The Mitigating Impact of Land Tenure Security on Drought-induced Food Insecurity: Evidence from Rural Malawi

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Bringing Rigour and Evidence to Economic Policy Making in Africa

The Mitigating Impact of Land Tenure Security on Drought-induced Food Insecurity: Evidence from Rural Malawi

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Abstract

This paper investigates the interaction between land tenure security and food security in agriculture-dependent households. We explore household variation in land tenure security and drought shocks across villages to investigate the extent to which land tenure systems affect the capacity of agricultural households in Malawi to cope with adverse impacts of weather shocks. Our findings reveal that land tenure security cushions the effect of drought regimes on food security. Further, we establish irrigation practice as the underlying channel that mediates the impact of drought shocks on food insecurity. The results of this study reinforce the growing consensus that property rights through land tenure security are associated with agricultural productivity and, consequently, household food security.

Keywords: *Food security, Rainfall shocks, Land tenure security, Agricultural productivity*

1. Introduction

Promoting agricultural productivity in order to ensure food security has been a major public policy issue in developing countries in recent years. Despite the enormous efforts by the governments, both national and international, evidence shows that the number of chronically undernourished people worldwide increased from about 804 million in 2016 to almost 821 million in 2017. And the prevalence of food insecurity is higher in Africa than in other regions in the world. About 256 million people in Africa, accounting for 21% of the population suffering chronic food deprivation in 2017 and for a significant proportion of global food insecurity cases (FAO et al. 2018). Since 1990–1992, about 42 million were added to the total number of undernourished people in sub-Saharan Africa with an estimated 217.8 million in 2014–2016 compared to 176 million in 1990–1992 (FAO, 2015). These dynamics are driven by the poverty statistics associated with this region compared to the rest of the world[1].

Many poor households in sub-Saharan Africa depend on smallholder agricultural practice for their livelihoods. Given this background, sustainable food security for most poor households in the region is often linked to enhanced productivity and growth of the agriculture sector. However, the sustainable agricultural productivity of these households is hampered by the variability of weather and climate. The bottom of the pyramid of agrarian households is the worst hit by this (Asfaw and von Braun , 2004; Fussel, 2010; Ericksen et al., 2011; Skoufias et al., 2011; Levine and Yang, 2014; Asfaw and Maggio, 2017)[2].

Besides climate and weather variability, land tenure insecurity has been a limiting factor in agricultural productivity and food security among agrarian households. When land rights are insecure, the motivation to invest in the land could be low. This can also lead to entitlement failure, in which farmers fail to make long-term plans or invest in crops with high yields on farmlands. These behaviours can have consequences, leading to a decrease in agricultural productivity and food insecurity (Besley, 1995; Potts, 2006; Woodhouse, 2006; Deininger et al. 2009; Bhaumik et al., 2016; Linkow, 2016; Lovo, 2016).

In light of the above, this project investigated the nexus between drought regimes, land tenure security and food security in Malawi using data from a household survey. We used two waves of household data, namely the Integrated Household Surveys (IHS) of 2013 and 2016. The first motivation for focussing the research context on Malawi

can be linked to an important reference from the World Bank (2010) statistics where Malawi emerged as the twelfth most exposed country to the effects of climate change. This vulnerability is likely explained by the country's historical climate distribution, which is characterized by frequent environmental shocks such as droughts and floods (Chinsinga, 2013).

Second, structural economic conditions exacerbate this vulnerability. For example, Malawi's agriculture sector contributes nearly 37% to the country's gross domestic product (GDP), with subsistence smallholders producing 75% of Malawi's total agricultural output using a production system that is predominantly rainfed with limited irrigation (Chirwa and Quinion, 2005). Moreover, according to the Global Food Security Index (GFSI), Malawi ranks 105/113 countries on overall food security index with a breakdown of 105, 101 and 106 in terms of affordability, availability and quality/safety of food respectively (GFSI, 2016). These features typically explain why micro and macro food security indices in Malawi may be highly elastic to rainfall shocks, especially droughts. This situation leaves Malawi highly susceptible to chronic food insecurity (Harrigan, 2008).

Third, Malawi has variations in land tenure security across plots belonging to different households. Basically, the nature of the land tenure security in Malawi could be categorized as secured and unsecured land tenure. Customs and traditions determine land tenure systems through the inheritance systems in place across villages[3] affecting efficient food production through agricultural practice. Patrilineal or matrilineal systems have direct effects on land ownership tenures and these are products of customs and traditions. Also, the inheritance system in practice plays a significant role in the institution of marriage across communities thereby determining the expected traditional union for couples – patrilocal or matrilocal. Hence, the customary gender-biased inheritance practices prevalent in the community could affect the extent of land tenure security (Peters and Kambewa, 2007; Peters, 2010; Lovo, 2016; Berge et al. 2014)[4].

The objectives of this study were twofold: first, to investigate the mitigating role of land tenure security in the relationship between droughts and household food security in Malawi[5]. This stems from the evidence that considers land tenure security as associated with food security (Besley and Burgess, 2000; Deininger et al., 2009; Ghebru and Holden, 2013; Mendola and Simtowe, 2015). Second, to investigate whether the mitigating role of land tenure security on the impacts of drought on food security differs between matrilineal and patrilineal societies.

Accordingly, this study addressed the following research questions: Do droughts have impacts on household food security in Malawi? If so, are households with land tenure security less vulnerable to the impacts of rainfall shocks than insecure land tenure holders? For example, households with land tenure security could have more investment on the land that mitigates the impact of rainfall shocks on food security. Are there differences in mitigating impact of land tenure security between matrilineal and patrilineal societies? This research is based on the following hypotheses: (1) drought affects household food security; (2) households

with land tenure security are less affected by drought; and (3) patrilineal societies with land tenure security are less affected by the impact of droughts on food security relative to matrilineal societies.

The paper contributes to the growing literature on the impact of rainfall shocks on household welfare (Jayachandran, 2006; Yang and Choi, 2007; Björkman-Nyqvist, 2013; Levine and Yang, 2014; Asfaw and Maggio, 2017) by considering the role of land tenure security in mitigating against drought shocks for rural households. The paper's novel approach in examining the mitigating role of land tenure security in the relationship between drought and household food security distinguishes it from the existing literature.

2. Land tenure system in Malawi: A background

The evolution of the customary land tenure system in Malawi is strongly linked to lineage systems across communities. Dating back to 1965, the Land Act in Malawi defines land ownership under three major categories, namely private, public and customary tenures (Kishindo, 2004). The public land ownership category is the most reliable followed by customary and private respectively. Weakness in private ownership is attributed to possibility of withdrawal of freehold/leasehold title or Certificate of Claim by the minister responsible for land matter. The customary land ownership category dominates in the rural areas where land distribution is delegated to chiefs and village heads by the minister. Whilst customary land is the legal property of Malawi (Nankumba and Machika, 1988), such land is usually operated under the customary law of each community. Therefore, the distribution of customary land to villagers is basically guided by cultural, socio-economic and demographic conditions of each locality. Hence, the variation in the sociocultural backgrounds in Malawi causes differences in the management and allocation of customary land across communities. In addition to a general perception that land is a free gift from God for subsistence, it belongs to lineages. These are a strong force in determining availability, access and control of customary land across communities.

Lands allocated to household units by chiefs and village heads are premised on user rights which can be terminated at any time. Also, chiefs only exercise trusteeship and are accountable to the community for due diligence – to ensure its tradition is preserved. In essence, the only sustaining factor for acquisition and distribution of land in rural Malawi is the lineage institution. The institution in this regard comprises kinship, descent tracing and inheritance systems which vary substantially across Malawi communities. The northern region of Malawi predominantly practises a patrilineal sociocultural system giving men primary rights and control over land while in the central and southern regions, which are predominantly matrilineal, these rights belong to women (Kishindo, 2004)[6].

