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Investment in Land, Tenure Security and Area Farmed in Northern Mozambique

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Abstract: The analysis of land investment and tenure security usually assumes land scarcity. However, some developing countries have communities with land abundance. This article therefore examines the effects of land abundance for investment and tenure security. The paper develops a formal test of land abundance and estimates a system of three simultaneous equations. The empirical analysis uncovers significant land abundance in Northern Mozambique. In contrast to the literature, area farmed is a determinant of investment and tenure security. However, no link exists between investment and tenure security. These findings have strong implications for rural development policy in land abundant communities.

JEL Codes: O12, O13, Q12, Q15
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1. Introduction

A large literature analyzes the effects of tenure security on land investments (Banerjee et al 2002, Jacoby et al 2002, Lanjouw and Levy 2002). These studies implicitly assume that land is a scarce factor of production in rural development. This paper uniquely considers the implications of potential land abundance on investment and tenure rights. It is argued that in some cases, such as for isolated African communities, there are strong theoretical and policy implications of land abundance for agricultural development.

The analysis is based on two strands of the rural development literature. The property rights literature has recently questioned the direction of causality between investment and tenure security: tenure security may not cause higher investment in land but might be induced by it (Bruce 1988). Based on his empirical analysis, Besley (1995) concluded that correcting for this potential endogeneity left the direction of causality from tenure security to investment unchanged but affected the estimated size of the tenure coefficients. Baland et al. (1999) and Brasselle et al. (2002) also allow for endogeneity between investment and tenure rights. However, the authors find a reverse causality from investment in land to tenure security as farmers use investments such as planting trees to improve their tenure rights over the associated land.

The second strand of literature concerns the implications of land abundance for rural development (Binswanger and McIntire 1987). Land abundance is defined here as the sufficient supply and accessibility of arable land. Should land abundance exist, then investment and tenure perceptions can be expected to be strongly altered. In particular, and as predicted by Boserup (1965), fewer incentives for land investment are expected in land abundant communities.

The empirical analysis presented here is based on farm survey data from Mozambique, which is commonly assumed to be a land scarce country. A formal and novel test of land abundance is presented and an econometric test is implemented to identify potential endogeneities between investment in land, tenure security and area farmed. The empirical analysis demonstrates that land abundance must be evaluated at the household and village levels, not regionally or nationally as is common in the literature.

The findings of this paper therefore complement and extend the two strands of literature on rural development by pointing to the primary role of household and area farmed in driving agricultural production decisions in land abundant areas. With the receding war and aid for post-war reconstruction in Mozambique, markets are expected to re-establish themselves and households will increasingly face standard incentives and constraints. There exist, however, many isolated communities in Africa where investment and property rights are determined differently from communities with land scarcity (such as in South Asia).

This paper therefore offers some insights into the decision making calculus of farm households in such land abundant areas and into how agricultural policies may assist the development of such isolated communities. It is further argued that war enhances this degree of isolation and land abundance. The findings caution against extending standard economic theories of development to such extreme settings. The insights of this paper are hence of interest to researchers and policy makers concerned with isolated rural communities, especially in war-torn African countries.

2. THEORY

Motivation

Land abundance potentially causes investment, tenure and area farmed to be interdependent. Land abundance has strong implications for tropical agriculture as it changes the calculus of farmers (Binswanger and McIntire 1987). Transport and information costs are high in areas with a low population density. Given the nature of agricultural production, farms are geographically dispersed and markets are fragile. Simple technology and low economies of scale dominate in such agricultural systems. Land markets and formal property rights are non-existent and land is allocated instead through traditional mechanisms.

Binswanger and McIntire predict that with a low population density and relatively low barriers to land acquisition it is always profitable for households to engage in some crop cultivation: there are no landless laborers. The costs of labor hiring and supervision, the low economies of scale and the small gains from specialization prevent a significant wage labor market from establishing itself. Consequently, households expand the area cultivated with own household labor in the course of the lifecycle rather than hiring-in labor.

Households in land abundant economies are formed as an insurance policy against individual, non-covariant risk and in response to an initial asset distribution. Long-term household structure, area farmed, asset accumulation and social institutions are thus related to the absence of technology, formal property rights, and credit markets (Chayanov 1925, Meillassoux 1981: 41).

Conceptual Framework

Consider the utility maximization problem of a farm household where utility is a function of output and leisure and where household i, through the allocation of labor ($\mathbf{L}_i$), can influence investments in land (I_i). Tenure security (T_i) and area farmed (A_i) are given. Assuming that the underlying functions have desirable properties, that the labor supply does not exceed the household labor endowment and that an internal maximum can be obtained, then the constrained maximization of preferences will yield a set of reduced form equations (Baland et al 1999).

In the traditional literature on the effects of tenure security on land investment, the key equation can be summarized as follows (Feder and Onchan 1987, Place and Hazell 1993, Sjaastad and Bromley 1997):

(1a) $I_i = f(\mathbf{L}_{Ii}, \mathbf{F}_{Ii}, \mathbf{K}_{Ii}, \mathbf{V}_{Ii}, T_i)$

where the subscript I denotes investment-specific variables for each of the vectors household labor characteristics **L**, household field characteristics **F**, household capital endowments including social capital **K**, and village specific effects **V**.

