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By

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Abstract

We investigate the extent of variation in output sharing in land rental contracts and alternative hypotheses to explain this variation. Close to half of the rental contracts in our study in northern Ethiopia have output shares that deviate from the dominant 50-50 equal sharing. Variation in land quality, the relative bargaining power of landlords and tenants, production risks and shocks are hypothesized to influence output shares. Matched data of landlords and tenants are used. The importance of endogenous matching of landlords and tenants is investigated by assessing how endogenous tenant characteristics are correlated with landlord characteristics. We find evidence of negative assortative matching for key resource characteristics. A control function approach is used to control for endogenous matching in the output share models. The results reveal that production risks as well as relative bargaining power affect output shares in the reverse tenancy setting with tenants being relatively wealthier and influential than landlords.

Key words: Land rental contracts, sharecropping, output shares, endogenous matching, control function approach.

JEL codes: Q15.

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1. Introduction

The logic of and efficiency implications of sharecropping contracts have been subjects of a lot of research including theoretical models and empirical studies since the early contributions of Cheung (1969) and Stiglitz (1974). While contract choice in form of the choice between sharecropping contract and fixed-rent contract has received a lot of attention, much less attention has been given to the determinants of the shares of output going to each of the contract partners. One reason for this may be the dominance of 50-50 sharing in many settings (Allen, 1985; Bardhan, 1984; Chao, 1983; Fujimoto, 1983; Mangahas et al., 1974; Nabi, 1986; Otsuka et al., 1992; Rao, 1971; Roumasset, 1984). The dominance of 50-50 output sharing has been explained as a "golden rule" of justice (Murrell, 1983; Otsuka et al., 1992). Equal share may be considered as a sign of fairness and trust between partners and deviation from this may result in social rejection also in situations where landlords have a strong position in determining contract characteristics. Landlords may therefore prefer to stick to contracts that are socially acceptable (Murrell, 1983; Young and Burke, 2001). In France and Italy share tenancy is even named "splitting in half" (*metayage* and *mezzadria*) and thereby making it harder to deviate from this rule (Mill, 1848; Otsuka et al., 1992). Mill (1848) notes, however, that on rich volcanic soils in Naples province the landlords claim two-thirds of the output and this is standardized across farms. Mill (1848) also quotes Simondi (1814, p. 41-42) who wrote about Tuscany and stated that landlords who tried to obtain higher proportions than the customary share would obtain dishonest tenants. In the Philippines the same word means both sharecropping and partnership (Kikuchi and Hayami, 1980). The sharing rule emphasizing equity may have been important for good and stable collaboration between the parties and contributed to trust and higher motivation to work by the tenants. This may also explain that Marshallian inefficiency is far from a universal outcome of such contracts (Otsuka et al., 1992).

Regardless of land quality, farming methods (modern or backward), and other factors that are expected to affect the productivity of the farm, output share has remained fixed at 50:50 share over long time in West Bengal (Rudra, 1975). Chao (1983, cited by Bhattacharyya and Lafontaine, 1995) found that 50-50 splits were standard in China for over 2000 years.

Despite this amazing "stickyness" of 50-50 output-sharing contracts in many places, there are nevertheless many examples of deviations from this "golden rule". Cheung (1969) cites evidence of such variations in China and Taiwan and that these vary with soil fertility. Roumasset (1976) found evidence that output sharing varied systematically with land quality on rice land in the Philippines where such lass was classified as first-class, second-class and third-class. Landlords received 50% of output on first-class, 40% on second-class and 30% on third-class rice land. Rudra (1975) also observed a case in West Bengal in India where landlords received a 60% share on superior quality land. Geertz (1965) reported that output shares varied from one-third to one-half to the landlord in Java, Indonesia, and that land quality was an important determinant of this share. While land rental markets have been found to be important and possibly expanding also in Africa and share tenancy common at least in some African countries such as Ethiopia, Madagascar and Tunisia (Bellemare, 2012; Holden et al., 2009; Laffont and Matoussi, 1995), we are not aware of any systematic studies of the extent of variation in output sharing in share tenancy systems in Africa. Our study is to our knowledge the first of this kind based on African data.

Much of the literature on share tenancy has focused on the choice between fixed rent versus share tenancy and its implications for efficiency and sharing of risk (Cheung, 1969; Marshall, 1920; Stiglitz, 1974). There are few studies that have investigated the determinants of output shares in sharecropping contracts. This may be explained by the dominance of 50-50 sharing and/or the belief that there is no or very limited variation in the shares. Exceptions include Roumasset and

James (1979) who investigated factors explaining variation in output shares in the Philippines. Utilizing a relatively small sample they found that the output share of the landlord is higher on good quality land, is higher in areas with high population density and is higher in areas with low wage rates. They emphasized that their study was of exploratory nature for hypothesis generation and that more careful empirical hypothesis tests would be needed.

In this study, we investigate the factors associated with varying output shares in sharecropping contracts in northern Ethiopia, where we find the output shares to the landlords to vary and be 0.5, 0.33 or 0.25 in sharecropping contracts while fixed rent contracts with zero output share to the landlord are relatively less common. With 52.5% of the rental contracts having 50-50 sharing and the remaining contracts being distributed across the other sharing rates we find sufficient variation in our data to investigate factors associated with this variation. We assess the extent to which land, landlord, tenant, climatic and other contextual factors are associated with the output shares and test a number of hypotheses related to land quality, complementarity of the resources of contract partners and their relative bargaining power. To our knowledge, this is the first study of this kind in Africa. We use a control function approach to control for endogeneity in the matching of contract partners. We find that better land quality is associated with a higher output share to the landlords. We find negative assortative matching in the market in line with the hypothesis that land and non-land resources of the partners are complementary. We also find evidence of bargaining power of tenants negatively affecting the output shares of the landlords.

The study is organized as follows. Section two provides information on the contextual setting that may have implications for contractual characteristics. Section three gives a theoretical framing for the specification of econometric models. Section four outlines the estimation strategy and data issues. Section five presents descriptive statistics, followed by section five that presents the econometric estimation results and discussion. Finally, section six concludes by discussing policy implications.

