Do Farm Land Rental Markets Really Promote Efficiency, Equity and Investment in Smallholder African Agriculture? Evidence from a Matched Tenant-Landlord Survey in Malawi.

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Abstract
The growth of rural land rental markets is often taken as a virtuous component of an African structural transformation process, by facilitating access to land by efficient but land-constrained farmers. Recent empirical work has generally supported this view. However, one of the shortcomings is that nearly all studies severely underreport activities of landlords, as compared with tenants. Failure to fully capture the landlord side of the rental market at best leaves out important information about the landlords' intentions, and at worst biases any results and conclusions that are drawn from such studies. The present paper estimates the efficiency, equity, and investment returns to land renting using a matched tenant-landlord survey of smallholder farm households in four districts (two rural, and two peri-urban) of Malawi. Our matched tenant-landlord sample allows us to use pairwise Fixed Effects to control for unobservable characteristics of tenant-landlord pairs that may otherwise bias model estimation. Results suggest that land rental markets do facilitate efficiency, as households that have higher farming ability and education are more likely to rent in land compared to those who rent out. In addition, we find that rental markets seem to encourage equity as households with more land *ex ante* are more likely to rent to those with less land. However, our study also identifies some important caveats to these otherwise positive results. First, we note that tenant households in our sample are wealthier than their landlord counterpart on average in all dimensions other than landholding (i.e. value of durable and livestock assets, off-farm income, education levels). In addition, most landlord households report the motive for renting out their land as either the need for immediate cash, or the lack of labor and/or capital to cultivate the plot that was rented out. While we find evidence that tenants farm more intensively than landlords and non-renters, the nature of tenants' productivity investments is mostly short term, i.e. chemical fertilizer and herbicides. Relatedly, we find that rented-in plots receive fewer fertility enhancing investments, such as use of organic manure, than owner-operated plots. Thus, it appears that in Malawi the majority of landlords are "stress renting" their land to tenants who seek short-term yield gains, potentially at the expense of longer-run soil health. This raises the question: if soil fertility declines on rented in plots, can the efficiency gains associated with land rental be maintained in the future? Our work suggests that this is an important trade-off to consider from a land policy perspective.

Key words: land rental markets, soil fertility, productivity, sub-Saharan Africa, Malawi

Introduction

In many parts of sub-Saharan Africa (SSA) farmland is held in customary tenure systems where the smallholder farm households who predominate in these farming systems have user rights that are granted by local chiefs or other customary leaders. While these rights can often be passed down from parent to children, either to male child or female child or both depending on the local cultural practices, the vast majority of smallholders have no formal title giving them ownership rights to the land that they cultivate. Buying, selling, and renting of land are often not explicitly allowed in traditional systems. However, recent empirical evidence suggests that land rental markets in SSA are much more developed

than commonly perceived, especially in areas of high population density and relatively good market access (Holden et al., 2009; Lunduka 2009; Chamberlin and Ricker-Gilbert 2016).[1] The type of tenancy arrangement varies across and within countries. Evidence suggests that share-cropping arrangements are dominant in some places (e.g. Deininger et al., 2008; Deininger et al, 2013 for Ethiopia), while fixed rent contracts predominate elsewhere in Eastern and Southern Africa (e.g. Jin and Jayne 2013 for Kenya; Ricker-Gilbert and Chamberlin 2016 for Tanzania; Chamberlin and Ricker-Gilbert 2016 for Malawi and Zambia).

The growth of land rental markets would seem to be in keeping with the general features of an African structural transformation as outlined in seminal studies by Johnston and Kilby (1975), Mellor (1976) and others. In fact, several recent studies find that in general land rental markets in SSA promote equity by transferring land from labor-poor to labor-rich and from land-rich to land-poor households. In addition, land rental markets have been found to promote production efficiency by transferring land from producers with lower farming ability to those with higher ability (Holden et al., 2009; Jin and Jayne 2013; Chamberlin and Ricker-Gilbert 2016). However, despite the general finding of positive benefits from renting in land, numerous questions remain about the ability of these markets to improve equity and efficiency in the smallholder farming system for both tenants and landlords. One of the major challenges associated with previous literature is that most studies in the region (and all of the studies mentioned above) severely underreport the activities of landlords. In fact, a recent article by Deininger et al. (2017) use nationally representative LSMS-ISA data from six countries in SSA collected within the past five years to show that total area rented out makes up less than 50 percent of total area rented in and six countries (Ethiopia, Malawi, Niger, Nigeria, Tanzania, and Uganda). Furthermore, rented out land makes up less than 6 percent of rented in land in three of the six countries (Malawi, Nigeria, and

[11] See also Sitko (2010) for documentation of "clandestine" land sales markets within a customary tenure system in Southern Zambia.

Uganda). The failure of most research to fully capture the landlord side of the rental market at best leaves out important details as to the landlords' intentions, and at worst, biases any results and conclusions that are drawn from such research.

Several anecdotal reasons for landlords under-reporting their activities in surveys have been advanced. They include: (i) landlords in customary tenure areas being reluctant to discuss renting out land because they fear that they could lose their cultivation rights if they are found to not be farming; (ii) land rental modules in surveys not being crafted properly, and survey enumerators not being instructed to probe respondents about land rented out; and (iii) landlords being more likely to be absent at harvest time when most agricultural surveys occur. Evidence of (i) would be a symptom of tenure insecurity in the land rental system. Should the problem be found to be associated with (ii) it would suggest problems with the design and implementation of land tenure modules in large surveys such as LSMS-ISA (Holden et al. 2016). Conversely, evidence of (iii) would be consistent with an indigenous African land grab where urban dwellers are acquiring land from poorer rural smallholders and leasing it to them on a seasonal basis (Sitko and Jayne 2014; Jayne et al. 2016; Anseeuw et al. 2016). Regardless of the reason, in order to interpret the role of rental markets in the ongoing structural transformation process in SSA, we need to better understand the nature of land transfers that are enabled by renting, and that requires accurate information about both the tenant and landlord sides of the market.

In this paper, we estimate the efficiency and equity returns to land renting using a matched tenant and landlord survey of smallholder households in Malawi. In doing so, we are able to more fully capture the economic returns of renting for both tenants and landlords. We also include proxies for household head ability and risk aversion in our models that test land rental market facilitation of equity and ability. In addition, we collected plot-level data on input use such as, labor, inorganic fertilizer and herbicides, along with information about longer-term soil fertility enhancing decisions such as using organic manure, composting and burying of crop residues after harvest. We collect this information for

both rented and owner-cultivated plots within the same household, which allows us to estimate input use and investment decisions across plot ownership within the same household.

By estimating efficiency and equity returns to land rental markets, along with estimating differences in input use and investment decisions with a matched sample, the present article makes an important empirical contribution to the existing literature. To our knowledge, few studies based in SSA have used a matched tenant-landlord sample in SSA, and those that have answer different questions. For example, Deininger et al. (2013) estimates the relative differences in Marshallian efficiency between share-cropped plots, plots that rented at a fixed rate, and owner-operated plots in Ethiopia. Bellmare (2012) uses data from Madagascar to estimate how a landlord's perception of tenure secure affects the choice of contract offered to tenants. He finds that landlords who feel insecure are more likely to offer share-cropped contracts as opposed to fixed rent contracts. In addition to answering different questions from our study, both of the articles mentioned above are conducted in places where the majority of the rental arrangements are share-cropped, as opposed to our context in Malawi where nearly all of the rental arrangements are fixed rent.

Second, most previous studies that have estimated the efficiency impacts of land rental markets have created a variable to proxy for ability that is simply the fixed effects (FE) component of a production function (Lanjouw 1999; Deininger and Jin 2005; Deininger and Mpuga 2009; Jin and Deininger 2009; Jin and Jayne 2013; Chamberlin and Ricker-Gilbert 2016). This approach, while innovative, has the shortcoming of causing all time-constant unobservable factors -- such as soil quality, farmer risk aversion, time-preferences, and ability – to be subsumed into the FE term. The fact that our model includes explicit measures of these factors allows us to control for them as separate covariates, which gives us an arguably more accurate measure of how a household's farming ability effects the land rental decision.

