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Property Rights and Investment Incentives: Theory and Evidence from Ghana

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This paper examines the link between property rights and investment incentives. I develop three theoretical arguments based on security of tenure, using land as collateral and obtaining gains from trade. The paper then presents empirical evidence from two regions in Ghana. I investigate the possibility that rights are endogenous, with farmers making improvements to enhance their land rights. Finally, I suggest tests for which of the theories might explain the results.

I. Introduction

The evolution of property rights and their effect on investment are central issues in the political economy of development. Moreover, the role of the state in codifying and protecting such rights is regarded, in many contemporary and historical discussions, as important to providing the preconditions for economic growth.[1] Such issues are par-

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[1] For historical discussions, see North (1981) and DeLong and Shleifer (1992). For an attempt to see whether measures of property right security matter in cross-country growth regressions, see Barro (1991).

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ticularly pressing in Africa, given its relatively poor economic performance and the fact that individualistic notions of ownership are not, as yet, fully accepted. Thus it is often argued that a state structure governing property rights needs to be developed before growth can resume.

Here, I investigate the link between investment and land rights using data from Ghana. Like many African countries, Ghana is in a transition between a traditional system of land rights (which emphasizes claims of the community) and a modern one (which emphasizes the claims of the individual). The data used here display sufficient variation in the rights that individuals enjoy on different fields to test whether property rights matter for investment decisions. However, there are good reasons to believe that land rights evolve systematically through time, and it is interesting to study the determinants of property rights as well as their consequences. In fact, a reverse causation has commonly been suggested in which investments on a piece of land can secure the owner's rights to the land. Thus rights can be endogenous, an issue that does not appear to have been taken seriously before.[2] One of the main tasks in this analysis is to see whether and how this can be handled. In doing so, I look at some of the determinants of the land rights that individuals enjoy.

Traditional land tenure systems in Africa are often referred to as *communal.* In such schemes a customary authority, such as a tribal chief, grants claims and regulates transfers of land. This authority may also play a role in regulating land investments. In the extreme, the current cultivator of a field may have no discretionary land transfer rights; these rights, often referred to as *usufructuary* rights, are granted only as long as the current operator remains on the land. Development of formal land rights in Africa has become more important with increases in population pressure, and these increases have been a key factor in the adoption of large-scale land titling programs (see, e.g., Atwood 1990).[3] They often emphasize individualistic rights, granting ability to transfer the land without needing a community sanction.

Ghanaian land rights roughly follow this model. Communal land tenure systems were dominant historically but have gradually been supplanted by individualistic property rights. For example, the courts have formally recognized the existence of "family land" in which control is wrested from the larger kinship group (see, e.g., Bruce 1988).

The two regions of Ghana studied here have quite different eco-

[2] Place and Hazell (1993) discuss this possibility but do not deal with it.

[3] Such a program was instituted in Ghana in the 1980s.

nomic environments.[4] The first is a cocoa growing region—Wassa. It is located in the west of the country. Here, I investigate the decision to plant trees. Most of the land is owned, rather than leased or rented. The second region is Anloga in the extreme southeastern part of the country, where farmers specialize in growing shallots (a small type of onion) on very small plots of land. Farmers here make a number of different land improvements detailed below. The land rental market is quite active in Anloga, and a good deal of the land is not owner-operated.

Land rights are hard to codify with any precision. Here, I focus on *transfer* rights, which are decomposed into rights to sell, rent, bequeath, pledge, mortgage, and gift. Whether each field owned and operated by a household has any of these rights is measured in the data, along with whether exercising this right requires lineage approval.[5] These rights may not correspond exactly to the rights that farmers care about in planning their investment. For example, formal (de jure) rights might have very little to do with the ability to exercise these rights (de facto). However, examining these self-reported transfer rights is a good place to begin. I return to measurement issues in discussing the robustness of the initial findings to the use of more disaggregated measures of land rights.

The idea that land rights depend in part on past investments is not new, although I am not aware of previous efforts to test whether it is empirically important. The argument is clearly stated in Bruce (1988, p. 41) in his review of African land tenure systems:

> Some observers have suggested that indigenous tenure systems pose a degree of insecurity that destroys incentives to plant tree crops. This may be true in some cases, but the literature is also replete with examples in which holders with temporary or fragile titles, having succeeded in planting trees, enhanced their tenure. The establishment of tree farms can be a critical step in the transition from shifting to stabilized cultivation, with trees defining permanent holdings. Tree planting may initially be discouraged by insecurity of tenure, but . . . tree planting can actually produce greater security of tenure and . . . act as a way of claiming land.

[4] Migot-Adholla and Place (1991) give a description of the data and some interesting background discussion about the regions being studied here.

[5] The meaning of lineage approval may vary from place to place. In some cases it just means permission from parents. I am grateful to Frank Place for putting me straight on this.

This sentiment is echoed in Atwood (1990). It can be viewed as an African adaptation of the Lockean theory of property rights;[6] individuals own the trees that they plant on the land and may lay claim to own the land in virtue of this. Active pursuit of rights has been discussed in the theoretical literature by de Meza and Gould (1992), who argue that actions to secure rights will follow concerns about insecurity. I focus here on the role of investments in enhancing rights. However, this does not rule out the possibility that farmers undertake other activities to enhance their rights. Unfortunately, these activities are not measured in the data set used here.

There is no *necessary* link between the development of individualistic property rights and increased investment. If individuals cared equally about all members of the community, then the incentive to invest need not be diminished by the fact that their land will revert to the community rather than to their own progeny at the end of their lives. Similarly, if consumption is shared among members of a community, then it is efficient to have investment on land decided at a community level.[7] Thus finding a link between investment and rights is not necessarily indicative of an efficiency loss associated with communal tenure systems. Indeed, if there are important externalities from investing, for example due to soil degradation, then the opposite could be true. Tensions between communal property rights and investment efficiency arise when other aspects of the economic environment and the system of property rights are not in harmony, as has, arguably, become increasingly the case in many parts of Africa during moves toward greater cash cropping. It is this dysfunction between communal rights and individualized decisions that may result in an efficiency loss.

Three arguments for a positive link between land rights and investment decisions are considered here. The traditional view, articulated in Demsetz (1967) and Alchian and Demsetz (1973), emphasizes freedom from expropriation. Individuals do not invest if the fruits of their investments are seized by others. Expropriations of land against the occupants have not been common in Ghana. Property rights appear to have been quite stable, with well-defined laws and customs governing rights to land.[8] Investment and property rights may also

[6] The political philosopher John Locke held that individuals created property rights by "mixing their labor" with some object.

[7] Community-based risk sharing is an important feature of the rural landscape in many developing economies. For evidence on this in an Indian context, see Townsend (1994).

[8] There have been isolated incidents. For example, in the Asante Akyem region of the country, a group of farmers had their land titles revoked in 1970 because it was

be linked through the credit market, as has been suggested by Feder et al. (1988) in the context of Thailand.[9] If better rights make it easier to use land as collateral, then constraints on funding investments can be diminished. Section II*B* develops a model of this. A third link between rights and investment comes via enhanced possibilities for gains from trade; investment is encouraged if improved transfer rights make it easier for individuals to rent or sell their land. A simple model of this is developed in Section II*C*. The primary purpose of the paper is not to argue for any particular theoretical view, although some effort is expended in testing between them below.

The remainder of the paper is organized as follows. Section II develops some simple theoretical models and discusses how land rights could enhance investment incentives in theory. The implications, in theory, of regarding land rights as being affected by past investments are also examined in this section. Section III develops an empirical model, and Section IV presents the results. Concluding remarks are in Section V.

