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

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September 24, 2008

Abstract

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 correspond 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.

Keywords: Land tenure, Investment, Institutions.

1 Introduction

Institutions matter for growth and development. In particular, it is apparent that investment incentives depend upon expectations of rights over 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 1987; Engerman and Sokoloff 2003; Mokyr 2002). Additional evidence has been contributed from cross-country regressions of economic growth on a variety of measures of institutional quality (Acemoglu, Johnson, Robinson 2001, 2002; Easterly and Levine 2003; Hall and Jones 1999; Pande and Udry 2006). This paper joins a growing microeconomic literature that explores the pathways though which particular institutions influence investment or productivity (Besley 1995; Brasselle et al., 2002; Field 2007; Johnson, McMillan, Woodruff 2002; Jacoby 2002; Galiani and Schargrodsky 2006; 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, 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 where fertilizer is expensive, land is relatively abundant, and crop returns 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 2. The primary source of land for farming is the allocation to individuals of

[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 outed 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, Volume 1, Book III, Chapter 2).

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 2. 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 3.

In section 4.1, 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 4.2, 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 4.3 we show that individuals with powerful positions in local political hierarchies leave their plots fallow for years longer than do other individuals, and this effect is stronger on plots allocated through the prevalent matrilineage allocation process than on plots obtained commercially. In this section we also disaggregate officeholding status into inherited versus non-inherited offices to examine the hypothesis of reverse causality running from farming choices to office holding. Perhaps most importantly, we also show that fallow durations vary across the different plots cultivated by a single farmer, depending upon 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$\times$cultivator interaction, such as tenure security.

In section 4.4 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 4.5 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 5 concludes.

2 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 4 separate plots. Land is allocated to individuals for use on the basis of his or her political influence and perceived need.

There is a rich literature that describes the land tenure systems of 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, pp 77, 277-78; Austin, 2004, p. 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, p. 104). To summarize, while

> "[i]n 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

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

[3] There are numerous descriptions of this principle. See Amanor (2001, pp. 64-76), Klingelhofer (1972, p. 132), Berry (2001, pp. 146-156), Austin (2004, p. 100), Wilks (1993), Rattray (1923, pp. 224-241).

improvements but also their status within the family, or even their claims of family membership itself." (Berry, 2001, p. 145).[4]

In our sample, there are a number of individuals (about 18% of the sample) who hold an office of social or political power in their village or matrilineage. Typical offices include lineage head (*abusuapanyin*), 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, on the other hand, 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, p. 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]

On the other hand, 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.[7] "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." (Quisumbing et al., 2001, pp. 71-72). Accordingly, we investigate the possibility that the chance that land might be lost while fallowed leads farmers to reduce the duration of the fallow period. It is the

[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 Fred-Mensah (1996), Biebuyck (1963), J. Bruce and S. Migot-Adholla, eds. (1994), Binswanger, Deininger and Feder (1995), Bassett (1993), Peters (1994), Bromley (1989), Amanor (2001), Sawadogo and Stramm (2000). Summarizing the conclusions of several studies from across the continent, Bassett and Crummey state:

> " 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. (Bassett and Crummey, 1993, p. 20)

[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, p. 145, citing N.A. Ollenu and G.R. Woodman, eds., *Ollenu's principles of customary law.* 2nd ed).

[6] See Austen (2004) and Pande and Udry (2006) for discussions of the interactions between this land tenure system and the 20th century cocoa boom in Ghana.

[7] See Firman-Sellers (1996, p. 65), Austin (2004, pp. 333-346).

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 1950*s*, 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.[8] 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 burnt. 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.[9] Of 519 plots in our sample, only 61 have been in cultivation for more than three 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 six to eight years are sufficient to maintain soil fertility in this farming system (de Rauw 1995, Nweke 2002). Ahn (1979) 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 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, the

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

[9] 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.

final column in Table 1 shows that plots cultivated by individuals who hold local offices are more likely to have been fallowed for at least 6 years than are plots cultivated by others.

To examine this differential and the attendant productivity effects, we use data from a two year rural survey in the Akwapim South District of the Eastern Region of Ghana.[10] Our sample consists of four village clusters (comprising 5 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 two 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 GPS 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 office-holding status of the individual. Average per-hectare profits and yields are comparable on the plots cultivated by office holders and non-office holders, but office holders cultivate larger plots. Inputs and measured soil organic matter and pH of plots is similar across office-holding status. The average duration of the last fallow period is almost a year longer for office holders, and office holders have had control over their plots for much longer than non-office holders. Office holders are significantly more likely to be cultivating plots that come from their own matrilineage than are others. There is some indication that office holders cultivate fewer plots obtained through commercial transactions. Approximately half of these commercial transactions are sharecropping contracts, and half are based on fixed rent.