More recent papers, that allow for potential endogeneity between tenure security and land investment, estimate the following system of equations (Baland et al 1999, Besley 1995, Brasselle et al 2002):

(1b) $I_i = f(\mathbf{L}_{Ii}, \mathbf{F}_{Ii}, \mathbf{K}_{Ii}, \mathbf{V}_{Ii}, T_i)$

(2b) $T_i = f(\mathbf{L}_{Ti}, \mathbf{F}_{Ti}, \mathbf{K}_{Ti}, \mathbf{V}_{Ti}, I_i)$

where area farmed is again assumed given.

Under land abundance, the area farmed cannot be taken as given and endogeneity between investment, tenure and cultivated area has to be tested explicitly thus suggesting the following system of equations for a given period:

(1c) $I_i = f(\mathbf{L}_{Ii}, \mathbf{F}_{Ii}, \mathbf{K}_{Ii}, \mathbf{V}_{Ii}, T_i, A_i)$

(2c) $T_i = f(\mathbf{L}_{Ti}, \mathbf{F}_{Ti}, \mathbf{K}_{Ti}, \mathbf{V}_{Ti}, I_i, A_i)$

(3c) $A_i = f(\mathbf{L}_{Ai}, \mathbf{F}_{Ai}, \mathbf{K}_{Ai}, \mathbf{V}_{Ai}, I_i, T_i)$

This system of equations will be tested empirically below. The equations do not include a credit equation as there are no formal credit transactions in land abundant areas (Binswanger and McIntire 1987). In addition, household size is considered to be an exogenous variable in the empirical analysis as the survey data used below refers to only one year, thus making the time frame too short to consider changing household sizes.

Hypotheses

In a perfectly land abundant economy, area can be accessed easily and farm households will maintain a constant land-labor ratio. In a perfectly land-constrained economy, on the other hand, farm households control a given area of land throughout the life cycle of the farm household. An increase in household size would cause the land-labor ratio to drop. The per capita land endowment elasticity of household size (that is the coefficient on the variable "number of economically active household members" in the area farmed regression) should hence lie between 0 for the case of perfect land abundance and -1 for the case of perfect land scarcity. This is the most comprehensive and first formal test of land abundance proposed in the literature, where the test controls for a range of factors such as household size, capital endowments, and the effects of war.

Six interactions between the variables investment, tenure security and area farmed are potentially endogenous, which will be tested empirically below. In equation (1c) increased tenure security may have a *positive* effect on land investment, as this will reduce the investment risk in the absence of formal property rights. This effect is therefore expected to operate in line with the traditional literature. Extending the area farmed implies less resources are available for improving the quality of the area farmed. This trade-off hence implies a *negative* effect of area on investment.

In equation (2c) higher land investment may have a *positive* effect on tenure security, as argued by the more recent literature on investment and property rights. The area farmed may have a *negative* effect on tenure security as households trade-off a higher quantity of land for a lower tenure status.

In equation (3c) increased land investment may have a *negative* effect on area farmed, as this might represent a more intensive and smaller scale production. Tenure security is expected to have a *negative* effect on area farmed, given the potential for trade-off between the quality and the quantity of land. For example, farmers may choose to cultivate more land if cultivating land is one way of establishing further land rights.

3. THE CASE OF NORTHERN MOZAMBIQUE

These hypotheses will be tested with household survey data from Northern Mozambique. The country provides a suitable case study as, in many areas, it has a very low population density but fertile land suitable for agriculture. Mozambique experienced a severe civil war until 1992, which damaged its economy dramatically, especially in the rural areas. The number of cattle in Mozambique, for example, declined from over 1.3 million in 1982 to 0.25 million in 1992 (Ministério da Agricultura 1994). Per capita food production only reached 90 percent of its pre-war level by 1996 (World Bank 2002). At the same time, farm productivity in the post-war period continued to remain well below regional averages (Tschirley and Weber 1994).

The North of Mozambique is often considered the “green belt” of the country. Post-war agricultural production was hampered by poor transport networks and the absence of irrigation and mechanized agricultural production. Furthermore, fieldwork in the sample area revealed that there are no formal or informal credit markets, in part due to the virtual absence of suitable collateral. Judging from the farm household data of the FSP survey, local agricultural crop markets were the most important and, occasionally, the only existing markets in this area. Northern Mozambique was therefore quite isolated for many months each year both during the war and the post-war period.

The population density in the survey period varied between 10 and 50 inhabitants per square kilometer across districts. There were few agricultural or non-agricultural employment opportunities and no migrant workers, unlike in southern Mozambique. In addition, the Macua culture, the main ethnic group in the sample area, has strong customs regulating the hiring-in of casual labor and the mutual exchange of group labor. For instance, only 11 percent of all rural households in that area occasionally or regularly employed agricultural labor (UNDP 1999). Fieldwork in the sample area confirmed that there are strong cultural barriers to labor markets and that there is very little wage labor being hired. If labor is being traded, it is generally in the form of group labor on some specific occasions in the agricultural year.