II. Theory

Consider an individual deciding at time t how much capital, denoted by k_t, to invest on a given field. The returns function for time $t + 1$ is $V(k_t, R_{t+1})$ and depends on property rights at $t + 1$ denoted by R_{t+1}. It is assumed that $V(\cdot, \cdot)$ is increasing in both arguments and concave in k_t. The cost of the investment is denoted by $c(k_t, R_{t+1})$, which is assumed to be increasing in k_t and nonincreasing in R_{t+1}. The optimal investment choice thus satisfies

$$\max_{k_t} \{W(k_t, R_{t+1})\} \equiv V(k_t, R_{t+1}) - c(k_t, R_{t+1}). \tag{1}$$

It is straightforward to see that

$$\frac{\partial k_t}{\partial R_{t+1}} = -\frac{W_{12}(k_t, R_{t+1})}{W_{11}(k_t, R_{t+1})}, \tag{2}$$

which, since $W_{11} < 0$ at a maximum, implies that investment increases as rights are improved if $W_{12} > 0$. The analysis explores this condition in three cases.

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deemed that the transactions had not been negotiated with the rightful authority (Migot-Adholla and Place 1991, p. 2-19). The colonial period in Ghana had a minimal effect on land rights, with most agricultural land remaining under indigenous control.

[9] The reader will find, however, that the authors' formal account of why land rights matter still puts quite a lot of weight on security of tenure. This is probably unnecessary. The formal reworking of their model in Sec. II*B* does not emphasize security as a driving force.

A. *The Security Argument*

Suppose that in period $t + 1$ there is some chance that an individual has his land expropriated and that the probability that this will happen is a decreasing function of the rights that he enjoys. Formally, the probability of expropriation function is $\tau(R_{t+1})$ ($\in [0, 1]$), where $\tau'(R_{t+1}) < 0$. The expected return to investing is $V(k_t, R_{t+1}) = [1 - \tau(R_{t+1})]F(k_t)$, where the physical return to the investment is $F(k_t)$, and it is assumed that the farmer keeps none of the return after an expropriation. It is straightforward to calculate that

$$V_{12} = -\tau'(R_{t+1})F'(k_t) > 0, \tag{3}$$

and, under the assumption that the costs are independent of R_{t+1}, then $W_{12} > 0$.

This approach models property right insecurity much like a random tax on land. It seems most relevant for situations in which either the rule of law has broken down and individuals are able to appropriate others' assets or else that the state seizes individuals' property after a revolution. It may also be relevant for modern Latin America, where squatters who have gained some rights to land through prolonged residence face a threat of eviction.

B. *A Collateral-Based View*

The collateral-based view was suggested in Feder et al. (1988). The development of this idea here is quite different, although the bottom line is the same. Here, it is shown that if land is easier to collateralize, then the bank will charge a lower interest rate. Since farmers equate the marginal return to investing on land to the interest rate, this increases land investment.[10]

Consider a two-period world in which a farmer can borrow from the credit market and invest in his land in period 1. The return to investing is stochastic, yielding $\theta(k)$ (where $\theta'(\cdot) > 0$, $\theta''(\cdot) < 0$) with probability q and nothing with probability $1 - q$. It is assumed that each loan is collateralized and that, in the event of default, the individual's land is seized by the lender at a cost of $\phi(R_{t+1})$, where $\phi'(\cdot) < 0$. The key assumption is that it is less costly to seize land if an individual has better transfer rights.[11] The lender is bound, by social

[10] The model developed here is basically a neoclassical credit market, and the main effect operates via a reduction in the equilibrium interest rate. Feder et al. appeal to credit rationing arguments to get a similar effect.

[11] This assumption is controversial. Some kinds of rights may actually increase the foreclosure costs of lenders, by making it easier for the borrower to entrench himself. For further discussion on the link between land rights and foreclosure costs, see Atwood (1990, p. 664) and references therein.

custom, to leave the borrower with some minimal level of consumption, $\underline{x}$, which gives utility $\underline{u}$. The borrower's initial wealth is y, and his two-period expected utility function is

$$u(y + b_t - k_t) + qu(\theta(k_t) - r_t b_t) + (1 - q)\underline{u}, \tag{4}$$

where r_t is the interest rate set by the lender and the utility function $u(\cdot)$ is smooth, increasing, and concave. The farmer is assumed to choose (b_t, k_t) to maximize (4) given an interest rate of r_t. It is straightforward to check that the first-order conditions reduce to

$$\theta'(k_t) = r_t; \tag{5}$$

that is, the marginal product of capital is set equal to the interest rate. This gives k_t as a decreasing function of r_t. Maximizing (4) also yields a borrowing demand equation $b_t = g(r_t)$, where $g'(\cdot) < 0$ under the assumptions made above; that is, the amount borrowed is a decreasing function of the interest rate. The lender's profits are

$$\begin{aligned}\Pi(r_t, R_{t+1}) = q(r_t - \rho)g(r_t) + (1 - q)[p(\theta'^{-1}(r_t)) \\ - \phi(R_{t+1}) - \underline{x} - \rho g(r_t)],\end{aligned} \tag{6}$$

where ρ denotes the lender's opportunity cost of funds and $p(\cdot)$ is the value of the land to the lender after a default.[12] There are basically two terms in (6): the first represents the case in which the loan is repaid and the second the case in which the borrower defaults. Entry into the credit market is assumed to have a fixed cost of C and $\Pi(\rho, R_{t+1}) < C$, so that lending at the opportunity cost of funds would not break even. The equilibrium interest rate, r_t^*, is then the smallest interest rate (above the opportunity cost of funds) at which the lender can break even, that is, $\min\{r|\Pi(r, R_{t+1}) = C\}$.[13] Hence, $\Pi(\cdot, R_{t+1})$ must be increasing at r_t^*. But $\Pi(r_t, \cdot)$ is also increasing. Thus an increase in R_{t+1} reduces the equilibrium interest rate, and the optimal investment level k_t^* is increasing in R_{t+1}. The latter follows from the observation that k_t is decreasing in r_t, from (4).[14]

[12] The best way to think of this is as the market price of the land. There is an implicit assumption that the sale does not yield any surplus for the lender in the relevant parameter space, i.e., $p(\cdot) - \phi(R_t + 1) - \underline{x} - \rho g(r_t) < 0$. Otherwise, the borrower could sell the land himself and would be better off by doing so and repaying the loan.

[13] Such an interest rate is assumed to exist.

[14] The argument can be made in terms of the derivative W_{12}. Let

$$W(k_t, R_{t+1}) = \max_{b_t} \{u(y + b_t - k_t) + qu(\theta(k_t) - r(R_{t+1})b_t) + (1 - q)\underline{u}\}.$$

The first-order condition for the choice of k_t after the envelope condition is used for the choice of b_t is $W_1 = \theta'(k_t) - r(R_{t+1})$. Thus $W_{12} = -dr/dR_{t+1} > 0$, as required.

The key assumption is that better land rights lower foreclosure costs. Improved rights reduce the equilibrium interest rate, and since the interest rate is set equal to the marginal productivity of capital invested in land, investment is stimulated. Other stories of how credit markets function, such as the one developed in Feder and Feeny (1991) based on credit rationing, yield similar conclusions. However, a basically neoclassical model of the credit market will do. The exact story is unimportant for what follows. All that matters is that improved possibilities for collateral generate a link between investment decisions and land rights.

The collateral-based view implies that land rights at the *household* rather than the field level matter to investment decisions; there is no reason why a farmer cannot collateralize *any* of his fields to invest in another. This is an important observation that is used below. There is no reason to find a link between land rights on a particular field and investment on *that* field, where a farmer has more than one field. Some measure of rights at the *household* level should matter. This is investigated empirically below.

C. *A Gains-from-Trade Perspective*

The third model examines whether better rights, leading to expanded trading opportunities and the ability to exploit gains from trade, enhance investment incentives. Superior transfer rights are modeled as lowering the costs of exchange if the land is either rented or sold. The desire to trade is generated by stochastic outside opportunities, such as an offer to buy or rent the land from the current owner.

The two-period framework is maintained. In the first period, the owner of the land chooses how much to invest. At the beginning of period 2, there is a shock that affects the productivity of the current owner if he chooses to keep the land. This shock also affects his return to the period 1 investment. It might be thought of as a health shock or an income shock, which makes it difficult for the owner to buy needed inputs. Also revealed at this point are possibilities for trade. The owner then faces a decision whether to sell or rent the land to another operator. It is assumed that there is a trading cost that depends on the operator's transfer rights; an infinite cost is like having no transfer rights at all. More generally, better transfer rights make it less costly to organize a trade. It is assumed that the current owner and alternative potential operator bargain to determine the price at which any trade takes place.