Marriage and residence are other bases for acquiring land use rights. This creates an additional basis for patrilocal or matrilocal practices across Malawi. Matchaya (2009) reviews residential factors determining access and security index of customary land tenures in Malawi. Results reveal that non-indigenous groups are associated with a higher likelihood of land tenure insecurity than other categories (indigenous, weakly indigenous and absolutely indigenous). This finding is consistent with the submission

of Kishindo (2004) who explains that non-indigenous residents are considered eligible for land use rights only after being accepted as members of their host community.

Lovo (2016) has shown that the gender-biased inheritance and residency system in Malawi could constitute a source of land tenure insecurity among farmers. The various systems are the matrilineal-matrilocal and the patrilineal-patrilocal systems. In a matrilineal-matrilocal system, the husband moves to the wife's village and cultivates the land his wife inherited from her relatives. Conversely, in a patrilineal–patrilocal system, the wife moves to the husband's village; he has inherited the land from his relatives so that a family is an integral part of the husband's lineage. Divorce or death of a spouse under these two practices effectively renders the non-local partner landless and he/she returns to the village of origin without any form of compensation for the investment made in the land. Death of the landowner usually results in the land being returned to her/his relatives (Takane, 2008; Peters, 2010; Lovo, 2016).

In 2002 a new policy was instituted in Malawi witnessed that allowed farmers to register their customary land as private property. The necessary legislative amendments required to keep the policy in place were not followed and the policy came to an abrupt end. The question of land reform, however, continues to be a topical issue on the agenda of the government. The major concerns of the land tenure system in Malawi have since focussed on land inheritance laws, and landlord-tenant relationships in the rapidly growing informal rental market (Peters, 2010).

Land policy reforms in Malawi

Post-independence, Malawi has undergone a series of land reforms to promote agricultural productivity and increase sustainable food security. Before 1996, efforts by the government failed to yield the desired outcomes at land reforms. For example, the 1967 land reform was largely unsuccessful because no major break from the past was instituted in terms of mode of land ownership. Rather, it was a continuation of the colonial framework of land tenure patterns and ownership (Ng'ong'ola, 1982; Kanyongolo, 2005). The unsuccessful post-colonial land reforms and the rapid rise in population, which had severe implications on per capita landholding, led to the quest for land policy reform that could address the issues associated with perverse land inequality in Malawi.

On 18 March 1996, the central government led by the United Democratic Front (UDF) put forward a Presidential Commission of Inquiry on Land Policy Reform (PCILPR), with the mandate to promote land reform efforts in Malawi. The recommendations by the PCILPR led to the formulation of a national policy on land reform which was approved by the Cabinet in 2002[7] (Chinsinga, 2011).

As a response to the increasing demand for arable land, the government instituted a Community-Based Rural Land Development Project (CBRLDP). It was a decentralized market-based land reform initiative introduced in 2004, and carried out in the southern region of Malawi, to ease land pressure and improve land access for needy rural households. The project was designed to address land redistribution issues

that emanate from stark inequality in land distribution, and to increase agricultural productivity and the incomes of about 15,000 poor rural families in southern Malawi (Mueller et al., 2014; Mendola and Simtowe, 2015).

Moreover, CBRLD is a market-assisted land redistribution programme based on voluntary transfers between landowners (willing-sellers) and the land-poor (willing-buyers), with government and donor agencies providing the finances and services to allow communities to buy and manage land themselves. The CBRLD was carried out in six districts, namely Machinga, Mangochi, Mulanje, Thyolo, Balaka, and Ntcheu (Mendola and Simtowe, 2015). The project was supported by the World Bank through the International Development Association (IDA), which provided US$27 million of the total cost of US$29.8 million.

Eligible households (landless or land-poor) were organized into 10–35 participant households and were provided with conditional cash and land transfer to relocate, purchase, develop and register new plots of farm land (Mueller et al., 2014). The total amount provided per household was US$1,050, with up to 30% allocated to the purchase of land, 8% for relocation allowance and 62% for farm development. The programme ended in September 2011. Although it had a modicum of success in terms of land ownership and access among rural farmers in the southern region, implementation was marred by stakeholders at the community level who exploited the programme to advance their own selfish interests (Chinsinga, 2011).

Another significant agricultural policy in Malawi was the introduction of a farm input-subsidy programme. This policy was heralded several policies such as the Agriculture and Livestock Development Strategy and Action Plan (ALDSAP) established in 1995; Malawi Agricultural Sector Investment Programme (MASIP) of 1999; the Agricultural Development Programme (ADP) of 2006; the Agricultural Sector Wide Approach (ASWAP) of 2007–2009 and 2010-2015 (Ministry of Agriculture and Food Security, 2010; FAO, 2014c).

Malawi's Farm Input Subsidy Programme (FISP) is an offshoot of the Agricultural Input Subsidy Programme, a small-scale targeted input subsidy programme, also known as the Starter Pack Scheme, and it was initiated in 1998. FISP gained prominence in 2005 after the country experienced severe drought. As a result of the drought, the scope of the programme was expanded from only a few farmers to about 50% of the country's farmers, and in recent years, it covers over 70% of farmers (Harou, 2018).

The objective of FISP is to give farmers access to improved agricultural inputs which can help achieve food sufficiency and enhance rural incomes via higher levels of food and cash crop production (Dorwad and Chirwa, 2011; Lunduka et al., 2013). The programme is implemented by handing out vouchers and coupons to smallholder farmers who own their farm lands and reside legitimately in their own villages for the purchase of farm input[8] at susbsidized rates (Dorward and Chirwa, 2011; Harou, 2018).

The distribution of the vouchers is done at two levels (Ricker-Gilbert and Jayne, 2017). The first level entails the allocation of fertilizer and seeds to regions and districts based on agricultural cultivation area and the number of smallholders in such location. At the second level, distribution is at community level. The community and village

heads are then involved to determine the eligible smallholders. By design, the original allocation of the vouchers targets smallholders and full-time farmers who are unable to purchase at most two bags of fertilizers at the prevailing commercial price in the community of the smallholder as determined by local leaders (Dorward et al., 2013). From 2008 onward, the target group was defined as a "vulnerable" group, including resource-poor households, and disabled, elderly, female and child-headed households (Ricker-Gilbert and Jayne, 2017).

In 2010 the government establish the National Agricultural Policy Framework (NAPF), which was tasked with the responsibility of harmonizing the various agricultural development strategies and promoting agricultural productivity and realizing national food security, amongst others (FAO, 2014c).

3. Conceptual framework and empirical literature

Conceptual framework

Land tenure entails how access is granted for rights to use, control and transfer land, and associated responsibilities and restraints (FAO, 2002). While a few studies have examined the nexus between weather-induced shocks and agricultural productivity, the roles of land tenure security in mitigating against climate risk are less well studied. Theoretically, the role of land tenure security in mitigating weather-induced shocks can be understood under the following headings below:

Direct channels

Land tenure security is being considered as part of social protection and safety net for agrarian households (Mahadevia, 2011; Holden and Gebru, 2016). Land tenure security is important in drought-prone areas because it provides incentive for landholders to invest in adaptation measures such as sustainable pasture use, use of irrigation systems and development of drought-resistant crops (FAO, 2011; Lokonon, 2018).