The identification strategy used in the present article employs tenant-landlord pair FE to control for unobservable differences between tenants and landlords who participate on opposite sides of a rental arrangement. This allows us to estimate the differences within pairs that affects land rental decisions and ultimately efficiency and equity estimates. We also have a rich set of household-level demographic information, and plot-level controls in addition to the proxies for ability, risk aversion, time-preferences, and soil quality that should control for the vast majority of remaining unobserved time-constant and time-varying unobservable factors that might bias our coefficient estimates.

Our results are consistent with previous studies in that they suggest that land rental markets do facilitate production efficiency, as rental arrangements transfer land from landlords with lower ability and education to tenants with higher ability and education. In addition, we find that rental markets facilitate land access equity as households with more land *ex ante* are more likely to rent to those with less land. However, consistent with Chamberlin and Ricker-Gilbert (2016), our balanced sample suggests that tenants are wealthier than their landlord pairs across all dimensions other than landholding, and the most tenants report that they rent out their land because they need immediate cash, or lack the labor and/or capital to cultivate the plot that was rented out.

While tenants appear to have the necessary capital to invest in farming, which may seem like a positive development, we find that most of their expenditure is on inputs like inorganic fertilizer and herbicides which may increase yields in the short term. At the same time, we find that rented-in plots receive fewer longer-term fertility enhancing investments such as use of organic manure, as compared with owner-operated plots.[2] We show evidence that the majority of landlords in Malawi are renting out land primarily in order to satisfy short-term cash needs what might be termed “stress renting” (see Deininger et al. [2013] and Chamberlin and Ricker-Gilbert [2016] for more on this idea). Furthermore,

[2] These findings are consistent and expand upon Dubois (2002), who finds that rented plots planted with corn are more likely to be under share-cropped contract then fixed rent in the Philippines. Dubios attributes this to the landlords desire align incentives with the tenant, so as to reduce the nitrogen depletion caused by corn cultivation.

we show evidence that tenants appear to prioritize short-term yield investments (e.g. via inorganic fertilizer), potentially at the expense of longer-run soil health. This raises the question: if soil fertility declines on rented in plots, can the efficiency gains associated with land rental be maintained in the future?

Background: land rental markets in Malawi

Malawi officially maintains two types of land tenure systems, private (freehold or leasehold), and customary (traditional).[3] Owners of private land hold titles to it, so their rights are recognized and protected by government. While freehold land is owned by the titleholder and can be used in perpetuity, leasehold land gives the operator explicit cultivation rights for a specified duration of time (e.g. 99 years). Private land can be bought, sold and rented at the discretion of the title holder.

Despite the existence of leasehold land, the vast majority of land in Malawi (and the vast majority of land cultivated by smallholders) falls under the traditional tenure system.[4] For example, Lunduka et al (2009) estimate that in the 1970's, 80 percent of all arable land was estimated to be under customary tenure, and by 1997, less than 10 percent of that land had been converted to private land.[5] As discussed earlier, the traditional tenure system grants user rights (not ownership rights) to households and is managed under the auspices of local traditional authorities (chiefs). Those rights can normally be passed down from parents to children, the chiefs have the authority to re-allocate land as they see fit. Buying, selling and renting of land is not explicitly allowed in the customary system, although it is often allowed in a *de facto* manner with the endorsement of the chiefs.

[3] Malawi also has designated public lands that are claimed by state entities. These lands include forest reserves, game parks and other protected areas. Officially public lands are not supposed to be used for agriculture, but in reality smallholders encroach upon these lands.

[4] The nationally representative IHS3 data from 2010 indicates less than 2 percent of smallholder plots where purchased with title.

[5] Though dated, these are the most recent figures available for Malawi.

Recent empirical evidence suggests that growth in land rental markets within customary land tenure system has been remarkable over the past 15-20 years in Malawi. Chamberlin and Ricker-Gilbert (2016) use nationally representative data to show that between 2002/03 and 2006/07 the proportion of smallholders in the sample who were engaged in land rental markets either as tenants or landlords increased from 11 to 20 percent, and in 2008/09 participation increased to 24 percent of the sample. Increased rental market activity is likely driven by small and declining farm sizes, population density and market access (Ricker-Gilbert et al., 2016). In fact, the median area under cultivation per smallholder household in Malawi is just 0.6 hectares, while Malawi's rural population is growing at an estimated rate of over 3 percent per year, and is expected to reach 20.8 million by 2020 (NSO, 2008). Clearly this high and growing level of rural rental market activity merits further attention from researchers, policy makers and civil society.

In recognition of the importance of land markets and land tenure, the government of Malawi passed a series of Land Acts in 2016. The objectives of the Land Acts, which had been circulating in parliament since 2002, are to make it easier for smallholders to obtain formal titles for the land that they cultivate (Nyasa Times, September 14, 2016). Households who cultivate land within the customary system will be allowed to register their land and obtain titles for it without paying a registration fee (a major barrier to titling for limited resource farmers in the past). The hope is that this will improve tenure security for poor households, particularly those headed by women. The impact of the land acts on land sales and rentals remains to be seen, but one might expect the law to facilitate their further development.

Previous literature on efficiency and equity in land rental markets

As land rental market activity has grown across SSA in the recent decades, so have the number of research studies estimating their impact on equity, efficiency and welfare for smallholder households.

The conceptual discussion, introduced by Skoufias (1995), suggests that rental markets have to potential improve equity and efficiency by allowing smallholders to adjust their operational farm size to reach their desired farm size, either through renting in or renting out land. However, in the presence of transactions costs, which include finding, negotiating, and enforcing rental agreements, the costs of monitoring land management by tenants, and the pressure not to rent out too much land lest a household be perceived as excessively wealthy, such adjustment might not be fully possible. This means that observed operational farm sizes are not necessarily equivalent with the optimal or desired farm sizes.

Numerous studies have estimated the degree to which land rental markets allow households to adjust their operational land size to their desired land size, and measure the extent that transactions costs affect adjustment. Generally, number of hectares rented in and rented out is regressed on *ex ante* landholding and household size or available labor, and other factors using a Tobit estimator to account for non-participation. Coefficient estimates on the land and labor variables allow inferences to be drawn on the extent to which land rental markets promote equity (equality) by transferring land from land-rich households (more land *ex ante*) to land-poor households, (less land *ex ante*), and labor-poor households (less available labor *ex ante*) to labor-rich households (more labor available *ex ante*). To our knowledge, these studies are all imbalanced with more observations for tenants than for landlords (Deininger et al., 2008; Ghebru and Holden, 2009; Yamano et al., 2009; Jin and Jayne 2013; Chamberlin and Ricker-Gilbert 2016). The general conclusion across studies is that (i) land rental markets allow for adjustment towards optimal farm sizes but full adjustment is never attained due to the presence of transactions costs; and (ii) there are equity gains as land is transferred from land rich to land poor households and from labor poor to labor rich households.[6]

[6] Although recall our assertion that these findings should be treated with caution, as the landlord side of the market is not fully observed in the data used by these studies, possibly biasing results.

Some studies also seek to add a measure of production efficiency to the analysis of land rental market impacts. The method for doing so, first presented in Lanjouw (1999), entails estimating the FE component from a production function, and including the FE coefficient as an additional covariate in the Tobit estimate of hectares rented in and rented out. To date, this method has been applied to a number of local contexts in Asia and SSA (Deininger and Jin 2005; Deininger and Mpuga 2009; Jin and Deininger 2009; Jin and Jayne 2013; Chamberlin and Ricker-Gilbert 2016). All of these samples are also unbalanced, with more observations for tenants than for landlords. The general finding is that households with higher ability are more likely to rent in land (e.g. estimates on the FE coefficient are positive and statistically significant in the land rented-in models). On the landlord side of the market, the coefficient estimate is either not statistically significant or negative and statistically significant.

