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Land Access, Tenure and Investment in Post-War Northern Mozambique

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Abstract

The relationship between land investment and tenure security is usually tested in land scarce but peaceful areas. This article examines instead the effects of land abundance and war for investment and tenure security. The paper demonstrates that war enhances land abundance. This implies that farm size for the analysis of land investment and tenure security. The paper formally tests for land abundance and estimates a system of equations using farm survey data from post-war Mozambique. Farm size is found to be a key determinant of both investment and tenure security. This raises important policy issues for post-war reconstruction.

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1. Introduction

There is a large literature analyzing 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 and abstract from the role of peace and war in rural development. This paper uniquely considers the implications of land abundance and war on investment and tenure rights.

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 does not cause higher investment in land but might be induced by it (Bruce, 1988). The issue was first tested empirically by Besley (1995). He 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. In contrast to the preceding literature, they 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. Civil war, this paper argues, enhances the degree of land abundance in a rural economy thus creating an ideal case study for the analysis of decisions and tenure insecurity under land abundance.

The empirical analysis presented here is based on farm survey data from early post-war Mozambique, which is often assumed to be a land abundant country. A formal and novel test of land abundance is then presented and an econometric test is implemented to identify potential endogeneities between investment in land, tenure security and farm size. 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. In addition, it demonstrates that war further enhances the degree of land abundance and emphasizes the shortage of labor in rural areas. This in turns weakens the post-war supply responses of rural, war-affected agriculture.

The findings of this paper therefore complement the two strands of literature on rural development by pointing to the primary role of household and farm size in driving post-war agricultural production decisions in land abundant areas. With the receding war and aid for post-war reconstruction, markets will re-establish themselves and households will increasingly face standard incentives and constraints. There exist, however, many isolated and war-affected areas in Africa where the common determinants of investment and the emergence of property rights are not yet standard practice.

2. Theory

2.1. Motivation

Both land abundance and war potentially cause investment, tenure and farm size 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.

With such 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 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, farm size, asset accumulation and social institutions are thus related to the absence of technology, formal property rights, and credit markets (Chayanov, 1925, Meillassoux, 1981: 41).

War similarly changes the options and the constraints facing households (Collier, 1999, Stewart and FitzGerald, 2001, Addison, 2003). In particular, war can affect the quality and quantity of land (for example through land mines), the quality and quantity of farm labor (for example by drafting working age men into the army or by forcing households to post sentries

during field work), the availability of complementary inputs into agricultural production (for example by looting farm machinery), and the functioning of agricultural markets (for example by undermining road transport). In addition, the quality of land is indirectly affected by war through a lack of investment in land during times of war. Looting and disease, for example, may reduce the number of livestock and hence the opportunities for animal husbandry and fertilizing.

Civil war also represents a challenge to the political and legal order, including the system of property rights. Under these circumstances, many endowments become exogenous and many markets cease to function. For instance, asset endowments such as livestock and tools are pre-determined and credit markets do not exist. Land on the other hand may be available in principle, even if its access at the household level might be regulated by preferences, production constraints and social norms. These dimensions of the post-war environment constitute a defining feature of this case study.

Hence war has an impact on investment in land, tenure security and farm size 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 is a common determinant, albeit indirectly, of investment, tenure and farm size. It is therefore important to test for endogeneity between these variables and to control explicitly for the effects of war in the empirical analysis.

2.2. Conceptual Framework

This section presents a conceptual framework of land investment, tenure security and farm size. 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):

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

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**.

The more recent literature allowing for potential endogeneity between tenure security and land investment estimates the following system of equations (Besley, 1995, Baland et al., 1999, Brasselle et al., 2002):

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

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

where area farmed is again assumed given.

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

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

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

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

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. A yield equation has been omitted as no suitable data for plot-level yields is available in the dataset described below. This is mainly due to households practicing intercropping for all crops except cotton, which is not grown by all households in the sample. In addition, the analysis applies to only one year, making the time frame too short to consider household size as an endogenous variable.

2.3. 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 farm size regression) should hence lie between 0 for the case of perfect land abundance and -1 for the case of perfect land scarcity. Given that the regression controls for a range of factors (including the effects of war), this is the most comprehensive and first formal test of land abundance proposed in the literature.

Six interactions between these variables are potentially endogenous, which will be tested empirically below. In equation (1c) more 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 farm size 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) more 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 some fallow land if a competing claim on that land emerges as a result of refugees returning to their original place of settlement.

3. The Case of Post-War Mozambique

These hypotheses will be tested with household survey data from post-war northern Mozambique. The country provides a suitable case study as it has a low population density and experienced a severe civil war until 1992. The Mozambican economy was badly damaged

by the civil war, which took place mainly in rural areas. For example, the number of cattle in Mozambique 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. The post-war population density 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. For example, only 11 percent of all rural households occasionally or regularly employed agricultural labor (UNDP, 1999). 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 the north. Northern Mozambique was quite isolated for many months each year both during the war and the post-war period.

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. In fact, the ethnic composition of the population and the traditional culture in rural areas was little affected by the war.

4. Data and Estimation Issues

The farm household survey used for this analysis includes 371 randomly selected households in 16 villages (the primary sampling units, PSU) in three districts in Nampula and Cabo Delgado provinces 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 main 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. Overall, FSP is one of the most carefully designed, collected, and cleaned rural household surveys from the early post-war period in Mozambique.

