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Gendered Effect of Climate Shocks on Resilience to Food Insecurity: the Role of Kinship Norms

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Gendered effect of climate shocks on resilience to food insecurity: the role of kinship norms. *

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Abstract

Social and cultural institutions interact with environmental and individual factors, shaping resilience against external shocks. Limited evidence exists regarding the impact of social and cultural norms on climate-induced food insecurity resilience. This study examines the influence of kinship norms on gender-specific food resilience outcomes among rural households facing drought. Leveraging data from the Malawi Integrated Household Survey spatially matched with climate data, matrilineal-matrilocal villages exhibit higher resilience to food insecurity (dietary diversity and nutritional quality) than other communities. Households with female land management residing in Matrilineal-Matrilocal communities show greater dietary diversity resilience. However, in the case of drought, they are found to be less resilient to food insecurity than their counterparts in other areas. We find suggestive evidence of different reallocations of men's and women's work hours when hit by a drought in Matrilineal-Matrilocal and other communities, possibly explaining our main result. The study highlights the need to consider socioeconomic, cultural, and ecological interactions when assessing resilience and advocates policies enhancing women's agricultural resilience and a broader range of outside options.

Keywords: Development resilience, Food security, Kinship norms, Gender, Drought, Malawi.

JEL codes: J16, Q15, Q18, Q54, Z13.

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1 Introduction

Climate-related vulnerability is recognized to differentially affect genders (IPCC, 2014), and climate shocks can exacerbate gender gaps in well-being outcomes such as food security. Women are fundamental in guaranteeing crop production and households' access to food and nutrition security (Doss et al., 2014). However, their ability to provide and contribute to their households' food security is hampered by the many constraints they face, whose nature is economic, social, and cultural (Quisumbing et al., 1995). Social norms often prescribe different behaviors, decisions, and roles based on gender that are at the root of most of the adverse conditions affecting women. In farming communities, gendered cultural norms can define who makes crop choices and which crops a farmer can produce, discriminating against women (Jayachandran, 2015). Socio-cultural norms and practices influence gender gaps in vulnerability by defining gender differences in the access to and distribution of resources, decision-making power, knowledge, and skills (Neumayer and Plümper, 2007; Nelson and Stathers, 2009; Sultana, 2014; Ravon, 2014; Sugden et al., 2014; Jordan, 2018; Rao et al., 2019). While it has become common wisdom that social norms shape the way local communities respond to adverse climate events[1], the evidence on how such norms and customs mediate the impacts of climate shocks on households is still limited. This paper aims to address this knowledge gap by testing the role of cultural norms on gender gaps in the resilience capacity after a negative aggregate income shock.

Land ownership, management, transfer, and economic rights are not equally distributed between men and women (FAO and IFPRI, 2018).[2] In rural and agricultural contexts, women's higher vulnerability to poverty is determined primarily by gender gaps in ownership of land and control over productive assets that lead to allocative inefficiencies and foregone economic output (Udry and Goldstein, 2008; O'Sullivan, 2017). Land tenure security also mitigates the negative effect of droughts on food security (Ajefu and Abiona, 2020), since land and non-transferable assets are often used as collateral (Besley,

[1] See (UN Adaptation Fund's Operational Policies & Guidelines: https://www.adaptation-fund.org/wp-content/uploads/2016/04/OPG-Annex-4_GP-and-GAP_approved-March2021pdf-1.pdf

[2] According to Agarwal (1994), the gender gap in property ownership and control is the primary determinant of gender inequality.

1995; Deininger and Castagnini, 2006) thus increasing access to credit that can be used for on-farm investments to increase agricultural productivity. Therefore, culturally-based gender gaps in land ownership and access may contribute to widening gender gaps in access to credit and other productive inputs, reinforcing gender gaps in food insecurity.

