are several mechanisms through which individuals can come to be cultivating plots that are not of their own matrilineage. Most commonly, this occurs as a consequence of a commercial transaction or because the land is obtained from one's spouse or father, who are often members of a different matrilineage. We hypothesize that holding a local political office is particularly effective in improving an individual's security of tenure over those plots that are allocated through the political process of allocating matrilineage land as described in Section II.

In column 3 of table 7, we present a household and spatial fixed-effects regression of the determinants of fallow duration focusing on the provenance of the plot and its interactions with the political status of the cultivator. The estimates show that the fallowing differential that we observe between those who hold a local political office and those who do not occurs only on land that is allocated through the matrilineage. On land obtained commercially or through immediate family, there is no statistically significant difference between the fallowing behavior of officeholders and that of other individuals. For nonofficeholders, there is no statistically significant difference between the fallow durations on plots that they cultivate that originate in their own matrilineage and on those plots obtained from other sources. However, on land allocated by the matrilineage, officeholders have fallow durations that are more than 3 years longer than those of nonofficeholders.

A similar pattern emerges in column 4, where we disaggregate between inherited and noninherited offices. Once again, for nonofficeholders, there is no statistically significant difference in fallowing on land obtained from the matrilineage versus other sources. Officeholders fallow matrilineage land longer than they do land obtained from other sources, although this difference is statistically significant only for holders of noninherited offices. In contrast to the result in column 3, when disaggregating we find that holders of inherited office fallow plots longer than nonofficeholders, even if they are not obtained from the matrilineage.

We saw in table 1 that individuals with local offices expressed more confidence in their rights over their plots, and table 7 shows that these officeholders fallow their land much longer than other individuals and that these variations in fallowing choices associated with local political status are mostly limited to matrilineage land. The complexity and ambiguity of land rights in the study area were discussed in Section II. One consequence of this complexity is that individuals commonly cultivate plots obtained from a variety of sources and through a variety of arrangements. This variety permits us to examine the within-cultivator determinants of fallowing behavior. The key advantage of this strategy is that we can distinguish between determinants of fallowing that operate at the individual level, such as the shadow costs of factors of production or unobserved ability, and those that might operate at the level of the plot × cultivator interaction, such as the security of tenure over a given plot.

In column 1 of table 8, we show that fallow durations vary across the plots of a given cultivator, depending on the source of the plot (these are also conditional on spatial fixed effects). The excluded category in this regression is the set of plots obtained via noncommercial arrangements, from individuals who are not close family members.[14] As reported in table 2, somewhat more than one-quarter of plots are obtained through commercial transactions, either fixed-rent or sharecropping contracts. These plots are left fallowed for almost 8 months longer than

[14] The sample size is smaller in col. 1 than in col. 2 or 3 because for some plots we are missing data on the identity of the individual from whom the plot was obtained.

TABLE 8
WITHIN-CULTIVATOR FALLOWING CHOICES
Dependent Variable: Fallow Duration

	All Plots: OLS			Exclude Commercial Plots: OLS	
	(1)	(2)	(3)	(4)	(5)
Plot in same *abusua* as cultivator		.05 (.18)	.07 (.22)	−1.10 (.37)	.86 (.62)
Cultivator holds office × Plot in same *abusua* as cultivator		2.30 (.86)		5.96 (2.16)	
Cultivator holds inherited office × Plot in same *abusua* as cultivator			3.49 (1.03)		6.57 (1.60)
Cultivator holds noninherited office × Plot in same *abusua* as cultivator			2.28 (.54)		4.03 (1.15)
Plot obtained commercially	.64 (.26)				
Plot obtained from spouse	−.58 (.41)				
Plot obtained from family	.83 (.36)				
Observations	388	402	402	266	266
Fixed effects	Individual cultivator and spatial fixed effects (250 meters)				

NOTE.—Standard errors are in parentheses.

other plots farmed by the same cultivator.[15] Plots obtained from one's spouse may be left fallow less than other plots, but the difference is not statistically significant at conventional levels. Plots that are obtained from other close family members are fallowed for almost 10 months longer than plots obtained from individuals who are not related.