The first dependent variable INVEST is defined as the actual number of land-related investment projects per household (Table 1). On average, 69.5 percent of all households undertook at least one investment project. Investments in fruit trees 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, not further specified 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 if a household head is concerned over land tenure security in the area (Table 1). The variable is coded such that tenure insecurity equals one and tenure security equals zero. 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.

The third dependent variable AREA45 is defined as the area cultivated in hectare per capita (Table 1). AREA35 is its natural log. Cultivated areas vary significantly across years in the study area. For example, each household cultivated 2.9 hectare in the study period but only 2.6 hectare in the subsequent agricultural year. The number of cultivated plots per household declined from 3.9 in the study period to 3.1 in the subsequent agricultural year.

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 (Rivers and Vuong, 1988, Davidson and MacKinnon, 1993: 236-42). 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

5.1. Post-War 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) covering the period 1991 to 1996. These results indicate that land inequality exists despite the apparent land abundance and that land inequality varies across space and time. However, compared to other measures of asset or income inequality in developing or developed countries, the degree of land inequality in post-war Mozambique does not appear to be extraordinary.

In the formal test of land abundance, the key variable of interest is ADULTLOG, which is the natural log of the number of non-dependent household members in the AREALOG regression. 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 land scarcity and the land abundance extremes.

This finding points to the important role played by 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 farm size with seasonality (Binswanger and McIntire, 1987). There are two further, war-related reasons why households may find it unprofitable to increase farm sizes. 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 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 rural Mozambique.

5.2. Endogenous Effects

The three regressions and the DWH test statistics are summarized in Table 4. In the survey-IV regression for investment, farm size 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 regressions have good fits with R^2 values of 0.46 (investment) and 0.68 (farm size). The farm size 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 post-war Mozambique (Table 4):

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

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

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

As expected, farm size has important endogenous effects on land investment and an important effect on tenure security in Mozambique, raising concerns about the ability of small farms to escape the strong negative effects of the war and about the distributional effects of post-war reconstruction. However, land investment and tenure security are not directly related to each other, unlike postulated in the literature on property rights in land scarce areas. In the long-term, as the effects of the war eventually disappear, land will 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 mostly does not test for endogeneity. For instance, in Rwanda 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. More 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 linkage 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 on average they may 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 farm size may thus be a key obstacle to escaping post-war poverty.

In equation (2d), neither investment nor farm size 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 post-war 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. This finding concurs with various studies where farm size mattered for tenure security (Baland et al., 1999, Holden and Yohannes, 2002, Carter and Olinto, 2003). 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 post-war 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 points to the importance of the life cycle and to the war effects on assets and markets in determining agricultural production decisions. In addition, cultural factors are important as indicated by the very small areas cultivated by female headed households.

6. Conclusions

This paper analyzes the effects of land abundance and war on land investment, tenure security and farm size. The analysis extends the literature in three regards. First, it outlines how land abundance in developing countries may potentially lead to the simultaneous determination of investment, tenure security and farm size. Land abundance changes the decision-making of farm households and results in household characteristics becoming important determinants of farm size.

Second, the paper demonstrates how war enhances the degree of land abundance by isolating households, reducing the effective supply of labor, destroying complementary agricultural inputs and raising transaction costs. War may also preserve social structures thus permitting a fluent system of land access for most households and inhibiting the formalization and individualization of land tenure.

Third, land abundance is not a universal concept but instead crucially depends 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 contributions. First, it emphasizes the importance of testing for endogeneity between land investment, tenure security and farm size in the analysis of land use and institutions in land abundant areas such as a war zone. 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 from post-war Mozambique, land in Mozambique is found to be quite abundant, though farm sizes are also strongly affected by household- and village-specific variables. The inability or unwillingness of some households to maintain a constant land-labor ratio is related to the effects of the recent war. Available land could be more effectively used with less uncertainty, more asset endowments and less social discrimination (especially against women). Under such a scenario, farm output could rise significantly without resorting to intensive production techniques. This is an important policy conclusion for Mozambique, where farm output in the early post-war years failed to rise to the pre-war levels.

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 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 years in mid-1994	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 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 in 1994 per household	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	Do 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	Very high soil quality per 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	Household owns 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 any 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	The place of birth of the main man in this household is 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	Do you think there is 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-	1.050	0.059	0.510	2.420

	1995				
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 Post-War 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 1994-95	371	0.54	0.22	0.38	0.54	0.73	1.34	6.09
		(100)	(11)	(17)	(19)	(25)	(28)	
FSP 1995-96	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 hectare per adult consumption equivalent (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 1994-96: Data are paired. LSMS 1996: data refer to rural 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 hectare. The coefficient on 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 farm size 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 farm size estimation of Table 3.

Table 4: Regression Results for Investment in Land, Tenure Security and Farm Size

	Equation 1c: INVEST		Equation 2c: TENURE		Equation 3c: AREA	
	Coeff (St Err)	Signif	Coeff (St Err)	Signif	Coeff (St Err)	Signif
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)	
Land Variables						
AREA	1.417	***	12.477	*		
	(0.504)		(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)	
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)	
Location Variables						
MILL	-0.327		2.251		-0.074	*
	(0.234)		(2.682)		(0.040)	
YIELDLOG	0.370	***	0.052	***		
	(0.134)		(0.049)			
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	***	391955.800	***	0.356	***
	(0.351)		(1451811.000)		(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				0.457	
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). 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-R^2 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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