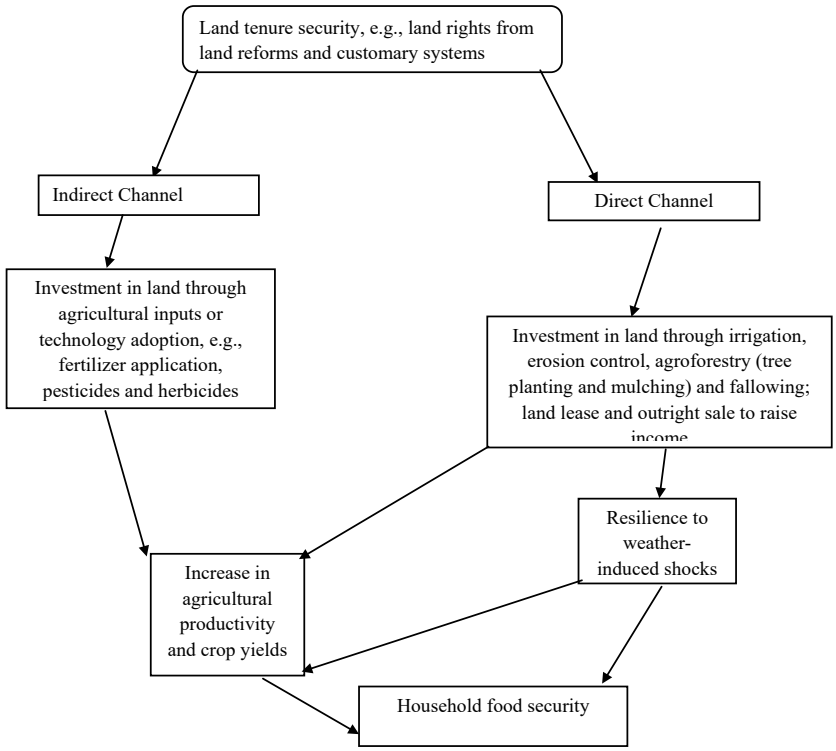
Smallholder households with stronger land rights may be more likely to invest in natural resources or environment management practices such as tree planting, fallowing, erosion control, and mulching (agroforestry). These practices reduce the exposure of land to climatic shocks (FAO, 2002; Deininger, 2003; Place, 2009; Meinzen-Dick et al., 2019)[9]. For example, in Bangladesh evidence shows that adverse shocks have insignificant impacts on households with joint land and asset holdings (Quisumbing et al., 2018). Moreover, secure land rights can enhance access to capital through the use of land as collateral or allow landholders to lease or sell the land in the event of profitable opportunity or in response to adverse income shocks in order to raise income. The benefits of security of one plot may spill over to other plots owned by the same household and provide opportunities to diversify to non-agricultural livelihoods (Besley, 1995; Deininger and Castagnini, 2006; Deininger and Jin, 2006)[10].

Indirect channels

A growing number of studies identify the association between secure land rights and investments on land as indirect pathways through which secure land tenure could mitigate the impact of weather-induced shocks. Secure land rights strengthen claims to the returns to investment. The propensity to invest is enhanced when an investor is certain of getting a wholesome reward from the investment on the land (Jacoby and Minten, 2007; Goldstein and Udry, 2008; Place, 2009; Lovo, 2016). The investment incentives as a result of secure land rights can lead to some forms of technology adoption, such as use of new crop varieties, fertilizer, pesticides and herbicides. This can lead to increased agricultural productivity and food security (Banerjee and Ghatak, 2004; Abdulai et al., 2011; Bambio and Agha, 2018).

Further, secure land rights provide the freedom to innovate and experiment, which community rights may not guarantee because of fears of the negative externalities from investment. This is known as innovation/experimentation effect (Besley, 1995; Allen, 2004). Considering the above arguments, secure land rights create a pathway for increased agricultural productivity and food security, through investment of labour and resources on the land. These theoretical relationships, summarized in Holden and Ghebru (2016), have been expanded by authors of this study in Figure 1.

Figure 1: Land tenure security, mitigation of shocks and food security



Source: Authors.

Empirical literature

This section discusses two strands of empirical evidence for the research. The first aspect of the evidence focuses on studies on land tenure security and food security. In an attempt to strengthen land tenure security in developing countries, various reforms such as land titling programmes, tenancy reforms, radical land reforms, customary tenure reforms (for example in Malawi, Tanzania and Uganda) and land redistribution have been implemented. The reforms were done in line with commonly held beliefs that land tenure security can stimulate investment and agricultural productivity (Besley, 1995).

While the reforms were successful in enhancing land tenure security in some settings, evidence has shown that land tenure reforms in other settings often led to "elite capture of land" and marginalization of the poor and minority groups. This indicates more access to land by the wealthy (Barrows and Roth, 1989; Roth, 1993; Platteau, 1996; Benjaminsen et al., 2009; Aryal and Holden, 2011; Simtowe et al., 2012).

There is mixed evidence on the effects of land tenure security on investment and agricultural productivity. Some studies in Latin America, Africa and Asia found positive investment impacts from land titling (Feder, 1988; Alston et al., 1995; Lopez, 1997; Deininger and Chamorro, 2004; Deininger et al., 2008; Lovo, 2016). Other studies on land titling in Africa have found no evidence of the impacts of investment (Migot-Adholla et al., 1994; Pinckney and Kimuyu, 1994).

Few existing studies investigate the direct effect of land tenure security on other measures of household welfare (such as food security and poverty). Ghebru and Holden (2013) found that the land certification programme in Ethiopia resulted in increased food production and food access for poor female-headed households who sharecropped out their land. A similar result was obtained on the impact of land reforms on poverty in India (Besley and Burgess, 2000; Deininger et al., 2008). Among agrarian households, Maxwell and Wiebe (1998) argue that a reduction in or outright loss of access to land leads directly to a reduction in income and access to food.

The second part of this literature review comprises evidence on weather shocks and household welfare. Weather risks such as floods, droughts, frost and hailstorms can have significant impacts on agricultural productivity and food security in agrarian households. Vegetation cover is likely to be poor with low rainfall and this can have severe implications for agricultural yields. Intensive rainfall in areas of poor or limited vegetation cover often leads to land degradation and crop damage (Holden and Ghebru, 2016). The literature on the impact of weather and climate variability on household welfare abound with evidence from developing countries' perspectives (Jayanchandran, 2006; Nordhaus, 2006; Yang and Choi, 2007; Dell et al., 2009; Schlenker and Lobell, 2010; Björkman-Nyqvist, 2013). For example, selected studies in developing countries, including Schlenker and Lobell (2010), found negative impacts of bad weather shocks (higher temperature) on agricultural yields for sub-Saharan Africa. Similarly, Guiteras (2009) working in India and Feng et al. (2010) in Mexico estimate

that higher temperature reduces agricultural output. With a slightly different result, other studies (e.g., Welch et al., 2010) show that for Asian countries higher minimum temperature reduces yields, whereas higher maximum temperature increases yields. With regard to precipitation, Levine and Yang (2014), using a panel of Indonesian districts, found a positive relationship between rainfall and rice production.

The absence of complete formal markets for credit and insurance among poor agrarian households, which have the capacity to mitigate the impact of covariate shocks, left rural households vulnerable to adverse shocks (Binswanger and Rosenzweig, 1986). In order to cushion the impacts of covariate shocks, most poor households often rely on informal coping mechanisms such as assets and income diversification strategies. A review of the literature also shows that rural households sometimes adapt land/labour ratio as a risk coping mechanism during weather shocks (Promsopha, 2018). Evidence has shown, however, that the informal coping mechanisms are limited in their capacity to cushion risk, mainly because of the correlation between these mechanisms and production shocks (Dercon, 2001).

Access to secured land tenure can have a mitigating impact that can support the welfare of poor agrarian households (Holden et al., 2008; Holden and Ghebru, 2016). Existing empirical evidence found a connection between egalitarian land distribution and household welfare. This includes cross-country evidence from five European countries which shows that land control is strongly correlated with food security (Petrescu-Mag et al 2019). With the perceived capacity of land as a reliable asset across countries, this study will investigate the shock-cushioning capacity of land possession/security to preserve food security during periods of drought shocks in Malawi.