For simplicity, the return to investing is made a linear function of k, and the owner's marginal (= average) product of capital if he

continues to use the land is denoted by θ. Viewed from period 1, it is distributed on $[\underline{\theta}, \bar{\theta}]$ with probability density function $f(\theta)$. The outside valuation is denoted by ω and is distributed on $[\underline{\omega}, \bar{\omega}]$ with probability density function $g(\omega)$.[15] It represents the marginal (= average) product of capital if the land is transferred to a new operator. It is assumed, for simplicity, that the valuations are independently distributed. To introduce the importance of rights, suppose that there is a cost of trade function, denoted $\mu(R_{t+1})k_t$, which is *decreasing* in R_{t+1}; that is, better land rights lower transfer costs.[16]

A full-information Nash bargain, with a status quo point of no trade, is assumed to determine the price at which trades take place. Thus, if the investment made in period 1 was k, then the equilibrium price of land solves

$$\max_{p} [p - (\mu + \theta)k](\omega k - p). \tag{7}$$

It is easy to check that the solution to (7) is $p^* = \frac{1}{2}[(\theta + \omega + \mu)k]$. Hence, the payoff to the owner of the land if he sells it is $\frac{1}{2}[(\theta + \omega - \mu)k]$. Note that investment here raises the value of the land. Better rights raise this price because they increase the extent of the market. To decide whether or not to sell, he compares this price with the return to operating the land himself where his payoff is θk. The expected return from investing k_t if rights are R_{t+1} is

$$V(k_t, R_{t+1}) = k_t E\{\max\{\tfrac{1}{2}[\theta + \omega - \mu(R_{t+1})], \theta\}\}, \tag{8}$$

where $E\{\cdot\}$ is the expectations operator taken over θ and ω. Differentiating (8) yields the expected marginal product of capital:

$$\frac{\partial V(k_t, R_{t+1})}{\partial k_t} = \int_{\underline{\omega}}^{\bar{\omega}} \left(\int_{\underline{\theta}}^{\omega - \mu(R_{t+1})} \{\tfrac{1}{2}[\theta + \omega - \mu(R_{t+1})]\} f(\theta) d\theta + \int_{\omega - \mu(R_{t+1})}^{\bar{\theta}} \theta f(\theta) d\theta \right) g(\omega) d\omega. \tag{9}$$

To show that this is increasing in R_{t+1}, differentiate (9) with respect to R_{t+1} to obtain

$$\frac{\partial^2 V(k_t, R_{t+1})}{\partial k_t \partial R_{t+1}} = -\left\{ \int_{\underline{\omega}}^{\bar{\omega}} F[\omega - \mu(R_{t+1})] g(\omega) d\omega \right\} \mu'(R_{t+1}) > 0. \tag{10}$$

It is straightforward to see why (10) is positive. When the cost of making a transfer is reduced, an improvement in rights increases the

[15] It is best to think of ω as the maximum outside offer available.

[16] This function is made proportional to k_t to avoid the possibility of increasing returns to capital driven by the cost of trade.

likelihood that the land is traded, which occurs if the buyer's valuation exceeds the owner's by a sufficient amount. By obtaining a higher price for the land, the owner reaps a return to investing.

Even though the formal structure is quite different, the main implication of this gains-from-trade model is the same as in the two previous models: improvements in land rights enhance investment incentives. However, this model does suggest a particular focus on the rights to sell and rent, since selling and renting is the most plausible case to which the model applies. Below, I look for evidence that these rights matter above all.

D. *Endogeneity*

The analysis above viewed land rights as exogenously given. Thus R_t or R_{t+1} could be used in the analysis equally well. Allowing the decision to invest to affect *future* land rights changes the analysis. Thus suppose that

$$R_{t+1} = \psi(\lambda k_t, R_t), \tag{11}$$

where $\psi(\cdot, \cdot)$ is increasing in both arguments. If $R_t = \psi(0, R_t)$, then the models above represent the special case in which $\lambda = 0$. From (11), the decision to invest is now captured by

$$\max_{k_t} W(k_t, \psi(\lambda k_t, R_t)) = V(k_t, \psi(\lambda k_t, R_t)) - c(k_t, \psi(\lambda k_t, R_t)), \tag{12}$$

and the first-order condition for the choice of k_t is

$$W_1(\cdot, \cdot) + W_2(\cdot, \cdot)\lambda\psi_1(\lambda k_t, R_t) = 0, \tag{13}$$

assuming an interior solution. The second term in (13) gives the enhanced incentive to invest due to the improvement in an individual's land rights. When (13) is solved, the investment function is $k_t = \kappa(R_t)$, and not a function of R_{t+1} as above. Putting R_{t+1} on the right-hand side of an investment equation would constitute a misspecification. I return to this below.

III. Empirical Analysis

A. *The Data*

The empirical analysis uses data from two regions of Ghana in West Africa, a mainly agricultural economy that is heavily dependent on cocoa production. Since Ghana gained independence from Britain in 1957, its economic performance has been generally poor, although an adjustment program was instituted in 1983 that has led to a significant improvement in the main economic indicators.

The first region studied here is Wassa, for which data on 217 households that own and operate 1,074 fields are used.[17] It is a cocoa growing region in the western central part of the country. The only significant investment made to improve the land in the data is planting tree crops. This is fairly common: 66 percent of the fields are reported as being improved by tree crops since the farmer acquired them. The transition from communal to individualistic land rights is most apparent in Wassa. Land was traditionally controlled by the "stool" (the tribal authority). However, postcolonial law has tried to marginalize such influences. Note, however, from table 1 that most rights reported here are still reported as being subject to lineage authority.

In the second region, Anloga, there are 494 owner-operated fields spread over 117 households. The land improvements made in Anloga are much more diverse and are described in greater detail below. Anloga is less dependent on agriculture than Wassa, and most agriculture is devoted to growing shallots on very small fields. The population density in this region is much higher than in Wassa. Most land here is passed on through inheritance. Most disputes concern subdivisions that occur after the death of the previous owner. Migot-Adholla and Place (1991) report a growing de facto individualization of rights, with acquiescence by courts. Thus table 1 reveals that the majority of rights here do not require lineage approval.

The data provide information on some basic household characteristics, such as the sex and age composition of the household. There are also some crude wealth measures such as the value of consumer durables, livestock, and the number of rooms in the family dwelling. Table 2 gives means and standard deviations of these household-level variables.

The survey asked each household to report its use and transfer rights on every field that it was operating at the time.[18] These rights fall into six categories: the rights to sell, rent, gift, mortgage, pledge, or bequeath each field.[19] The survey also asked whether approval

[17] From an original 1,203 fields, I dropped those for which I had no information on mode of acquisition. I also eliminated a couple of outliers, where the field area was listed as being greater than 80 hectares.

[18] Only fields that are owned and operated by the farmer are included in the analysis. The data collected on other fields are much less complete.

[19] It is interesting that some farmers report that they have the right to sell but not to rent a particular field. One might have thought that two farmers could always implement a rental contract by some sale and buyback arrangement. This raises a question of whether the rights categories are really distinct. However, the customs that govern land transactions, such as the ritual of drinking gin and pouring the libation over the land in order to seal a transaction in Anloga (Migot-Adholla and Place 1991), may create a distinction in the minds of farmers.