2. Contextual setting and implications for land rental and contract characteristics

Reverse share tenancy dominates in Ethiopia which is a country with an egalitarian land distribution after the 1975 radical land tenure reform. The Ethiopian low-cost land registration and certification reform started in Tigray region in 1998 and provided household level land certificates specifying the plots of land held by households (Deininger et al., 2008). This land reform has been found to have enhanced tenure security, investment in land, land productivity, and land rental activity in the region (Holden et al., 2009, 2011) and the reform has also contributed to the strengthening of women's land rights and the nutritional status of children (Ghebru and Holden, 2013; Holden and Ghebru, 2013). The implications in the land rental market are that households that are poor in non-land resources (often female-headed households) rent out their land to households that are richer in non-land resources (often male-headed households) (Ghebru and Holden, 2015). The land certification may have strengthened the bargaining power of landlords who have become more tenure secure. This may also have affected the contractual terms in rental contracts such as the output sharing agreements. It is possible the that the strengthened land rights of landlords is associated with them being able to get a larger share of the output, something we want to investigate in this study.

The majority of farm households in Tigray are subsistence-oriented producers and vulnerable to weather-related shocks. Gebregziabher and Holden (2011) found that the land rental market may used as a coping mechanism of last resort in this area as distress renting of plots occurs after droughts. Some households may then be forced to rent out their land under unfavorable contractual terms in form of fixed rental contracts at a low price due to their weak bargaining power and urgent need for cash. Climatic variability thus creates variation in the extent of land renting as well as contract choices. This contradicts the general theoretical belief that risk is associated with higher probability of sharecropping contracts over fixed rent contracts. One purpose of this paper is to investigate further how the variation in output sharing contracts is associated with risk and shocks.

3. Theoretical framework

The land rental market requires a search and matching process where potential landlords (having surplus land) and potential tenants (with additional demand for land) look for partners within their spatial reach. The immobility of land and distance from the homes of owners and potential tenants represent important constraints in this type of market due to the costs of transporting inputs and outputs to and from the land (Binswanger and Rosenzweig, 1986). Transaction costs and asymmetric information may thus constrain the matching process and ability to find the optimal partner in the market. Risk in production and seasonality constraints in rain fed agriculture add to the timing constraints for reallocation of land through the rental market and this may have efficiency implications for production on spatially dispersed plots (Binswanger and Rosenzweig, 1986). Tenure security characteristics may affect the supply and demand for land and the search and matching process. We first model the probability that a plot of land is joining the rental market. This depends on the plot, owner (operator), socio-economic and agro-ecological characteristics;

$$Prob(Plot\ is\ rented) = F(Z^P, Z^O, R,\ P^M) \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The net outcome of the search and matching process is pairs of one landlord and one tenant for each plot of rented land. While one should ideally model the partner matching process, our data do not allow that. We therefore jump directly to the endogenous contract but keep in mind that we have endogenous matching of landlords and tenants such that their characteristics will be endogenous in the contract choice model. Landlord characteristics are more external in the sense that they are based on ownership status that does not change frequently or easily in our environment where land sales are illegal. Landlords may, however, change tenant partners more frequently and for that reason we model endogenous tenant characteristics as functions of landlord characteristics. The matching process may imply negative or positive assortative matching. From theory, we expect negative assortative matching to dominate for factors of production that are complementary in production and have low elasticities of substitution. Landlords that are poor in one type of factor may thus search for a tenant partner who is relatively richer in this factor of production. More generally, relatively more land-rich landlords that are poor in non-land resources search for relatively more land-poor and non-land resource-rich tenants to facilitate a more optimal mix of land and non-land resources in production. This should enhance land use efficiency and the surplus production for sharing among the contract parties. We test the extent to which this hypothesis holds for each factor of production (land, labor, oxen (for traction)). We include spatial fixed effects (c_v), similar to Ackerberg and Botticini (2002) as instruments for identification and assume that these are correlated with the tenant characteristics but not directly with the output shares (which tenants may affect directly through bargaining based on their observable characteristics, such as labor and oxen endowment).

$$Z^T | rented\ plot = f(Z^L; c_v) \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (2)$$

We control for endogeneity in plot selection by including the Inverse Mills Ratio from the initial land rental model. They form a rental contract and the contract characteristics are assumed to be the outcome of a negotiation process between the contract partners and to depend on the characteristics of the plot (land quality and spatial position (relative to the contract partners, roads, markets), landlords, tenants, and communities (population density, market access, tenure, agroecology, weather). It is one of these contract characteristics, i=o, the output share, which is of central interest to us in this paper.

$$C_{i=o}^{PLT}|rented\ plot = f\ (Z^P, Z^L, Z^T, R,\ P^M) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(3)}$$

where $C_{i=o}^{PLT}$ is the output share to the landlord on rented plot P for landlord L and tenant T. Z^P is a vector of plot characteristics, Z^L is a vector of landlord characteristics, Z^T is a vector of tenant characteristics, R is average and recent rainfall measured at the nearest weather station, and P^M is a vector of price and market characteristics.

A higher output share to the landlord is obviously in the interest of the landlord but at direct expense to the tenant unless output sharing is combined with some other form of payment such as cash (fixed rent) or sharing of input costs as well. Fixed tent contracts therefore ensure payment through and other logic than the output share. We approach this by analyzing separately factors associated with the choice between fixed rent and sharecropping contracts. We also the robustness of the output share logic handling the output share along a continuum (as a continuous variable) including all sharecropping and fixed rent contracts and compare it with models where the fixed rent contracts are left out. In this way, we assess whether there is a different logic behind choice of fixed rent contracts than the logic of handling fixed rent along the output share continuum.

Roumasset and James (1979) developed a model to show that output shares could depend on land quality. More labor will be invested on higher quality land in order to equalize marginal returns to labor across farms. The net return is therefore also higher on better quality land and such land may thus facilitate a higher output share to the landlord if different qualities of land are rented in the same environment and marginal returns to land are equalized across farms. This is the basis for our first hypothesis and implies that output shares to the landlord should be higher on better quality land, *ceteris paribus* (Hypothesis H1).

Landlords are typically poorer than tenants in our study area – which may be called a reverse share tenancy system - as sharecropping contracts also are the dominating contract form (Gebregziabher and Holden, 2011; Ghebru and Holden, 2015; Holden et al., 2011). Households' endowment of non-land assets determine their relative poverty and their decisions on whether to participate in the land rental market as tenant or as landlord. Households with more non-land endowments are more likely to participate in the land rental market as tenants, while those with more land endowments, and few non-land relative to land resources (often female-headed households) (Ghebru and Holden, 2015; Holden et al., 2011) are more likely to participate as landlords. In this reverse tenancy system it is less obvious that landlords are the most powerful part that decides on the contract terms than in the classical rich landlord and poor tenant situation that dominated in many feudal agricultural settings in the past, including in Ethiopia before 1974. We therefore propose a bargaining power hypothesis that we will try to test. It states that the output share to the landlord varies with the relative bargaining power of landlords and tenants in such a way that more resource-poor landlords get lower output shares and more resource-rich tenants get higher output shares (implying lower share to the landlord) (Hypothesis H2).