Regardless of these findings, the fact that the landlord side of the market is not fully observed in previous studies raises questions about the true efficiency and equity gains from these markets for all participants. Chamberlin and Ricker-Gilbert (2016) have limited observations on landlords in their dataset, but find some evidence of stress renting by landlords in Malawi. They find that landlords experience lower net incomes and are more likely to be in poverty than tenants and other households, even after accounting for the income that they earn from renting out land. This raises the question of why would someone part with their most productive asset, even temporarily, if they are worse off at the end of the year, unless they were under financial duress or were coerced into doing so? Would the findings from Chamberlin and Ricker-Gilbert (*ibid*) hold up if all landlord pairs are observed in the data? It is possible that the missing landlords in most datasets are urban dwellers who may be better-off than the landlords who live in the same village as tenants and seem to be of more limited resources. The present study intends to inform this issue by looking at efficiency and equity returns to renting in and renting out land for a matched sample of tenants and landlords.

Methods

To estimate the effect of land renting on efficiency, equity, input use and investments in the smallholder agricultural sector of Malawi, first consider household j's decision whether or not to enter into the land rental market as either a tenant or landlord, or to remain autarkic and not participate in the market as follows:

1) $$R_j = \delta_1 A_j + \delta_2 L_j + \delta_3 G_j + \delta_4 R_j + \delta_5 P_j + \boldsymbol{H_j \delta_6} + v_j$$

Where R represents the number of hectares that a household rents in or rents out in a given season. This decision is a function of numerous factors including labor available to the household as represented by A, with δ_1 as the corresponding parameter to estimate. Following previous literature, should $\hat{\delta_1} < 0$ in the hectares rented-out equation and/or $\hat{\delta_1} > 0$ in the hectares rented-in equation, it would suggest that land rental market transfer land from labor poor to labor rich households, thus promoting equity in labor markets. The variable L represents pre-rental landholding by the household, which includes all land that is cultivated by the household (excluding rented in land) in addition to land that will be rented out, and land that is fallowed, used as a woodlot or in pasture. The parameter of interest is represented by δ_2, and consistent with previous literature on the topic a coefficient estimate of $\hat{\delta_2} > 0$ in the hectares rented-out equation and/or $\hat{\delta_2} < 0$ in the hectares rented-in equation would indicate that rental markets create equity by transferring land from land-rich to land-poor households.

New to this study is an explicit proxy for household farming ability measured as a grit scale and denoted by the variable G. The basic scale is built from the psychology literature on motivation, self-control and grit (Duckworth et al. 2007; Duckworth and Quinn 2009; Duckworth and Gross 2014). We asked all survey respondents to answer the same set of eight questions that describe how well they believe a certain characteristic related to self-control and grit describes them. This is then converted into a scale with possible scores from 8-40 (see Appendix 1 for the actual scale that was used in the

survey). Using this scale to construct G allows us to use it as a proxy for household ability that can be used to estimate how ability affects the efficiency of land rental markets. If the coefficient estimate on is $\hat{\delta}_3 < 0$ in the hectares rented-out equation and $\hat{\delta}_3 > 0$ in the hectares rented-in equation, it would suggest that land rental markets transfer land from less efficient to more efficient producers.

We also elicit risk aversion and present biases/discount rates from respondents in the survey. Doing so allows us arguably disentangle ability from these other household characteristics that the previous literature treats as unobservable. Our measure of respondent risk aversion is represented by R with corresponding parameter δ_4. Just like in the grit scale measure, respondents are asked hypothetical questions about their preferences for winning a certain amount of money or playing a lottery with a chance to win nothing and a chance to win a greater sum of money. Time preferences are represented by P with δ_5 as parameter to estimate. Respondents are asked questions about receiving an amount of money now or waiting a certain amount of time to receive a larger sum of money. These measures are built from the seminal work on measuring risk aversion by Holt and Laury (2002), along with Ashraf et al. (2006), and Gine and Karlan (2014). The full set of questions we asked respondents can be seen in Appendix II.

Equation 1 also contains a vector of household-level demographics is included by the vector **H**, with δ_6 as the parameter vector to estimate. Whether or not the household is headed by a female is included as a binary variable in H. Previous research suggests that female headed households are much more likely to rent out their land than they are to rent in, most certainly due to resource constraints (Deininger et al. 2013). Age of the household head, and education of the household head are also included in H, along with household durable and livestock assets. Household savings is also included in **H**. One of the important questions surrounding the landlord side of the market if credit constraints and the need for cash a planting force households to rent out some or all of their land, indicating stress rentals" as evidence in Chamberlin and Ricker-Gilbert (2016) would suggest. Inclusion of the savings

variable, along with assets, age and education, tell us about equity in land rental markets based on factors other than just land and labor. District-level dummies are also included in **H**. The individual specific error is represented by v in equation 1.

Equation 1 is estimated via Tobit to account for the corner solution nature of the data with many zeros, as tenants and autarkic households do not rent out land, and landlords and autarkic households do not rent in land. Given the large proportion of zeros, OLS will likely give biased coefficient estimates, causing us to move to a Tobit estimator instead (Wooldridge, 2010).

Identification strategy

Our primary concern for identifying the coefficients of interest in this equation is that there may be correlation between **v** and the observed covariates due to omitted variable bias. We deal with this in two ways. First, by adding the rich set of controls as mentioned above including proxies for household ability, risk aversion, and discount rates we are able to bring those factors out of the error term and remove correlation between them and the error term. We present parsimonious specifications where only the key variables of interest are included in our study, and compare these specifications with a model that includes full controls. The coefficient estimates of interest change little in our estimates and leave the main results intact.

Second, we test the robustness of the estimates in equation 1) using a method similar to Deininger et al., (2013) that exploits the within variation of our tenant-landlord pairs. By matching tenants with their landlord pairs and ignoring autarkic households, the rental decision for household *j* in rental pair *p* is specified as follows:

2) $$R_{jp} = \delta_1 A_{jp} + \delta_2 L_{jp} + \delta_3 G_{jp} + \delta_4 R_{jp} + \delta_5 P_{jp} + \boldsymbol{H_{jp}\delta_6} + \alpha_p + \varepsilon_{jp}$$

Where the covariates and parameters to estimate are the same in equation 2 as in equation 1 except for the fact that the error term now has two components. The unobserved pair-specific fixed-effect is represented by α, which captures unobserved differences in between tenant-landlord pairs. Which could influence the rental decision. Such unobservables include social and power dynamics and social connections within the rental partner pair, while ε represents the individual specific error that is assumed to be i.i.d. normal, conditional on the observed covariates and α. Though we did our best to identify the equations of interest in this study, we recognize that as is the case with any study using observational data our results should not be taken as showing full causality.

Plot-level input use and investments

After considering the effect of land rental markets on different measures of efficiency, we turn towards estimating their impact on input use and investment on sub-plot i for household *j* in rental pair *p* as follows:

3) $$X_{ijp} = \beta_1 I_{ijp} + \beta_2 T_{jp} + \beta_3 A_{jp} + \beta_4 L_{jp} + \beta_5 G_{jp} + \beta_6 R_{jp} + \beta_7 P_{jp} + \boldsymbol{H_{jp}\beta_8} + c_p + \mu_{ijp}$$

Where *X* represents input, or investment decision on the sub-plot. The variable *I* is a binary indicator of whether or not the sub-plot is rented or owner-cultivated, and represents the corresponding parameter to estimate, β_1. Examples of input use decisions are application of inorganic fertilizer, herbicides, or planting hybrid maize on the sub-plot. All of these would be expected to increase productivity in the current year. Conversely, applying organic manure, compost, or leaving crop residues are examples of longer-term investments on the plot that restore soil fertility but take time for the benefits to be translated into increased productivity. Therefore, we might expect input use to be higher among tenant and on rented in plots because the operators seek short-term gains. At the same time, we hypothesize that soil fertility investments might be lower on rented-in sub-plots than they are on owner-cultivated sub-plots because of the longer time horizon for these benefits to materialize and the likely shorter-

term nature of the rental arrangements. With this in mind, a statistically significant coefficient estimate on $\hat{\beta}_1$ would suggest that rented in plots get more or less of a particular input or investment than owner operated plots *ceteris paribus*.