This work investigates how cultural norms influence the relationship between climate shocks and gender gaps in households' resilience to food insecurity. The analysis uses panel data from the Malawi Integrated Household Survey (MIHS) collected in 2010, 2013, and 2016, including detailed food consumption information and combining grid-level weather indicators. Controlling for temporal and spatial fixed effects, we estimate OLS models to assess the interplay effect of social norms (proxied by the combination of Matrilocal and Matrilineal customs) and weather shocks (proxied by drought) on the gender gap in two different food security and resilience indicators. The identification of the effect of drought relies on its temporal and spatial variability. Food Security (FS) outcomes include the Food Consumption Score (FCS) and the Household Dietary Diversity Score (HDDS). We build on Cissé and Barrett (2018) to construct the resilience score indicators based on the FS outcomes. As for the social norms, we defined matrilineal-matrilocal communities based on a time-consistent definition of the current norm measured at the village level, which considers transitions between different kinship norms over time.[3]

Our results show that households residing in Matrilineal-Matrilocal villages present higher resilience to food insecurity. We found, however, an ambiguous effect of the role of female-biased cultural norms on gender gaps in resilience. On the one hand, households with female land management are more likely to have adequate dietary diversity, in terms of number of food groups consumed, in Matrilineal-Matrilocal (MM) communities than in others. This finding is consistent with the literature prescribing that women in Matrilineal-Matrilocal communities are better off than those living in patriarchal contexts. On the other hand, when considering the nutritional quality of food groups consumed, Matrilineal-Matrilocal households with female land management do not have better outcomes than similar households in other villages. This result highlights the im-

[3]Previous works relied on ancestral norms assigned through ethnolinguistic affiliation at the household level (Aminjonov et al., 2022); districts' classification based on ethnic group domination (more than 50% of the villages) using the 2007 National Census of Agriculture and Livestock (NACAL) (Berge et al., 2014; Asfaw and Maggio, 2018); or the current prevalent norm in the village (Lovo, 2016). To our knowledge, this is the first time-consistent definition of social norms.

portance of considering different dimensions of food security. Finally, we find that in non-Matrilineal-Matrilocal areas, when there is a drought, households with female land management are more resilient than those with male land management. At the same time, the women's empowering environment guaranteed by Matrilineal-Matrilocal traditions is not enough to offset the tremendous negative impact of droughts on households with female land management, which seems to be, in fact, the most disadvantaged group in case of droughts. Some suggestive evidence on the different reallocation of work time suggests that during droughts, in non-Matrilineal-Matrilocal areas, men show a greater engagement in wage labor, while women increase the time spent on farms. In contrast, in Matrilineal-Matrilocal communities, women do not change their working time, while men only increase their labor supply in the informal sector. Our results generally survive several robustness checks, including the control for potential norms' confounders, the use of different definitions of land management, the replacement of the current norm with the ancestral norm, the control for households' loss of income earners during splits, and the exclusion of split households from the sample.

Our paper contributes to the literature in several ways. (i) We provide new evidence of the relationship between social norms and food security. Culture is one of the main drivers of food security (WFP, 2012). As discussed by Briones Alonso et al. (2018), culture affects food security along the lines of all its four 'pillars': (i) defining *what* is considered as food and shaping *how* food is produced (availability); (ii) affecting wealth and social inclusion that in turn determine economic and social access to food (access); (iii) shaping ways to process and prepare food (utilization); and (iv) determining efficiency and sustainability of resource use through, for example, the transmission of dietary rules and the selection of crop varieties (stability). As social structures constitute the first determinant of which groups of the population are food insecure and which are not (Molnar, 1999), it is crucial to consider that gender gaps in food insecurity are both directly and indirectly defined by cultural gender norms and family structures and relations (Briones Alonso et al., 2018).

(ii) Our main contribution is to assess whether cultural norms represent an additional stressor for the gender gap in household resilience to climate shocks. The use of development resilience[4] in food security analysis is relatively recent and basically related to the emphasis put by humanitarian and development agencies on the need to integrate humanitarian (i.e., short-run, emergency) interventions and development (i.e., long-run) interventions (Montalbano and Romano, 2022).[5] Such as vulnerability (Dasgupta et al., 2010), resilience is an intrinsically intersectional[6] concept (Chisty et al., 2021; Phuong et al., 2023), where intersectionality means the interaction between identity, power dynamics, subjectivity, and domination such as emphasized by contemporary feminist approaches (Schmitt, 2013). The intersectional approach is particularly suitable to highlight how social and cultural institutions interplay with environmental and individual factors in shaping people's ability to cope with exogenous shocks. In particular, understanding the dynamic relationship between socially induced discriminations – mediated by gender differences in land ownership/management – and household food security contributes to shedding light on well-being outcomes in risk-prone contexts, providing insights on targeting interventions and designing welfare-enhancing policies. Indeed, resilience is not only a matter of economic power and opportunities but also largely determined by social and cultural factors (Weichselgartner and Kelman, 2015). The relationship between resilience and gendered sociocultural practices is crucial to understanding and addressing the power relationships based on differentials in resilience, as they can both enhance resilience or make individuals more vulnerable (Jordan, 2018).