Office holders are much more likely to 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

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

the village for 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 office-holders were less likely to have been educated than others in the village, perhaps reflecting the age of the office-holders.

3 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, *inter alia*, on the opportunity cost of capital to that individual and his or her confidence in her ability to re-establish 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.[11] 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).

Suppose that the profit (per-hectare) that can be generated from cultivating a plot depends upon 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 2 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.

Supposing for the moment that cultivation itself takes no time, then the expected present discounted value of profits from $i's$ plots is

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

[11] 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 PDV of the stream of profits from each of the individual's plots is maximized.

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

$$\frac{\pi'_p(\tau_p^*)}{\pi_p(\tau_p^*)} = -\frac{\ln(\frac{1-\omega_p}{1+\rho_p})}{1-\left(\frac{1-\omega_p}{1+\rho_h}\right)^{\tau_p^*}}. \tag{2}$$

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.[12]

We supposed "for the moment" that cultivation occurred instantaneously. In fact, as we discussed above, the cultivation cycle in this farming system occurs over a period of two 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 two year period during which cultivation occurs changes the expected present discounted value of profits of the plots cultivated by i to

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

[12] This general message is robust to imperfect markets which provide an incentive for individuals to adjust harvest periods to smooth factor demand. Consider, for example, 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

$$\begin{array}{c} v_2 = \max\{\beta v_2, Y + \beta v_1, 2\theta Y + \beta v_0\} \\ v_1 = \max\{\beta v_2, Y + \beta v_1, \theta Y(1+\delta) + \beta v_0\} \\ v_0 = \max\{\beta v_2, \delta Y + \beta v_1, 2\delta\theta Y + \beta v_0\} \end{array}.$$

The choices in each maximand correspond to fallowing 2, 1 or 0 plots, respectively. Depending upon parameter values, there are a number of possible equilibria. The interesting case is the two equilibria

$$\begin{array}{c} 0 \to 2, 1 \to 1, 2 \to 1 \\ 0 \to 0, 1 \to 1, 2 \to 1 \end{array}.$$

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.

(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:

$$\pi(\tau_p^*(X_p, \omega_p), X_p) \tag{3}$$

where 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

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

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

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

where π_{pt} is the profit measured on plot p in year t, α is $\frac{\partial \pi}{\partial \tau}$, β is $\frac{\partial \pi}{\partial X}$ and G_p is the gender of the individual who cultivates plot p. $\lambda_{h_p,t}$ is a fixed effect for the household-year. 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 $\gamma = 0$. 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) as well as 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, based on the discussion of section 2, 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.

4 Results

4.1 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 X_p and household-specific shadow prices. (3) becomes $\pi_t(\tau(X_p), X_p)$, where $\tau(.)$ 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

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

In (6) $\tilde{\beta}$ is $\frac{\partial \pi}{\partial \tau}\frac{\partial \tau}{\partial X} + \frac{\partial \pi}{\partial X}$; that is, it captures both the direct and the indirect (through fallowing choice) effect on plot profits of variation in plot characteristics. The 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 interpretation of the results is 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 results.[13] 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 thousand cedis less in profits per hectare then their husbands. Average profits per hectare are approximately 600 thousand cedis, so this is a very large effect.

[13] The standard errors in all our specifications use limiting results for cross section estimation with spatial dependence characterized by physical distance between plots 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 km and remains at zero for larger distances. This estimator allows general correlation patterns up to the cutoff distances.

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 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.[14] 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 run-off. 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 are plots separated by larger distances. This can be seen in 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:

$$\begin{aligned}\pi_{pt} - \frac{1}{N_p}\sum_{q\in N_p}\pi_{qt} &= (\mathbf{X}_p - \frac{1}{N_p}\sum_{q\in N_p}X_q)\tilde{\beta} + \tilde{\gamma}(G_p - \frac{1}{N_p}\sum_{q\in N_p}G_q) \qquad (7)\\ &\quad + \tilde{\lambda}_{h_p t} - \frac{1}{N_p}\sum_{q\in N_p}\tilde{\lambda}_{h_q t} + \tilde{\epsilon}_{pt} - \frac{1}{N_p}\sum_{q\in N_p}\tilde{\varepsilon}_{qt}.\end{aligned}$$

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

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

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 due to 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 which ignore the potential endogeneity of τ^*. Unsurprisingly, given the discussion of soil fertility in section 2, we find that longer fallow durations are strongly associated with higher profits Perhaps more importantly, 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 2, we saw that an individual's security of tenure security on a given plot is influenced by his/her position in local social and political hierarchies. Conditional on the assumption 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 4.3.