Equation 3 also includes the variable T, which is a binary indicator equal to one if household p who operates sub-plot i is a tenant, and equal to zero if the household is a landlord. The corresponding parameter to estimate is β_2, and a statistically significant coefficient estimate on $\hat{\beta}_2$ would indicate that tenants use more or less of a particular input or investment across all of their plots than their corresponding landlord pair *ceteris paribus*.

The other factors in equation 3 are the same as in equations 1 and 2 with β_3 - β_8 as parameters to estimate. In equation 3, *c* represents the unobserved pair-specific effect. Our model allows for correlation between c and the observed covariates in equation 3 because c is removed through the demeaning process when pair FE is used to estimate the model. The sub-plot specific error term is denoted by μ. It is i.i.d normal, conditional on the observed covariates and *c*.

Data

Data used in this article were collected by Lilongwe University of Agriculture and Natural Resources (LUANAR) through the Center for Agricultural Research and Development (CARD) in collaboration with CIMMYT and Purdue University. Four districts were purposively sampled based on potential for active land rental market participation in 2009/10 according to the nationally representative third Integrated Household Survey (IHS3) data. These districts are: Lilongwe, Salima and Nkhotakota in the Central region and Zomba in the Southern region. Nkhotakota and Salima were selected to represent rural areas, while Lilongwe and Zomba were selected to represent peri-urban areas. The total target sample size was 600, representing 150 farm households per sampled district. In each sampled district, the entry point was the District Agricultural Development Officer (DADO) who was regarded as someone

knowledgeable about Extension Planning Areas (EPAs) where land renting activities were common in the district. The DADO could then refer the survey team to EPAs with high land renting activities. Simple random sampling procedure was used to sample EPAs with high land renting activities. Guided by the Agriculture Extension and Development Coordinator (AEDC) at the EPA, at least one village was sampled for the household interviews using simple random procedure.

The field supervisors would then go to the sampled village in advance for household listing. Smallholder farm households participating in land renting were identified through a Focus Group Discussion (FGD) with the Village Headman, Lead Farmers, and members of both Village Development Committee (VDC) and members of the Vulnerability Assessment Committee (VAC). These were taken as key individuals that are conversant with the history of the village and land issues including land renting in the sampled village. On average, the FGD comprised about 10 individuals of which 50 percent were women and community level issues regarding landownership, land availability and use, drivers of landing renting, and prevailing farm gate prices of cash crops were discussed.[7] At the end of each FGD, we would then sample individual farming households from the village list of all households with the Chief using simple random procedure.[8] The list served as a sampling frame. Households involved in renting in land (tenants) or renting out land (landlord), and those that neither renting in nor out land (Autarkic) during the 2015/16 season were sampled for the interviews. Each sampled landlord was matched to his or her tenant as pairs for the household interviews. Thus if a tenant household was sampled, its corresponding landlord was automatically sampled for the interview and vice versa.[9] This

[7] The use of key informants to help identify respondents to answer questions about sensitive land-related issues has been used in many previous studies including Macours et al. (2010); Macours (2014); Vranken et al. (2011), and Bardhan and Mookherjee (2010).

[8] Village lists in Malawi are regarded as being very accurate because they are used to determine how many input subsidy vouchers are given to a particular community. Therefore, households have incentives to make sure they are included on the list.

[9] If at tenant (landlord) had multiple landlords (tenants) then only the landlord (tenant) who owned (operated) the largest rented plot was found for interview.

process was repeated until a sample size of 10 matched pairs was reached (i.e. 20 households). Furthermore, 10 Autarkic households were randomly selected from the list as control households. Thus, a total of 30 households were sampled per village for the household interviews. To account for non-responses and both tenant and landlord absenteeism, the farm households were oversampled. In each district, five villages were selected with 30 farming households per village adding up to 150 households in five villages at the district level.

Given that issues are very sensitive in Malawi, several challenges were encountered during sampling. It was noted that there were fears for people to come out openly that they are involved in land renting. Some were afraid if they disclosed their activities, they would risk losing their land to government as they would be assumed to have more land. Another challenge was that, at the time of the survey, a new Land Act was being debated and passed by the Malawian Parliament. As a result, some tenants were renting the land and they were afraid that may be their landlords may be following up on them. As a result, they would 'run away' shunning to be interviewed. Such incidences were encountered in Zomba and Salima. This was addressed by a proper introduction to the farmers so as to eliminate such fears. In addition, in some villages it was not possible to get 30 households. In such situations, households were sampled at Group Village Headman level (a cluster of several villages under the leadership of one chief), and in other instances, households were oversampled in villages which had relatively more households to maintain five villages sampled per district.

Upon cleaning the data and identifying rental partners, we have a sample of 173 tenants and 173 landlords who can be matched with their pair. In addition, we have 187 autarkic households who can be identified in the same communities for a total sample size of 533 unique households. These households farm 1,502 unique sub-plots, of these 404 are rented in (cultivated by tenants), while 1,191

are owner-cultivated.[10],[11] Of these 1,191 owner cultivated plots, 25 percent are cultivated by tenants, 33 percent are cultivated by landlords and 42 percent are cultivated by autarkic households.

Results

Table 1 presents means for key indicators between the 173 tenants, their 173 landlords, and 187 autarkic households who live in the same communities. The first row of table 1 shows that pre-rental landholding is about 1 hectare greater on average for landlords than it is for tenants, at 1.854 versus 0.844 hectares, while cultivated area is larger for tenants on average than it is for their landlords, at 1.713 hectares versus 0.961 hectares respectively. These numbers provide some *prima facia* evidence of land rental markets creating equity by transferring land from land rich to land poor households. Similarly, the demographic section of the table indicates that on average tenants have larger families than landlords (5.462 versus 4.988 members), with more adult equivalents (4.531 versus 4.128) meaning that they have more mouths to feed. At the same time, tenant households have a lower average dependency ratio than their landlords (1.033 versus 1.297) which means that tenants have more working age adults supporting few children and elderly. These descriptive demographic variables provide some cursory evidence of land rental markets promoting equity in labor by transferring land from labor poor landlords to labor rich tenant households.

However, table 1 also shows that tenants have a much higher average value of total assets, including both livestock and durables, than their landlords (USD 748 to USD 119). Tenants are more likely to have received credit than landlords in the past year (38.7% versus 29.5%), and are less likely to work casual labor on another farm (27.7% versus 58.4%). This form of employment, called *ganyu* labor,

[10] Six landlord households are also tenants, and they cultivate 13 unique sub-plots that are rented in. Conversely, nine tenant household are also landlords and rent out nine unique sub-plots.
[11] In the data used in this study, a 'plot' is a field that may contain one or more sub-plots. The entire plot, or one or more sub-plots in the field may be rented, while the other sub-plots may be owner-cultivated.

is generally considered to an income source of last resort in Malawi (Alwang and Siegel 1999). These numbers provide descriptive evidence that tenants seem to be wealthier than their landlord pairs on average, and perhaps as a result purchase more inorganic fertilizer (169 kilograms vs 30 kilograms) and more hybrid maize seed (10 kilograms versus 4 kilograms) on average. As such, tenants seem to have more investment capital and other resources, which would suggest that rental markets may facilitate the infusion of such resources into smallholder agriculture, an apparently virtuous outcome. However, the question of whether or not transferring land from those that are poorer among all dimensions other than land to those who are better off on all dimensions other than land raises an important question about the whether such transfers are actually equity enhancing, as suggested by earlier studies (e.g. Jin and Jayne 2013).