The third main hypothesis relates to the logic of endogenous matching in the land rental market where land, labor, and traction power (oxen) are complementary resources in production. We hypothesize that endogenous matching implies that landlords that are poor in some non-land resources that are essential for efficient production find a tenant that is relatively richer in this resource. This implies negative assortative matching for these resource characteristics of landlords and tenants (Hypothesis H3).

The study area is characterized as semi-arid and dominated by rain-fed agriculture with some irrigation. Droughts are common such that production is risky. This may explain the dominance of sharecropping contracts which imply that landlords and tenants share the risk. However, Gebregziabher and Holden (2011) showed that fixed-rent contracts also appeared as distress rental contracts after shocks such as droughts where some households in desperate need for cash resorted to renting out their land through fixed rent contracts to meet their immediate cash needs. They were then in a weak bargaining position and such contracts may be considered unfavorable as cash payments implied a very low rent for the land compared to the value of output shares in typical sharecropping contracts. We therefore propose the hypothesis that a lower output share (fixed rent contracts) to the landlords is associated with shock exposures in the recent past (Hypothesis H4).

Finally, we propose that irrigation is associated with lower production risk due to more predictable access to water and that fixed rent contracts (lower output share to the landlord) are more likely on such land. However, these types of contracts may not be unfavorable to landlords in the same sense as the distress rental contracts (Gebregziabher and Holden, 2011) (Hypothesis H5).

4. Estimation strategy

We estimate land rental contact terms as a three-step procedure to control for sample selection and endogenous matching in the market. The first stage handles selection into plots being rented (equation 1). We use the generated inverse mills ratio (IMR) to control for selection into plots being rented due observable and unobservable characteristics of land and landowners.

Next, we investigate the endogenous matching of landlord owners of rented plots and their matched tenants. We do this by regressing the endogenous tenant characteristics on the landlord characteristics for rented plots for which we have complete data of landlord and tenant characteristics. The factor endowments of landlords and tenants other than land are normalized with their own land holding to capture the ratio between non-land and land resources, while the land is in absolute terms (ha/household). We have an attrition problem in our data as we failed to obtain complete data on landlords and tenants for all rented plots. We control for potential attrition bias by using inverse probability weighting (IPW) based on probit models for plots with complete data versus all other plots. This controls for attrition bias due to observable characteristics associated with attrition. Spatial fixed effects are used as instruments (Ackerberg and Botticini, 2002) using community (*tabia*) fixed effects. Spatial dispersion and the immobility of land imposes constraints on matching and may limit competition in the market. We also control for sample selection by including the IMR from the first selection model in the partner matching models:

$$Z^T | rented\ plot = f(Z^L; c_v, IMR, IPW) \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (2a)$$

The primary focus of this study is to assess the logic behind the observed variation in output shares in the land rental contracts and to test the related hypotheses. We use a combination of fractional probit models and probit models for this. We also tested multinomial models but have not included the results from these as the findings in these were similar. Fractional probit models treat output shares to the landlord as a continuous variable between zero and one. To test whether there is a different logic behind the switch between sharecropping and fixed rent contracts we use probit models (Fixed rent contract=1, sharecropping contract=0). We run the fractional probit models with and without the fixed rent observations to assess whether this changed the results.

Sample selection and attrition is controlled for in the same way in the output sharing models as in the partner matching models. To investigate the significance of the matching endogeneity a stepwise procedure is used. First models are run with only plot, weather and landlord characteristics with IMR and IPW. Second models with additional endogenous tenant characteristics are run. These models obviously suffer from endogeneity bias and the models are included in order to inspect the implication of this type of bias. We use a control function approach to control for this endogeneity. The error terms from the set of matching models in equation two are included to control for the endogeneity bias, relying on the spatial controls as valid instruments (assuming that the relative bargaining power of landlords and tenants can vary across locations and that this affects bargaining in the market through the observable tenant characteristics).

There is a need to correct standard errors from control function models and we do this with bootstrapping. One problem with bootstrapping is that it cannot be combined with inverse probability weighting. To resolve this problem we first assess the models with and without IPW to assess how big the bias due to attrition is. We find that this attrition results in only minor changes in model parameters. We therefore proceed and run bootstrapped models with IMR correction but without IPW. We present the models with and without IPW for inspection of our claim and then the models with bootstrapped standard errors as our strategy for robust estimation.

$$C_{i=o}^{PLT}|rented\ plot = f\ \left(Z^P, Z^L, Z^T, R, \widehat{errZ}^T; IMR; (IPW)\right) \dots\dots\dots\dots\dots\dots\dots\dots (3a)$$

We were unable to implement the control function approach in the probit models for choice between fixed rent and sharecropping due to collinearity problems when errors from the matching models were included. For these probit models, we include the results with stepwise inclusion of landlord and tenant characteristics while controlling for sample selection with IMR and IPW. These models provide some additional insights of relevance.

5. Data and descriptive statistics

5.1. Data and sampling

The dataset used for this study was collected in 2015 from 21 different communities (*tabias*) in 11 districts (*woredas*) across the semi-arid highlands in Tigray region of Ethiopia. A two-level sampling procedure was usedused to select *tabias*[2]. *Tabia* selection criteria were bases on the crop production potential, access to irrigation, market distance, and population density. Random sampling was used to select households within communities. Data on tenancy and contract choice arrangements collected from 631 main sample households with 2816 plots out of which 844 plots were under rental contracts, see Table 1 for details by district.