There is important variation in fallow durations across the plots cultivated by a given individual, depending on the provenance of the plot. This variation corresponds to the confidence that individuals express regarding their rights in focus group discussions, in which it was argued that commercial transactions or close family ties help to secure one's ability to reestablish cultivation on a fallowed plot; whereas women expressed particular concern over their ability to maintain control over plots obtained indirectly from another source via their spouse. Where relevant, these results also correspond to cultivators' self-assessed rights over plots. Farmers claim the right to rent out land obtained from family on 39 percent of such plots, but claim this right only on 3 percent of plots obtained from nonfamily and only on 1 percent of plots obtained

[15] We find no significant differences in fallowing choices between sharecropped and fixed-rent contracts.

from their spouse. Similar patterns are observed for the right to lend out the plot, sell it, or decide who will inherit it.[16]

We saw in column 3 of table 7 that, conditional on household fixed effects, officeholders fallow matrilineage land much longer than they do land from outside the matrilineage. This accords with the literature on land rights in southern Ghana, which makes it clear that tenure security is not a universal attribute of an individual. Rather, an individual's security of tenure over a particular plot reflects that individual's position within the local social and political hierarchy *and* the manner in which that plot was obtained.

Looking only across plots cultivated by a given individual, in column 2 of table 8 we show that officeholders fallow land from within their own matrilineage for more than 2 years longer than they do other plots that they cultivate. Because officeholders are in a superior political position, they are more confident of their ability to reestablish cultivation on fallowed plots that they have obtained through the matrilineage allocation process and therefore leave such plots fallow for longer.

We replicate these results in column 3 for disaggregated offices: holders of both inherited and noninherited offices fallow their matrilineage plots longer than they do their other plots. The point estimate is larger for those who hold inherited office than for those who do not, but the difference is not statistically significant. Officeholders leave their matrilineage-obtained plots to fallow for 2–4 years longer than they do their other plots.

We expect the increased security of plots cultivated by officeholders to be particularly evident on plots that were obtained via this political process. Therefore, we restrict attention in the specification reported in column 4 to plots that were not obtained through commercial transactions. Officeholders fallow noncommercial land from within their own matrilineage for almost 6 years longer than they do noncommercial land from other sources; in stark contrast, nonofficeholders fallow noncommercial land from within their own matrilineage even less than they do land from other sources. In column 5, we again disaggregate offices and find the same general story. In this case, we no longer find that nonofficeholders leave their matrilineage land fallow less than their other plots. Holders of both inherited and noninherited offices leave their matrilineage land fallow much longer (4–7 years) than their other plots.

Officeholders leave land fallow for longer periods than other individuals within these villages. However, this is not simply a matter of officeholders having a superior political and social position than other

[16] No farmer cultivating a plot commercially claims the right to rent it or lend it out, sell it, or decide who will inherit it.

individuals and thus having more tenure security in general. Instead, their political power is exercised within specific contexts. Officeholders are able to use their social and political status to secure their rights over plots that they obtain through the explicitly political process of land allocation through the matrilineage. However, this ability does not fully spill over into improved security of tenure in other contexts.

D. Tenure Duration and the Hazard of Expropriation

We have argued that the dramatic variation we observe in investment across plots is driven by variation in the likelihood that these plots will be expropriated while fallow. In this subsection, we provide direct evidence of this variation in tenure security and show that it corresponds to the variation in fallowing choices that we observe.

For each plot in our data we have information on the duration of tenure. That is, we know how long the current cultivator has controlled the plot. The expected duration of tenure depends on ω_p, the likelihood of losing the plot in any year in which it is fallow. Plots that are held more securely will, on average, be held for longer durations.[17]

We have shown that fallowing varies according to officeholding status and the origin of the plot. These findings correspond to the ethnographic evidence on tenure security discussed in Section II, which also emphasizes the potential importance of the gender of the cultivator. Suppose, therefore, that $\omega_p = \exp(\boldsymbol{\Omega}_p'\boldsymbol{\gamma})$, where $\boldsymbol{\Omega}_p$ is a vector that includes indicators of the gender and officeholding status of the cultivator of p, an indicator equal to one if the plot belongs to the same matrilineage as its cultivator, and interactions of these indicator variables.