4. Data sources and empirical methodology

Data sources

This study used household and plot-level data provided by the Integrated Household Panel Survey (IHPS) 2013 and the Fourth Integrated Household Survey (IHS4) 2016/2017 for Malawi[11]. These surveys were conducted by the Government of Malawi through the National Statistical Office, with the support of the World Bank. The surveys collect information on households across the entire country and provide information on various rainfall and temperature measures in the geospatial data relating to seasonal variation of weather. Other plot-specific information relating to agricultural productivity includes the topographic and vegetation indicators of household plot characteristics. The surveys collected data for 4,000 households for 2013 and for 12,447 households for 2016/2017.

To measure local rainfall shocks, we rely on rainfall data from terrestrial precipitation: the 1900–2017 gridded monthly time series (version 5.01), from the University of Delaware's (UDel) Center for Climatic Research. The data set provides estimates of monthly precipitation on a 0.5° by 0.5° grid covering terrestrial areas across the globe for the period 1900–2014. Rainfall estimates are based on climatologically-aided interpolation of available weather station information. The data have been compiled and made available by Matsuura and Willmott (2018). We use the GPS information provided for each locality referenced as enumeration area in the IHPS and IHS4 respectively for 2013 and 2016/2017 waves to access the UDel rainfall repository by matching each locality to the four closest weather stations to obtain rainfall data for the years spanning 1900 to 2017.

We establish rainfall deviation and shocks based on the previous theories. For food shock/nutrition pathway, we rely on rainfall deviation and shocks emanating from the harvest realizations from cultivation during agricultural seasons for rural households who predominantly depend on harvests for sustenance. By extension, this model captures the income shock pathway of the harvest variation from rainfall shocks[12]. This pathway requires a lag period (an interval) between the planting season and harvesting season which determines the level of household food security before future harvesting seasons[13].

$$\text{Rainfall shock}_{lt-1} = ln\,\text{Rainfall}_{lt-1} - ln\,\overline{\text{Rainfall}_{l}} \quad (1)$$

Where Rainfall_lt indicates the yearly precipitation for the current agricultural season within locality *l*; and $\overline{\text{Rainfall}_l}$ is the average historical yearly precipitation of the community over 30 years. Thus, $\text{Rainfall Deviation}_{lt-1}$ is defined as the deviation between the natural logarithm of the total precipitation in the agricultural season and the natural logarithm of the corresponding average seasonal historical precipitation at the community level. This approach to locality precipitation dynamics essentially denotes a percentage deviation from mean value and is measured in log-points deviation (Maccini and Yang, 2009).

Disintegration of linear shock in Equation 1 is increasingly becoming important due to evidence of asymmetric impacts emanating from either side of the shock spectrum. The basic approach is the use of quantified negative and positive deviations to measure the potentially asymmetric impacts from either side of the shock spectrum (Sekhri and Storeygard, 2014). This is closely followed by use of stage-wise thresholds to characterize shock depths and intensities (Comfort, 2016). Following Corno et al. (2017), we model village-level drought shocks using percentile threshold of the historical precipitation pattern of each locality. This is similar to the use of standard deviation movements of seasonal rainfall patterns (Rocha and Soares, 2015; Riley, 2018). Similar to Rocha and Soares (2015), we construct a one-sided drought shock component below (low rainfall shock dummy) for extreme precipitation measure across localities in Equation 2 while disregarding the flood component used in some studies.

$$\text{Drought shock}^{14}_{lt-1} = \begin{Bmatrix} 1 \text{ if rainfall within locality is below 15th percentile of norm} \\ 0 \text{ if rainfall within locality is above 15th percentile of norm} \end{Bmatrix} \quad (2)$$

We focus on land tenure security questions consistent across the two panel waves, similar to Ma et al. (2016), Owoo and Boakye-Yiadom (2015), and Rao et al. (2016). We restrict our analysis to questions directed to land (or garden) ownership rights and dispute. These sorts of questions directly capture land tenure security and vary at the household level. The questions we explore include an indicator for title ownership[15] to capture control over land use and land dispute[16] to determine existing concerns regarding land security that may affect investment patterns. We use a variety of these indicators in our econometric specifications to capture the diverse role of land tenure security denoted. For the food security indicators, we follow Beegle et al. (2017) by using the following food security outcomes, alongside other subjective measures, in our analysis: (i) log of per capita food expenditure; (ii) log per capita food consumption; (iii) food resilience score; and (iv) food consumption score.

Summary statistics

Table 1 presents the summary statistics of various variables used in the regression. The statistics are extracted from two waves of the Malawi Integrated Household Survey between 2013 and 2016/2017 and comprise 12,822 observations from rural households. Average household size is just above four, average age of household head is 44 years, and 29% of the household heads are women. For the food security measures, log of real per capita expenditure is 6. Just under one-third (62%) of the sample households reported food dissatisfaction in the previous week and 59% (74) reported food insecurity in the previous week (year). The mean food resilience index is -8, the mean food consumption score is 46; 70% of the households had an above average food consumption score in the sample. Food resilience is the negative of the World Food Programme coping strategy index. This is calculated as the negative of the weighted sum of the number of days in the past seven days that households had to reduce the quantity and quality of food consumed. Food consumption score is calculated based on the sum of the weighted number of days in the previous week that the household ate from eight food groups (cereals, nuts and pulses, vegetables, meat and fish, fruits, milk, fat and oil and sugar).

Table 1: Summary statistics

Variables	Mean	Std. dev.
Demographic statistics		
HH size	4.519	2.112
Gender of HH head	0.287	0.452
Age of HH head	43.735	16.674
Food security measures		
Expenditure (Total & food)		
Natural log of real per-capita expenditure	5.870	0.981
Natural log of real per-capita food expenditure	5.550	1.110
Subjective food insecurity indicators		
Food insecure (in the previous week)—indicator	0.593	0.491
Dissatisfaction with food indicator (in the previous month)	0.622	0.485
Food insecure (in the previous year)—indicator	0.737	0.440
Standard food insecurity measures		
Food resilience	-7.882	9.087
Food consumption score	45.958	17.366
Food consumption score (indicator)	0.701	0.458
Rainfall shock		
Drought shock	0.167	0.373

Notes: Linear shock is measured as a deviation of seasonal precipitation level from the historical mean. Drought shocks are computed as an indicator variable in Equation 2.

Table 2 presents self-reported causes of food insecurity. For the various causes of food insecurity identified in the survey, 59% reported drought as the cause; 2.1% reported pest damage; 15% reported market access; 46% identified farm input; and 42% reported expensive food. Moreover, 0.7% identified transport cost, market food reduction is 3.3%, and flood is 2.9% .

Table 2: Self-reported cause of food security issues

Variables	Mean	Std. dev.
Drought	0.594	0.491
Pest damage	0.021	0.145
Land access	0.153	0.36
Farm input	0.457	0.498
Expensive food	0.418	0.493
Transport cost	0.007	0.081
Market food reduction	0.033	0.178
Flood	0.029	0.167
Others	0.074	0.261

Notes: The causes listed above are not mutually exclusive events as household can specify multiple causes of food insecurity at the same time.

Table 3 presents summary statistics on a diversity of land tenure security measures. These include possession of title for land, right to land sales/lease, dispute/disagreement regarding land vis-à-vis certainty of land possession over the years[17]. The right of households to sell or rent out land and its likelihood to retain possession for 10 years appears to be the most important land security measures with 62% and 66% proclaiming these attributes of land security respectively. Title possession is the least ranked land security measure with only 1% of households indicating this. The descriptive statistics typify the distinction of land security appraisal of rural households in developing countries. Household's possession of the most acceptable legal document (land title) being reported the least classification does not signify weakness of its effectiveness just that it is not widespread in rural areas. We use each of the variables reported in Table 3 in the interaction of drought shock and land security measures to capture both formal and informal ways of measuring land security and their roles in rural settings. This approach will give an understanding of the multidimensional nature of rural tenure landscape and aid interpretation diversity of land tenure for policy intervention in Malawi.