Table 1: Sample Districts, Households and Plots Distribution

S.no	District's Name	Sampled HH	Sampled plots	Plots under tenancy
1	Seharit- Samire	168	804	251
2	Enderta	39	174	59
3	Kilte-Aulalo	41	279	96
4	Degua-Temben	21	105	28
5	Saes Tsaedaemba	23	121	32
6	Gulemekda	25	77	39
7	Ahferom	44	267	31
8	Merbleka	25	122	26
9	Laelay-Adyabo	42	140	32
10	Tahtay-Koraro	41	200	60
11	Raya Azebo	162	527	190
	Total	631	2,816	844

Source: NMBU-MU Household survey 2015, authors' compilation

5.2. Descriptive statistics

Table 2 shows that 52.5% of rented plots have 50-50 equal sharing of output, while 19% of the contracts are of the fixed rent type with zero share of output to the landlord, 17.4% have one third share to the landlord and 11.1% have one quarter share to the landlord. In other words, there is sufficient deviation from the "golden rule" to allow econometric assessment of factors associated with the variation in output sharing.

[2] The *tabia* is the lowest administrative unit above village in the structure of Regional Government of Tigray.

Table 2. Output sharing contracts in Tigray region, Ethiopia

Contract	Output share to the landlord	Frequency	Percent
C1	0.5	443	52.49
C2	0.33	147	17.42
C3	0.25	94	11.14
C4	Fixed rent, zero output share to landlord	160	18.96
Total		844	100.00

*Note***:** Observations are at plot level for each contract type for matched tenant and landlord households. *Source*: NMBU-MU Household survey 2015, authors' compilation

5.3. Association between land quality and output shares

Since the output shares and land quality variables can be classified as categorical variables, we used Chi-square tests to assess the association between land quality characteristics and output shares. Results of the descriptive analysis are presented in Table 3. From the table it is not very obvious that better land quality is positively associated with higher share to the landlord. We see, however, that irrigated land is associated with a relatively higher probability of contracts being of the fixed rent type.

Table 3. Test for significant association between output share contract choice and plot characteristics

VARIABLE		Output share to landlord										Significance of association
		50%		33%		25%		0%		Total		chi2 test*
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	
Output share	All plots	443	52.49	147	17.42	94	11.14	160	18.96	844	100.00	
Soil depth	Shallow	146	53.09	33	12.00	26	9.45	70	25.45	275	100.00	32.65***
	Medium	138	52.08	33	12.45	36	13.58	58	21.89	265	100.00	
	Deep	136	52.31	64	24.62	30	11.54	30	11.54	260	100.00	
Soil quality	Poor	121	55.50	39	17.89	32	14.68	26	11.93	218	100.00	34.31***
	Medium	172	60.56	41	14.44	21	7.39	50	17.61	284	100.00	
	Good	127	41.78	56	18.42	39	12.83	82	26.97	304	100.00	
Soil type	Baekel[1]	66	55.93	12	10.17	23	19.49	17	14.41	118	100.00	34.82***
	Walka[2]	165	44.35	73	19.62	46	12.37	88	23.66	372	100.00	
	Hutsa[3]	66	66.67	14	14.14	3	3.03	16	16.16	99	100.00	
	Mekeyih[4]	122	57.01	36	16.82	21	9.81	35	16.36	214	100.00	
Slope of the plot	Plain	346	52.91	108	16.51	69	10.55	131	20.03	654	100.00	24.46***
	Foot hill	52	67.53	12	15.58	8	10.39	5	6.49	77	100.00	
	Mid hill	9	47.37	3	15.79	7	36.84	0	0.00	19	100.00	
	Steep hill	0	0.00	2	50.00	2	50.00	0	0.00	4	100.00	
Irrigated plot	No	400	53.19	140	18.62	90	11.97	122	16.22	752	100.00	37.82***
	Yes	43	46.74	7	7.61	4	4.35	38	41.30	92	100.00	

Note: *** Significance at 1%, ** significance at 5%, significance at 10%. *Source*: NMBU-MU Household survey 2015, authors' computation

Soil characteristics: [1]*Baekel* is a local name for Silty or Cambisols soil type, [2]*Walka* is a local name for Clay or Vertisols soil type [3] *Hutsa* is a local name for Sandy soil type, [4]*Mekeyih* is a local name for Luvisols soil type.

5.4. Difference in characteristics of landlord and tenant

Household characteristics were significantly associated with tenancy type. There was a significant difference in endowment and characteristics of tenants and landlords. Landlords have significantly higher female adult labor force than tenants (significant at 1% level). However, tenants have higher male adult labor force than landlords (significant at 10% level). This result shows the difference in gender, reflected in farming activities in the study area. Farming activity is more related to males than females in the study area. Likewise, tenants have significantly larger oxen and total livestock in TLU than landlords, this is significant at less than 1% level (table 4). This result was as expected since landlords are poorer than tenants in the study area; and their relative wealth is reflected by the endowment of oxen, livestock and male adult labor forces. Similarly, gender and age of the household head between tenants and landlords were significantly different (at 5 and 1% level respectively). Average years of age was 60 for landlords while it is 56 for tenants. Thus tenants are male headed, younger and have bigger household size than landlords (significant at1% level).

Table 4. Test for significant difference in household characteristics between tenancy partners

Variable	Tenancy						Significance of difference
	Tenant			Landlord			
Household Characteristics	Obs.	Mean	St. Err	Obs.	Mean	St. Err	t-test
Sex of household head	349	.203	.0215	480	.264	.020	-2.041**
Age of household head	343	56.17	.866	478	59.82	.681	-3.358****
Education of household head	349	.306	.024	480	.325	.021	-0.561
Household size per hectare	348	6.82	.87	479	4.94	.26	2.33 **
Female adult per hectare	349	1.83	.32	480	1.65	.11	0.57
Male adult per hectare	349	2.52	.38	480	1.66	.10	2.45 **
Oxen per hectare	349	1.57	.21	480	.66	.04	4.64 ****
Total livestock TLU per hectare	349	5.91	.74	480	2.93	.21	4.36****
Any shock experience	349	.38	.02	480	.36	.02	0.52

Note: *** Significance at 1%, ** significance at 5%, significance at 10%. *Source*: NMBU-MU Household survey 2015, authors' computation

6. Results and discussion

6.1. Endogenous matching of tenants and landlords

Table 5 presents the results of the endogenous matching models for each characteristic of tenants that we have regressed on the vector of landlord characteristics while controlling for location-specific characteristics with spatial fixed effects. The models provide evidence that there are significant correlations between tenant and landlord characteristics after controlling for spatial fixed effects. Several of the significant variables are in line with our hypothesis about negative assortative matching. I.e. there is a strong negative correlation between oxen endowments of landlords and tenants. This is in line with previous research, which has demonstrated that lack of oxen is a primary reason for landlords to rent out land as oxen are required for land cultivation and the rental market for hiring oxen to cultivate land functions poorly (Ghebru and Holden, 2009). We also see a strong negative correlation between farm size of landlords and tenants, implying that relatively land-rich landlords are matched with relatively more land-poor tenants. There is also a significant negative correlation between sex of head of landlord and tenant households. Previous research has also shown that landlords often are female-headed households while most tenants are male-headed households. This is also related to the fact that land cultivation with oxen is primarily a male task. Finally, we also see that there is a significant correlation between the exposure to recent shock variables, but in opposite direction (positive assortative matching). This is more surprising. While shock exposure can trigger land rental market participation as a coping strategy, we expected this to be primarily a factor at the landlord side that would not be correlated with a similar exposure on the tenant side.