In column 1 of table 9 we show the mean tenure durations across the categories defined by $\boldsymbol{\Omega}_p$. As expected, officeholders have held their plots longer than nonofficeholders, and within each category of individual, plots that come from within their matrilineage have been held longer than plots obtained from other matrilineages (except for female officeholders, where the standard errors are enormous, reflecting the tiny sample of such individuals).

Data on the duration of tenure provide direct evidence on the variation across plots in ω_p. Consider a set of plots (say, all plots from within the matrilineage controlled by officeholding males) with a common $\omega_p = k$. If cultivation were instantaneous, so that in every year the prob-

[17] This statement is subject to the caveat that fallow durations are not so much longer on more securely held plots as to outweigh the direct effect of increased security on average tenure durations. See eq. (9).

TABLE 9
THE HAZARD OF EXPROPRIATION

	YEARS PLOT HAS BEEN HELD BY CULTIVATOR: MEAN (1)	ANNUAL RATE OF EXPROPRIATION WHILE FALLOW:* MAXIMUM LIKELIHOOD (2)	FALLOW DURATION: MEAN (3)	PROFIT: MEAN (4)	IMPLIED DISCOUNT RATE	
					Lower Bound (5)	Upper Bound (6)
Officeholders:						
Male, plot from same *abusua*	16.41	.20	4.9	.79	.07	1.04
	(1.85)	(.024)				
Female, plot from same *abusua*	11.09	.24	5.0	.37	.25	8
	(1.20)	(.034)				
Male, plot from different *abusua*	12.90	.22	4.4	.83	.12	1.96
	(1.81)	(.019)				
Female, plot from different *abusua*	12.74	.27	4.0	−.62	1	NA
	(7.32)	(.029)				
Nonofficeholders:						
Male, plot from same *abusua*	8.90	.29	4.3	.74	.09	4.25
	(.74)	(.015)				
Female, plot from same *abusua*	7.86	.34	3.7	−.46	NA	NA
	(1.20)	(.022)				
Male, plot from different *abusua*	6.59	.35	3.8	.55	.25	8
	(.51)	(.018)				
Female, plot from different *abusua*	4.95	.41	4.0	−.03	NA	NA
	(.79)	(.023)				
Observations	753	753	770	770	NA	NA

NOTE.—Standard errors are in parentheses.
* Calculated from maximum likelihood estimates of γ in (9) and reported in table A1. Standard errors calculated from table A1 using the delta method.

ability of losing the plot is k, the expected average tenure in the cross section of these plots is

$$T_k = k\sum_{t=0}^{\infty} t(1-k)^t = \frac{1-k}{k}, \tag{8}$$

which obviously decreases in k.[18]

In fact, cultivation occurs over a period of 2 years in this fallow system, and during cultivation the probability of losing land drops to zero. If it were possible to cultivate continuously without fallowing, land would not be lost at all. Hence the expected value of tenure duration depends on both ω_p and the fallow duration τ_p^*. Equation (8) is not correct because it does not take into account the period during which the plot is cultivated. Since plots are not expropriated during the 2-year period of cultivation, the likelihood of observing a plot of tenure duration d is

$$\begin{aligned} l(d,\ \omega_p,\ \tau_p^*) = {} & \frac{1}{\tau^* + 2}(1-\omega_p)^{N\tau_p^*} \\ & \times \{(t-1)(1-\omega_p)^{t-2} + 2(1-\omega_p)^{t-1} \\ & + [\tau_p^* - (t-1)](1-\omega_p)^t\}, \end{aligned} \tag{9}$$

where $N = \text{int}[d/(\tau_p^* + 2)]$ is the number of completed fallow-cultivation cycles associated with duration d given τ_p^* and the remainder $t = d - N$. The first term is straightforward, being the likelihood of a plot surviving through N complete fallow cycles, during each of which it is at risk of being lost for τ_p^* years. The final term reflects the fact that during every fallow cycle there are two years during which the plot is being cultivated, and these two years may occur during any two consecutive years of the cycle (because the starting year of the cycle is arbitrary). Given $\omega_p = \exp(\boldsymbol{\Omega}_p'\boldsymbol{\gamma})$, we can estimate $\boldsymbol{\gamma}$ using the likelihood function implied by (9). The maximum likelihood estimates are presented in Appendix table A1; the more interesting implied hazard rates ω_p are presented in column 2 of table 9.