Table 3 also provides information to suggest that tenants have high higher ability than their landlords, as on average they have three more years of schooling (7.775 versus 4.751), and higher grit scores (30.34 versus 28.65) than their landlords. Tenants also have lower discount rates on average and are less risk averse their landlords. All of this descriptive evidence would indicate that land rental markets promote efficiency, by transferring land from less able to more able farmers.

Table 2 shows the descriptive statistics for the same questions asked to the tenants and the landlords about the rented sub-plots and the nature of their relationship with their rental partner. Responses are very similar between tenants and landlords, for questions that relate to statements of facts. For example, both agree that the vast majority of rental partners are of the same ethnicity (80 - 84%) and live in the same community (72% - 78%). In addition, very few rental contracts are written (7% - 8%). These findings are consistent with previous literature, and the notion that in places where tenure is insecure people rent to those with whom they have closer social ties (Macours, 2014).

We find some very interesting differences between tenants and landlords in their responses to questions about future plans (table 2). For example, tenants say that they plan to continue renting land

for an average of 4.70 seasons beyond the current one (median is 4.0 seasons), while landlords say that they plan to only continue renting out their land for an average of 1.14 seasons beyond the current one (median is 0 seasons). In addition, 63 percent of tenants say that they plan to purchase the plot in the future, while only 4 percent of landlords say that they plan to sell the land that they currently rent out. These findings would perhaps provide a clue to support the notion that landlords are "stress renting" out their land on what they hope will be a short-term basis.

Reasons for engaging in land rental are given in table 3. By far, the main reason why landlords rent out their land is due to the need for cash (75%), followed by 18 percent of respondents who say that they rent out the sub-plot because they lack the labor to cultivate it. Only 2 percent of landlords say that they rent out land in order to engage in more profitable activities. This is consistent with Chamberlin and Ricker-Gilbert (2016) who find no evidence that landlords in Malawi and Zambia have significantly higher off-farm income than other households after renting out their land. In total, it indicates that money earned from renting out land goes to fulfill immediate consumption needs rather than investment. These results are also consistent with the notion of "stress renting" by landlords. Conversely, table 3 indicates that tenants rent in land as an initial pathway into farming (69%), and to expand the area that they operate (21%). This suggests that the tenants view farming as a gateway to a better livelihood and as an opportunity to increase their income and food security.

Table 4 presents mean differences in input use and soil fertility investments on rented versus owner-cultivated sub-plots (columns a) and b)), and on plots controlled by tenants (both rented in and owner-cultivated) and by landlords (columns c) and d)). The top of the table shows that the rented plots are more likely to receive herbicide application and receive more inorganic fertilizer than owner-cultivated plots. These inputs are likely applied to rented in plots in an effort to boost yields which are found to be 150 kilograms per hectare higher on rented in than on owner-cultivated plots. On the right side of the top column of table 4, we see the consistent finding that tenants use significantly more

herbicides, apply more inorganic fertilizer and have higher maize yields across all of their plots than landlords do on average.

While average input use is higher on rented plots compared to owner-cultivated plots, and for tenants than it is for landlords, the bottom of table 4 shows that soil fertility investments are just the opposite on average. For example, rented in plots are less likely to receive animal manure, and green compost. They are also less likely to be intercropped, and are less likely to have crop residue left on them. The same is true for all plots operated by the tenants compared to landlords, as seen on the lower right-side of table 4. These findings provide descriptive suggestions that tenants do not invest in the soil fertility enhancing technologies on rented in plots, which is perhaps to be expected. Making these investments requires labor and other resources, and the yield enhancing benefits are often not realized for a number of years. However, it also seems that landlords may be better stewards of the land than tenants, as evidenced by them making more of these soil fertility investments than tenants across all sub-plots including those that are owned and those that are rented in.

Table 5 presents the regression results for factors affecting the amount of area rented in by households. The models in columns 1 - 6 are estimated by Tobit and include the 187 autarkic households in the dataset along with the tenant-landlord pairs. The models in columns 7 - 12 are estimated by tenant/landlord pair FE, so autarkic households are excluded from the estimation. Overall results are similar between the tobit and pair FE estimators. Education is positively associated with more land rented in across specifications. Grit score is also positively associated with renting in more land, but is only significant in the parsimonious specifications in columns 2 and 8. The positive coefficients on education and grit score support for the notion that land rental markets promote efficiency by transferring land to more educated households with more grit (or ability) than other households.

Pre-rental landholding has a negative and statistically significant coefficient across specifications in table 5, indicating that land rental markets promote land-based equity by transferring land from land

rich households to land poor households *ceteris paribus*. In addition, the coefficient estimates on number of household members are also statistically significant and positive across specifications, suggesting that land rental markets promote labor-based equity, as they transfer land from labor-poor to labor-rich households, *ceteris paribus*. These findings are consistent with previous literature on the topic and indicate that land rental markets generate positive benefits. However, as suggested in the descriptive statistics, the full specifications in columns 6, and 12 suggest that households with more savings rent in significantly more land, while in column 6 households with more assets rent in significantly more land. This combined with the fact that younger households rent in significantly more land and female-headed households rent in significantly less land in column 6, further raises concern about whether or not land rental markets promote equity in other dimensions besides land and labor.

Table 6 presents the factors affecting the amount of area rented out by households in hectares. Table 6 is presented in the same way as table 5, and the results are very much consistent between the two tables. There is evidence that households with less education rent out more land, and households with less grit (ability) are also more likely to rent out their land. In total, these results support the notion that less able landlords are renting out their land to more able tenants, which is a positive sign for potential productivity gains to agriculture through land renting.

The coefficients estimates on pre-rental landholding are positive and statistically significant across specifications, indicating that households with more land *ex ante* are more likely to rent out their land. In addition, the coefficient estimate on number of family members is statistically significant and negative across specifications suggesting that households with less labor are more likely to rent out their land *ceteris paribus*. All of this would again support the notion of equity benefits coming from land rental markets. However, there is some evidence in table 6 that households with less savings at harvest

are significantly more likely to rent out their land, which could be interpreted as a potential sign of stress-renting.

Table 7 presents the results for factors affecting input use and yields at the sub-plot level, estimated by tenant/landlord pair FE. The key variables of interest, whether or not the sub-plot is rented, and whether or not the sub-plot is operated by the tenant (be it their rented in sub-plot or their owner-cultivated sub-plot) are presented in the top rows of the table. The table reveals interesting insights into the input use and management decisions by the tenants and landlords on their respective sub-plots. For example, rented in plots are not significantly more or less likely to receive herbicides than owner-cultivated plots, but tenants are 11 percentage points more likely to apply herbicides across all of their plots, *ceteris paribus*. This is consistent with inorganic fertilizer application, as tenants apply 53 kilograms more inorganic fertilizer per hectare than their landlord pair across all plots but the difference is not statistically significant on rented-in versus owner cultivated sub-plots. Column 4 suggests that maize is less likely to be the main crop grown on rented in sub-plots, probably because rented-in sub-plots are used to grow cash crops such as groundnuts, tobacco or cotton. Column 5 reveals that rented in plots are 8 percentage points less likely to grow hybrid maize as the main crop, but tenants are 8 percentage points more likely to grow hybrid maize across all of their plots. Again, this is probably because rented in plots are more likely to have cash crops grown on them, but across all plots tenants are more likely to invest in hybrid maize seed than landlords. The finding about tenants using more inputs across all their plots is consistent with finding in column 6 that tenants obtaining yields that on average are 262 kilograms/ha higher than their landlord pair (p-value=0.066). In total, the regression results from table 7 are consistent with earlier findings that wealthier tenants who have more assets, savings and credit access than their landlords are bringing those resources into agriculture and farming more intensively.