Table 5. Endogenous matching models: Tenant characteristics as functions of landlord characteristics with spatial controls

	Tenant characteristics models							
Landlord characteristics	Female adults per ha	Male adults per ha	Oxen per ha	Farm size, ha	Head sex female, dummy	Head age	Education, literate dummy	Any shock experience, dummy
IMR	0.565	1.605	-1.446	-2.337*	0.212	-9.002	0.361	0.358*
	(1.070)	(1.193)	(1.182)	(1.383)	(0.195)	(9.716)	(0.317)	(0.213)
Female adults per ha	-0.073	-0.205*	-0.121	0.008	-0.011	-1.449	-0.020	0.032
	(0.182)	(0.105)	(0.083)	(0.060)	(0.016)	(0.975)	(0.030)	(0.030)
Male adults per ha	-0.108	-0.040	0.183	-0.053	-0.053**	0.693	0.041	-0.035
	(0.147)	(0.141)	(0.115)	(0.051)	(0.021)	(1.205)	(0.031)	(0.028)
Oxen per ha	0.162	0.050	-0.290***	-0.263**	0.055**	-0.128	-0.010	-0.033
	(0.161)	(0.154)	(0.099)	(0.103)	(0.024)	(2.175)	(0.049)	(0.033)
Farm size, ha	0.047	0.039	-0.041	-0.473***	0.015	-0.441	0.001	-0.009
	(0.161)	(0.112)	(0.081)	(0.140)	(0.027)	(1.035)	(0.036)	(0.030)
Head sex female, dummy	-0.539	-0.606	0.261	-0.295	-0.149**	-4.684	-0.169	-0.209**
	(0.387)	(0.372)	(0.324)	(0.289)	(0.058)	(3.684)	(0.122)	(0.098)
Head age	0.003	-0.006	0.008	0.003	-0.004**	-0.060	0.002	-0.005**
	(0.013)	(0.012)	(0.013)	(0.007)	(0.002)	(0.076)	(0.003)	(0.003)
Education, literate dummy	-1.030	-1.430**	-0.433	0.769**	-0.030	-3.030	-0.050	0.048
	(0.716)	(0.575)	(0.551)	(0.360)	(0.071)	(4.906)	(0.183)	(0.141)
Any shock experience, dummy	0.404	0.086	-0.058	-0.783**	0.047	-3.809	-0.116	0.202**
	(0.445)	(0.447)	(0.471)	(0.297)	(0.074)	(3.272)	(0.149)	(0.093)
Spatial FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	272	272	286	286	286	282	277	282
R-squared	0.245	0.394	0.269	0.448	0.421	0.300	0.227	0.396

Note: Standard errors in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01, **** p<0.001

6.2. Output share models

Table 6 presents the output share models for fractional probit models without and with the fixed rent plot observations and stepwise inclusion of tenant characteristics, error terms from tenant characteristics matching models without and with inverse probability weighting, and the final control function approach models with bootstrapped standard errors. The table presents average marginal effects. Here we focus on the testing of the key hypotheses related to output sharing. We have already observed the evidence of endogenous matching and negative assortative matching in the previous section. This evidence indicates that it is important to control for this endogeneity in the analyis of the hypotheses about factors associated with output sharing.

The models without tenant characteristics indicate that output shares are significantly associated with land quality and that higher shares to the landlord are associated with higher land quality, like also found by Roumasset and James (1979). However, these findings are not robust to the addition of tenant characteristics and control for endogenous matching. Also, the rainfall variables did not provide robust evidence in terms of their impacts on output shares. We cannot therefore reject the first hypothesis (H1) about land quality and output shares but the evidence in favor of it is not very strong. The evidence that rainfall and weather shocks affect output shares is weak. Plot elevation is significant and with positive sign in many models and is a unique plot characteristic measured with GPS while rainfall is observed at the nearest weather station. It is possible the plot elevation is correlated with rainfall and higher elevation being associated with higher and more reliable rainfall and thus also higher output shares but we should be cautious with this interpretation.

For the bargaining power hypothesis, we see that female labor force of landlords is significantly associated with higher output shares in the models without fixed rent contracts. We also see that female landlords and older landlords have lower output shares. These may be indicators of bargaining power effects on output shares from the landlord side. It is, however, surprising that literate landlords have a significantly lower output share than illiterate landlords as we would expect literacy being positively correlated with bargaining power.

Inspecting the tenant characteristics we see that male labor force and literacy of tenants are significantly negatively associated with the landlords' output shares and this may indicate that tenants have been able to bargain for a higher output share for themselves. Likewise, older tenants appear to have been less able to bargain in their own favor. Surprisingly, tenants with more oxen received significantly lower output shares. Perhaps more oxen made it more important for them to get additional land and that may have made them more willing to accept less favorable contracts. However, we think the results provide convincing evidence that some of the variation in output sharing can be due to bargaining between landlords and tenants and therefore we cannot reject the bargaining hypothesis (H2). In our setting with reverse share tenancy and relatively more resource-rich tenants and resource-poor landlords can contribute to the deviation from the "golden rule" of 50-50 output sharing through local negotiations in spatially dispersed markets with limited competition.