(iii) We also contribute to the literature that studies the relationship between social norms and gender gaps in land management. In Sub-Saharan Africa (SSA), land is often managed through customary tenure systems based on various cultural practices of lineage transmission and post-marital residence. In recent times, there has been increased attention in economics to focus on the effect of cultural norms and institutions on development (Baland et al., 2020; Nunn, 2020). Bau and Fernández (2021) emphasize the importance of the interplay between culture and the family institution, recognizing that the family is a fundamental economic unit central to production and distribution and plays

[4]Development resilience can be broadly defined as "the capacity over time of a person, household or other aggregate units to avoid poverty in the face of various stressors and in the wake of myriad shocks" (Barrett and Constas, 2014: 14626).

[5]As acknowledged by the Hyogo Framework for Action, that represents the most important result of the World Conference on Disaster Reduction (UNISDR, 2005), and more recently by the UN World Humanitarian Summit (UN, 2016).

[6]The intersectional dimension of resilience is increasingly explored in the health literature (Njeze et al., 2020; Siller and Aydin, 2022) and in social and environmental sciences (Adger, 2000).

a primary role in shaping social beliefs as the initial transmitter of such values. Particular attention has been gained by the link between gender disparities in socio-economic outcomes and variations in traditional family structure (Jayachandran, 2021). Gender-biased ancestral norms regulating marriage patterns and living arrangements (e.g., endogamy or patrilocality), the transmission of lineage and inheritance (e.g., patrilineality), and marriage payments (dowries or bride price) have been studied concerning individual poverty (Calvi and Keskar, 2021; Ulugbek et al., 2023), inter-generational transfers (La Ferrara, 2007), health and education (Loper, 2019; Lowes, 2020; Dessy et al., 2023), vulnerability to climate shocks and wellbeing (Asfaw and Maggio, 2018), time of marriage and fertility outcomes (Lowes and Nunn, 2018; Corno et al., 2020), and domestic violence (Lowes and Nunn, 2018; Lowes, 2020; Alesina et al., 2021).

(iv) We provide new evidence for Malawi on the role of cultural norms as a shaper of food resilience abilities across genders. We chose Malawi as the setting of our empirical analysis because it offers the opportunity to exploit a significant intra-national variability in kinship norms of inheritance (lineage) and post-marital residence. In fact, Malawi is part of the so-called *Maltrilineal Belt*, an area characterized by ethnic groups following female-biased inheritance and residence norms. Interestingly, in Malawi, different cultural norms coexist, making this country an ideal setting to study the role that these norms play in determining economic outcomes like gender-biased land tenure insecurity (Lovo, 2016) and the gendered-differentiated effect of weather shocks on households' welfare (Asfaw and Maggio, 2018). Moreover, residency norms (matri- or patri-locality) contribute to shaping intra-household allocation of resources, thus affecting women's risk of poverty (Ulugbek et al., 2023). At the same time, Malawi is exposed to many different climate shocks - such as floods and droughts - that have been increasing in frequency, intensity, and impact over the last decades, making the issue of building resilience to climate shocks a legitimate policy objective in the country.[7]

Two main takeaways arise from our results. First, when it comes to climate-induced food insecurity, resilience capacity is not gender neutral, and the gendered patterns trig-

[7] Weather shocks in the country have had devastating effects on agricultural production, food availability, and food security (Giertz et al., 2015), as the case of the 2015-16 drought, that caused more than 365 million dollars in damages and losses, severely affecting the rural areas and especially farming (World Bank Group, United Nations and European Union, 2016).

gered by climate shocks can be different from those observed in situations not stressed by these shocks[8]. Second, cultural norms play a pivotal role in shaping these different gender-specific resilience patterns by defining channels of vulnerability and coping behaviors. Including the social norms' role in designing policy interventions is critical to improving female farmers' access, entitlement, and utilization of resilience-enhancing skills, assets, and knowledge and, therefore, to reaching food security for some of the most vulnerable households. Off-farm employment and income diversification may become particularly important when climate shocks threaten agricultural productivity. Improving women's access to outside options is fundamental, but policymakers must account for the role of social norms that limit women's sectoral mobility and, if unaccounted for, can make the policy interventions less effective.