TABLE 1

FIELD MEANS

	Anloga (N = 494)	Wassa (N = 1,074)
Rights:		
Sell	.78	.71
Rent	.95	.94
Mortgage	.83	.98
Pledge	.89	.95
Bequeath	.79	.97
Gift	.75	.94
Number of rights with approval	.77	4.41
Number of rights without approval	4.22	1.07
Mode of acquisition:		
Field inherited	.95	.09
Field purchased	.03	.22
Field allocated	.00	.38
Field appropriated	. . .	.20
Field gifted	.02	.11
Existing improvements:		
Drainage	.48	. . .
Tree crops	.04	.08
Continuous manuring	.73	. . .
Land excavation	.54	. . .
Irrigation	.65	. . .
Mulching	.25	. . .
Making shallot beds	.71	. . .
Number of past tree plantings	. . .	1.08
Field area (hectares)	.07	3.56
Distance from house (kilometers)	1.15	1.86
New improvements:		
Drainage	.48	. . .
Continuous manuring	.93	. . .
Land excavation	.44	. . .
Irrigation	.51	. . .
Mulching	.35	. . .
Making shallot beds	.75	. . .
Planting trees	. . .	.66
Other:		
Ever litigated on field	.07	.09
No title deed	.89	.70
Number of years owned	22.50	17.96
Soil very fertile	. . .	.29
Soil fertile	. . .	.64
Soil poor	1.0	.07

NOTE.—Soil type variables refer to fraction of land in soil category.

from the lineage was required to exercise the right. Thus for each field, there are 12 categorical variables describing the transfer rights. I experimented with some different ways of aggregating them into different measures for use in the quantitative analysis. In most of the results that are presented here, the *number* of rights that a farmer has on each field in the approval and no-approval categories is used,

TABLE 2

HOUSEHOLD MEANS

	Anloga (N = 117)	Wassa (N = 217)
Average age of household	27	22
	(11)	(7)
Value of durables (cedis)	18,968	7,614
	(27,070)	(13,030)
Livestock value (cedis)	27,730	52,886
	(141,406)	(132,920)
Formal education of head (years)	1.58	1.59
	(.73)	(.60)
Number of females	3.78	4.22
	(2.80)	(2.35)
Number of males	4.46	4.24
	(2.99)	(2.67)
Number of rooms in home	6.36	4.86
	(4.02)	(2.95)
Number of fields per household	4.92	6.70
	(2.56)	(2.90)

NOTE.—Standard deviations are in parentheses.

giving a simple bivariate measure of a field's rights.[20] More disaggregated measures are discussed in Section IV*C*, where I also experiment with the idea that there is a hierarchy of rights, with some mattering more than others. Table 1 gives the means of each right across all fields for each region. It also gives the means of the aggregate rights variables.[21]

For each plot, the following characteristics are also known: soil type (irrelevant for Anloga, where all soil is sandy and therefore poor), mode of acquisition, the improvements at the time of acquisition, the litigation history of the plot, the area of the plot, the distance from the house, and the presence or absence of a transfer deed.

The survey asked a number of questions about the improvements that farmers had made on the land since they acquired it. Here, I work with the last decision by a farmer to improve the land. In Wassa this means planting trees. In Anloga, draining, continuous manuring, excavating land, irrigating, mulching, and making shallot beds are

[20] The main trade-off comes from the desire to take endogeneity of rights seriously. There would be little chance of identifying a model that allowed each right to be endogenous, given the data available. If only certain rights really matter to investment, then aggregation introduces measurement error into the right-hand side of the investment equations. However, this bivariate specification of rights is a reasonable compromise given the available data. Using a bivariate representation in which the rights variable is instead the *product* of the six underlying rights yields results similar to those reported here.

[21] Table 8 below gives the correlation matrix for the different rights.

studied. While planting trees is a long-term investment, arguably many of the other activities have quite short payback periods. However, even activities such as continuous manuring and mulching affect the land's productivity in future cropping seasons. It is also possible that the investments in Anloga differ in the externalities that they generate. For example, irrigation and drainage might affect other fields. They may also affect the way in which rights interact with investment decisions, especially if one function of the community is to internalize investment externalities. Finally, note that since the last improvement on a given field may be made some time before the survey was conducted and the rights are those collected at the time of the survey, the data correspond to (k_t, R_{t+1}) from the theoretical model. Table 1 also gives the means of the land improvement variables.

B. *Empirical Models and Econometric Concerns*

The theoretical models suggested estimating an equation for investment on field j, owned by farmer i at time t, with land rights (R_{ijt+1}), field characteristics (z_{it}), and household characteristics (x_{ijt}) on the right-hand side. This can be is written as

$$k_{ijt} = f(R_{ijt+1}, z_{it}, x_{ijt}). \tag{14}$$

Above, I discussed why R_{ijt+1} could be endogenous. Thus there is some interest in a second equation:

$$R_{ijt+1} = g(k_{ijt}, z_{it}, x_{ijt}, R_{ijt}). \tag{15}$$

These two equations form the backbone of the analysis.[22]

All of this assumes that R_{ijt+1} is well measured. Failure to model (15) or to take account of measurement error in the rights variable will bias attempts to estimate some version of (14). This can be seen clearly using the following simple empirical model:

$$\begin{aligned} k_{ijt} &= \beta R_{ijt+1} + \epsilon_{ijt}, \\ R_{ijt+1} &= \lambda k_{ijt} + \alpha R_{ijt} + \eta_{ijt}, \\ \text{var}(\epsilon_{ijt}) &= \sigma_\epsilon^2; \text{var}(\eta_{ijt}) = \sigma_\eta^2 \quad \text{with cov}(\epsilon_{ijt}, \eta_{ijt}) = 0, \end{aligned} \tag{16}$$

[22] A more general analysis could include a larger system of equations with other left-hand-side variables of interest. One interesting possibility, suggested by a referee, is to model the value of the land. This would provide an extra link in the gains-from-trade story told above. Data on land transactions could also be related to the rights that the individuals enjoy. Unfortunately, however, this is not measured in the Ghanaian data. For an interesting analysis of Brazil that makes use of land value data, see Alston, Libecap, and Schneider (1994).

where $1 - \lambda\beta > 0$, to guarantee a solution with positive investment. Suppose that the researcher observes (k_{ijt}, ρ_{ijt+1}), with $\rho_{ijt+1} \equiv R_{ijt+1} + \phi_{ijt+1}$, where ϕ_{ijt+1} is "classical" measurement error with mean zero and variance σ_ϕ^2 and is uncorrelated with all other variables. Suppose that we estimate β by regressing k_{ijt} on ρ_{ijt+1}. Then a standard argument yields

$$\operatorname{plim}\hat{\beta} = \beta + (1 - \lambda\beta)\left[\frac{\lambda\sigma_\epsilon^2 - \beta(1 - \lambda\beta)\sigma_\phi^2}{\alpha^2 \operatorname{var}(R_{ijt}) + \sigma_\eta^2 + \lambda^2\sigma_\epsilon^2 + (1 - \lambda\beta)^2\sigma_\phi^2}\right]. \quad (17)$$

The sign of the bias is unpredictable a priori, depending on whether $\sigma_\epsilon^2/\sigma_\phi^2 > (<)\ [(1 - \lambda\beta)\beta]/\lambda$. There is an endogeneity bias that biases upward the coefficient on land rights in the investment equation, whereas measurement error will tend to bias it downward.

Given the specification in (16), R_{ijt} would make a sensible choice of instrument for the land rights in the investment equation. However, this is not observed directly. Instead some other variables are used that could plausibly be thought to determine R_{ijt+1}, perhaps proxying for R_{ijt}, but might not affect investment directly (assuming that rights are otherwise well measured).[23] These variables are (1) whether there is a transfer deed for the field, (2) whether the household has ever litigated over its right to that field, (3) how the field was acquired,[24] and (4) how many years the field has been owned. Below, these variables are shown to have statistically significant effects on the current rights that a farmer enjoys and are used as instruments. Incorporating them in this way is the nearest the data permit us to running an equation like (15) with the available data.

Above, investment was modeled as a continuous variable. However, the improvements data come in a discrete form: whether a particular improvement was undertaken on a given field. Specifically, we measure investment as a variable equal to one if the field has been improved since it was acquired, and zero otherwise. Thus the analytical framework needs to be modified to allow for discrete choice. From here onward the time subscripts are dropped from all variables; all values of variables should be understood as those measured at the time of the survey, with the investment being the last one undertaken. Let $y_{ijk} \in \{0, 1\}$ be a variable that equals one if household i has invested in improvement k on field j, and zero otherwise. Suppose that a household undertakes the investment if the expected return, π^*_{ijk}, from doing so is positive, that is,

[23] Some specification tests for the choice of instruments are presented below.