In order to assess whether there is a different logic behind the switching between sharecropping and fixed rent contracts than the reduction in output shares, we need to inspect the results from the output share models with and without the fixed rent observations in Table 5 and the probit models for fixed rent contracts in Table 6. Theoretically, we expect there to possibly be such a change primarily related to irrigated plots where production risk is lower and where the production of cash crops also may favor cash payment (hypothesis H5). The results in Table 6 show that irrigated plots are significantly more likely to have fixed rent contracts in support of this hypothesis. Table 6 also provides evidence in support of hypothesis H4 that shocks can lead to distress fixed rent contracts as the lagged relative rainfall variable is negatively correlated with the probability of that fixed rent contracts are chosen (significant at 5% level in two of three models). These significant findings pull us in direction of giving more emphasis to the fractional probit models without fixed rent observations than the models with fixed rent observations as we think the fixed rent contracts fit less well into the continuous output share framework. Table 5 also shows some significant changes when we add the fixed rent observations. The weakness, however, for the probit fixed rent choice models is that we were unable to use the control function approach to control for endogenous matching. We have therefore retained the fractional probit models with fixed rent observations. One of the important changes we see compared to the fractional probit models without the fixed rent observations is that irrigated plots are associated with a significantly lower output share to the landlord (such as fixed rent contracts) after controlling for endogenous matching. The significance levels also changed for many of the landlord and tenant characteristics when the fixed rent observations were added but the signs of the variables did not change and the observed bargaining effects appear therefore relatively robust.

The average marginal effects of landlord and tenant characteristics for alternative model specifications are presented in Figure 1. The age variables required a different scaling and are therefore presented in Figure 2. The visual image shows the variables that pull towards a lower output share on the left side of the graphs, which give point estimates and 95% confidence intervals. The graphs also illustrate the importance of controlling for endogenous matching while the attrition bias that we controlled for with inverse probability weighting appeared to be small. Correction of standard errors with bootstrapping while dropping inverse probability weighting should therefore provide robust and not very biased estimates.

Table 6. Factors associated with output shares in tenancy contracts.

VARIABLES	Fractional Probit Models with/without IPW & Bootstrapping									
	---------------------------Without Fixed Rent Contracts-----------------					---------------------- With Fixed Rent Contracts ----------------------				
	LL;IPW	LL+TN; IPW	LL+TN+ err; IPW	LL+TN+err; no IPW	LL+TN+err; no IPW, Bootstr.	LL;IPW	LL+TN; IPW	LL+TN+ err; IPW	LL+TN+err; no IPW	LL+TN+err; no IPW, Bootstr.
IMR land market particip.	0.180***	0.080	0.197**	0.173**	0.173*	0.201**	0.108	0.411***	0.415***	0.415**
Land quality: Base: Poor										
Medium	0.023**	-0.013	-0.00036	0.00035	0.00035	-0.00024	0.009	0.046*	0.043	0.043
Good	0.036***	0.024	0.010	0.006	0.006	-0.005	0.005	0.005	0.021	0.021
Slope: Base: Flat										
Foot hill sloped plot	-0.023*	-0.025	-0.011	-0.009	-0.009	0.016	-0.023	-0.009	-0.002	-0.002
Mid hill sloped plot	-0.091***	-0.057	-0.036	-0.044	-0.044	-0.055*	-0.007	0.028	0.020	0.020
Certified plot, dummy	-0.025**	-0.004	-0.027	-0.023	-0.023	-0.042**	-0.017	-0.051	-0.039	-0.039
Irrigated plot, dummy	0.012	0.026	0.016	0.010	0.010	-0.075**	-0.052	-0.064	-0.086**	-0.086*
Plot elevation	0.00007***	0.00009***	0.00006***	0.00007***	0.00007**	0.00012***	0.00008*	0.00006	0.00005	0.00005
Mean Rain Fall	0.00044*	-0.00004	-0.001	-0.001	-0.001	0.001	0.00038	-0.003*	-0.002	-0.002
Relative Rainfall one year lag	-0.083***	0.025	-0.011	-0.011	-0.011	0.038	0.166*	0.098	0.156	0.156
Landlord characteristics										
Female adults per ha	0.007***	0.008**	0.011***	0.009**	0.009*	0.009**	0.003	0.013*	0.011	0.011
Male adults per ha	-0.005**	-0.001	-0.007	-0.006	-0.006	-0.004	0.002	-0.012	-0.010	-0.010
Oxen per ha	0.002	-0.004	-0.001	-0.004	-0.004	0.007	-0.010	0.003	-0.005	-0.005
Farm size, ha	-0.002	-0.011	-0.005	-0.010	-0.010	0.009	0.002	0.022	0.017	0.017
Head sex female, dummy	-0.008	-0.007	-0.048**	-0.046**	-0.046*	0.024	0.047	-0.047	-0.054	-0.054
Head age	-0.000	-0.000	-0.001***	-0.001***	-0.001**	-0.001	-0.001	-0.003***	-0.003***	-0.003***
Education, literate dummy	-0.027**	-0.046**	-0.054***	-0.051***	-0.051***	-0.057***	-0.016	-0.035	-0.044	-0.044
Shock experience, dummy	-0.000	0.016	0.024	0.025	0.025	0.024	-0.022	-0.001	0.002	0.002
Tenant characteristics										
Female adults per ha		0.001	0.019*	0.016	0.016		0.003	0.073***	0.079***	0.079***
Male adults per ha		-0.012***	-0.042***	-0.039***	-0.039***		-0.010	-0.064***	-0.064***	-0.064***
Oxen per ha		0.010***	0.036***	0.035***	0.035**		0.001	0.048***	0.036*	0.036
Farm size, ha		-0.008	-0.010	-0.013	-0.013		-0.035***	-0.016	-0.022	-0.022
Head sex female, dummy		-0.017	-0.085**	-0.075*	-0.075		-0.064*	-0.317***	-0.311***	-0.311***
Head age tenant		0.001***	0.004***	0.004***	0.004***		0.000	0.004***	0.003*	0.003
Education, literate dummy		0.002	-0.083***	-0.075***	-0.075**		-0.019	-0.190***	-0.191***	-0.191***

Shock experience, dummy		0.025*	-0.038	-0.036	-0.036		0.065**	-0.122	-0.131	-0.131
Errors Tenant Matching										
Error, Female adults per ha			-0.025**	-0.021*	-0.021			-0.086***	-0.088***	-0.088***
Error, Male adults per ha			0.041***	0.038***	0.038***			0.069***	0.065***	0.065***
Error, Oxen per ha			-0.032***	-0.032***	-0.032**			-0.053**	-0.038	-0.038
Error, Farm size, ha			0.000	0.001	0.001			-0.020	-0.017	-0.017
Error, Head female, dummy			0.079	0.067	0.067			0.330***	0.324***	0.324**
Error, Head age			-0.004***	-0.003***	-0.003***			-0.005***	-0.004*	-0.004
Error, Education, lit. dummy			0.105***	0.101***	0.101***			0.215***	0.224***	0.224***
Shock experience, dummy			0.083*	0.076	0.076			0.205**	0.219**	0.219*
Observations	450	214	214	214	214	541	264	264	264	264

Note: The table presents marginal effects. *** p<0.01, ** p<0.05, * p<0.1. Table column headings: LL=landlord characteristics, TN=tenant characteristics, err=Errors from tenant matching models, IPW=inverse probability weighting, Boot=bootstrapped standard errors (500 replications).