We provide additional summary statistics on the distribution of the villages by customary marriage practice and inheritance customs in Table 4. The customary marriage practice details marriage customs with priority given to either matrilineal or patrilineal in addition to a secondary customary marriage practice. As expected, matrilineal customary practice is the most prevalent across the villages, accounting for 87% of all villages[18]. Within the matrilineal category, matrilocal features as a secondary marriage practice in 66% of the villages. Also, 57% of communities trace

their descents to only mothers while sharing with fathers in an additional 21% of the villages. These statistics support prevalence of matrilineal and female descent tracing in Malawi.

Table 3: Summary statistics of land tenure security measures

Variables	Mean	Std. dev.
HH possesses a land title for plot	0.012	0.110
HH experienced land dispute on plot	0.082	0.274
HH has the right to sell/rent land	0.621	0.485
HH experienced land dispute on plot recently	0.051	0.220
HH may disagree on land in 5 years	0.016	0.126
HH may possess land in 10 years	0.656	0.475

Notes: Summary statistics of the land tenure security measures are indicator variables for the various categories specified above; HH = household.

Table 4: Customary marriage practice and inheritance customs

Variables	Mean	Std. dev.
Customary marriage practice		
Matrilineal and neolocal	0.051	0.220
Matrilineal and matrilocal	0.659	0.474
Matrilineal and patrilocal	0.160	0.367
Patrilineal and neolocal	0.040	0.197
Patrilineal and patrilocal	0.090	0.286
Inheritance customs		
Father	0.222	0.415
Mother	0.574	0.495
Both	0.205	0.403

Notes: Summary statistics of the customary practice and inheritance customs are all indicator variables representing the proportional contribution of each category at the community/village level.

Empirical methodology

This research uses quantitative data to investigate whether land tenure security mitigates the impact of drought shocks on food security in Malawi. The study adopts an identification strategy similar to that of Björkman-Nyqvist (2013) and Yang and Choi (2007), and exploits the exogenous variations in seasonal precipitation pattern to investigate the causal impact of drought shocks on household food security. The primary focus of the estimation is to model the interaction of land tenure security on the relationship between rainfall shocks and household food security as follows:

$$FS_{ht} = \delta_t + \boldsymbol{\phi}(\text{Drought shock}_{\text{ct}-1}) + \boldsymbol{\tau}(\text{Drought shock}_{\text{ct}-1}\ \text{X}\ \text{TS}_{\text{ht}}) + X'_{ht}\,\boldsymbol{\beta} + \varepsilon_{ht} \qquad (3)$$

Where FS_{ht} denotes food security measures for household h at time t. δ_t represents year fixed effects. Also, parameter φ denote the direct effect of drought shock on household food security, τ captures our parameter of interest—the interaction of drought shock and land tenure security status of the household (TS). Evaluating the relationship between interactions of coefficient estimates from φ and τ is the underlying basis for Equation 3. Lastly, X'_{ht} denotes household covariates used as controls[19] in the estimation and ε_{ht} is the error term which is assumed to be normally distributed. The error term is assumed to be independent and identically distributed between villages but correlated within villages; hence we cluster the standard errors at the village level for all estimations.

We use a variety of outcome variables on expenditure, subjective food security indicators from the questionnaire and food security measures constructed using the standardized World Food Programme Guidelines (WFPG) measure of food security to compute food resilience and food consumption scores. Results on expenditure outcome are linked to poverty dynamics and so presented on the same platform on the first set of result tables. Natural logarithm of expenditure is a continuous variable while extreme and relative poverty are dummies. Also, results for food expenditure and self-reported food security indicators are reported in the result section. Natural log of real (per capita) food expenditure is a continuous outcome, and food insecurity in the last week/year and food dissatisfaction in the past month are binary outcomes. Lastly, we construct standardized World Food Programme Guidelines'(WFPG's) food security measures, namely food resilience and food consumption scores. Food resilience and food consumption scores are both continuous outcomes. In addition to the use of food consumption scores as a continuous variable, we create a binary choice outcome using the applicable threshold for sufficient food intake within the household. Tables 6–8, Panel A uses the natural logarithm of real per capita expenditure and food expenditure respectively; Panel B contains subjective food security measures using indicator variables for food insecurity within the household in the past week and year respectively. The food insecurity indicators are assigned 1 for households that face food security concerns within this period and 0 otherwise. Dependent variables in Panel C uses the standard WFPG measure of food security to compute food security score, food resilience and food consumption scores. Additional outcome is an indicator variable from food consumption score using a threshold of 35 where food consumption scores higher than 35 are considered as acceptable levels and are assigned 1; values lower than 35 are assigned 0. Coefficient estimates from the indicator outcomes are marginal effects from (ordered) Probit regressions.

5. Results

The role of land tenure security in mitigating impact of drought shocks

All the results in the tables report coefficient estimates for drought shocks and interaction term with land tenure security measures for diverse food security measures where drought shock is measured as an indicator variable from Equation 2. Observations are restricted to households in rural areas. We investigate the mitigating role of land tenure security using change in consumption as our dependent variable. Consumption change is measured as a difference in the natural logarithm of total household expenditure across the two waves (2013–2017). The results for change in consumption present a decrease in consumption growth as expected. Contrary to a priori theoretical expectation, the estimated coefficient of the interaction term for land ownership indicated a further diminishing impact of land security (significant at 1%). Coefficient estimates of interaction term for dispute-free and right to sell measures are positive (but smaller) as expected and not statistically significant. It is imperative to note that household observations in each panel wave are significantly smaller than the independently collated waves. This may lead to lower variability in weather pattern and/or land tenure measures required for better identification. One reason for inconsistent pattern in the new result may be contraction in panel data used to capture a panel of households across the two waves. Also, the performance of consumption change as food security measure relative to natural log of consumption may differ across data sets, setting etc.

Table 6 presents the results of the interaction of land title ownership with drought shocks. We use the household's land title ownership as a proxy for land tenure security. Panels A–C present coefficient estimates on diverse sub-heading including expenditures, reported food insecurity and standard food security measures respectively. In general, drought coefficient estimates for all outcome variables are consistent with the expected signs. In Panel A an incidence of drought decreases total expenditure and food expenditure by 25.8 and 27.6 percentage points respectively while in Panel B it increases food security concerns by 7.1 and 4.6 percentage points over a period of one week or a year respectively. In Panel C the

direct impact of drought results into reduction in the food security measures from around 4.0 to 278.5 percentage points depending on the measure. The interaction term coefficient estimates from Columns 1–2 of Panel A indicate that the possession of land title helps to cushion the impact of drought shocks on household general expenditure patterns and food specifically. In Panel B the increase in weekly food insecurity indicator shown in column 3 is reversed by the interaction coefficient. We find a similar significant result for column 8 in Panel C, which uses the food consumption score indicator as a standard measure of household food security. One important feature of the magnitudes of the interaction terms relative to the drought shock is how each of these overcompensates for the adverse impacts of drought shock in each case. This is a clear indication that possession of land titles by households could increase the food security measures during drought shocks compared to households without land title ownership. The findings of this paper are consistent with those of studies that established a positive relationship between land tenure security, agricultural productivity and food security (Chand and Yala, 2009; Holden et al., 2009; Godfray et al., 2010; Lambin and Meyfroidt, 2011; Holden and Ghebru, 2016). More specifically, our results are consistent with evidence of food security linkage for land tenure reforms in poor agrarian economies (Ghebru and Holden 2013; Holden and Ghebru 2016). However, our results are more intuitive for the relevance of such evidence in the context of extreme weather events.