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 2 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. Office holders fallow their plots for 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 4.2-4.4.

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 thousand cedis additional profits per hectare. This is a very large effect, given a standard deviation of fallowing of about 3 years. The 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 variation in age and education are not driving the variation across plots in fallow durations or profits. We saw in Table 2 that office holders 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 office holders 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 large profits than their husbands once we condition on fallow duration.

4.2 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 office holders do not have characteristics that distinguish them from the wives of non-officeholders along the dimensions that determine fallowing, aside from having an officeholder as a spouse. Nor are their attributes vis-a-vis the wives of non-officeholder those typically associated with diminished intrahousehold bargaining power in the West African context. For example, wives of office holders 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 4.3 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 4.4 we estimate a hazard model that provides direct evidence of land tenure insecurity that coincides with these results.

An alternative hypothesis is that office holders 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 office-holding status, and migratory history. The identification assumption is that conditional on these other dimensions of the cultivators 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 4.3 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, office holders 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) instrumental variables 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 $1,000,000$ 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.

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 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 office holders having more land, and therefore mechanically fallowing land for longer.

4.3 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 for 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, office holders 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 based, in part, on 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 (for example, *abusuapanyin*, or lineage head). The second are offices that are not inherited (for example, 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 office holding and fallow durations. The point estimate is stronger for inherited offices than for non-inherited 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 office holders have unobserved characteristics that might be associated with longer fallow durations is addressed in the within-individual analysis that follows in section 4.3. For the remainder of the paper, we will report results both for the aggregate set of office holders, 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 sixty 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 individuals' security of tenure over those plots that are allocated through the political process of allocating matrilineage land as described in section 2.

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 other individuals. For non-officeholders, 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 non-officeholders.

A similar pattern emerges in column 4, where we disaggregate between inherited and non-inherited offices. Once again, for non-office holders, 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 non-inherited offices. In contrast to the result in column 3, when disaggregating we find that holders of inherited office fallow plots longer than non-officeholders 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 for 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 was discussed in section 2. 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$\times$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 upon 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 non-commercial arrangements, from individuals who are not close family members.[15] 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 eight months longer than are other plots farmed by the same cultivator.[16] Plots obtained from one's spouse may be left fallow less than other 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 ten months longer than are plots obtained from individuals who are not related.

There is important variation in fallow durations across the plots cultivated by a given individual, depending upon 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 re-establish cultivation on a fallowed plot, while women expressed particular concern over their ability to maintain control over plots obtained indirectly from other source via their

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

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

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% of such plots, but only claim this right on 3% of plots obtained from non-family, and only on 1% of plots obtained from their spouse. Similar patterns are observed for the right to lend out the plot, sell it, or decide who will inherit it.[17]

We saw in column 3 of Table 7 that, conditional on household fixed effects, office holders fallow matrilineage land for 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 individuals' 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 office holders fallow land from within their own matrilineage for more than two years longer than they do other plots that they cultivate. Because office holders 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 non-inherited offices fallow their matrilineage plots for 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 office holders 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. Office holders fallow noncommercial land from within their own matrilineage for almost 6 years longer than they do noncommercial land from other sources; in stark contrast, non-officeholders 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 non-office holders leave their matrilineage land fallow less than their other plots. Holders of both inherited and non-inherited offices leave their matrilineage land fallow for much longer $(4-7$ years) than their other plots.

Office holders leave land fallow for longer periods than do other individuals within these villages. However, this is not simply a matter of office holders having a superior political and social position than other individuals and thus having more tenure security in general. Instead, their political power is exercised within specific contexts. Office holders are able to use their social and

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

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.

4.4 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 section, 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 upon ω_p, the likelihood of losing the plot in any year in which it is fallow. Plots which are held more securely will, on average, be held for longer durations.[18]

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 2, which also emphasizes the potential importance of the gender of the cultivator. Suppose, therefore, that $\omega_p = \exp(\Omega'_p\gamma)$, where Ω_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 Ω_p. As expected, officeholders have held their plots longer than non-officeholders, and within each category of individual, plots that come from within their matrilineage have been held for 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 office holding males) with a common $\omega_p = k$. If cultivation were instantaneous, so that in every year the probability 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.[19]

[18] 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 equation (9).