Table 7. Factors associated with fixed rent contract.

VARIABLES	Probit Models With IPW ------------ Fixed Rent(=1) --------------		
IMR land market particip.	-0.083	-0.078	0.023
Land quality: Base: Poor			
Medium	0.039	0.061*	-0.031
Good	0.100***	0.101**	0.046
Slope: Base: Flat			
Foot hill sloped plot	-0.069	-0.108**	-0.006
Mid hill sloped plot			
Certified plot, dummy	0.050	0.086*	0.075
Irrigated plot, dummy	0.119***	0.132***	0.155**
Plot elevation	-0.00006	-0.0001**	-0.00001
Mean Rain Fall	-0.005***	-0.003**	-0.002
Relative rainfall one year lag	-0.227**	-0.132	-0.331**
Landlord characteristics			
Female adults per ha		-0.005	0.003
Male adults per ha		0.001	-0.001
Oxen per ha		-0.006	0.023
Farm size, ha		-0.017	-0.017
Head sex female, dummy		-0.059	-0.098
Head age		0.001	0.0005
Education, literate dummy		0.054	-0.061
Shock experience, dummy		-0.030	0.103*
Tenant characteristics			
Female adults per ha			-0.009
Male adults per ha			0.001
Oxen per ha			0.022
Farm size, ha			0.056***
Head sex female, dummy			0.113
Head age tenant			0.001
Education, literate dummy			0.037
Shock experience, dummy			-0.097*
Tabia (village) fixed effect	No	No	No
Observations	706	528	257

Note: The table presents marginal effects. Significance levels: *** p<0.01, ** p<0.05, * p<0.1

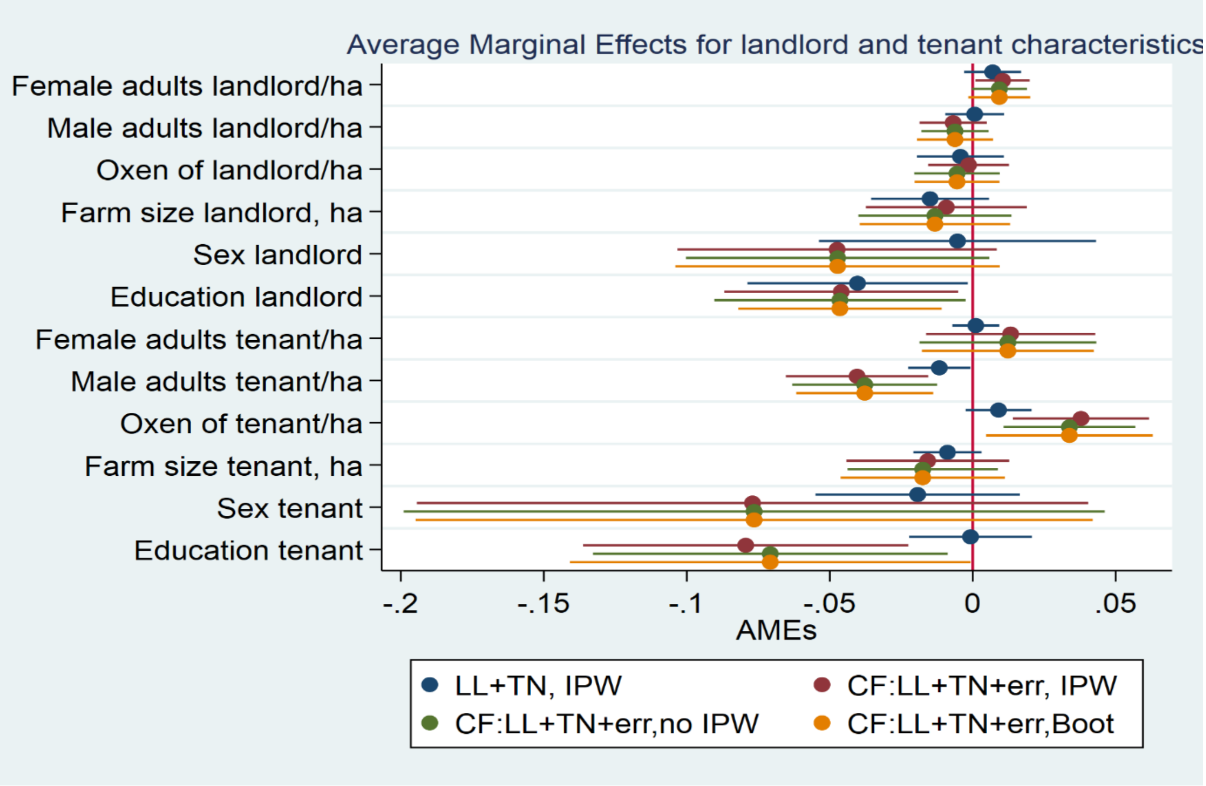

Figure 1. Average marginal effects of landlord and tenant characteristics on output shares in sharecropping contracts for alternative model specifications