There are practically no rural landless households in Northern Mozambique. Land is generally allocated through traditional mechanisms (Marule 1998). These factors suggest that the analysis of land in the North should take into account the role of traditional authorities and kinship groups, in addition to the usual exogenous variables. The ethnic composition of the population and the traditional culture in rural areas was, in fact, little affected by the war.

War, as it had occurred in Mozambique, is likely to affect investment in land, tenure security and area farmed in three ways. First, war enhances the degree of land abundance in directly war-affected rural areas. This is achieved by reducing the effective supply of labor, by reducing the returns to legal economic activity and by preventing markets from functioning properly. Second, war has a direct effect on formal property rights, thus potentially raising the incentive to establish informal property rights through land-based investments in the post-war period. Third, war can have indirect effects on investment, tenure and area farmed. It is therefore important to control for the effects of war in the empirical analysis of Northern Mozambique.

4. DATA AND ESTIMATION ISSUES

The farm household survey used for this analysis includes 371 households in 16 villages (the primary sampling units, PSU) in three cotton-growing districts in the provinces of Nampula and Cabo Delgado in Northern Mozambique (MAP/MSU Research Team 1996). The sample was stratified according to households' cotton growing status. The sample is broadly representative of Nampula and Cabo Delgado provinces in Northern Mozambique in 1995. The survey data, here denoted FSP, was collected by the Food Security Project at the Ministry of Agriculture, Maputo, from June 1994 to January 1996. The variables constructed from the dataset refer to the year 1995. Not enough repeat observations were collected to construct a panel or to analyze changes between two years.

A weakness of the survey is that it, quite naturally, misrepresents the history of the war by focusing on surviving individuals and households and not recording war-related deaths. Furthermore, no data on land acquisition was collected. Personal fieldwork in the study area revealed that there is little variation in the mode of land acquisition, which could be expected in an area of land abundance. Overall, however, FSP is one of the most carefully designed, collected, and cleaned rural household surveys from Northern Mozambique.

The first dependent variable INVEST is defined as the actual number of land-related investment projects per household in 1995-96 (Table 1). On average, 69.5 percent of all households undertook at least one investment project. Investment in fruit and cashew trees were the most common activities, with about 40 percent of all activities belonging to each group. The remainder is split between other activities (9 percent), crop storage (7 percent) and investment in fences and terracing (5 percent). A similar definition of household land investments has been used in other studies (Place et al 1994).

The second dependent variable TENURE measures the perception of tenure insecurity in the area. Specifically, the variable is coded one if the household head is concerned over land tenure security in the area in 1995 and zero otherwise (Table 1). The FSP dataset does not include the method of land acquisition, which has been a significant variable in other studies (Place et al 1994). However, this variable is less important in Mozambique as the relative land abundance, the weak formal legal institutions, and the uncertainty induced by the war imply that the majority of households acquired communal or virgin land. The institutional history of each plot is thus less likely to determine current land investment and tenure perception and the variation in that institutional history across plots is likely to be small. Furthermore, the social capital variables of the FSP dataset help to control for a household's past land tenure position.

Area farmed, AREA45, is defined as the area cultivated in hectares per capita in mid-1995 (Table 1). AREA35 is its natural log. Cultivated areas vary significantly across years in the study area. For example, each household, on average, cultivated 2.9 hectare in the study period but only 2.6 hectare in the subsequent agricultural year. The average number of cultivated plots per household declined from 3.9 in the study period to 3.1 in the subsequent agricultural year. This is first evidence that land access is quite flexible in the Macua culture, responding strongly to other influences .

The set of estimates of equations (1c) to (3c) obtained by ordinary least squares (OLS) is consistent if no endogeneity is present. The Durbin-Wu-Hausman (DWH) test can check for endogeneity in such instances (Davidson and MacKinnon 1993: 236-42, Rivers and Vuong 1988). The DWH test estimates an augmented regression of the original model where the regression also includes the residuals of each endogenous right-hand-side variable as a function of all exogenous variables. If the coefficients on the residuals are significantly different from zero, then OLS is not consistent and an instrumental variable (IV) approach should be adopted. The survey IV estimation used below also accounts for stratification, clustering and weights matching the survey design of the data, leading to appropriate adjustments to the standard errors of the estimates (StataCorp. 1999).

5. RESULTS

Land Abundance

While fertile land appears to be abundant in Mozambique, land is also considered to be unequally distributed at the household level (Jayne et al 2003). To illustrate this point, Table 2 summarizes a divergent set of household survey results from various study sites in Northern Mozambique. The table shows land holdings per adult consumption equivalent (ACE) in the period 1991 to 1996. These results indicate that land inequality exists despite the apparent land abundance and that land access varies across space and time. The paired data from 1994 and 1995 from the FSP survey demonstrates that households varied their land use across years. However, compared to other measures of asset or income inequality in developing or developed countries, the degree of land inequality in Northern Mozambique does not appear to be extraordinary.