The most striking feature of these results overall is the magnitude of the hazard of plot loss faced by people in Akwapim. Even male officeholders cultivating plots from within their own matrilineage face a 20 percent chance of losing a plot in any year in which it is left fallow. This probability rises to over 40 percent for female nonofficeholders cultivating plots outside their matrilineage.

This dramatic risk makes it unsurprising that fallows are relatively

[18] This calculation assumes that this is a stationary environment. In each period, plots are lost with probability ω_p ($= k$). Stationarity requires that plots arrive with the same probability.

short in our sample; leaving a plot fallow entails a striking risk of losing the plot. Moreover, the doubling of the annual risk of loss depending on personal and plot characteristics rationalizes the large difference in the fallowing choices that we observe across the plots in our sample.

E. *How Inefficient Is Fallowing in Ghana?*

In a fully efficient allocation within a village, fallow durations would be the same on all similar plots (by eq. [2], noting that shadow prices are the same across plots within an efficient allocation). Even if shadow prices vary across households because of other imperfections in factor markets, similar plots within a household should be fallowed similarly. However, we have shown that fallow durations on similar plots vary within households, and even across the plots held by an individual. In table 9 we have shown that the annual hazard that an individual will lose a plot while it is fallow depends on the position of the individual in local political and social hierarchies and the manner in which the plot was acquired. In this subsection we provide a rough estimate of the productivity costs of the inefficient fallowing that results from insecurity of land tenure.

The linear approximation to the profit function presented in table 4 implies that per-hectare profits can be increased without limit for sufficiently long fallow periods. Since this is not possible, we now estimate a profit function that is potentially concave in fallow duration. We would like to estimate a semiparametric (say, partial linear) model that places few restrictions on the relationship between profit and τ_p. However, our data do not contain sufficient information to detect the degree of concavity of the profit function without additional aid.

We observed in Section II that soil scientists working in the region conclude that a fallow duration of 6–8 years is sufficient to maintain soil fertility. Therefore, we impose the restriction that fallow durations of longer than 7 years have no further impact on profits, and we specify a flexible functional relationship between fallow duration and profits. We estimate the profit function

$$\pi_{pt} = \mathbf{X}_p\boldsymbol{\beta} + g(\tau_p) + \lambda_{h_p,t} + \epsilon_{pt}, \tag{10}$$

where the contribution of fallow duration (τ_p) to profits is

$$g(\tau_p) = \begin{cases} a\ln(\tau_p + b) - \dfrac{a}{7+b}\tau_p & \text{for } \tau_p \leq 7 \\ a\ln(7 + b) - \dfrac{a}{7+b}7 & \text{for } \tau_p > 7. \end{cases} \tag{11}$$

The values a and b determine the slope and concavity of the relationship

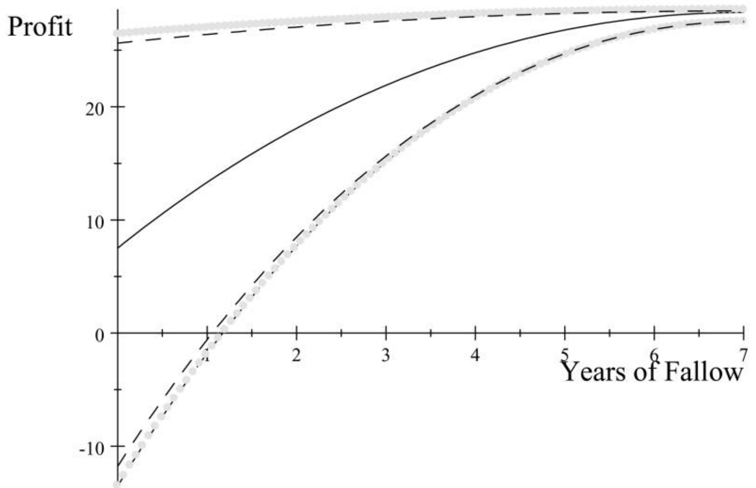

FIG. 2.—Nonlinear IV estimate of the profit function. Central line: $g(\hat{a}, \hat{b})$, where $(\hat{a}, \hat{b})$ are point estimates from nonlinear IV estimates of the profit function. Outer band: 90 percent confidence interval for $\hat{a}$ and corresponding values of $\hat{b}$. Inner band: 90 percent confidence interval for $\hat{b}$ and corresponding values of $\hat{a}$. Confidence intervals are taken from 1,000 block-bootstrap iterations, with blocks defined by household-year groups.