[19] 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.

In fact, cultivation occurs over a period of two 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^*. (8) is not correct, because it does not take into account the period during which the plot is cultivated. Noting that plots are not expropriated during the two year period of cultivation, the likelihood of observing a plot of tenure duration d is

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

where $N = int(\frac{d}{\tau_p^*+2})$ is the number of completed fallow-cultivation cycles associated with duration d given τ_p^* and the remainder $t = d - N(\tau_p^* + 2)$. 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 $\omega_p = \exp(\Omega_p'\gamma)$, we can estimate γ using the likelihood function implied by (9). The maximum likelihood estimates are presented in Appendix Table 1; 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% chance of losing a plot in any year in which it is left fallow. This probability rises to over 40% for female nonofficeholders cultivating plots outside their matrilineage.

This dramatic risk makes it unsurprising that fallows are relatively 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 upon personal and plot characteristics rationalizes the large difference in the fallowing choices that we observe across the plots in our sample.

4.5 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 (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 section 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 which 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 2 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 seven years have no further impact on profits, and specify a flexible functional relationship between fallow duration and profits. We estimate the profit function

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

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

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

a and b determine the slope and concavity of the relationship between fallowing and profits. The second term simply ensures that the derivative of the function is 0 at $\tau_p = 7$. This profit function is estimated by nonlinear instrumental variables, with the same instrument set that was employed in Table 4.[20] 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 chosen fallow durations, given the estimated profit function and hazards of losing land while it is fallow.

[20] Define $\tilde{\beta} = (\beta, a, b)'$ and $g_{pt}(a, b)$ 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 $\bar{X}_p$ and $\bar{g}_{pt}$ and the instruments Z_p. We define the within-household differences $\pi^d_{pt} = \pi_{pt} - \bar{\pi}_{pt}$; $X^d_{pt} = X_p - \bar{X}_p$, $Z^d_p = Z_p - \bar{Z}_p$ and $g^d_{pt}(a, b) = g_{pt}(a, b) - \bar{g}_{pt}(a, b)$. Then if

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

our estimate minimizes the quadratic form

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

Ninety percent confidence intervals are constructed using 1000 bootstrap iterations (clustered at the household-year level).

Suppose 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

$$\sum_{p\in P_h} \left(\pi_p + \Delta_p^1\right) * \frac{2}{2+\tau^e} - \pi_p * \frac{2}{2+\tau_p}, \text{ where} \tag{12}$$

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

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 $\frac{2}{2+\tau_h}$ 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.[22] 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 is planted to maize and cassava and located in regions where we might expect the land tenure system to be similar[23]. 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% of 1997 national GDP[24]. Another perspective on this magnitude is provided by the depth of poverty in Ghana. The aggregate

[22]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.

[23]The regional breakdown of farming area comes from "Special Report: FAO/WFP Crop and Food Supply Assessment Mission to Northern Ghana", FAO 13 March 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 as it excludes some single cropped fields).

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

yield loss in these 4 regions is approximately 6% of the *national* poverty gap.[25]

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

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

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

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.[26] 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 consistent with reasonably low discount rates, in the range of 10 to 30 percent per annum.

5 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 as 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

[25] The poverty gap is the amount which, if perfectly targeted, would bring all the poor to the poverty line. Using 1998 national household survey data (the Ghana Living Standards Survey, round 4), the poverty gap is estimated at 14% 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.

[26] 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.

subtle impacts of insecure property rights on investment behavior (for example, Besley 1998, Brasselle et al 2002; Field, 2007; Galiani and Schargrodsky 2006; Jacoby et al,.2002). 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, p. 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 upon the individual's position in relevant political and social hierarchies. Even conditional on the individual's position, her security depends upon 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 (p. 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." Based on her rich understanding of Akan land tenure, Berry (2001, pp. 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."[27]

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

[27] Doubt is not confined to those studying property rights in Africa. Regarding European growth, Clark (2007, p. 727) argues that "quantitative research in recent years suggests that common rights, at least by the seventeenth century, had negligible impacts on agricultural performance (see Robert C. Allen, 1982; Gregory Clark 1998; and Philip T. Hoffmann 1989)."