The remainder of the paper is organized as follows: Section 2 describes kinship norms of land inheritance and post-marital residence in Malawi and justifies why resilience is used to analyze the relationship between shocks and household wellbeing. Section 3 presents the data, the data cleaning and preparation process, and describes some summary statistics of the population under scrutiny. Section 4 presents the econometric approach, describing the models used to estimate the correlation between resilience, gender, kinship norms, and climate shocks. Section 5 discusses the main results and presents several robustness checks. Section 6 concludes, highlighting the policy implications, discussing the limits of the analysis, and advancing some proposals for future research.

2 Background

2.1 Development resilience

Natural, economic, and political risks faced by individuals, households, firms, economies, and even whole countries are rising in frequency and severity (Zseleczky and Yosef, 2014). At the same time, conventional approaches to dealing with humanitarian aid

[8]Even though Malawian farmers are negatively affected not only by droughts but also by frequent flooding, the two types of events have different implications in terms of the size of the affected population and impact on agricultural production, and thus on households' food security. For this reason, we limit the analysis to droughts.

and development assistance have been questioned, calling for higher integration of humanitarian (i.e., short-run, emergency) and development (i.e., long-run, investment) interventions (UNISDR, 2005; UN, 2016. This is why resilience has become a legitimate policy objective, capturing the attention of many audiences because "it provides a new perspective on how to effectively plan for and analyze the effects of shocks and stressors that threaten the well-being of vulnerable populations" (Constas et al., 2014a: 4). In fact, the idea of resilience holds particular appeal as (i) it provides a unified response to shocks resulting from catastrophic events and crises, and to the stressors associated with the ongoing exposure to risks that threaten well-being, and (ii) it carries the meaning of a generalized ability to respond to an array of threats that have become more difficult to predict (Constas et al., 2014b).

The use of resilience in food security analysis is even more recent. There is considerable debate and ambiguity on whether it is just the flip side of vulnerability and over the very nature of resilience (Montalbano and Romano, 2022). Even focusing only on the literature explicitly dealing with the so-called "development resilience" – that is, the capacity of an individual or a household to avoid long-lasting negative consequences in terms of well-being – we can find different conceptualizations and definitions that highlight theoretical heterogeneity and lead to other measurement methods (Barrett et al., 2021). As a result, typologies of resilience and "shopping lists" of resilience properties abound (Watts, 2016: 263). By and large, the development resilience literature identifies four broad conceptualizations, namely resilience as a capacity[9], resilience as a return to equilibrium[10], resilience as transformation[11], and resilience as a normative condition, which is the approach adopted in this study.

The resilience as a normative condition approach conceptualizes resilience as a construct measured regarding a normative well-being anchoring (Barrett and Constas, 2014), which is a condition that reflects one's capacity to avoid adverse well-being states rather

[9]Resilience as a capacity (Alinovi et al., 2008; Alinovi et al., 2010; d'Errico et al., 2018; Smith and Frankenberger, 2017) treats the resilience indicator as an explanatory variable of the final outcome (e.g., any poverty or food security indicator).

[10]Resilience as the return to equilibrium is the individual/household speed of recovery from a shock (Pimm, 1984; Knippenberg et al., 2019).

[11]Resilience as transformation as emphasized in the literature on socio-ecological systems (Walker et al., 2004; Reyers et al., 2018) views transformability as a key feature of resilience reflecting the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable.

than a capacity itself.[12] Cissé and Barrett (2018) translate this conceptualization into a conditional moment-based approach econometric strategy, i.e., it estimates resilience as a conditional probability of satisfying some normative standard of living, such as a minimum per capita expenditures level, food consumption score, herd size, etc.[13] Its features have made it popular among academics doing impact evaluation (Phadera et al., 2019; Premand and Stoeffler, 2020) or trying to describe the resilience of distinct populations as the estimated measure provides clear insights on resilience change, makes possible comparisons across sub-populations, and can be aggregated from individual or household level into community, region or national resilience indicators.