Table 5: Interaction effects of land tenure security measures on the impacts of drought on change in consumption measure in Malawi

Variables	Dependent variable: Consumption change		
	Title ownership	Dispute-free land	Right to sell
	(1)	(2)	(3)
Drought	-0.169*	-0.377	-0.223**
	(0.087)	(0.309)	(0.099)
Interaction	-0.462***	0.219	0.084
	(0.118)	(0.311)	(0.093)
Constant	-0.241**	-0.255**	-0.257**
	(0.121)	(0.120)	(0.120)
Year Fixed Effect	✓	✓	✓
Controls	✓	✓	✓
Observations	2,313	2,329	2,334
R-squared	0.019	0.019	0.020

Notes: Columns 1–3 report results for indicator variables for land title ownership, dispute-free land and right to sell land by the households. Robust standard errors (clustered at the enumeration area level) are reported in parentheses; ***, ** and * represent significance at 1%, 5% and 10% levels respectively.

Table 6: Interaction effects of land title ownership on the impacts of drought on food security outcomes in Malawi

Variables	Dependent variables:							
	Panel A: Expenditures		Panel B: Subjective food insecurity		Panel C: Food security measures			
	ln(total)	ln(food)	Week (indicator)	Year (indicator)	Security score	Resilience	Consumption score	Consumption score (indicator)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drought shock	-0.258***	-0.276***	0.071***	0.046***	-0.040**	-1.629***	-2.785***	-0.096***
	(0.052)	(0.061)	(0.019)	(0.017)	(0.018)	(0.489)	(0.769)	(0.020)
Interaction	0.336*	0.380**	-0.264**	0.178	0.028	3.079	0.159	0.222*
	(0.173)	(0.152)	(0.135)	(0.156)	(0.142)	(1.931)	(3.363)	(0.135)
Constant	6.875***	6.572***	-0.415***	-0.364***	NA	-1.094*	48.401***	0.643***
	(0.061)	(0.070)	(0.089)	(0.095)	NA	(0.603)	(1.124)	(0.091)
Year Fixed Effect	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Observations	9,659	9,620	9,667	9,667	9,234	9,665	9,655	9,655
R-squared	0.138	0.106	0.111	0.107	0.095	0.139	0.157	0.074

Notes: Robust standard errors (clustered at the enumeration area level) are reported in parentheses. ***, ** and * represent significance at 1%, 5% and 10% levels respectively.

In Table 7 we use reported cases of dispute-free land as a proxy for land tenure security. Results emerge for columns 3, 5 and 7 for subjective food insecurity and standard food security measures. In column 3 an incidence of drought increases likelihood of food insecurity by 14.2 percentage points while the interaction indicates that 7.9 percentage points is compensated for as a result of possessing a dispute-free land. Similar pattern is revealed for food security and food consumption scores where 6.7 and 291.1 percentage points are restored from a decline of 10.1 and 550.3 percentage points respectively for columns 5 and 7. In Table 8 we use household's control over land through authority to sell it to represent land tenure security. Only limited results emerge from this land tenure security measure. Evidence in columns 1 and 2 of Panel A showcases the mitigating role of land tenure security for expenditure measures where only about half of the impact of drought on expenditure patterns are recovered by the consideration of this proxy.

Results in Tables 6–8 suggest that land tenure security plays an important role in mitigating the impact of drought-induced food insecurity in rural Malawi. One striking feature of the results is the overcompensation pattern of the results for possession of formal land title as a land security measure. The results signal that land title is a more reliable source of land security than informal sources such as having a dispute-free land and authority to sell land. The pattern of mitigating roles for informal land tenure security depicts the sort of incomplete insurance mechanisms documented in the literature (Dercon, 2001).

Another important characteristic of our results is the impacts of drought on expenditure categories and the persistent mitigating role of land tenure security for them. The former suggests that there may be two mechanisms for the impact of drought on household welfare. One mechanism is through agricultural income shocks where household expenditure pattern is affected as a result of income from harvest[20]. More importantly, the comparative nature of estimates between total and food expenditure suggests that the food expenditure component of the household expenditure is more affected by the income shock following the harvesting season. Another mechanism is the direct food shock as a result of lean harvest. Households may share yields into market and store components after harvest seasons, leading to differential impacts depending on the priority setting of each household.

We also check for balanced demographic characteristics across divisions of land tenure security measures using various measures. Table A1 presents tests for equality of means of demographic characteristics for households with and without land titles respectively. The Z-values from all the variables suggest equality of means across the two groups of households. Similar results are obtained for dichotomized statistics by households with dispute-free land and the right to sell land in Tables A2 and A3 respectively. This pattern is consistent with balanced characteristics expected for different categories of households and exonerates our results from possible bias of interaction of shocks and land tenure security measures.

Table 7: Interaction effects of dispute-free land possession on the impacts of drought on food security outcomes in Malawi

Variables	Dependent variables:							
	Panel A: Expenditures		Panel B: Subjective food insecurity		Panel C: Food security measures			
	ln(total)	ln(food)	Week (indicator)	Year (indicator)	Security score	Resilience	Consumption score	Consumption score (indicator)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drought shock	-0.257***	-0.301***	0.142***	0.112**	-0.101**	-3.273***	-5.503***	-0.110**
	(0.083)	(0.099)	(0.048)	(0.046)	(0.042)	(1.242)	(1.450)	(0.046)
Interaction	-0.000	0.029	-0.079*	-0.070	0.067*	1.794	2.911**	0.016
	(0.085)	(0.101)	(0.047)	(0.045)	(0.040)	(1.172)	(1.426)	(0.045)
Constant	6.871***	6.566***	-0.419***	-0.373***	NA	-1.071*	48.436***	0.648***
	(0.061)	(0.070)	(0.089)	(0.095)	NA	(0.602)	(1.124)	(0.091)
Year Fixed Effect	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Observations	9,683	9,644	9,691	9,691	9,256	9,689	9,679	9,679
R-squared	0.138	0.106	0.111	0.108	0.096	0.140	0.158	0.074

Notes: Robust standard errors (clustered at the enumeration area level) are reported in parentheses. ***, ** and * represent significance at 1%, 5% and 10% levels respectively.

Table 8: Interaction effects of authority to sell land on the impacts of drought on food security outcomes in Malawi

Variables	Dependent variables:							
	Panel A: Expenditures		Panel B: Subjective food insecurity		Panel C: Food security measures			
	ln(total)	ln(food)	Week (indicator)	Year (indicator)	Security score	Resilience	Consumption score	Consumption score (indicator)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drought	-0.380***	-0.393***	0.028	-0.027	-0.021	-2.130***	0.783	-0.021
	(0.068)	(0.077)	(0.025)	(0.022)	(0.022)	(0.590)	(1.093)	(0.025)
Interaction	0.185***	0.178***	0.061**	0.122***	-0.027	0.788	-5.359***	-0.111***
	(0.054)	(0.059)	(0.027)	(0.026)	(0.023)	(0.634)	(1.151)	(0.026)
Constant	6.879***	6.574***	-0.410***	-0.351***	NA	-1.043*	48.170***	0.630***
	(0.061)	(0.070)	(0.088)	(0.095)	NA	(0.603)	(1.118)	(0.090)
Year Fixed Effect	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Observations	9,688	9,649	9,696	9,696	9,261	9,694	9,684	9,684
R-squared	0.139	0.107	0.112	0.110	0.096	0.139	0.161	0.076

Notes: Robust standard errors (clustered at the enumeration area level) are reported in parentheses. ***, ** and * represent significance at 1%, 5% and 10% levels respectively.

Moreover, in Table A4 we include household fixed effects in our regressions to investigate the mitigating impacts of land tenure security. However, the results do not offer any useful insight into the counteracting role of land tenure security during drought in a manner that may be compared to the results from the cross-sectional data.