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

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Table 1: Perceptions of Land Rights

	Percent of Cultivated Plots on which Respondent Claims Right to: **Determine Inheritance (1)**	**Rent Out (2)**	**Lend Out (3)**	**Sell (4)**	Percent of Plots Fallowed more than Six Years: **(5)**
Non-office holders	4	15	21	10	18
Office holders	18	37	42	22	26
t-test for equality	6.39	6.51	5.56	4.36	2.23
Number of observations	846	847	847	846	813

Table 2: Summary Statistics

Plot Level Data

Variable	Office Holders Mean	Office Holders Std. Dev.	Non-Office Holders Mean	Non-Office Holders Std. Dev.	|t|
profit x1000 cedis/hect	649.10	2374.87	580.59	6864.34	0.11
yield x1000 cedis/hect	1490.32	2850.93	1615.14	7353.06	0.18
hectares	0.48	0.62	0.31	0.30	4.26
labor cost x1000 cedis/hect	651.39	1155.59	883.14	2223.01	1.11
seed cost x1000 cedis/hect	282.12	612.24	243.08	719.98	0.45
ph	6.36	0.71	6.34	0.75	0.22
organic matter	3.22	1.06	3.13	1.08	0.67
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	0.66	0.47	0.56	0.50	1.79
plot obtained via commercial transaction	0.25	0.43	0.30	0.46	1.17
number of observations		122		484	

Individual Level Data

Variable	Office Holders Mean	Office Holders Std. Dev.	Non-Office Holders Mean	Non-Office Holders Std. Dev.	|t|
gender (1=female)	0.11	0.32	0.40	0.49	3.73
age	51.92	13.47	40.08	12.21	5.41
average assets x1000 cedis	1475.52	1767.18	620.39	902.57	4.71
years of schooling	7.56	6.98	7.09	4.92	0.50
1 if mother was a trader	0.09	0.29	0.24	0.43	2.23
1 if mother was a farmer	0.89	0.32	0.72	0.45	2.35
1 if father was a farmer	0.82	0.39	0.79	0.41	0.46
1 if father was an artisan	0.07	0.25	0.11	0.31	0.76
1 if father was a civil servant	0.09	0.29	0.09	0.29	0.02
1 if father was a laborer	0.00	0.00	0.00	0.07	0.46
1 if first in village of family	0.11	0.32	0.23	0.42	1.82
yrs family or resp 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	0.64	2.94
1 if fostered as a child	0.58	0.50	0.69	0.46	1.46
size of inherited land	0.62	0.83	0.13	0.39	6.10
1 if mother had any school	0.04	0.21	0.12	0.32	1.43
1 if father had any school	0.16	0.37	0.31	0.46	2.09
number of observations		45		207	

Table 3: Profits and Gender

	1		2		3	
	OLS		OLS		OLS	
dependent variable	profit x1000 cedis/hect		profit x1000 cedis/hect		profit x1000 cedis/hect	
	estimate	std error	estimate	std error	estimate	std error
gender: 1=woman	-913	365	-985	468	-1683	380
Plot Size Decile = 2	198	486	1049	571	1646	265
Plot Size Decile = 3	689	507	1239	590	749	265
Plot Size Decile = 4	655	508	1806	591	1557	364
Plot Size Decile = 5	25	502	883	583	923	147
Plot Size Decile = 6	377	489	1447	581	819	222
Plot Size Decile = 7	-79	494	1206	548	628	252
Plot Size Decile = 8	-389	520	593	594	-180	259
Plot Size Decile = 9	46	513	705	633	420	261
Plot Size Decile = 10	-383	597	-17	693	-693	338
Soil Type = Loam	629	342	35	396	-21	151
Soil Type = Clay	226	381	-58	463	122	321
Toposequence: midslope	-364	1110	339	1581	-705	493
Toposequence: bottom	-45	1104	661	1569	-722	552
Toposequence: steep	-800	1153	-83	1610	476	695
pH			-122	247	-202	78
Organic Matter			-26	150	135	49
Observations	888		614		575	
Fixed effects	household x year		household x year		spatial (250 meters) and household x year	