The conditional moment-based approach shows clear advantages from the theoretical viewpoint vis-à-vis the other resilience approaches. In fact, the resilience score estimated using the moments-based approach is normatively anchored, it is easy to interpret being a probability, and it offers the possibility to set different thresholds. Furthermore, the resilience as a normative condition is the only approach that can measure food security in a way that meets all four of the food security measurement axioms Upton et al., 2016.[14]. In particular, the access axiom, linked to the access dimension of food security, is the entry point for the analysis carried out in this paper. In fact, the moment-based approach explicitly conditions the estimate of the agent's well-being and resilience score to a set of individual-, household-, and community-level covariates. So far, the few applications that forecast household resilience or simulate household responses to shocks are usually quite parsimonious in the number of covariates conditioning the estimates, i.e., a few socio-demographics and shocks. To the best of our knowledge, this paper is the first

[12] In doing this, this approach overcomes the major limitations of development as a return to a pre-shock condition that is the need to address a normatively undesirable initial state explicitly.

[13] For details on how this strategy is operationalized, see Annex B.

[14] According to Upton et al. (2016), an ideal FNS measure metric would satisfy four basic axioms: (i) *scale*, i.e. being able to address both individuals and groups at any scale of aggregation, including geographic regions and political jurisdictions; (ii) *time*, i.e. encompassing both predictable and unpredictable variability over time capturing the stability dimension of food security; (iii) *access*, i.e. referring to various notions of individual and collective well-being, capturing explicitly the access dimension and implicitly also the availability dimension of food security as a necessary condition for access to food; and (iv) *outcome*, i.e. focusing on dietary, health, and/or nutrition outcomes is required to capture the utilization dimension of food security. In fact, the measure of resilience as a normative condition is aggregable into different level groups (i.e. individuals, households, social groups, regions, etc.), thereby satisfying the scale axiom; the approach is explicitly dynamic and forward-looking, thereby satisfying the time axiom; the analyst can condition the moments of the FNS distribution on any of a host of economic, physical, and social factors, thereby satisfying the access axiom. By using suitable health or nutritional status measures as dependent variables, this method also satisfies the outcomes axiom.

that, besides socio-demographic variables, also includes socio-cultural norms – and the interactions thereof – to assess their interplay role in determining the relevant outcome (i.e., the resilience to food insecurity).

2.2 Gender-biased kinship norms and wellbeing

In many Sub-Saharan African countries, inheritance is the principal mechanism through which men and women obtain ownership of agricultural plots, and men are more likely to inherit land than women (Slavchevska et al., 2021). Inheritance and ownership are often guaranteed by traditional cultural norms that prescribe how material (land, assets) and immaterial (descendence and lineage) goods are transmitted from one generation to another. However, even if inheritance systems may seem to play a prominent role in defining women's access to land and other productive assets, Lovo (2016) underlines the importance of looking at the combination of inheritance practices and post-marital residence in determining men's and women's security over land and assets.

Unilineal lineages and gender-biased inheritance systems: Regarding lineage and inheritance systems, the most common pattern worldwide is to find communities characterized by practices positively biased toward men. In Patrilineal systems, the lineage is transmitted to male descendants (and males only, thus being a unilineal lineage system). In these communities, children have stronger ties with their paternal relatives, and women do not own property, as their family's land and assets are inherited by their brothers. The lineal descent usually follows lineage systems, so the estate's inheritance is gender-biased. However, some communities are where the norm is biased towards females (Giuliano, 2017). Matrilineal kinship systems, which also are unilineal but track the lineage through the mother, are characterized by stronger ties between children and their maternal relatives (Mtika and Victor, 2002). In matrilineal societies, the land is intergenerationally transmitted to female members of the kinship and, in case of the husband's death, wives do not risk losing their land. The Matrilineal Belt is a large area in south-central Africa[15], where the vast majority of matrilineal societies are found.

[15] The Matrilineal Belt intersects present-day Angola, Republic of Congo, DRC, Gabon, Malawi, Mozambique, Namibia, Tanzania, and Zambia.

Differently from Asia, where matrilineal principles are used to preserve family-owned property through primogeniture inheritance, in Sub-Saharan Africa, this inheritance practice favors an equal division norm (partible inheritance) (Platteau and Baland, 2001). However, households may leverage lineage norms to select which gender of offspring is preferred in a land tenure systems reform (Quisumbing and Otsuka, 2001) or income shocks Dessy et al. (2023). In addition, inheritance norms influence intra-household division of tasks and responsibility (Djurfeldt et al., 2018) as well as cooperation and affect domestic violence and children's health (Lowes, 2020) and education (Sear, 2008), the likelihood of receiving transfers from children (La Ferrara, 2007), and the hazard of risky sexual behaviors and HIV contraction (Loper, 2019).