Channels of mitigating role of land tenure between drought and food security

There are two main channels through which land tenure security mitigates food insecurity generated by weather shocks. Farmers may take proactive measures to invest in land before and/or during planting seasons. Since having land tenure security authorizes a farmer to invest in farmlands; this could compensate for the potential adverse effects in the future by helping to build farm resilience. These include farm irrigation and other land conservation methods[21].

Another way is the reactive measure and afterwards the adverse impacts of droughts. In this case, farmers affected by weather shocks could experience low harvest and face food insecurity which they can mitigate by borrowing if they have tenure security. We posit that holding a land title and having authority to sell lands translate to formal and informal collateral respectively.

We explore the role of household credit facilities and irrigation practice in our results to understand the potential channels by using credit and irrigation outcome variables in our regression set up. Table 9 presents the coefficient estimates of drought shock as an indicator of the role of each component to mitigate the resultant effects of droughts in Panels A and B respectively. Panel A presents the results of the indicator and natural logarithm of household food-related credit facilities in the past 12 months in columns 1 and 2; Panel B reports results of indicator variables for household irrigation practice and access to extension service within the same period. Indicator variable in column 1 is designated 1 if the household accesses a credit facility for consumption, 0 otherwise. Indicators in columns 3 and 4 are assigned 1 if a household practises irrigation or has access to any extension service within the last season, 0 otherwise.

Coefficient estimates from the indicator outcomes are marginal effects from (ordered) Probit regressions. Results from columns 1 and 2 of Panel A demonstrate that drought shock is not significantly associated with the use of credit to cushion the food insecurity in the aftermath of reduced harvest. Drought shock coefficient estimates in column 3 shows a significant estimate of 0.8 percentage points. However, the drought shock coefficient is not significantly associated with having access to extension service. This pattern shows an interaction of one arm of irrigation which demonstrates a pathway for the mitigating impact of shocks on food security in a manner not revealed by credit. These results further reinforce the role of farm

investment to mitigate the negative impacts of shocks alongside land tenure security. In general, Table 9 provides some evidence in support of effectiveness of proactive, and not reactive, measures as having an important part to play in the mitigating role of land tenure on drought-induced food security in Malawi.

Table 9: Impacts of drought shock on household credit and irrigation outcomes in Malawi

Variables	Dependent variables:			
	Panel A: Credit		Panel B: Irrigation indicators	
	Indicator	Ln(credit)	Irrigation practice	Extension service
	(1)	(2)	(3)	(4)
Drought shock	0.005	0.066	0.008**	0.013
	(0.012)	(0.111)	(0.003)	(0.019)
Constant	-1.682***	0.309**	-2.988***	-0.699***
	(0.094)	(0.136)	(0.205)	(0.082)
Year Fixed Effect	✓	✓	✓	✓
Controls	✓	✓	✓	✓
Observations	12,822	12,822	11,403	11,312
R-squared	0.039	0.024	0.051	0.049

Notes: Robust standard errors (clustered at the enumeration area level) are reported in parentheses. ***, ** and * represent significance at 1%, 5% and 10% levels respectively.

Heterogeneous impacts between matrilineal and patrilineal societies

We model heterogeneous impacts of rainfall shocks and interaction by matrilineal and patrilineal societies separately. Coefficient estimates for matrilineal societies in Table 10 are stronger and maintains robust statistical significance for expenditures and consumption score outcomes in columns 1, 2 and 5 respectively; that for patrilineal societies in Table 11 is consistent for weekly food insecurity and food resilience measures. This distribution of results between Tables 9 and 10 suggests that there is no evidence of gender supremacy in land transactions and/or investments in rural areas in Malawi.

Table 10: Interaction effects of land tenure security in matrilineal communities

Variables	Dependent variables:				
	ln(total)	ln(food)	Week (indicator)	Resilience	Consumption score (indicator)
	(1)	(2)	(3)	(4)	(5)
Drought shock	-0.256***	-0.260***	0.076***	-0.538	-0.091***
	(0.059)	(0.067)	(0.021)	(0.517)	(0.023)
Interaction	0.455**	0.471***	-0.218	2.049	0.310*
	(0.209)	(0.181)	(0.159)	(1.570)	(0.171)
Constant	6.859***	6.564***	-0.461***	-0.877	0.698***
	(0.071)	(0.081)	(0.104)	(0.739)	(0.107)
Year Fixed Effect	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓
Observations	6,799	6,779	6,805	6,803	6,795
R-squared	0.145	0.113	0.102	0.129	0.065

Notes: Robust standard errors (clustered at the enumeration area level) are reported in parentheses. ***, ** and * represent significance at 1%, 5% and 10% levels respectively.

Table 11: Interaction effects of land tenure security in patrilineal communities

Variables	Dependent variables:				
	ln(total)	ln(food)	Week (indicator)	Resilience	Consumption score (indicator)
	(1)	(2)	(3)	(4)	(5)
Drought shock	-0.240**	-0.297*	0.084**	-6.231***	-0.109***
	(0.111)	(0.152)	(0.042)	(0.877)	(0.042)
Interaction	-0.046	0.101	-0.468**	7.822*	0.106
	(0.124)	(0.149)	(0.206)	(4.434)	(0.201)
Constant	6.908***	6.596***	-0.220	-2.491**	0.318***
	(0.116)	(0.137)	(0.171)	(0.977)	(0.177)
Year FE	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓
Observations	2,806	2,787	2,808	2,808	2,806
R-squared	0.137	0.102	0.150	0.238	0.114

Notes: Robust standard errors (clustered at the enumeration area level) are reported in parentheses. ***, ** and * represent significance at 1%, 5% and 10% levels respectively.

6. Conclusion and policy implications

Climate variability has been a major threat to agricultural production, food security and livelihoods of most agrarian households in developing countries. Over the years, governments – both local and international – have made efforts to design sustainable policies (directly or indirectly) to help households cope or mitigate the pernicious impacts of weather shocks. In view of this, our study extends the existing literature by evaluating the mitigating role of land tenure security on food security in regions that depend on agriculture. Specifically, we explored variations in land tenure security and drought regimes across villages to investigate the extent to which the land tenure system matters in household capacity to cope with negative consequences of climate shocks for rural agricultural dependent households in Malawi.

Our findings reveal that drought shocks significantly affect household food security among rural households in Malawi. More importantly, we investigated the role of land tenure security across households and the capacity to cope with drought shocks. The results show a counteracting role of land tenure security on the effect of drought shocks on food security. Land tenure security arrangements in Malawi are widely diversified across legal, institutional and customary perspectives. However, we found the strongest mitigating signals from the land titling relative to informal measures. These results are consistent with the importance of formalizing land ownership in rural areas for example through expanding legal documentation of rural lands. This finding has an important policy direction for government agencies in charge of land acquisition in Malawi. Also, we established a pathway for the mitigating effects of land tenure security as an irrigation practice. The coefficient estimates for matrilineal and patrilineal communities are distributed along outcome variables in a manner that does not suggest any differential roles of land tenure security.

The results suggest that land tenure security can have important policy implications, particularly from the perspective of safety nets. The results of this study reinforce the growing consensus that property rights through land tenure security are associated with agricultural productivity and household food security in rural areas. The most efficient way to achieve land tenure security is through formalization of land rights by issuing land titles to land owners as showcased in our study. Even though most of the land in Malawi is acquired through customary tenure systems (inheritance), the need for land owners to have formal titles will prevent land grabbing and expropriation

by the government. Having formal land titles is often associated with land tenure security, which can lead to increased soil conservation practices and agricultural productivity by the land owners.