In the formal test of land abundance for the year 1995, the key variable of interest is ADULTLOG, which is the natural log of the number of non-dependent household members. Recall that land scarcity implies a per capita land endowment elasticity of household size of -1 (that is a larger household farms no extra land per person) while land abundance implies a per capita land endowment elasticity of household size of zero (that is a larger household expands the area farmed per person correspondingly).

In fact, the estimated coefficient is -0.544 and the 95 percent confidence interval of the estimate ranges from -0.715 to -0.373 (Table 3). Increasing the average household by one working adult would reduce the area cultivated per capita by 10 percent. This result is therefore half-way between the extreme situations of land scarcity and of land abundance.

This finding points to the importance of economies of scale in household size, the household-specific transaction costs in searching for, acquiring, clearing and planting new fields, and the diminishing returns of extending the area farmed in an agricultural system constrained by seasonality (Binswanger and McIntire 1987).

There are two further reasons why households may find it unprofitable to increase the area farmed. First, the war destroyed many assets, such as cattle, thus depriving households of an important complementary production input. Second, the war led to a high mortality rate thus inducing uncertainty about future household sizes. These factors reduce the incentives to expand the scale of agricultural production with changes in the household composition. This also explains the sluggish agricultural supply response to peace in post-war Northern Mozambique.

Overall, this finding suggests a degree of land abundance in Northern Mozambique. However, the intermediate value of the test statistic also emphasizes the role played by other factors in determining land-labor ratios, such as those proposed by Binswanger and McIntire and those created by the recent war. Rural development policy could help to overcome these barriers to land access by reducing transaction costs in land access, reducing the strong effects of seasonality, supporting the build up of assets and collateral and reducing household mortality.

Endogenous Effects

The three regressions (1c) to (3c) and the DWH test statistics are summarized in Table 4. In the survey-IV regression for investment, area farmed was instrumented using several household and land characteristics. There is no suggestion of over-identification: applying the Davidson-MacKinnon test of over-identification yields a test statistic of 5.20 (which is distributed as a χ^2 with 6 degrees of freedom). This suggests that the investment equation is properly specified and that the instruments are valid (Davidson and MacKinnon 1993: 236).

The 2SLS and linear regressions have good fits with R^2 values of 0.46 (investment) and 0.68 (area farmed), respectively. The area farmed equation also serves as the first round equation in the IV estimation of investment. All three regressions are highly significant. Variance inflation factor analysis yielded no evidence of multicollinearity. While some coefficients are not significant individually at the usual levels of significance, each group of exogenous variables **L**, **F**, **K** and **V** is significant (data not shown).

The empirical tests of the potential endogeneities suggest the following system of equations for Northern Mozambique (Table 4):

(1d) $I_i = f(\mathbf{L}_{Ii}, \mathbf{F}_{Ii}, \mathbf{K}_{Ii}, \mathbf{V}_{Ii}, A_i)$

(2d) $T_i = f(\mathbf{L}_{Ti}, \mathbf{F}_{Ti}, \mathbf{K}_{Ti}, \mathbf{V}_{Ti}, A_i)$

(3d) $A_i = f(\mathbf{L}_{Ai}, \mathbf{F}_{Ai}, \mathbf{K}_{Ai}, \mathbf{V}_{Ai})$

As expected, area farmed has important endogenous effects on land investment and an important effect on tenure security in Mozambique, raising concerns over the ability of small farms to escape the strong negative effects of the war and over the distributional effects of post-war reconstruction. However, unlike postulated in the literature on property rights in land scarce areas, land investment and tenure security are not directly related to each other. In the long-term, as the effects of the war eventually disappear, land is expected to become more scarce. Such rural economies would then start to resemble the case studies known from the existing literature on agricultural investment and property rights.

In equation (1d), there is no effect of tenure security on investment (Table 4). This contrasts with the traditional literature which concerns peaceful, land scarce environments and which for most part does not test for endogeneity. In Rwanda, for instance, a positive effect of land tenure security on investment was observed (Place and Hazell 1993). This is explained by

Rwanda's very high population density, which raises the returns to expropriation and hence undermines the net present value of investments on insecurely held land. Increased land tenure security also raises land investment in Thailand where the effect works through the credit market (Feder and Feeny 1991). This effect cannot apply in war-affected Mozambique where credit markets were non-existent as argued above. Hence the joint existence of war and land abundance break the link between land investment and tenure security.