[24] The possible categories are inherited, purchased, appropriated, gifted, and allocated. In Anloga, almost all fields were inherited. There is greater variation in Wassa (see table 1).

$$y_{ijk} = \begin{cases} 1 & \text{if } \pi^{*}_{ijk} > 0 \\ 0 & \text{otherwise.} \end{cases} \tag{18}$$

Throughout the analysis a linear probability specification is used for the discrete choice model in (18). In contrast to standard nonlinear discrete choice models, such as probits or logits, it is possible to allow for household fixed effects without biasing the coefficients.[25] The main problem with the linear probability model is that it makes no recognition of the fact that the dependent variable is zero or one. In particular, this can cause the model to predict values of the dependent variable outside the unit interval. This situation was checked for the models estimated here, and the outcome did not appear too unsatisfactory. This tends to be the case when the mean of the dependent variable is not close to zero or one (see, e.g., Maddala 1983), which is typically true here (see table 1). Second, for the cases in which a fixed effect was not used, it was possible to compare the results with those obtained from a probit or logit to check that the coefficients were similar. This suggests that the linear probability model does not perform too badly. In light of this and of the fact that there are not many good ways of dealing with household heterogeneity otherwise, the compromises involved in using a linear probability model seem worth making.

Controlling for heterogeneity between farmers is likely to be important in satisfactorily explaining their investment behavior. If one incorporates available measures of farmer differences, a vector $\mathbf{z}_i$, then the following specification of the investment equation makes sense:

$$y_{ijk} = \alpha_k \mathbf{z}_i + \beta_k R_{ij} + \gamma_k \mathbf{x}_{ij} + e_{ijk}, \tag{19}$$

where $\mathbf{x}_{ij}$ is a vector of plot-specific characteristics. In this empirical analysis, the vector $\mathbf{z}_i$ includes all the measures of household characteristics available to us from the data (listed in table 2) as well as village dummy variables.[26] However, this list is limited, leaving a concern that measured rights might also proxy for omitted variables, such as investment ability or knowledge.[27] If this were true, then one could find a spurious link between land rights and investment.

[25] The problems with using these standard models in panel data specifications are covered in Hsiao (1986, chap 7). While one could have used a conditional logit model instead of a linear probability model, the likelihood function for this application would be quite cumbersome, given the significant differences in the number of fields being operated by different farmers.

[26] There are five villages in the Anloga sample and 10 in the Wassa sample.

[27] One might also worry that household characteristics are affected by past decisions to invest. This would also bias the estimates of (19).

To deal with this concern, I allowed for a household fixed effect. Any effect of land rights is now identified from variation in investment decisions across fields owned and operated by a given farmer. This model can be written as

$$y_{ijk} = \alpha_{ki} + \beta_k R_{ij} + \gamma_k \mathbf{x}_{ij} + e_{ijk}, \tag{20}$$

where α_{ki} is the fixed effect. While farmer heterogeneity is better controlled for if we incorporate a household dummy variable, this may come at a cost. If only *average* household land rights matter for investment decisions, as in the collateral-based story, then one would identify no effect of land rights on investment from (20).

There are also differences across fields in terms of quality and location. These differences affect the suitability of the land for various investments and may also determine whether farmers make conscious efforts to develop their rights to the field in any ways available to them. To deal with this situation, a number of field-level characteristics, relating to soil quality, distance from house, and the improvements that had already been made at the time the land was acquired, are included in the analysis. I shall also investigate how these characteristics are related to the rights that the farmers enjoy.

IV. Results

For each region and investment, equation (19) is estimated with and without instrumentation for land rights. Equation (20) is also estimated with and without instrumentation. In addition, the determinants of land rights are investigated by regressing these variables on those included in the investment equations and the list of instruments detailed above. Finally, different ways of including the rights variables are explored in an attempt to distinguish between the different theoretical models.

A. Wassa

For Wassa, let us study tree planting. In the case in which a farmer has planted trees on a field more than once, we shall study the *last* decision to plant trees and condition for past tree plantings by the existing operator to this point, as well as planting decisions by previous operators. To see this end, I generated a variable to represent the stock of past investments in trees, measured as the number of times the owner has planted trees on the field prior to the decision, plus one if the land had trees on it at the time of acquisition. The mean of this variable is 1.08 (see table 1). This helps to pick up unmeasured field-specific characteristics and may also crudely cap-

ture a stock adjustment process. However, since this depends on past values of the right-hand-side variables, it measures field-specific effects with error. Hence, it is instrumented for using the set of instruments described below.[28]

Table 3 gives results based on equation (19). They suggest that, in line with the theory, land rights matter for investment in trees. An extra right with approval from the lineage raises the probability of investing by 2.5 percent and is significant at a 5 percent level. The size of the coefficient for an extra right without approval is similar but is not significant at conventional levels. Trees are more likely to be planted by households with more males, and tree crops appear to be a substitute for livestock. In all cases, having planted trees more often in the past makes it significantly more likely that a household plants more trees in the future on that field. This may be proxying for the land's suitability for cocoa trees. With unmeasured household heterogeneity, it could also reflect household knowledge about cocoa production. The village dummies (coefficients not reported) revealed significant cluster effects in the data, perhaps proxying for agroclimatic variation and access to infrastructure. They could also represent village-level variation in land rights.

The size of the coefficient on land rights with approval increases to about 28 percent; for rights without approval, it is 11 percent when land rights are instrumented for with the mode of acquisition, whether or not the owner has a title deed, whether there was ever litigation on the field, and whether there were trees at the time of acquisition. This is reported in column 2 of table 3. I tested the overidentifying restrictions by regressing the residuals from the second-stage investment equation, after instrumenting, on the instruments and other exogenous variables. The p-value for the F-test on the joint significance of the instruments in this regression is reported, showing that the test passes comfortably. All in all, the initial finding that rights have a positive effect on investment is robust. Indeed the effect appears larger and more significant after instrumenting.

Table 3 also reports the (first-stage) regressions of land rights on household and field-level variables as well as the instruments. Household characteristics do appear related to the rights that households enjoy. Rights with approval are related to the mode of acquisition; they are negatively associated with the acquisition of the land by gift.[29] Rights without approval are significantly higher if the land was gifted

[28] The effect of instrumenting this way is to increase the coefficient and reduce the t-value on this variable. The raw results are available on request, as are the first-stage regressions for this variable.

[29] The omitted category on mode of acquisition is inheritance of the field.

or purchased. This is quite consonant with their being good instruments for the original rights that farmers enjoyed. Not having a transfer deed is significantly and negatively related to rights without approval but does not seem to affect rights with approval. The village effects revealed that three out of the 10 villages tended to grant rights without approval. This is consistent with the village organization's importance in the determination of land rights. As a further test of instrument quality, the F-test on the joint significance of the instruments in the land rights regressions is reported. The hypothesis that they are jointly zero is rejected at better than the 1 percent level.

Are the results in table 3 robust to the inclusion of household fixed effects? Table 4 shows that they are in column 1, where rights are entered without instrumentation. The coefficient on rights with approval is now 4 percent and is significant at 4 percent. An extra right without approval, however, has no significant effect on investment. Comparing this column with column 1 of table 3 shows that after heterogeneity is better controlled for, only rights with approval appear important for investment choices. The number of past tree plantings continues to be significant (and has a magnitude similar to that of table 3). The negative relationship with field size is also apparent. Again a test of the overidentifying restrictions passes comfortably. This again is encouraging for the initial findings.

Column 2 of table 4 gives results after instrumentation for land rights. The initial findings are once again robust: instrumenting for land rights actually increases the size of the coefficient on this variable. However, it is significantly different from zero only for rights without approval, where an extra right increases the probability of investing by 28 percent.[30] While this does not rule out the possibility that rights are endogenous, as suggested by Bruce (1988) and others, it seems more likely that this finding reflects the importance of measurement error. More specifically, it is indicative of the fact that the rights as measured here do not capture exactly what farmers care about when they make their investment decisions.