Table 4: Profits and Fallow Duration

	1		2		3		4		5		6	
	OLS		OLS		IV		IV		OLS		IV	
dependent variable	profit		fallow		profit		profit		fallow		profit	
	x1000		duration		x1000 cedis/hect		x 1000		duration		x 1000	
	est	std error	est	std error	est	std error	est	std error	est	std error†	est	std error†
fallow duration (years)*	145	48			541	233	662	261			326	58
gender: 1=woman	-473	393	-0.58	0.67	130	555	-688	732	-0.34	0.24	328	148
age							-118	62				
> 6 years of school							-286	720				
1 if first of family in town			-0.44	0.66					0.30	0.19		
years family/resp lived in village			-0.01	0.01					0.01	0.00		
1 if resp holds trad. office			3.91	1.11					1.82	0.33		
number of wives of father			0.39	0.35					0.50	0.13		
number of father's children			-0.08	0.07					-0.01	0.02		
parity of mom in father's wives			-0.44	0.41					-0.43	0.32		
1 if fostered as child			0.86	0.74					0.37	0.34		
size of inherited land			-0.29	0.63					-0.45	0.21		
1 if mother had any education			-0.87	1.17					1.18	0.61		
1 if father had any education			-0.13	0.80					-1.16	0.31		
Observations	760		755		755		672		609		609	
Fixed Effects	Household x Year								Spatial (250 meters) & Household x Year			
J-Stat of Over-ID Restrictions					Chi2(16) = 10.25		Chi2(9) = 2.25				Chi2(9) = 2.43	
F-test of instruments			F(10,415) = 2.10						F(10,272) = 20.83			

Note: All regressions include the plot characteristics use in Table 3, column 1. †Standard errors are consistent for arbitrary spatial correlation.

* Treated as endogenous in columns 3,5 and 6. Instruments as indicated in columns 2 and 4.

Table 5: Characteristics of Wives of Officeholders and Non-Officeholders

Individual Level Data

	Office Holders		Non-Office Holders		
Variable	Mean	Std. Dev.	Mean	Std. Dev.	|t|
age	45.52	12.86	36.40	12.67	3.62
average assets x1000 cedis	720.48	1202.12	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	0.18	0.39	0.26	0.44	0.93
1 if mother was a farmer	0.82	0.39	0.69	0.46	1.42
1 if father was a farmer	0.76	0.44	0.79	0.41	0.45
1 if father was an artisan	0.09	0.29	0.06	0.23	0.71
1 if father was a civil servant	0.15	0.36	0.13	0.34	0.30
1 if father was a laborer	0.00	0.00	0.01	0.10	0.55
1 if first in village of family	0.52	0.51	0.25	0.44	2.91
yrs family or resp has been in village	38.26	32.81	49.17	41.35	1.37
number of wives of father	2.09	1.01	2.13	1.10	0.19
number of children of father	8.85	4.95	11.71	7.57	2.04
parity of mother in father's wives	1.33	0.60	1.30	0.74	0.24
1 if fostered as a child	0.76	0.43	0.72	0.45	0.48
size of inherited land	0.12	0.33	0.04	0.23	1.58
1 if mother had any school	0.03	0.17	0.18	0.38	2.16
1 if father had any school	0.26	0.45	0.41	0.49	1.50
number of observations		38		118	

Table 6: Fallow, Wealth and Land Owned

	1		2		3	
	OLS		IV		OLS	
dependent variable	wealth (x 1000 cedis)		fallow duration		fallow duration	
	estimate	std error	estimate	std error	estimate	std error
wealth (x 1000 cedis)*			-0.0001	0.001		
gender: 1=woman	32	107	-0.13	0.51	-0.27	0.23
area on other plots (ha)					-0.16	0.07
1 if first of family in town	145	89	0.04	0.62	0.22	0.28
years family/resp lived in village	8	1	0.01	0.01	0.01	0.00
1 if resp holds trad. office	497	174	2.01	0.97	2.01	0.36
number of wives of father	128	36	0.32	0.28	0.33	0.17
number of father's children	-46	10	-0.02	0.07	0.00	0.02
parity of mom in father's wives	141	64	-0.30	0.42	-0.40	0.34
1 if fostered as child	-152	86	0.31	0.60	0.38	0.34
size of inherited land	-262	118	-0.44	0.64	-0.33	0.23
1 if mother had any education	-318	239	0.56	1.10	0.67	0.52
1 if father had any education	-84	91	-0.81	0.61	-0.83	0.41
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-Stat of Over-ID Restrictions	Chi2(2) = 1.40					
F-test of instruments	F(3,409) = 6.51					

Table 7: Fallow Duration and Plot Origin

	1		2		3		4	
	OLS		OLS		OLS		OLS	
	All Plots		All Plots		All Plots		All Plots	
dependent variable	fallow duration		fallow duration		fallow duration		fallow duration	
	estimate	std error	estimate	std error	estimate	std error	estimate	std error
gender: 1=woman	-0.35	0.20	-0.36	0.20	-0.28	0.22	-0.48	0.24
1 if office holder	1.73	0.49			0.68	0.59		
1 if holds inherited office			2.28	0.93			1.49	0.65
1 if non-inherited office			1.29	0.53			-0.52	0.95
Plot in Same Abusua					0.25	0.21	0.36	0.27
as Cultivator								
Cultivator Holds Office *					3.24	0.89		
Plot in Same Abusua as Cultivator								
Cultivator Holds Inherited Office *							1.63	1.57
Plot in Same Abusua as Cultivator								
Cultivator Holds Non-inheritedOffice *							2.92	1.01
Plot in Same Abusua as Cultivator								
Observations	402		402		402		402	
Fixed Effects	Household and Spatial Fixed Effects (250 Meters)							