The unexpected positive coefficient for cultivated area in the investment regression points to the existence of significant economies of scale in rural production. Larger farms may find it easier to produce enough surplus to build up investments and may, on average, find investments cheaper to implement than smaller farms. Larger farms may also internalize more benefits of investments. Other studies of smallholder investment in land quality in developing countries have found the opposite relationship, albeit for peace time economies and without correcting for endogeneity (Baland et al 1999). This suggests that war reinforces economic inequalities, with larger farms increasing their land investments. Smaller farms are more vulnerable to the effects of war and may find it more difficult to escape these effects through endogenously generated and re-invested agricultural surpluses. A small area farmed is thus a key obstacle to escaping poverty, which is an important conclusion for poverty alleviation policy.

In equation (2d), neither investment nor area farmed are endogenous (Table 4). The absence of an effect of investment on tenure thus contradicts some recent studies which also corrected for endogeneity (Baland et al 1999, Brasselle et al 2002). Methodologically, the result of this investigation may be due to the aggregate level and binary nature at which tenure security has been measured in the FSP survey. If continuous data had been collected on a per plot basis, then more accurate estimates of the effect of investment on tenure security may have been possible. However, it is analytically quite plausible that in an insecure environment characterized by land abundance the traditional chain of causality would maintain, as discussed above.

The positive and significant coefficient of area farmed on tenure insecurity confirms that households with larger per capita land endowments experience significantly lower land tenure security. This suggests that households are compensated for restrictions in land access with tenure security. Increasing area farmed is feasible in a land abundant economy but additional land may have a lesser tenure status, especially in an imperfectly land abundant area. Hence household heads with more land have more reason to be worried about land tenure status than heads with less but more secure land holdings.

This finding concurs with various studies where area farmed mattered for tenure security (Baland et al 1999, Carter and Olinto 2003, Holden and Yohannes 2002). However, in some of these studies, the effect had the opposite sign: larger farms benefited disproportionately from higher tenure security. This effect operates through better access to credit, which is of little importance in Northern Mozambique.

In equation (3d), endogeneity for tenure security and land investment can be clearly rejected (Table 4). Investment and tenure security are not determinants of cultivated area and were thus omitted from the regression. This result suggests that the household life cycle has strong effects on assets and markets and thus in determining agricultural production decisions. In addition, cultural factors (such as the variables ANCEST, AUTHORITY or FEMHEAD) are found to be important. This is shown, for instance, by the very small areas cultivated by female headed households.

6. CONCLUSIONS

The paper analyzes the effects of land abundance on land investment, tenure security and area farmed, especially for African rural development. The paper hence makes two new contributions to the literature. First, it outlines how land abundance in developing countries leads to the simultaneous determination of investment, tenure security and area farmed. Land abundance changes the decision-making of farm households and results in household characteristics becoming important determinants of the area farmed.

Second, land abundance is not a universal concept but instead depends crucially on household-specific and local factors. Two neighbors may be identical in many ways but one might experience land scarcity while the other has abundant access to land. Female-headed households, for example, are severely land-constrained even when controlling for observable differences in their asset endowments and skills.

Methodologically, the paper makes two novel contributions to the debate on land abundance. First, it emphasizes the importance of testing for endogeneity between land investment, tenure security and area farmed in the analysis of land use and institutions in land abundant areas. Endogeneity may be tested by implementing the DWH test.

Second, the paper demonstrates that unconditional summary statistics of land inequality do not constitute a useful proof of constrained access to land. A formal test of land abundance is developed, which focuses on the elasticity of per capita land endowment with respect to household size.

Using household survey data, land in Northern Mozambique is found to be quite abundant, though the area farmed by households is also strongly affected by household- and village-specific variables. The existence of land abundance in Mozambique, coupled with continuously low farm yields, can hence help explain why farm output in the early post-war years failed to rise to the pre-war levels.

These findings have important implications for the design of rural development policies in land abundant tropical agriculture. Formal land right regimes may not require modification when land is abundant. Instead, agricultural development benefits from removing social and institutional inequalities in land access, capitalizing households with assets, encouraging credit and labor markets, and generally reducing market access barriers at the household and community levels.

Most importantly, available land could be more effectively used with less uncertainty, more asset endowments and less social discrimination (especially against women). Under such a scenario, and in strong contrast to findings from land scarce areas, the area farmed and hence farm output could rise significantly without resorting to intensive production techniques. This is an important but controversial policy conclusion for Mozambique.