The regressions of rights on the instruments, fixed effects, and other exogenous variables yield some interesting findings. As in table 3, the mode of acquisition significantly affects the rights that the owner has on the field. Having purchased the field significantly increases rights without approval, which is consonant with the gains-from-trade model. Receiving the land as a gift tends to increase rights with approval and reduce those without, suggesting that lineage man-

[30] It is not possible to reject the hypothesis that the coefficients on the two rights variables are equal, however.

TABLE 3

WASSA: INVESTMENTS IN TREE PLANTING (N = 1,074)

	Uninstrumented (1)	Instrumented (2)	Rights with Approval (3)	Rights without Approval (4)
Rights with approval	.03	.12		
	(1.93)	(1.93)		
Rights without approval	.02	.11		
	(1.56)	(1.68)		
Number of past tree plantings	.19	.14		
	(4.34)	(2.72)		
Average age	−.00	−.00	−.01	−.00
	(.40)	(.04)	(.26)	(.52)
Value of durables	.00	.00	−.00	−.00
	(1.80)	(2.21)	(.49)	(1.98)
Livestock value	−.00	−.00	−.00	.00
	(2.05)	(1.78)	(2.48)	(2.77)
Formal education of head	.01	−.01	.18	.00
	(.23)	(.47)	(1.68)	(.04)
Women	−.01	−.01	−.08	.04
	(.78)	(.21)	(2.66)	(1.58)
Men	.01	.02	−.02	.03
	(2.03)	(2.28)	(1.67)	(1.32)
Rooms	−.00	−.01	.08	−.03
	(.45)	(1.22)	(3.93)	(1.34)
Distance from house	.01	.01	−.05	.01
	(1.44)	(1.63)	(1.39)	(.35)

Soil very fertile	.07	.09	−.58	.41
	(1.38)	(1.52)	(2.43)	(1.87)
Soil fertile	−.07	.10	−.87	.51
	(1.43)	(1.68)	(4.02)	(2.53)
Field area	−.02	−.02	.00	−.00
	(12.55)	(12.01)	(.01)	(.06)
Field purchased			−.22	.60
			(.90)	(2.64)
Field allocated			−.13	.28
			(.61)	(1.47)
Field appropriated			.36	.28
			(1.57)	(1.31)
Field gifted			−.86	.98
			(3.49)	(4.29)
No title deed			.01	−.34
			(.34)	(2.25)
Number of years owned			−.01	.01
			(.75)	(.91)
Trees existing at time of acquisition			.08	−.18
			(.43)	(.97)
Ever litigated on field			−.11	.23
			(.56)	(1.25)
Test of overidentification restriction (p-value)		.90		
Village dummy variables	Yes	Yes	Yes	Yes
F-test on significance of instruments (p-value)			.00	.00
$\bar{R}^2$	.35	.33	.38	.39

NOTE.—Absolute values of t-statistics are in parentheses. The omitted classification in the mode of acquisition is inheritance and in soil type is poor.

TABLE 4

WASSA: INVESTMENTS IN TREE PLANTING (with Household Dummy Variables)
(N = 1,074)

	Uninstrumented (1)	Instrumented (2)	Rights with Approval (3)	Rights without Approval (4)
Rights with approval	.07	.11		
	(1.77)	(1.02)		
Rights without approval	.05	.28		
	(.86)	(1.94)		
Number of past tree plantings	.22	.19		
	(3.52)	(2.85)		
Soil very fertile	.08	.05	.58	−.10
	(.70)	(.42)	(4.38)	(1.29)
Soil fertile	.05	.03	.26	−.07
	(.49)	(.32)	(2.16)	(1.01)
Distance from house	.00	.01	−.06	−.02
	(.19)	(.58)	(3.64)	(1.78)
Field area	−.03	−.03	.00	−.00
	(12.78)	(12.78)	(1.04)	(.24)

Field purchased			.25	.44
			(1.62)	(4.84)
Field allocated			.14	.03
			(1.29)	(.53)
Field appropriated			.36	.02
			(3.24)	(.25)
Field gifted			.57	−.26
			(4.24)	(3.21)
No title deed			−.26	−.06
			(2.39)	(1.00)
Number of years owned			.01	.00
			(2.90)	(1.13)
Existing trees			−.14	.00
			(2.17)	(.03)
Ever litigated on field			.08	−.02
			(.92)	(.36)
Test of overidentification restriction (p-value)		.99		
F-test of significance of instruments (p-value)			.00	.00
R^2	.32	.33	.10	.09

NOTE.—Absolute values of t-statistics are in parentheses. The omitted classification in the mode of acquisition is inheritance and in soil type is poor.

agement may be important in administering gifts.[31] Not possessing an ownership deed reduces rights in both categories, although the effect is significant only for rights with approval.[32] In addition, a longer period of ownership seems to strengthen rights. This agrees with the idea that land rights are in transition, where possession of a field enhances the owner's rights.[33] Past litigation has no statistically significant effect on rights. It is also interesting to find that, if there were trees when the land was initially acquired, then the owner reports fewer current rights with approval. This is consonant with the model in which land rights are endogenous since, if planting trees enhances a household's rights, then acquiring land with other people's trees on it would likely *reduce* the current owner's rights.[34] An F-test shows that the instruments are jointly significant in these regressions at better than the 1 percent level. Finally, note that fields located nearer to the owner's house tend to have more rights associated with them and that the more fertile fields are those with rights subject to lineage approval. All these results seem quite consonant with the idea that land rights are determined in part by the history of the field, as well as by unchanging characteristics.

In summary, the findings for tree planting in Wassa found investments significantly related to land rights. Moreover, this is robust to attempts to control for farmer heterogeneity and instrumenting for land rights. The fact that the size and significance of the rights effects without approval increase after instrumenting suggests that just using the measured land transfer rights could underestimate the importance of land rights to investment. Moreover, it suggests caution in using formally stated transfer rights as reflective of what farmers actually care about in making their investment decisions. While there may also be a problem of endogeneity, it is not a leading candidate to explain the findings in Wassa.

B. Anloga

Table 5 reports benchmark results from Anloga, that is, from the model in (19). In all cases, except continuous manuring and irriga-

[31] This contrasts with the results in table 3, suggesting the importance of properly controlling for household heterogeneity.

[32] Title deeds need to be registered under the Land Registration Act of 1962 to be effective, and only documents that are registered are supposed to have legal force. The finding that having a document increases rights with approval from the lineage may actually reflect a formal contract with the lineage authority that has been registered.

[33] The reason may also be that a prolonged period of ownership makes it more likely that other steps have been taken to enhance rights to the land.

[34] The idea is that a past owner might be better able to challenge the right of the current owner if he had planted trees on the land.

tion, the rights variables have a positive and significant effect on the probability of investing. The size of the effect varies across the different improvements, with an extra right making an investment between 1 percent and 9 percent more likely. Whether the rights are granted with or without lineage approval does not seem to make a significant difference. These results broadly agree with the theory and the findings from Wassa.

Improvements at the time of acquisition also have significant effects on investment decisions. The fact that drainage and irrigation appear to be substitutes as expected and that trees existing at the time of acquisition consistently affect choices about improvements makes one more sanguine about the quality of the data. Pre-existing trees on the land also appear to have a significant effect on decisions to improve the land in most cases. A number of household characteristics also enter significantly in table 5, although they are difficult to interpret in this reduced-form way. As for Wassa, the village dummies are significant in most cases, underlying the importance of village-level authorities in managing investment and transfers of land in Ghana.

The instruments for Anloga are broadly the same as those used for Wassa, although the mode of acquisition is now a dichotomous variable denoting whether or not the land is inherited. Again, the overidentifying restrictions are tested in the manner noted above. They could not be rejected in every case. The first-stage (land rights) regressions are in table 6. Inherited land has significantly more rights with approval and fewer rights without. Thus the vestiges of the communal land tenure system remain, with transfer rights on land that has been inherited still being influenced by the lineage. The absence of a transfer deed is positively associated with rights with approval, suggesting that lineage sanctions provide an alternative to the formality of a paper title. If the land has been held for a long time, then rights without approval appear to accrue, suggesting that lineage control may break down in such cases. I also find that larger fields have more rights without approval and fewer with approval, and fields that are more distant have more rights with approval and fewer without. The F-tests for the joint significance of the instruments are reported at the bottom of table 6. For brevity's sake, the results for the determinants of improvements when land rights are instrumented for are not reported. However, they are easily summarized. Land rights cease to have a significant effect on investment decisions. The other coefficients are largely as reported in table 6.