Table 8: Within-Cultivator Fallowing Choices

	All Plots						Exclude Commercial Plots			
	1		2		3		4		5	
	OLS		OLS		OLS		OLS		OLS	
dependent variable	fallow duration		fallow duration		fallow duration		fallow duration		fallow duration	
	estimate	std error	estimate	std error	estimate	std error	estimate	std error	estimate	std error
Plot in Same Abusua as Cultivator			0.05	0.18	0.69	0.22	-1.10	0.37	0.86	0.62
Cultivator Holds Office *			2.30	0.86			5.96	2.16		
Plot in Same Abusua as Cultivator										
Cultivator Holds Inherited Office *					3.49	1.03			6.57	1.60
Plot in Same Abusua as Cultivator										
Cultivator Holds Non-inheritedOffice *					2.28	0.54			4.03	1.15
Plot in Same Abusua as Cultivator										
Plot obtained Commercially	0.64	0.26								
Plot obtained from Spouse	-0.58	0.41								
Plot obtained from Family	0.83	0.36								
Observations	388		402		402		266		266	
Fixed Effects	Individual Cultivator and Spatial Fixed Effects (250 meters)									

Table 9: The Hazard of Expropriation

	1 Years plot has been held by cultivator		2 Annual Rate of Expropriation while Fallow*		3 Fallow Duration	4 Profit	5 Implied Discount Rate	6 Implied Discount Rate
	Mean	Std Error	Max Likelihood	Std Error	Mean	Mean	Lower Bound	Upper Bound
Office Holders:								
Male, plot from same abusua	16.41	1.85	0.20	0.024	4.9	0.79	0.07	1.04
Female, plot from same abusua	11.09	1.20	0.24	0.034	5.0	0.37	0.25	8
Male, plot from different abusua	12.90	1.81	0.22	0.019	4.4	0.83	0.12	1.96
Female, plot from different abusua	12.74	7.32	0.27	0.029	4.0	-0.62	1	na
Non Office Holders:								
Male, plot from same abusua	8.90	0.74	0.29	0.015	4.3	0.74	0.09	4.25
Female, plot from same abusua	7.86	1.20	0.34	0.022	3.7	-0.46	na	na
Male, plot from different abusua	6.59	0.51	0.35	0.018	3.8	0.55	0.25	8
Female, plot from different abusua	4.95	0.79	0.41	0.023	4.0	-0.03	na	na
Observations		753		753	770	770	na	na