Table 1: Summary Statistics of the FSP Survey

Name	Definition	Mean	St Err	Min	Max
Dependent Variables					
INVEST	Number of investments undertaken per household in 1995-96	1.221	0.121	0	4
TENURE	Are you worried about household land tenure in 1995?	0.522	0.075	0	1
AREA	Cultivated area per capita per household in mid-1995 in hectare	0.433	0.045	0.036	2.900
Labor Variables					
ADULTLOG	Natural log of number of non-dependent, resident household members in mid-1994	1.582	0.062	0	2.639
AGEHEAD	Age of household head in years in mid-1994	39.928	1.354	18	82
AGEHEADSQUARE	Square of age of household head in mid-1994 in years	1749.170	109.202	324	6724
DEPEND	Number of dependent household residents in mid-1994	2.045	0.102	0	7
DEPENDSQUARE	Square of number of dependent household residents in mid-1994	6.350	0.510	0	49
EDUINFRA	Total household schooling in years in accessible areas	4.075	1.011	0	41
FEMALE	Ratio of females over total number of people per household in 1995	0.470	0.015	0	1
FEMHEAD	Was this a female-headed household in mid-1994?	0.013	0.006	0	1
ILLDAYS	Total number of days ill per household in 1994-95	46.066	10.599	0	433
REFUGEE	Was this household recognized as a refugee household?	0.159	0.046	0	1
TIMEWATER	Natural log of hours per month wife collected water in hungry season in 1995	2.474	0.055	-0.693	4.094
TIMEWOOD	Natural log of hours per month wife collected firewood in hungry season in 1995	1.678	0.127	-0.693	4.094
Land Variables					
AREALOG	Natural log of cultivated area per capita in mid-1995 per household in hectare	-1.033	0.089	-3.337	1.065
DISTANCE	Distance to fields in minutes per household in 1994	40.589	3.206	2	191.250
EASYLAND	Is it very easy to get new land for your household?	0.422	0.052	0	1
PEST	Did most of your crops suffer from pests in 1995?	0.404	0.071	0	1
RAIN	Proportion of cultivated area per household with lack of rain in 1994-95	0.296	0.049	0	1
SOIL	Is soil quality very high in your household?	0.408	0.053	0	1
Asset Variables					
ANCEST	Does the household have ancestors who were buried locally?	0.844	0.041	0	1
ANIMAL	Did household own at least one large animal in late 1992?	0.112	0.027	0	1
ASSET	Natural log of value of assets in real 1996 US$ per household in late 1992	2.925	0.254	0	7.813
AUTHORITY	Is household head in a position of traditional or political authority?	0.071	0.013	0	1
CYCLONE	Was the household affected by cyclone Nadia?	0.332	0.082	0	1
DONATION	Has this household received food, seed or in-kind aid?	0.079	0.027	0	1
ORIGIN	Is the place of birth of the main man in this household this village?	0.678	0.049	0	1
TOOL	Number tools per capita per household in mid-1995	0.926	0.063	0	4
Location Variables					
MILL	Was there a grain mill in your village in 1995?	0.195	0.063	0	1
YIELDLOG	Natural log of mean yield for cotton per village in kilograms per hectare in 1994-95	6.351	0.134	4.934	7.249
Control Variables					
PRICE13	Paasche price index for purchased food in mid-1995	1.093	0.044	0.558	2.682
PRICE14	Paasche price index for purchased food in late 1995	0.929	0.036	0.297	2.587
PRICE15	Paasche price index for purchased food in early 1996	1.128	0.073	0.333	3.554
PRICE23	Paasche price index for purchased non-food in mid-1995	1.050	0.059	0.510	2.420

PRICE24	Paasche price index for purchased non-food in late 1995	0.978	0.051	0.399	3.212
PRICE25	Paasche price index for purchased non-food in early 1996	1.064	0.038	0.552	3.182
PRICE33	Paasche price index for home-produced food crops in mid-1995	1.044	0.066	0.456	2.736
PRICE34	Paasche price index for home-produced food crops in late 1995	1.096	0.152	0.375	2.473
PRICE35	Paasche price index for home-produced food crops in early 1996	1.299	0.208	0.382	2.618
VILLAGE111	Does this household live in village 111?	0.042	0.030	0	1
VILLAGE112	Does this household live in village 112?	0.042	0.034	0	1
VILLAGE113	Does this household live in village 113?	0.039	0.028	0	1
VILLAGE114	Does this household live in village 114?	0.022	0.018	0	1
VILLAGE121	Does this household live in village 121?	0.104	0.091	0	1
VILLAGE122	Does this household live in village 122?	0.084	0.076	0	1
VILLAGE123	Does this household live in village 123?	0.169	0.118	0	1
VILLAGE214	Does this household live in village 214?	0.047	0.034	0	1
VILLAGE215	Does this household live in village 215?	0.034	0.029	0	1
VILLAGE221	Does this household live in village 221?	0.042	0.033	0	1
VILLAGE231	Does this household live in village 231?	0.035	0.032	0	1
VILLAGE232	Does this household live in village 232?	0.038	0.034	0	1
VILLAGE312	Does this household live in village 312?	0.095	0.086	0	1
VILLAGE313	Does this household live in village 312?	0.072	0.050	0	1
VILLAGE321	Does this household live in village 313?	0.082	0.063	0	1
VILLAGE332	Does this household live in village 332?	0.054	0.045	0	1

Notes: The data is weighted using WEIGHT. Categorical variables are coded to answer the questions shown above with no=0 and yes=1, except in the case of TENURE. The variable ASSET was set to zero for households holding no assets in late 1992.