The models allowing for household fixed effects were also estimated. These models should be treated with caution: there are only 494 observations on 117 households to identify the fixed effects. Not too surprisingly, therefore, the results from table 5 are not robust.

TABLE 5

ANLOGA: NEW INVESTMENTS (N = 494)

	Drainage	Continuous Manuring	Land Excavation	Irrigation	Mulching	Making Shallot Beds
Rights with approval	.07	.01	.08	−.02	.05	.07
	(4.65)	(.66)	(4.94)	(1.18)	(3.28)	(4.96)
Rights without approval	.08	.01	.09	−.01	.05	.08
	(6.20)	(1.30)	(6.12)	(.38)	(3.59)	(6.03)
Average age	−.01	.00	.01	−.00	.00	−.00
	(2.57)	(1.75)	(2.73)	(.08)	(.47)	(2.17)
Value of durables	−.00	−.00	.00	.00	.00	−.00
	(3.01)	(.22)	(3.32)	(3.90)	(.30)	(.75)
Livestock value	−.00	.00	.00	−.00	−.00	−.00
	(1.18)	(.65)	(1.41)	(.33)	(.88)	(.37)
Formal education of head	−.05	.01	.00	.02	−.04	.08
	(2.18)	(.37)	(.34)	(.86)	(1.52)	(3.17)
Women	−.01	.01	−.01	.02	−.00	.01
	(1.60)	(1.35)	(1.11)	(1.86)	(.68)	(.93)
Men	−.01	.01	−.00	.02	−.01	−.00
	(1.53)	(2.29)	(.19)	(2.15)	(1.52)	(.05)
Rooms	.00	−.00	−.00	.02	.00	.02
	(.53)	(1.39)	(.33)	(3.51)	(.97)	(3.70)

Existing fencing	−.40	.17	−.34	.70	−.31	.11
	(1.12)	(.66)	(.82)	(1.73)	(.80)	(.28)
Existing drainage	.56	.03	−.27	−.30	.15	−.01
	(14.72)	(.97)	(6.11)	(7.21)	(3.58)	(.14)
Existing trees	−.50	−.28	.53	.35	−.35	.09
	(5.66)	(4.45)	(5.12)	(3.52)	(3.66)	(.96)
Existing access road	.59	.20	.30	−.66	−.39	.15
	(1.65)	(.80)	(.72)	(1.64)	(1.02)	(.41)
Existing continuous manuring	−.02	.04	−.16	.00	−.04	−.03
	(.36)	(1.40)	(3.08)	(.03)	(.94)	(.61)
Existing land excavation	−.12	−.05	.28	.10	−.04	−.09
	(3.37)	(1.80)	(6.68)	(2.38)	(1.03)	(2.45)
Existing irrigation	.00	.03	.07	−.22	.05	.02
	(.01)	(.97)	(1.56)	(5.07)	(1.29)	(.53)
Existing mulching	−.11	.05	−.04	.07	.49	.11
	(2.55)	(1.62)	(.69)	(1.33)	(10.34)	(2.33)
Existing shallot beds	−.08	−.01	.08	−.10	−.04	−.05
	(2.14)	(.44)	(1.73)	(2.30)	(.98)	(1.23)
Field area	−.11	.10	.21	.23	−.37	−.04
	(.73)	(.95)	(1.20)	(1.39)	(2.32)	(.28)
Distance from house	−.03	−.01	−.04	−.01	.05	.02
	(1.64)	(.57)	(2.33)	(.56)	(2.85)	(1.21)
Village dummy variables	Yes	Yes	Yes	Yes	Yes	Yes
$\bar{R}^2$	.75	.94	.63	.70	.61	.81

NOTE.—Absolute values of *t*-statistics are in parentheses.

TABLE 6

ANLOGA: RIGHTS REGRESSIONS (N = 494)

	Rights with Approval	Rights without Approval
Average age	.00	−.02
	(.36)	(1.76)
Value of durables	−.00	.00
	(.45)	(1.76)
Livestock value	−.00	.00
	(2.38)	(2.34)
Formal education of head	.02	.14
	(.17)	(1.04)
Women	−.02	.19
	(.71)	(4.93)
Men	.11	−.05
	(2.95)	(1.12)
Rooms	.05	−.01
	(2.05)	(.51)
Existing fencing	.41	−.80
	(2.41)	(.41)
Existing drainage	−.46	1.47
	(2.65)	(7.55)
Existing trees	−.41	1.05
	(.94)	(2.12)
Existing access road	.36	1.45
	(.21)	(.74)
Existing continuous manuring	.28	−.82
	(1.31)	(3.41)
Existing land excavation	−.47	.80
	(2.72)	(4.04)
Existing irrigation	.28	−.06
	(1.50)	(0.27)
Existing mulching	.53	.86
	(2.70)	(3.82)
Existing shallot beds	.03	.07
	(.15)	(.34)
Field area	1.54	−2.47
	(2.10)	(2.97)
Distance from house	−.14	.21
	(1.83)	(2.34)
Land inherited	.80	−.97
	(2.11)	(2.27)
Number of years owned	−.03	.04
	(5.48)	(5.65)
No title deed	.57	−.11
	(1.97)	(.35)
Ever litigated on field	−.20	.24
	(.61)	(.66)
Village dummy variables	Yes	Yes
F-test on significance of instruments (p-value)	.00	.00
$\bar{R}^2$	.30	.84

NOTE.—Absolute values of t-statistics are in parentheses.

In every case, land rights do not show up as significant for investment decisions. Moreover, many of the sensible effects of other variables on investment are no longer found. While this could be due to unmeasured heterogeneity, it seems more likely that the small sample problem is driving this finding.

Thus for Anloga, the initial finding that rights seem to positively affect land rights seems quite unrobust. The two-stage least-squares results give most concern since the instruments do seem quite reasonable.

In summary, one should be cautious in accepting the conclusion that land rights are not important for investment. Rather, the findings suggest that the measured rights variables that appear, at first sight, to affect investment may actually evolve symbiotically with investment. Rights may also be affected by other, unobserved, actions, which future survey work might study in greater detail. Thus rights should properly be regarded as something that farmers affect, not as exogenously given conditions, which reinforces the importance of studying the *determinants* of rights, effective and nominal, and not just their consequences.

C. *Testing between Models*

There are two ways to see which of the theories may be at work. First, the collateral-based argument suggests that *household* rights rather than field-specific rights should matter for the investment decision; rendering land as collateral should not be tied to financing an improvement on that field. The farmer could always offer up another field with secure rights as collateral. Second, I test whether there appears to be a hierarchy of rights, with some mattering more than others. The gains-from-trade view suggested looking for the particular importance of the rights to sell and rent.

The fact that, in Wassa, the rights variables remained significant, when a household fixed effect is allowed for, is prima facie evidence that field-specific rights matter apart from household means. Thus there is already evidence against the collateral-based view for Wassa. For Anloga, the non–fixed effects regressions are used. However, they now include mean household rights (over all fields) as a regressor. I then test whether the field-specific rights appeared to affect improvement decisions in addition. These results are reported in table 7, where only the coefficients on the rights variables are reported. The first two rows give the coefficients on the household rights variables, and the next two give those on field-specific rights. Note that the coefficients on household and field rights should now be added for comparability with earlier results. In each case, the p-value for an

TABLE 7

ANLOGA: INVESTMENTS WITH HOUSEHOLD AND FIELD-LEVEL RIGHTS (N = 494)

	Drainage	Continuous Manuring	Land Excavation	Irrigation	Mulching	Making Shallot Beds
Mean household rights with approval	−.03	−.01	.02	.01	−.04	−.03
	(.95)	(.44)	(.41)	(.33)	(1.14)	(.81)
Mean household rights without approval	.01	−.01	.00	−.02	−.07	.04
	(.89)	(.58)	(.13)	(.85)	(4.58)	(2.41)
Field-level rights with approval	.09	.02	.07	−.03	.08	.10
	(2.91)	(.69)	(1.83)	(.81)	(2.59)	(2.91)
Field-level rights without approval	.07	.02	.09	.01	.10	.05
	(3.96)	(1.37)	(4.31)	(.28)	(5.86)	(2.81)
p-value	.00	.38	.00	.60	.00	.00
$\overline{R}^2$	.75	.94	.63	.70	.63	.82

NOTE.—Absolute values of t-statistics are in parentheses. The p-value denotes the initial probability for rejection of the hypothesis that the field-level rights variables are both zero.