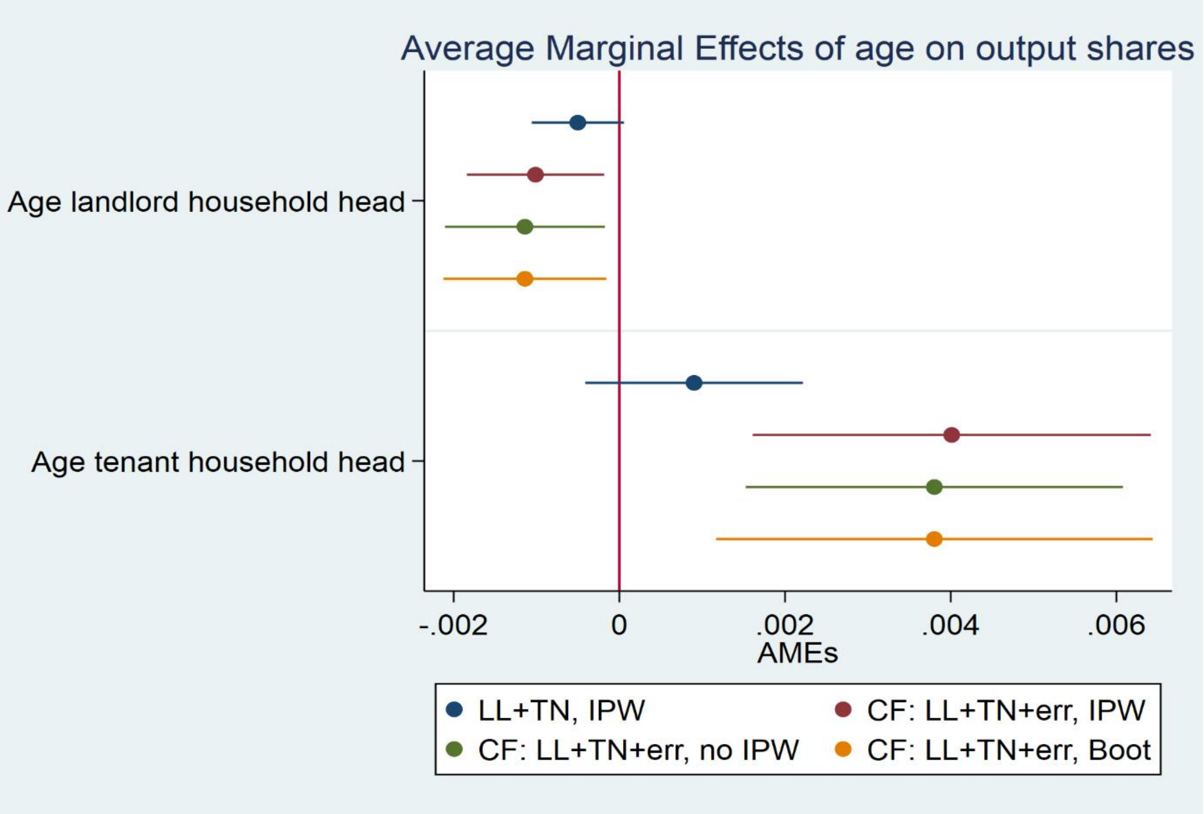

Figure 2. Average marginal effects for age of landlords and tenants on output shares in sharecropping models for alternative model specifications

7. Conclusions

We have investigated the nature of endogenous matching in the land rental market in northern Ethiopia and the extent of deviation from the "golden rule" of 50-50 sharing of output in sharecropping contracts. We found evidence of negative assortative matching when relating endogenous tenant characteristics to landlord characteristics. Relatively more land-rich landlords were matched with more land-poor tenants and relatively more non-land resource poor landlords were matched with relatively more non-land resource rich tenants.

While 50-50 sharing dominates in our study areas and was chosen in 52.5% of the contracts, we found output shares of landlords of 0.33 and 0.25 to be common and fixed rent contracts with zero output share to the landlord were also quite common. We tested the hypothesis of Roumasset and James (1979) that land quality can explain this variation in output shares against a set of potentially competing hypotheses such as output share variation being due to variation in the relative bargaining power of landlords and tenants. In our setting with reverse tenancy, where tenants are relatively more wealthy and possibly more powerful than the relatively poorer landlord households, tenants may be able bargain the contractual terms in their favor. Our findings indicated that this bargaining hypothesis plays a role while the land quality hypothesis turned out to be less robust than we initially thought. However, the analysis also revealed that lower production risk on irrigated land was associated with a low output share to the landlords due to the higher probability of use of fixed rent contracts on such land. The bargaining hypothesis was also favored by some evidence of recent rainfall shocks leading to higher likelihood of distress fixed rent contracts.

Appendix A

Table A1. Description of Variables Used In the Empirical Analysis

Variable Name	Definition of variables	Mean	Std. Dev.
IMR land market participation	IMR from probit model for land market participation	1.104	.1742
IPW1	Inverse Probability Weights for model with land characteristics	1.106	0.093
IPW2	Inverse Probability Weights for model with land and landlord characteristics	1.341	0.175
IPW3	Inverse Probability Weights for model with land, landlord and tenant charact.	2.726	0.805
Land quality	land quality of the plot, 1= poor, 2= Medium, 3= Good	1.997	.786
slope plot	slope plot: 1= Flat , 2= Foot hill, 3= Mid hill	1.193	.481
Certified plot, dummy	Dose plot certified	.816	.387
Irrigated plot, dummy	Plot is irrigated=1	.096	.295
Plot elevation	Plot elevation above sea level in meters	2024.913	330.417
Mean rainfall	Mean of Rainfall for the last 5 years in Millimeter	52.949	11.762
Relative Rainfall one year lag	Ratio of 2013 average rainfall to last 5 years average rainfall in Millimeter	1.052	.152
Landlord characteristics			
Female adults per ha	Number of Female adults in the landlord per hectare of farm size	1.811	2.826
Male adults per ha	Number of Male adults in the landlord per hectare of farm size	1.688	2.362
Oxen per ha	Oxen own by the landlord in number per hectare of farm size	.868	1.309
Farm size, ha	Farm size holding of the landlord in hectare	1.710	1.589
Head sex female, dummy	sex of the landlord household head	.316	.465
Head age	Age of the of the landlord household head in years	57.263	16.056
Education, literate dummy	educational status of the landlord, Dummy 1=Literate	.319	.466
Any shock experience, dummy	Has this Landlord household experienced any major shock since 2011 to 2013 GC? 1=yes	.334	.472
Tenant characteristics			
Female adults per ha	Number of Female adults in the Tenant per hectare of farm size	1.897	5.121
Male adults per ha	Number of Male adults in the Tenant per hectare of farm size	2.277	5.931
Oxen per ha	Oxen own by the Tenant in number per hectare of farm size	1.730	3.487
Farm size, ha	Farm size holding of the Tenant in hectare	1.912	1.940
Head sex female, dummy	sex of the Tenant household head, 1=Female	.113	.317

Head age tenant	Age of the of the Tenant household head in years	53.612	16.416
Education, literate dummy	educational status of the Tenant , Dummy 1=Literate	.334	.472
Any shock experience, dummy	Has this Tenant household experienced any major shock since 2011 to 2013 GC?1=yes	.368	.482

Source: NMBU-MU Household survey 2015, authors’ computation

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