The findings from table 7 stand somewhat in contrast to the findings in table 8, which shows factors affecting soil fertility investment on the sub-plot. The table suggests that in almost all of the columns rented-in sub-plots are statistically less likely to receive investments such as organic manure, green compost, erosion control, minimum tillage or have crop residues left on them. These findings are interesting and make sense as these practices all require complimentary investments such as labor and capital to implement and the yield enhancing benefits are often not observed for several years. Given the short-term nature of the rental agreement, it seems that tenants are unwilling to implement these practices on their rented in plots. At the individual operator level, the only model where tenants implement more of one of these practices across all of their sub-plots is the practice of leaving crop residues on the field in column 6. This may suggest that they leave the crop residues on the sub-plots that they own, but take them for other uses, such as feeding livestock, from the plots that they rent in.

Conclusions

This study has compiled new data on rural land rental market participation and impacts by smallholders in Malawi. A novel feature of our study is the use of a paired landlord-tenant survey, which fully captures the landlord side of the rental market, a key shortcoming of earlier empirical studies in sub-Saharan Africa. This matched sample structure also allows us to use pairwise Fixed Effects to control for unobservable characteristics of tenant-landlord pairs that may otherwise bias model estimation.

Our study shows that rental markets do tend to transfer land from land-rich to land-poor households, and from labor-poor to labor rich households, thus ostensibly contribute to improved equity in land access. This finding is consistent with previous literature on the topic (Holden et al., 2009; Jin and Jayne 2013; Chamberlin and Ricker-Gilbert 2016). However, our matched sample also indicates that tenants are wealthier than landlord pairs in most observable dimensions, such as savings, value of assets, and access to credit, raising questions about net equity gains from a broader perspective.

Our study has also shown evidence in support of production efficiency gains through land rental markets, as tenants show lower levels of risk aversion and time-discounting, and higher levels of "grit" – all of which signal characteristics of farmers who are more likely to make productivity-enhancing investments. This corresponds to policy objectives for the smallholder sector. Accordingly, tenants are observed to have higher yields than non-tenants. However, offsetting this ostensibly positive outcome is the evidence we have assembled about the nature of investments being made by rental market participants and non-participants. While tenants are more likely to invest in inorganic fertilizer and herbicide (which contribute to short term yield outcomes), they are less likely to make investments that contribute to longer-term productivity outcomes (e.g. organic fertilizer, green manure, erosion control structures, minimum tillage, intercropping, crop residue retention). This is not surprising, given the short term nature of rental arrangements. These results suggest that rental markets may facilitate short term productivity gains at the expense of longer term gains, and that landlords may in fact be better stewards of the land then their tenant pair.

We also find that most tenant-landlord pairs are of the same ethnicity and reside in the same village. Thus it seems that the reason why many large-scale nationally representative datasets such as the LSMS-ISA from the region under-report landlord activities is likely due to the way the land modules are written and administered, and that enumerators do not probe respondents enough to learn about land rented out (Holden et al. 2016). This stands in contrast to the notion that there are a large number of absentee landlords in Malawi who acquire land and then rent it out to smallholders.[12]

The majority of landlords in our sample are resource constrained and rent out land in order to satisfy short term liquidity constraints, features which align with the "stress rental" hypothesis advanced by Chamberlin and Ricker-Gilbert (2016). Given tenants' short-term investment orientation, this may

[12] Some absentee landlords may exist, but they will likely not be part of a village list and are unlikely to be sampled in a population based survey such ours or the LSMS-ISA.

contribute to nutrient mining and depletion of land productivity over the longer term. If poor landlords had access to more investment capital, it appears likely that they would reap greater benefits from cultivation, as opposed to renting out, when considered over the longer term. More research on the magnitude of the foregone benefits would help clarify policy options.

The results of this study have practical policy implications, as Malawi passed a series of land bills in 2016. One key provision of these Land Acts is to enable smallholders who cultivate land in the customary tenure system to register their land with the national government, effectively bypassing chiefs and traditional authorities. If tenure security improves with the passing of the land bill, land rental markets may experience growth as a result, because would-be landlords may be less worried about losing control of land which is rented out. However, our work suggests that land rental markets may facilitate shorter-term efficiency gains at the expense of longer term soil fertility outcomes. Such tradeoffs need to be evaluated carefully, in order to define a land policy that is consistent with maximizing agricultural productivity over the longer term.

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Table 1: Averages for key variables by rental market status

Variable Category	Variable	Tenants	Landlords	Autarkic
Land	Pre-rental landholding in ha	0.844	1.854	1.278
	Cultivated area in ha	1.713	0.961	1.160
social connections	chief's relative (0, 1)	0.445	0.595	0.610
	village government(0, 1)	0.052	0.058	0.043
	Received FISP coupon	0.416	0.543	0.513
Input purchases	Kgs commercial fertilizer purchased	169	30	79
	Kgs of commercial maize seed purchased	10	4	4
Savings and assets	Household savings in USD	83	10	40
	household needed credit (0,1)	0.584	0.520	0.556
	household received credit (0, 1)	0.387	0.295	0.326
	total livestock value USD	276	80	160
	total value durables USD	472	39	74
	total value all assets USD	748	119	234
	value of houses USD	1,386	1,074	2,568
Demographics	Number of family members	5.462	4.988	5.086
	female headed hh (0,1)	0.104	0.260	0.299
	head is a migrant (0,1)	0.497	0.301	0.278
	head age	40.439	47.231	49.428
	head years schooling	7.775	4.751	5.139
	Adult equivalents	4.531	4.128	4.225
	Dependency ratio	1.033	1.297	1.212
Revenue sources	Member works as casual laborer on other farm	0.277	0.584	0.428
	Member works as casual laborer off farm	0.179	0.254	0.182
	Total cash earned USD	836	276	439
	Total cash from casual work USD	71	41	141
	total cash from non-farm work USD	445	83	140
Scales	Grit score[i]	30.34	28.65	29.81
	discount rate[ii]	55,477	39,725	45,535
	risk preferences[iii]	169,383	229,392	70,741

N= 533, 173 tenants, 173 landlords, 187 autarkic; [i] scale from 8-40, higher score = more grit and higher ability; [ii] higher score = lower discount rate, less present bias; [iii] lower score = less risk averse

Table 2: Rental market comparisons by market participation status

	Response by tenant	Response by landlord
Rental agreement is fixed rent or borrowed	0.99	0.95
Rental partner same ethnicity	0.84	0.80
Rental partner lives in same community	0.72	0.78
Rental partners main occupation is farming	0.86	0.70
Have a written rental agreement with partner	0.08	0.07
Number of years that you plan to continue in this arrangement (mean)	4.70	1.14
Number of years that you plan to continue in this arrangement (median)	4	0
Plan to eventually buy(sell) this rented in(out) sub-plot	0.63	0.04

Table 3: Main reason for engaging in rental market by rental status

	Tenant (%)			Landlord (%)
Acquire initial land for farming	69		Needed cash	75
Expand the area that I farm	21		Did not have enough labor to cultivate	18
Expand land for investment	4		More profitable to rent out than cultivate	3
Acquire land for investment	2		Engaged in other more profitable activities	2
Other	4		Not interested in farming sub-plot	2

Table 4: Input use and investment by plot management and rental status

	(a) Rented in plots	(b) Owner cultivated plots	(a-b) Difference	(c) Tenant household	(d) Landlord household	(c-d) difference
Input use and yield						
Number of weedings	1.60	1.69	-0.09	1.69	1.62	0.08
Apply herbicides	0.22	0.15	0.07***	0.23	0.09	0.14***
Apply inorganic fertilizer	0.57	0.55	0.02	0.58	0.51	0.07**
Inorganic fertilizer application in kg/ha	128	107	21**	132	87	45***
Maize is main crop	0.55	0.53	0.08***	0.57	0.64	-0.07**
Hybrid maize is main crop	0.35	0.38	-0.03	0.38	0.35	0.03
Maize yield kg/ha	963	813	150*	1,043	596	447***
Investments						
Intercropping	0.21	0.25	-0.04**	0.20	0.28	-0.08***
Apply animal manure	0.13	0.23	-0.10***	0.18	0.20	-0.02
Apply green compost	0.06	0.12	-0.06***	0.08	0.14	-0.06***
Erosion control	0.12	0.26	-0.14***	0.17	0.27	-0.10***
Minimum tillage used	0.05	0.12	-0.07***	0.08	0.11	-0.03*
Crop residue left on plot	0.46	0.66	-0.20***	0.57	0.62	-0.05*
Soil is self-assessed as good	0.40	0.49	-0.09***	0.43	0.51	-0.08**

Note: *, **, *** indicates that the corresponding means are different from each other at the 10%, 5%, and 1% level respectively.