This study stresses that land reforms aimed at increasing tenure security and inclusive ownership for land users may improve productivity thereby mitigating the negative impacts of weather shocks and enhancing household welfare among households that depend on agriculture. Therefore, land tenure security can be a policy instrument to enhance or change the welfare distribution of households, which can lead to a reduction in poverty, and promote growth and sustainable development in developing countries.

One limitation of this study is the non-randomness of land tenure security across households in rural Malawi. Although there is evidence supporting the claim we made in this paper that land acquisitions in rural Malawi are mostly through inheritance, this mode of acquisition is, to some extent, an exogenous source of land tenure security. Future research could consider a more plausibly exogenous source of land tenure security such as land titling that provides a clear treatment and control groups in an experimental setting. This sort of study will provide a more causal claim or argument for the mitigating impact of land tenure security than this current paper.

Notes

1. As of 2012, the share of people living on US$1.90 or less a day was 47% (501 million people) of the population of sub-Saharan Africa. This resulted in 233 million undernourished people in sub-Saharan Africa within the same period (World Bank, 2017).

2. Recent evidence shows that climate and weather variability have deleterious effects on household welfare through crop failures and yields variability. Therefore, climate change can potentially affect all aspects of food security through reduction in food access and utilization, and price instability (Challinor et al., 2010; IPCC, 2014).

3. Takane (2008) documents that approximately 70% of Malawi land ownership is determined through the customary land tenure system.

4. Land tenure refers to 'the relationships between individuals and groups of individuals by which rights and obligations are defined with respect to control and use of land' (Bruce, 1986; Moyo, 1995; Shivji et al., 1998).

5. Food security is commonly defined as prevailing 'when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life' (FAO, 2014a).

6. Communities sharing both descent tracing categories may resolve to propensity of affiliation by community for land allocation and accessibility index.

7. The new land policy aimed to correct the social tension and stark inequality associated with land ownership in the country.

8. These include fertilizers for maize production, improved maize seeds, pesticides and tobacco fertilizers.

9. Rural households with secure land tenure could adapt to seasonal variations in climatic conditions through migration to other less-affected areas for the drier months. For example, the traditional customary rights of pastoralists in Mongolia allow them to migrate to other rangeland in case of emergencies (FAO, 2011; Lokonon, 2018).

10. Secure land tenure could also increase the need for smallholder farmers to use government or agricultural extension services (Meinzen-Dick et al., 2019).

11. The IHS is also known as Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA).

12. The idiosyncratic nature of harvest realizations commonly noticeable within the household food security framework while the covariate impacts is indirectly reflected in the local prices of consumption goods. The covariate impact of shocks is a common phenomenon in the rural areas of low-income countries because of spatial correlation of weather patterns where coexisting families and localities that share boundaries have synonymous experience of reduced supply in comparison to the demand of consumption goods after harvest leading to increase in general price of commodities.

13. Harvests from each planting season cover both the contemporaneous and intermittent food requirements of rural households before future harvests. Food storage is a unique strategy used to cater for intermittent food requirements and this depends mainly on the level of harvest in the first instance.

14. Does your household (HH) currently have a title for this plot (garden)? And does the owner have the right to sell this plot or use it as collateral?

15. Have you ever been concerned that somebody might dispute your ownership of this plot (garden)?

16. Last three rows representing indicators for a household's experience of land dispute, prospective short-term disagreement on land and certainty of land possession in the long term are available for the 2017 wave only.

17. We merge the marriage practice by combining each sub-category based on the priority marriage practice only.

18. Controls include household characteristics such as household size, gender and age of HH head; and community socio-economic characteristics such as availability of telephone stall, pharmacy, health clinics, banks, Saving and Credit Cooperative (SACCO) and aid group for insecticides, HIV intervention and school feeding programmes. We also control for a politician coming from a locality as an important political representativeness of each community.

19. Drought shock is lagged to cover harvests from the previous agricultural season in such a way that income shock will be realized around the survey period.

20. This may reflect in the manner of land preparation or crop cultivation.

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Appendix A

Table A1: Test for difference in normalized means in demographic characteristics by HH land title ownership

Variable	No land title		Possess land title		Norm-difference
	Mean	Std. dev.	Mean	Std. dev.	
HH size	4.5951	2.0646	5.0480	2.2535	-0.1482
HH income category	3.5312	1.1650	2.9200	1.3235	0.3467
HH head					
Age	44.8441	16.7414	46.7280	16.3896	-0.0804
Gender	0.3036	0.4598	0.2640	0.4426	0.0621
Attend school	0.7992	0.4006	0.8320	0.3754	-0.0597
No education	0.2010	0.4008	0.1680	0.3754	0.0601
Primary	0.6388	0.4804	0.6000	0.4919	0.0565
Junior secondary	0.0998	0.2998	0.1120	0.3166	-0.0279
Senior secondary	0.0547	0.2275	0.0960	0.2958	-0.1106
Higher education	0.0050	0.0706	0.0160	0.1260	-0.0762
University	0.0006	0.0245	0.0080	0.0894	-0.0798

Table A2: Test for difference in normalized means in demographic characteristics by HH land dispute experience

	No land dispute		Land dispute		Norm-difference
Variable	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	
HH size	4.5948	2.0638	4.7238	2.2050	-0.0427
HH income category	3.5198	1.1658	3.5428	1.2147	-0.0137
HH head					
Age	44.9989	16.7913	43.5935	15.9747	0.0606
Gender	0.3036	0.4598	0.2955	0.4566	0.0124
Attend school	0.7980	0.4015	0.8200	0.3844	-0.0397
No education	0.2022	0.4017	0.1800	0.3844	0.0401
Primary	0.6362	0.4811	0.6618	0.4734	-0.0380
Junior secondary	0.1012	0.3016	0.0870	0.2819	0.0346
Senior secondary	0.0547	0.2275	0.0604	0.2383	-0.0171
Higher education	0.0047	0.0686	0.0109	0.1038	-0.0494
University	0.0009	0.0293	0.0000	0.0000	0.0293

Table A3: Test for difference in normalized means in demographic characteristics by HH right to sell land

Variable	**No right to sell land**		**Right to sell land**		**Norm-difference**
	Mean	**Std. dev.**	**Mean**	**Std. dev.**	
HH size	4.5604	2.1516	4.6336	2.0296	-0.0247
HH income category	3.4599	1.1771	3.5593	1.1642	-0.0600
HH head					
Age	44.6502	17.0980	45.0225	16.5032	-0.0157
Gender	0.3282	0.4696	0.2874	0.4526	0.0626
Attend school	0.7861	0.4101	0.8080	0.3939	-0.0384
No education	0.2144	0.4105	0.1920	0.3939	0.0393
Primary	0.6279	0.4834	0.6446	0.4787	-0.0246
Junior secondary	0.0971	0.2961	0.1018	0.3024	-0.0112
Senior secondary	0.0549	0.2278	0.0553	0.2287	-0.0014
Higher training	0.0047	0.0683	0.0056	0.0743	-0.0086
University	0.0010	0.0322	0.0006	0.0252	0.0099

Table A4: Interaction effects of land tenure security measures on the impacts of drought on change in consumption measure in Malawi

Variables	Dependent variable: Consumption change		
	Title ownership	Dispute-free land	Right to sell
	(1)	(2)	(3)
Drought	-0.220	-0.279	-0.162
	(0.189)	(0.590)	(0.246)
Interaction	0.000	0.088	-0.065
	(0.000)	(0.587)	(0.200)
Constant	-0.241**	1.450*	1.421*
	(0.121)	(0.738)	(0.724)
Household Fixed Effect			
Year Fixed Effect			
Controls			
Observations	2,313	2,329	2,334
R-squared	0.074	0.076	0.076

Notes: Robust standard errors (clustered at the enumeration area level) are reported in parentheses. ***, ** and * represent significance at 1%, 5% and 10% levels respectively.

Mission

To strengthen local capacity for conducting independent, rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

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