Table 2: Land Holdings and Distributions in Mozambique

Survey	N	ha/ACE (percent)	Q1 ha (percent)	Q2 ha (percent)	Q3 ha (percent)	Q4 ha (percent)	Q5 ha (percent)	Q5/Q1
FSP 1991	343	0.55	0.16	0.29	0.44	0.67	1.28	8.00
		(101)	(7)	(11)	(17)	(23)	(43)	
CARE 1993-94	238	0.89	0.33	0.53	0.74	1.03	1.80	5.45
		(100)	(7)	(12)	(17)	(24)	(40)	
CARE 1994-95	238	1.03	0.37	0.62	0.85	1.17	2.14	5.78
		(100)	(7)	(12)	(17)	(22)	(42)	
FSP 1994	371	0.54	0.22	0.38	0.54	0.73	1.34	6.09
		(100)	(11)	(17)	(19)	(25)	(28)	
FSP 1995	371	0.46	0.16	0.31	0.42	0.64	1.22	7.63
		(99)	(8)	(14)	(23)	(23)	(31)	
TIA 1996	685	0.51	0.12	0.25	0.39	0.58	1.21	10.08
		(101)	(5)	(10)	(16)	(24)	(46)	
LSMS 1996	701	0.75	0.23	0.39	0.56	0.86	1.71	7.43
		(100)	(6)	(11)	(15)	(23)	(45)	

Notes: The data for the quintiles Q1 to Q5 have been ranked by area per adult consumption equivalent (in ha/ACE) and show the mean ha/ACE per household per quintile and the share of total land held by each quintile. All measures refer to cultivated land and resident household members. Some percentages do not add up to 100 due to rounding. CARE 1993-95: Data are paired. FSP 1994-95: Data are paired. The FSP 1995 data are used for the regression analysis. LSMS 1996: data refer to the rural areas of Nampula province.

Table 3: Testing for Land Abundance

	Coeff	St Err	Signif
Test Statistics			
ADULTLOG	-0.544	0.084	***
DEPEND	-0.028	0.060	
DEPENDSQUARE	-0.011	0.011	
Summary Statistics			
Weight		WEIGHT	
Strata		CATEGORY	
PSU		VILLAGE	
Number of obs		371	
Number of strata		4	
Number of PSUs		43	
Population size		32540	
F - statistic		F (38 , 2) = 665.80	
Prob > F		0.002	
R-squared		0.680	

Notes: The test for land abundance involves estimating the determinants of AREALOG, the natural log of the cultivated area per capita in hectares. The coefficient of ADULTLOG, the natural log of the number of resident non-dependent household members, can thus be interpreted as the per capita land endowment elasticity of household size. The independent variables of this regression are identical to the area farmed estimation of Table 3. The coefficients and standard errors of the remaining determinants are not shown here. The signs of the coefficients are identical to the area farmed estimation of Table 3.

Table 4: Regression Results for Investment in Land, Tenure Security and Area farmed

	Equation 1c: INVEST		Equation 2c: TENURE		Equation 3c: AREA	
	Coeff (St Err)	Signif	Coeff (St Err)	Signif	Coeff (St Err)	Signif
Endogenous Variables						
AREA	1.417	***				
	(0.504)					
Exogenous Labor Variables						
ADULTLOG	0.542	***	1.578		-0.331	***
	(0.196)		(0.877)		(0.090)	
AGEHEAD	-0.031				0.022	***
	(0.028)				(0.005)	
AGEHEADSQUARE	0.000				-0.000	***
	(0.000)				(0.000)	
FEMALE					-0.251	**
					(0.188)	
FEMHEAD					-0.345	***
					(0.077)	
ILLDAYS	-0.001		0.998		-0.000	
	(0.001)		(0.003)		(0.000)	
EDUINFRA	-0.003		0.939		0.005	*
	(0.008)		(0.040)		(0.002)	
DEPEND	-0.188				-0.037	
	(0.125)				(0.028)	
DEPENDSQUARE	0.024				0.001	
	(0.020)				(0.005)	
REFUGEE	0.206					
	(0.141)					
TIMEWOOD					0.023	
					(0.020)	
TIMEWATER					-0.017	
					(0.049)	
Exogenous Land Variables						
AREA			12.477	*		
			(17.420)			
DISTANCE					-0.001	
					(0.001)	
EASYLAND					0.046	*
					(0.024)	
PEST	-0.290	**			0.065	*
	(0.138)				(0.032)	
RAIN			4.210	**		
			(2.882)			
SOIL	0.010				0.054	
	(0.137)				(0.037)	
Exogenous Asset Variables						
ANCEST	0.394	**				
	(0.150)					
ANIMAL	0.313	*	1.245		0.091	**
	(0.157)		(0.527)		(0.041)	
ASSET			0.983		0.017	***
			(0.098)		(0.006)	
AUTHORITY	-0.394	**	0.046	***	0.076	
	(0.170)		(0.038)		(0.049)	
CYCLONE	0.327	*			0.104	***
	(0.174)				(0.034)	
DONATION	0.603	**				
	(0.246)					
ORIGIN			0.756			
			(0.354)			
TOOL	-0.024				0.085	**
	(0.132)				(0.039)	
Exogenous Location Variables						
MILL	-0.327		2.251		-0.074	*
	(0.234)		(2.682)		(0.040)	
YIELDLOG	0.370	***	0.052	***		
	(0.134)		(0.049)			
Exogenous Control Variables						
PRICE13	0.151		0.264		-0.114	*