between fallowing and profits. The second term simply ensures that the derivative of the function is zero at $\tau_p = 7$. This profit function is estimated by nonlinear IV, with the same instrument set that was employed in table 4.[19] The results are reported in figure 2. Before we proceed, one point should be made clear: these are wide confidence bounds. We can be confident that $g(\hat{a}, \hat{b})$ is upward sloping and concave, but the data are not sufficiently rich to provide us with a tight estimate of the degree of concavity. With that caveat in mind, we now have in hand the requirements for two sets of calculations of interest. The first set involves calibrating the output lost to inefficient fallowing behavior. The second concerns the household-specific discount rates that rationalize the cho-

[19] Define $\tilde{\boldsymbol{\beta}} = (\boldsymbol{\beta}, a, b)'$ and let $g_{pt}(a, b)$ be the value of the g function at parameter values a and b for plot pt. Let $\bar{\pi}_{pt}$ be the household-year average profit of the household that cultivates plot p, and similarly for $\overline{\mathbf{X}}_p$ and $\bar{g}_{pt}$ and the instruments $\overline{\mathbf{Z}}_p$. We define the within-household differences $\pi^d_{pt} = \pi_{pt} - \bar{\pi}_{pt}$, $\mathbf{X}^d_{pt} = \mathbf{X}_p - \overline{\mathbf{X}}_p$, $\mathbf{Z}^d_p = \mathbf{Z}_p - \overline{\mathbf{Z}}_p$, and $g^d_{pt}(a, b) = g_{pt}(a, b) - \bar{g}_{pt}(a, b)$. Then if

$$u^d_{pt}(\tilde{\boldsymbol{\beta}}) = \pi^d_{pt} - \mathbf{X}^d_{pt}\boldsymbol{\beta} - g^d_{pt}(a, b),$$

our estimate minimizes the quadratic form

$$u(\tilde{\boldsymbol{\beta}})'\mathbf{Z}^d(\mathbf{Z}^{d\prime}\mathbf{Z}^d)^{-1}\mathbf{Z}^{d\prime}u(\tilde{\boldsymbol{\beta}}).$$

Ninety percent confidence intervals are constructed using 1,000 bootstrap iterations (clustered at the household-year level).

sen fallow durations, given the estimated profit function and hazards of losing land while it is fallow.

Suppose that all farmers adjusted their fallow durations to the mean fallow duration within their household. This experiment would eliminate the inefficiency associated with the intrahousehold dispersion in fallow durations that is associated with variations in tenure security across plots within the household, but of course does not account for cross-household variations in security of tenure. The change in profits for household h is

$$\sum_{p \in P_h} (\pi_p + \Delta_p) \times \frac{2}{2 + \tau^e} - \pi_p \times \frac{2}{2 + \tau_p}, \tag{12}$$

where

$$\Delta_p \equiv \left[a \ln (\tau^e + b) - \frac{a}{7 + b}\tau^e\right] - \left[a \ln (\tau_p + b) - \frac{a}{7 + b}\tau_p\right].$$

The term τ^e is the "experimental" fallow duration, here equal to the average duration of fallow on plots held by household h; Δ_p is the absolute change in the level of profits on each household from this change; and $2/(2 + \tau_h)$ is the proportion of years the plot would be cultivated given the change in fallow duration. The average (median) change in profits per household associated with this change, given our estimates of a and b, is approximately 60,000 (0) cedis, compared to average (median) household farm profits of 240,000 (0) cedis.[20] This calculation abstracts from any cross-household variation in tenure security and thus provides a lower bound to the change in profits associated with more secure property rights.