Figure 1: Plots of Sample Members in One Village

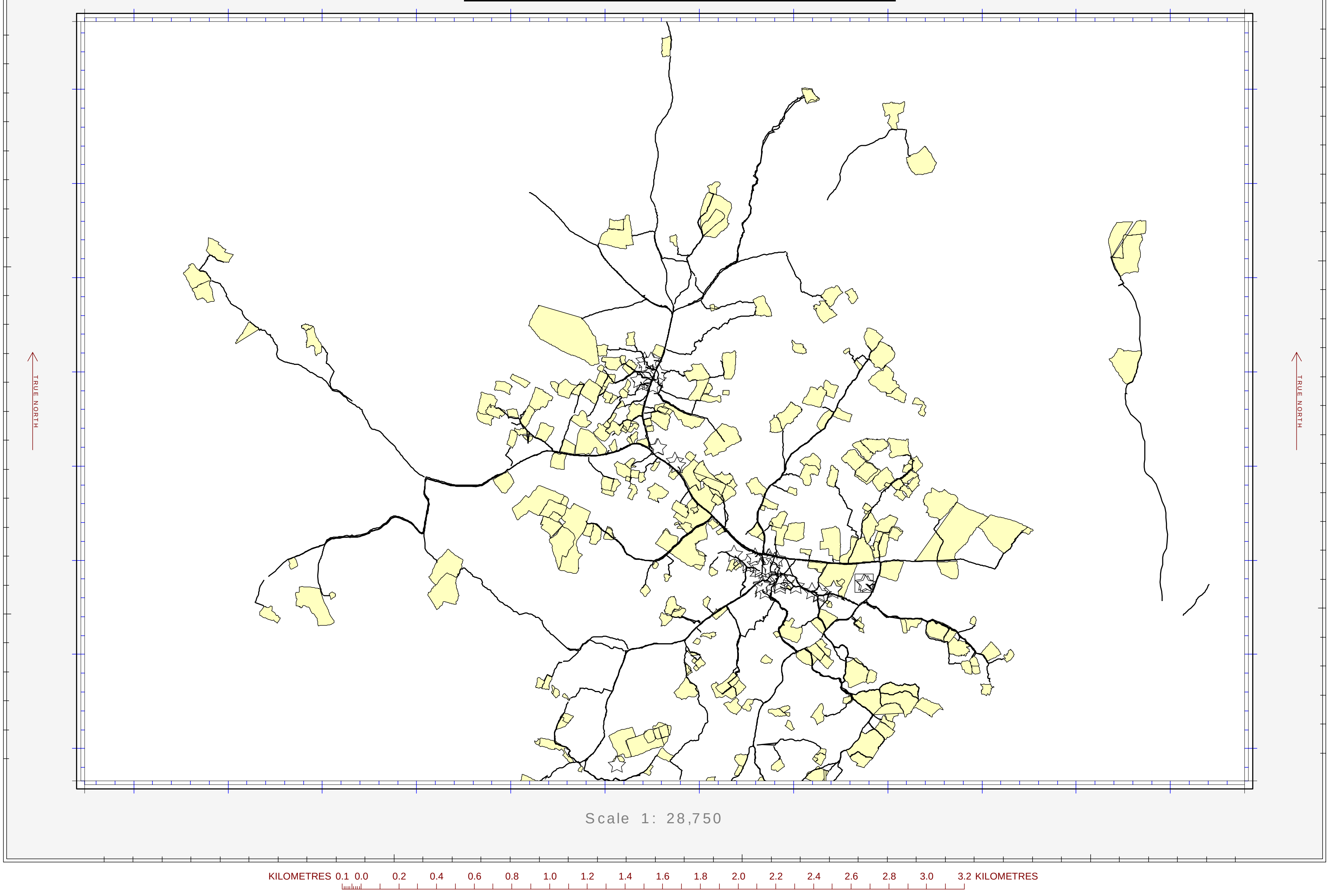
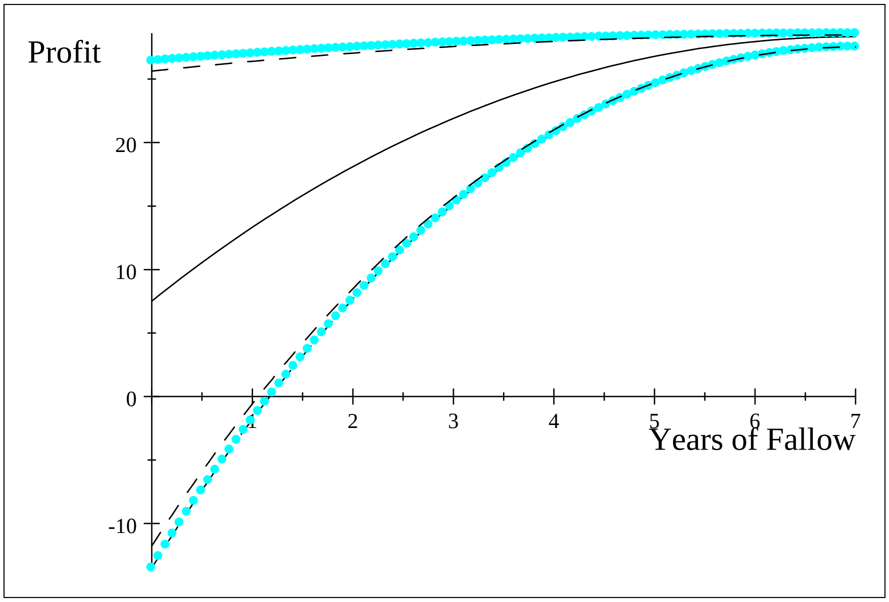


Figure 2: Non-Linear IV Estimate of the Profit Function



Central line: $g(\hat{a}, \hat{b})$, where $(\hat{a}, \hat{b})$ are point estimates from from NLIV estimates of the profit function

Outer band: 90% confidence interval for $\hat{a}$, and corresponding values of $\hat{b}$.

Inner band: 90% confidence interval for $\hat{b}$, and corresponding values of $\hat{a}$.

Confidence intervals taken from 1000 block-bootstrap iterations, with blocks defined by household-year groups.