	(0.238)		(0.316)		(0.064)	*
PRICE14	0.455		1.518		-0.024	
	(0.342)		(1.896)	**	(0.086)	
PRICE15	-0.162		10.521		-0.055	
	(0.224)		(9.949)		(0.028)	
PRICE23	1.306	*	264.879		0.140	
	(0.775)		(959.346)		(0.124)	
PRICE24	-0.166		0.112	*	0.024	
	(0.260)		(0.143)		(0.059)	
PRICE25	-0.207		0.144		0.016	
	(0.254)		(0.264)		(0.033)	
PRICE33	0.307		0.007	*	0.281	*
	(0.588)		(0.019)		(0.167)	
PRICE34	0.267		0.000	***	0.173	**
	(0.176)		(0.000)		(0.081)	
PRICE35	0.379	**	1.535		0.162	*
	(0.169)		(1.084)		(0.084)	
VILLAGE111	0.691	**	0.048	**	0.418	**
	(0.318)		(0.069)		(0.164)	
VILLAGE112	0.066		0.015		0.269	**
	(0.579)		(0.046)		(0.131)	
VILLAGE113	-0.399		2.942		0.307	*
	(0.348)		(5.432)		(0.165)	
VILLAGE114	D		D		0.556	***
					(0.153)	
VILLAGE121	1.038	***	391955	***	0.356	***
	(0.351)		(1451811)		(0.125)	
VILLAGE122	D		D		0.245	**
					(0.096)	
VILLAGE214	1.110	***	0.247		0.302	**
	(0.276)		(0.364)		(0.122)	
VILLAGE215	1.594	***	0.000	***	0.128	
	(0.404)		(0.000)		(0.108)	
VILLAGE221	0.627	*	0.000	***	-0.032	
	(0.370)		(0.000)		(0.182)	
VILLAGE231	1.092	***	F		0.149	
	(0.342)				(0.127)	
VILLAGE232	0.887	***	0.001	***	0.161	
	(0.281)		(0.001)		(0.115)	
VILLAGE312	1.062	*	F		-0.015	
	(0.567)				(0.160)	
VILLAGE313	1.540	**	0.032		D	
	(0.738)		(0.128)			
VILLAGE321	0.766		0.000	***	0.570	***
	(0.490)		(0.001)		(0.208)	
VILLAGE332	0.121		0.001	**	-0.108	
	(0.234)		(0.003)		(0.086)	
Constant	-5.245	***			-0.507	
	(1.198)				(0.320)	
Summary Statistics						
Weight	WEIGHT		WEIGHT		WEIGHT	
Strata	CATEGORY		CATEGORY		CATEGORY	
PSU	VILLAGE		VILLAGE		VILLAGE	
Number of obs	371		325		371	
Number of strata	4		4		4	
Number of PSUs	43		38		43	
Population size	32539.53		28303.67		32539.53	
F-statistic	F(38 , 2) = 791.73		F(31 , 4) = 70.96		F(38 , 2) = 84.24	
Prob > F	0.001		0.000		0.012	
R-Squared	0.455				0.623	
DWH Tests of Endogeneity						
Null Hypothesis	TENURE and AREA are exogenous		INVEST and AREA are exogenous		INVEST and TENURE are exogenous	
F-statistic	F(2 , 39) = 1.70		F(2 , 34) = 0.29		F(2 , 39) = 0.96	
Prob > F	0.195		0.752		0.393	
Null Hypothesis	TENURE is exogenous		INVEST is exogenous		INVEST is exogenous	
t-value	-0.849		0.640		1.081	
Prob > | t |	0.401		0.526		0.286	
Null Hypothesis	AREA is exogenous		AREA is exogenous		TENURE is exogenous	
t-value	-1.841		-0.758		1.104	
Prob > | t |	0.073	*	0.454		0.276	

Notes: INVEST, TENURE and AREA were estimated as survey 2SLS, survey logit and survey linear regressions, respectively (StataCorp., 1999). In equation 1c, AREA is instrumented with FEMALE, FEMHEAD, TIMEWATER, TIMEWOOD, DISTANCE, EASYLAND and ASSET. The equation is hence over-identified. Variables labeled D have been dropped due to collinearity. Variables labeled F predict failure perfectly and were dropped. The sample size was reduced accordingly. In equation 2c, 0 failures and 2 successes were completely determined. Stata 6 cannot account for survey stratification in logit regressions thus giving misleading standard errors for the coefficients of the TENURE regression. The pseudo-R2 for the TENURE regression is 0.43 when implemented as a weighted, clustered logit regression.

* Significantly different from 0 at the 10-percent level.

** Significantly different from 0 at the 5-percent level.

*** Significantly different from 0 at the 1-percent level.

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