F-test that field-specific rights do not matter is reported. It is striking that the household-level rights are rarely significant (and are actually negative for mulching), whereas the field-specific rights effects remain positive and significant in almost all cases. Hence, although no fixed effect has been removed, deviations from mean household rights do appear positive and significant in the basic Anloga regressions. In further confirmation that this may be bad news for the credit-based view, it should also be noted that Migot-Adholla, Hazell, and Place (1991) found no link between current use of credit and land rights using these data.[35]

To see whether particular rights are important for investment decisions, the land rights are decomposed into six different categories, pooling across the approval categories. Given the similarity of the coefficients of rights with and without approval in most cases above, this does not seem unreasonable. The correlation matrices for these rights in Wassa and Anloga appear in table 8. Rights are fairly highly correlated. In fact the variance-covariance matrix for the rights is close to singular, suggesting that attributing investment effects to particular rights may be fairly precarious. Including or excluding rights in a particular category also tended to lead to significant changes in the signs and sizes of the coefficients on other rights. There are, however, some remarkable differences in rights across the two regions in the study. In Anloga, the rights to sell and bequeath are highly correlated (.74), whereas in Wassa they are not (.15). It is still interesting to see whether anything can be learned from the individual land rights variables.

In Wassa, the fixed effects regressions were rerun, with all six rights variables. The coefficients on the rights variables are reported in table 9. The right to bequeath is positive and significant, and the right to mortgage is negative and significant. There seems to be very little theoretical justification for this finding, and a possible interpretation is offered below. I tested for the joint significance of the rights variables, rejecting it at a 1 percent level. A number of other hypotheses, that particular groups of rights could be excluded from the regression, were also tested. The most interesting finding is the inability to reject the hypothesis that the rights to sell and rent are jointly zero, contrary to the gains-from-trade model.

The findings for Anloga are also in table 9. Again, I report only the coefficients on the rights variables. The results are quite mixed, with different rights being significant for different investments.

[35] Although a cross section is used, it is possible that the data come from a year with little credit because of either demand or supply factors, making it difficult to find an effect.

TABLE 8

CORRELATION MATRIX FOR RIGHTS

	Sell	Rent	Mortgage	Pledge	Bequeath	Gift
			Anloga			
Sell	1.00					
Rent	−.12	1.00				
Mortgage	.65	.02	1.00			
Pledge	.45	.01	.59	1.00		
Bequeath	.74	−.05	.70	.54	1.00	
Gift	.88	.06	.62	.45	.75	1.00
			Wassa			
Sell	1.00					
Rent	.17	1.00				
Mortgage	.19	.43	1.00			
Pledge	.16	.55	.49	1.00		
Bequeath	.15	.42	.51	.49	1.00	
Gift	.23	.33	.30	.35	.50	1.00

Looking at the coefficients, one cannot easily pinpoint any emergent patterns. This was confirmed by tests based on excluding subsets of rights from the regressions. More encouraging for the gains-from-trade view, the hypothesis that the rights to sell and rent are significantly different from zero was rejected using a 95 percent confidence interval in all but two cases (land excavation and continuous manuring). However, it did not appear that these rights were more robustly related to investment than others that were included.

On the whole, these more disaggregated results are not as supportive of the idea that land rights matter to investment as those in Sections IV*A* and IV*B*. The more aggregated rights measures may, however, serve as a better proxy for the degree of confidence that an owner has in his title and his ability to transfer a given field. The specific subjective measures that the data report in different categories may not be individually decisive in measuring this. For example, suppose that a farmer would like to bequeath his land and that his desire to do so affects his willingness to improve the land. The farmer may not have a formal right to bequeath (de jure). However, his confidence that he will be able to bequeath (de facto) may be affected by the other rights that he has. Thus, for example, not reporting the right may not mean that he cannot bequeath his land for sure, and his confidence in his ability to do so may be increased by having other rights. For this reason, the more aggregative results may actually make more sense for the exercise conducted here.

TABLE 9

WASSA AND ANLOGA: INVESTMENT EQUATIONS WITH DISAGGREGATED RIGHTS MEASURES

	WASSA (N = 1,074):	ANLOGA (N = 494)					
	Planting Trees	Drainage	Continuous Manuring	Land Excavation	Irrigation	Mulching	Making Shallot Beds
Right to sell	.13	.20	.13	.11	.17	.34	.49
	(.76)	(2.09)	(2.00)	(.96)	(1.60)	(3.41)	(4.87)
Right to rent	.27	.15	−.17	.13	.12	.29	.12
	(.84)	(1.70)	(2.84)	(1.29)	(1.23)	(3.14)	(1.31)
Right to mortgage	−.41	.06	.18	−.01	−.02	.12	.22
	(2.06)	(.75)	(3.46)	(.05)	(.21)	(1.49)	(2.83)
Right to pledge	−.00	.06	.00	−.09	−.22	.14	.05
	(.03)	(.94)	(.08)	(1.18)	(2.97)	(1.96)	(.68)
Right to bequeath	.42	−.09	−.08	.23	−.13	−.12	−.21
	(2.04)	(1.26)	(1.51)	(2.75)	(1.57)	(1.57)	(2.75)
Right to gift	−.07	.14	−.15	.13	.08	−.17	−.11
	(.45)	(1.51)	(2.26)	(1.13)	(.74)	(1.66)	(1.11)
$\bar{R}^2$	.35	.75	.94	.63	.71	.62	.82

NOTE.—Absolute values of t-statistics are in parentheses. The Wassa regression was run with a household fixed effect.

Overall, the results do not strongly support any particular theoretical view. The most that can be said is that proponents of the credit-based view might find it particularly difficult to explain the results. Further investigation of the gains-from-trade view might be possible with data on land transactions that are not available here. Collecting such information and relating it to land investment would be interesting. It would also cast light on the role of land in portfolio management decisions by poor farmers.

V. Concluding Remarks

This paper makes two main contributions. First, it reviews and extends the conceptual framework for thinking about property rights and investment incentives. The paper has developed three theoretical models that implied this link and pointed out some differences in their implications. The analysis also discussed some implications of the endogeneity of land rights. Second, I tested some of these ideas using data from two regions of Ghana. The findings for Wassa were quite supportive of the idea that better land rights facilitate investment. Moreover, the size and significance of these effects were increased after instrumentation of land rights, suggesting an interpretation in terms of measurement error in our index of rights. The formal transfer rights that farmers declare when surveyed do not exactly capture what they care about when making their investment decisions in practice. In Anloga, the results were not so robust, and there the idea that rights could be endogenous is a leading candidate to explain this. The empirical analysis also yielded insights into the determinants of transfer rights in both regions.

In tests between the models, it was hard to find a hierarchy of rights as suggested by the gains-from-trade model. The tests did, however, suggest that variation in rights across fields has some explanatory power beyond mean household rights. Thus something beyond the collateral-based view may be at work.

The results in this paper reinforce the need for careful empirical studies of land rights and investment in low-income environments. They also reinforce the importance of understanding the determinants of rights as well as their consequences. Given the importance of investment to long-term poverty alleviation, it is important to understand what, if anything, governments can do. Developing land rights is often offered as a feasible intervention, especially in Africa. It would be premature to say that this does not work. However, the analysis of this paper warns against viewing it as a panacea for problems of low growth and investment before the process determining the evolution of rights is properly understood.

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