Table 5: Factors affecting area rented in by households

Dependent variable = area rented in (ha)	Tobit estimator (1) – (6)						Pair FE estimator (7) – (12)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Education of HH head	0.05***				0.04***	0.03***	0.07***				0.06***	0.04***
	(0.000)				(0.000)	(0.000)	(0.000)				(0.000)	(0.009)
Grit score		0.01***			0.01	0.00		0.03*			0.01	-0.00
		(0.009)			(0.222)	(0.771)		(0.064)			(0.406)	(0.777)
Discount rate			0.00		0.00	0.00			0.00		0.00	-0.00
			(0.378)		(0.898)	(0.705)			(0.565)		(0.872)	(0.958)
Risk aversion				0.00	-0.00	-0.00				-0.00	0.00	0.00
				(0.798)	(0.956)	(0.820)				(0.931)	(0.883)	(0.951)
Pre-rental landholding in ha	-0.11***	-0.12***	-0.12***	-0.12***	-0.11***	-0.09***	-0.22***	-0.26***	-0.27***	-0.27***	-0.22***	-0.17***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Number of HH members	0.04***	0.05***	0.05***	0.05***	0.04***	0.03***	0.09***	0.11***	0.11***	0.11***	0.09***	0.07**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.004)	(0.001)	(0.001)	(0.001)	(0.005)	(0.025)
=1 if HH head is female						-0.17**						-0.19
						(0.028)						(0.293)
=1 if migrant HH head						0.21***						0.37***
						(0.000)						(0.010)
age of household head * 10						-0.08***						-0.10*
						(0.000)						(0.059)
Savings in USD *100						0.02**						0.06*
						(0.031)						(0.082)
Value of assets in USD *100						0.002**						0.003
						(0.020)						(0.295)
Number of observations	533	533	533	533	533	533	346	346	346	346	346	346
R-squared	0.09	0.04	0.04	0.03	0.09	0.13	0.26	0.19	0.18	0.17	0.26	0.33
Number of matched pairs	-	-	-	-	-	-	173	173	173	173	173	173

Note: *, **, *** indicates that the corresponding means are different from each other at the 10%, 5%, and 1% level respectively; p-values in parentheses; models include district dummies; Coefficient estimates from Tobit estimator are average partial effects

Table 6: Factors affecting area rented out by households

Dependent variable = area rented out (ha)	Tobit estimator (1) – (6)						Pair FE estimator (7) – (12)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Education of HH head	-0.02***				-0.01***	-0.01***	-0.01				-0.01	0.00
	(0.000)				(0.003)	(0.010)	(0.338)				(0.495)	(0.891)
Grit score		-0.01***			-0.01***	-0.01***		-0.01			-0.01	-0.01
		(0.000)			(0.002)	(0.006)		(0.131)			(0.219)	(0.559)
Discount rate			-0.00		-0.00	-0.00			0.00		0.00	0.00
			(0.599)		(0.766)	(0.837)			(0.187)		(0.221)	(0.277)
Risk aversion				0.00	0.00	0.00				0.00	0.00	0.00
				(0.666)	(0.755)	(0.696)				(0.409)	(0.478)	(0.756)
Pre-rental landholding in ha	0.18***	0.18***	0.18***	0.18***	0.18***	0.20***	0.52***	0.52***	0.53***	0.53***	0.52***	0.51***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of HH members	-0.02***	-0.03***	-0.03***	-0.03***	-0.02**	-0.02*	-0.09***	-0.10***	-0.10***	-0.10***	-0.09***	-0.09***
	(0.009)	(0.005)	(0.003)	(0.004)	(0.012)	(0.062)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
=1 if HH head is female						0.04						0.21
						(0.420)						(0.126)
=1 if migrant HH head						0.03						0.06
						(0.418)						(0.557)
age of household head *10						-0.02*						0.06*
						(0.075)						(0.098)
Savings in USD * 100						-0.06**						-0.04
						(0.020)						(0.127)
Value of assets in USD *100						-0.004						-0.00
						(0.204)						(0.702)
Number of observations	533	533	533	533	533	533	346	346	346	346	346	346
R-squared	0.17	0.17	0.15	0.15	0.18	0.20	0.57	0.58	0.57	0.57	0.58	0.60
Number of matched pairs	-	-	-	-	-	-	173	173	173	173	173	173

Note: *, **, *** indicates that the corresponding means are different from each other at the 10%, 5%, and 1% level respectively; p-values in parentheses; models include district dummies; Coefficient estimates from Tobit estimator are average partial effects

Table 7: Factors affecting sub-plot level input use and yields using rental-pair fixed effects (FE)

	(1)	(2)	(3)	(4)	(5)	(6)
	# of weedings	apply herbicide	inorganic fertilizer kg/ha	maize is main crop grown	hybrid maize is main crop grown	maize yield kg/ha
=1 if plot is rented	-0.35	-0.01	-4.58	-0.09**	-0.08**	-170.23
	(0.249)	(0.695)	(0.694)	(0.045)	(0.036)	(0.166)
=1 if plot is operated by a tenant	-0.19	0.11***	52.96***	-0.01	0.08*	262.32*
	(0.615)	(0.000)	(0.000)	(0.839)	(0.099)	(0.066)
Education of HH head	-0.00	-0.01**	-0.63	-0.00	0.01	1.71
	(0.950)	(0.036)	(0.740)	(0.932)	(0.171)	(0.924)
Grit score	0.01	0.01*	3.61**	-0.01	0.00	-5.52
	(0.831)	(0.054)	(0.017)	(0.359)	(0.793)	(0.707)
Discount rate	0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	(0.991)	(0.686)	(0.293)	(0.500)	(0.407)	(0.903)
Risk aversion	0.00	0.00	0.00	-0.00	0.00	-0.00
	(0.994)	(0.562)	(0.940)	(0.771)	(0.426)	(0.243)
Pre-rental landholding in ha	-0.01	0.03**	0.67	-0.02	0.03	77.82
	(0.939)	(0.020)	(0.914)	(0.285)	(0.217)	(0.175)
Number of HH members	-0.00	0.01	-6.61*	-0.01	-0.00	4.97
	(0.961)	(0.215)	(0.051)	(0.544)	(0.817)	(0.874)
=1 if HH head is female	0.13	-0.05	5.40	-0.01	-0.05	-8.62
	(0.198)	(0.208)	(0.781)	(0.916)	(0.451)	(0.963)
age of household head in years	-0.00	-0.00***	0.60	0.01***	0.00	-12.22**
	(0.840)	(0.000)	(0.287)	(0.008)	(0.803)	(0.020)
Savings in USD	0.00	-0.00	0.01	0.00	0.00	0.18
	(0.913)	(0.791)	(0.796)	(0.467)	(0.996)	(0.525)
Value of assets in USD	-0.00	-0.00	0.00	0.00	-0.00	-0.03
	(0.833)	(0.369)	(0.256)	(0.377)	(0.271)	(0.123)
Kilograms of inorganic fertilizer applied per ha						1.80***
						(0.000)
Number of times this sub-plot was weeded						155.88**
						(0.034)
=1 if soil of good quality (self-assessed)						164.70
						(0.235)
=1 if soil of fair quality (self-assessed)						-83.63
						(0.556)
Number of observations	1,017	1,017	1,017	1,017	1,017	1,017
R-squared	0.02	0.09	0.05	0.02	0.01	0.12
Number of matched pairs	173	173	173	173	173	173

Note: *, **, *** indicates that the corresponding means are different from each other at the 10%, 5%, and 1% level respectively; p-values in parentheses; models include district dummies; models with binary dependent variables estimated as linear probability models with rental-pair FE.