An alternative would be to consider the implications of moving all plots to a fallow duration that corresponds to the mean duration we observe on plots that are cultivated by officeholders on plots that they obtain from their own matrilineage. This average is 5 years, so we repeat the calculation above with τ^e set to 5. In this case, the average (median) change in household farm profits is 195,000 (75,000) cedis. This is likely to be an overestimate because it assumes that the discount rate is equal across households, which is unlikely to be correct in an environment of highly imperfect capital markets.

A speculative calculation can help to put these numbers into a broader perspective. Approximately 434,000 hectares of Ghana's farmland are planted to maize and cassava and located in regions where we might

[20] For reference, the mean (median) value of household farm profits without deducting the imputed value of household labor used on plots is 665,000 (320,000) cedis.

expect the land tenure system to be similar.[21] If the yield losses from inefficient fallowing are similar on all of this land, then we estimate the aggregate costs at 86 billion cedis. This translates into just under 1 percent of 1997 national GDP.[22] Another perspective on this magnitude is provided by the depth of poverty in Ghana. The aggregate yield loss in these four regions is approximately 6 percent of the national poverty gap.[23]

Finally, we calculate the discount rates that rationalize the observed fallowing choices, given our estimates of the profit function and hazards of losing land while fallow. If households are risk neutral, then the decision to fallow a plot for τ_p years implies

$$\pi(\tau_p) \geq \left(\frac{1-\omega_p}{1+\rho_h}\right)\pi(\tau_p+1) \tag{13}$$

and

$$\left(\frac{1-\omega_p}{1+\rho_h}\right)\pi(\tau_p) \geq \pi(\tau_p-1), \tag{14}$$

which together imply

$$\begin{aligned} \ln(1-\omega_p) + \ln\pi(\tau_p) - \ln\pi(\tau_p - 1) &\geq \ln(1+\rho_h) \\ &\geq \ln(1-\omega_p) + \ln\pi(\tau_p+1) - \ln\pi(\tau_p). \end{aligned} \tag{15}$$

We present these bounds for the mean values of tenure duration and profits achieved in each of our broad categories of tenure security in table 9.[24] Because of the sharp concavity of $\hat{\pi}(\tau_p)$, the bounds are wide, but the key point is clear: the high hazard of losing a plot while it is fallow implies that the short mean fallowing decisions we observe are

[21] The regional breakdown of farming area comes from "Special Report: FAO/WFP Crop and Food Supply Assessment Mission to Northern Ghana," World Food Programme, Food and Agricultural Organization (March 13, 2002). We use area planted to maize and cassava figures from 2000 for the western, central, eastern, and Ashanti regions. As per personal communication with the Ministry of Food and Agriculture, we use the larger of maize or cassava area figures to account for intercropping (this biases the area figure downward since it excludes some single cropped fields).

[22] GDP figures come from the World Bank's World Development Indicators database.

[23] The poverty gap is the amount that, if perfectly targeted, would bring all the poor to the poverty line. From 1998 national household survey data (the Ghana Living Standards Survey, round 4), the poverty gap is estimated at 14 percent of the poverty line. We can use this figure to calculate the aggregate poverty gap, which is about 1.55 trillion cedis (converting the 1998 cedis to 1997). This is based on a poverty line of 688,401 cedis per capita. We are grateful to Kalpana Mehra for these statistics.

[24] We cannot calculate the bounds for plots cultivated by women who do not hold office because mean profits in these plots are negative at the baseline fallowing duration.

consistent with reasonably low discount rates, in the range of 10–30 percent per year.

V. Conclusion

We find that insecure land tenure in Ghana is associated with greatly reduced investment in land fertility. Individuals who are not central to the networks of social and political power that permeate these villages are much more likely to have their land expropriated while it is fallow. Their reduced confidence of maintaining their rights over land while it is fallow induces such individuals to fallow their land less than would be technically optimal. As a consequence, farm productivity for these individuals is correspondingly reduced. There is a strong gender dimension to this pattern since women are rarely in positions of sufficient political power to be confident of their rights to land. So women fallow their plots less than their husbands and achieve much lower yields.