Table 8: Factors affecting sub-plot level soil fertility investments using rental-pair fixed effects (FE)

	(1)	(2)	(3)	(4)	(5)	(6)
	Intercropping	Animal manure	Green compost	Soil erosion control	Minimum tillage	Crop residues left
=1 if plot is rented	-0.03	-0.12***	-0.04*	-0.11***	-0.05**	-0.26***
	(0.321)	(0.000)	(0.053)	(0.001)	(0.038)	(0.000)
=1 if plot is operated by a tenant	0.00	0.03	-0.03	-0.02	-0.01	0.12***
	(0.967)	(0.393)	(0.359)	(0.640)	(0.809)	(0.007)
Education of HH head	-0.01	-0.01	-0.00	-0.00	-0.00	-0.02***
	(0.174)	(0.128)	(0.565)	(0.603)	(0.631)	(0.007)
Grit score	0.00	0.00	0.01**	0.00	0.01***	0.00
	(0.262)	(0.434)	(0.019)	(0.395)	(0.008)	(0.419)
Discount rate	0.00	0.00	-0.00	0.00*	0.00	0.00
	(0.544)	(0.343)	(0.599)	(0.063)	(0.787)	(0.335)
Risk aversion	0.00	-0.00**	0.00	-0.00	-0.00	0.00
	(0.767)	(0.022)	(0.229)	(0.569)	(0.735)	(0.349)
Pre-rental landholding in ha	-0.04**	0.01	-0.01	0.00	0.02*	0.00
	(0.020)	(0.621)	(0.238)	(0.919)	(0.064)	(0.833)
Number of HH members	0.02*	-0.03***	-0.01	0.00	0.01	0.01
	(0.054)	(0.004)	(0.244)	(0.750)	(0.379)	(0.169)
=1 if HH head is female	0.05	-0.10*	-0.02	0.02	-0.01	0.06
	(0.342)	(0.051)	(0.513)	(0.692)	(0.707)	(0.291)
age of household head in years	0.00	0.00	0.00**	0.00	0.00	-0.00
	(0.173)	(0.730)	(0.045)	(0.816)	(0.574)	(0.435)
Savings in USD	0.00	0.00*	0.00	0.00	0.00	0.00
	(0.982)	(0.090)	(0.471)	(0.208)	(0.146)	(0.772)
Value of assets in USD	0.00	-0.00	-0.00*	-0.00	-0.00***	-0.00
	(0.947)	(0.482)	(0.054)	(0.942)	(0.001)	(0.117)
Number of observations	1,017	1,017	1,017	1,017	1,017	1,017
R-squared	0.02	0.05	0.05	0.03	0.06	0.09
Number of matched pairs	173	173	173	173	173	173

Note: *, **, *** indicates that the corresponding means are different from each other at the 10%, 5%, and 1% level respectively; p-values in parentheses; models include district dummies; models with binary dependent variables estimated as linear probability models with rental-pair FE.

APPENDIX I:
GRIT SCALE

I. New ideas and projects sometimes distract me from previous ones. 1) Very much like me 2) Mostly like me 3) Somewhat like me 4) Not much like me 5) Not like me at all	V. I often set a goal but later choose to pursue a different one. 1) Very much like me 2) Mostly like me 3) Somewhat like me 4) Not much like me 5) Not like me at all
II. Setbacks don't discourage me. 1) Very much like me 2) Mostly like me 3) Somewhat like me 4) Not much like me 5) Not like me at all	VI. I have difficulty maintaining my focus on projects that take more than a few months to complete. 1) Very much like me 2) Mostly like me 3) Somewhat like me 4) Not much like me 5) Not like me at all
III. I have been obsessed with a certain idea or project for a short time but later lost interest. 1) Very much like me 2) Mostly like me 3) Somewhat like me 4) Not much like me 5) Not like me at all	VII. I finish whatever I begin. 1) Very much like me 2) Mostly like me 3) Somewhat like me 4) Not much like me 5) Not like me at all
IV. I am a hard worker 1) Very much like me 2) Mostly like me 3) Somewhat like me 4) Not much like me 5) Not like me at all	VIII. I am diligent 1) Very much like me 2) Mostly like me 3) Somewhat like me 4) Not much like me 5) Not like me at all

Note: Statements with positive connotations are scored in reverse (eg: more points given if statement describes the person).

APPENDIX II:

DISCOUNT RATE AND PRESENT BIAS QUESTIONS

Suppose you win a raffle today. The lottery administrator gives you options for how you would like to accept your cash prize. One option will be to accept your cash prize today; the other option would be to accept a larger cash prize, but with a three months delay. You will be asked to pick the option you prefer. Please make your decisions based on how you expect you would answer if the choice were actual and not hypothetical.	
1. Do you prefer a MK 10 000 prize guaranteed today or a MK 12 500 prize guaranteed 3 months from now?	MK 10 000 today MK 12 500 in 3 months .....B
2. Do you prefer a MK 10 000 prize guaranteed today or a MK 15 000 prize guaranteed 3 months from now?	MK 10 000 today MK 15 000 in 3 months .....B
3. Do you prefer a MK 10 000 prize guaranteed today or a MK 17 500 prize guaranteed 3 months from now?	MK 10 000 today MK 17 500 in 3 months .....B
4. Do you prefer a MK 10 000 prize guaranteed today or a MK 20 000 prize guaranteed 3 months from now?	MK 10 000 today MK 20 000 in 3 months .....B
IF ANSWER IS (A) TO 1 AND 2 AND 3 AND 4, ASK: 5. How much would the prize have to be for you to choose to wait?	MK _____

MK = Malawi Kwacha; USD 1.00 ≈ 700 MK during survey

RISK AVERSION QUESTIONS

I am going to give you a series of choices. Please tell me which choice you would like to take, imagining that they are real choices.	
1. Do you prefer a gift of MK 20 000, or participating in a lottery which gives you 50% chance to win MK 40 000 and 50% chance to win nothing?	Gift of MK 20 000.....A Lottery for MK 40 000.....B
2. Do you prefer a gift of MK 20 000, or participating in a lottery which gives you 50% chance to win MK 50 000 and 50% chance to win nothing?	Gift of MK 20 000.....A Lottery for MK 50 000.....B
3. Do you prefer a gift of MK 20 000, or participating in a lottery which gives you 50% chance to win MK 60 000 and 50% chance to win nothing?	Gift of MK 20 000.....A Lottery for MK 60 000.....B
4. Do you prefer a gift of MK 20 000, or participating in a lottery which gives you 50% chance to win MK 70 000 and 50% chance to win nothing?	Gift of Q200 .....1 Lottery for Q 70 000 2
IF ANSWER IS (A) TO 1 AND 2 AND 3 AND 4, ASK: 5. How much would you have to be paid to choose the lottery?	MK _____

MK = Malawi Kwacha; USD 1.00 ≈ 700 MK during survey