These large effects of land tenure insecurity on investment and productivity stand in contrast to the great majority of the recent microeconomic literature on property rights and investment. That literature tends to find no or only subtle impacts of insecure property rights on investment behavior (e.g., Besley 1998; Brasselle et al. 2002; Jacoby et al. 2002; Galiani and Schargrodsky 2006; Field 2007). The large effects that we find of tenure insecurity are likely a consequence of three factors. First, the degree of insecurity in property rights that we document is huge. Individuals have on the order of a one in three chance of losing control over a plot in any year in which it is not cultivated. Expropriation risk is therefore a very salient aspect of the economic environment. Moreover, there is very large variation across the sample plots in the extent of tenure insecurity. The annual hazard of losing a plot while fallow approximately doubles between the least and most securely held plots. Second, many studies focus on de jure rights over land. De jure variation in the security of property rights may not be reflected in variations in de facto tenure security. Third, we study a well-measured and highly productive investment that everyone undertakes. We therefore avoid some of the econometric challenges that many researchers face.

Our results provide support for the argument that in West Africa "the process of acquiring and defending rights in land is inherently a political process based on power relations among members of the social group. . . . A person's status . . . can and often does determine his or her capacity to engage in tenure building" (Bassett and Crummey 1993, 20). Rights over a particular plot of land are political: they depend on the farmer's ability to mobilize support for her right over that particular plot. Hence the security of tenure is highly dependent on the individual's position in relevant political and social hierarchies. Even conditional on the individual's position, her security depends on the circumstances through which she came to obtain access to the particular plot.

The lack of success of widespread land titling programs in Africa has led many to question the conventional wisdom regarding the importance of secure property rights for investment in land. Bassett (1993, 4) notes that "colonial administrators, African elites, and foreign aid donors have historically viewed indigenous landholding systems as obstacles to increasing agricultural output. . . . There is a need to transcend [the World Bank's] technocratic and theological approaches that posit a direct link between freehold tenure and productivity." On the basis of her rich understanding of Akan land tenure, Berry (2001, 155–56) argues that "contrary to recent literature, which argues that sustainable development will not take place unless rights to valuable resources are 'clearly defined, complete, enforced and transferable,' assets and relationships in Kumawu appear to be flexible and resilient because they are *not* clearly defined, or completely and unambiguously transferable."[25]

We have shown that a great deal of potential output is lost in the study area because land tenure is insecure. Pande and Udry (2006) provide a summary of the historical origins of the institution in which land use rights are allocated through the matrilineage. They show that this institution emerged during a long period of land abundance, during which fallow periods on virtually all land were sufficiently long for full restoration of land fertility. Tenure insecurity would have no consequence for fallow durations under such conditions. However, over the past several decades land has become more scarce, and therefore individuals' uncertainty regarding their ability to reestablish cultivation after a period of fallow now has implications for fallow durations and hence productivity. We do not adhere to a view that institutions necessarily adjust to capture all potential Pareto gains. However, the persistence of this method of land allocation in the face of the losses of output associated with tenure insecurity requires investigation.

We interpret the resilience of this system of land tenure to its crucial and flexible role in redistributing resources in the face of unobserved variations in need. Similar processes of land reallocation through corporate groups exist in most societies in West Africa; as a consequence, the region is distinguished by the almost complete absence of a rural landless class. This system may provide important insurance in times of need and a remarkable degree of social stability due to the redistribution of land within rural communities. This paper reveals that this stability

[25] Doubt is not confined to those studying property rights in Africa. Regarding European growth, Clark (2007, 727) argues that "quantitative research in recent years suggests that common rights, at least by the seventeenth century, had negligible impacts on agricultural performance" (citing Allen [1982], Hoffman [1988], and Clark [1998]).

and insurance come at a steep price paid by those distant from local centers of political power.

Appendix

TABLE A1
Determinants of the Rate of Expropriation

	Maximum Likelihood: Annual Hazard of Expropriation While Fallow*	
	Estimate	Standard Error
1 if officeholder	−.66	.14
1 if woman	.27	.10
Plot in same *abusua* as cultivator	−.29	.10
Officeholder × Plot in same *abusua* as cultivator	.16	.21
Constant	−.62	.08
Observations	753	

* Maximum likelihood estimates of $\boldsymbol{\gamma}$, where annual rate of expropriation $\omega = \exp(\boldsymbol{\Omega}_p'\boldsymbol{\gamma})$, and the likelihood is defined in eq. (9).

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