Post-marital residence practices: Patrilocality consists of the practice of residing with the husband's kinship for the newly married couple. In patrilocal societies, women leave their family of origin after marriage to go live in their husband's village and extended family. On the contrary, matrilocality is the tradition prescribing that the new couple resides with the wife's kinship. The hypothesis that matrilocality precedes and favors the transition to matrilineality seems to be confirmed by anthropological studies showing a significant positive correlation between matrilocal residence and several female-biased patterns, such as inheritance of real/movable property and hereditary political succession, while there is a negative association with male-biased counterparts (Surowiec et al., 2019).

Patrilocality is associated with smaller resources allocated to women (Ulugbek et al., 2023) and is correlated with the male-skewed sex ratio (Ebenstein, 2014; Jayachandran, 2015). Combining matrilocality with matrilineality leads to stronger security over resources for women than only matrilineality (Lovo, 2016), possibly because matrilineal communities are contaminated with the patrilocal practice (Dessy et al., 2023). Matrilocality may be even more central in determining women's access to immaterial resources as the woman is not separated by her original network (kinship), comprised of her sisters and their families.

Kinship norms in Malawi: The Matrilineal Belt crosses Malawi, and most of the matrilineal communities are situated in the central and southern parts of the country, while patrilineal societies are more common in the north. The customary landholding system in Malawi is strong, as the power of the cultural beliefs that connect a specific lineage to the land they occupy is made strong by both a large number of people and the cohesion of the groups that claim a legitimate right to the land based on their lineage (Berge et al., 2014). For the majority of the ethnic groups, the land is inherited matrilineally, but it usually passes to daughters only because matrilineality in the country is often associated with the matrilocal practice, so sons are expected to leave when they marry and use their wives' land Peters, 2010.

The Chewa people, constituting the largest ethnic group in Malawi, were traditionally matrilineal and matrilocal. Cattle adoption, and pastoralism in general, are found to be usually associated with the loss of matrilineality (Holden et al., 2003), which is instead associated with extensive agriculture (Surowiec et al., 2019). However, the Chewa are likely to own cattle, mainly because of the land scarcity that characterizes the area they occupy (Richards, 1987; Radcliffe-Brown and Forde, 2015). There is also some evidence in recent years that the Chewa are adopting more patrilineal customs, with men becoming more likely to own their land and pass it on to sons (Mtika and Doctor, 2002), as tends to happen to matrilineal societies during economic development (Holden et al., 2003). The Yao, instead, forming the second largest group in the country, also traditionally matrilineal and matrilocal, historically inhabited territories with less scarcity of land and closer to railways, thus specializing in cash crops production (Radcliffe-Brown and Forde, 2015).

3 Data

3.1 Data sources and preparation

Data source: The empirical analysis uses household-level data from the Malawi Integrated Household Panel Survey 2010-2013-2016 that the Government of Malawi conducted through the National Statistical Office (NSO) under the technical and financial assistance of the Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) project of the World Bank, funded by the Bill and Melinda Gates Foundation. The Malawi Integrated Household Panel Survey (MIHPS) Program started with implementing the Third Integrated Household Survey (IHS3) in 2010/11. Households were selected with a stratified two-stage sample design to be representative at the national and rural/urban levels (NSO, 2012). A sample of 3,246 households from IHS3 was then selected for the panel survey. The Integrated Household Panel Survey (IHPS) 2013 was implemented to track and re-interview households that were previously interviewed during the IHS3, plus the new households of tracked split-off individuals, with a total panel sample of 4,000 observations that could be traced back to 3,104 baseline households, with an overall attrition rate of 3.78 percent (NSO, 2014). The Fourth Integrated Household Survey (IHS4) was conducted in 2016/17. From 1,989 households selected from the previous round, 1,908 were reached to be interviewed (4% attrition rate), for a total of 2,508 households (Sample 0 in Table 1) given by the sample expansion through the tracking of split-off individuals and the new households that they form (NSO, 2017).

Sample selection: The sample for the analysis is selected by applying the following criteria presented in Table 1: (i) households resident in rural areas; (ii) owning or cultivating plots (agricultural households); (iii) with consumption recorded by November after the end of the reference rainy season[16]; (iv) observed at least in two consecutive survey rounds[17].

The last criterion is necessary as we measure resilience as the probability of being above the food security threshold given, among other things, the previous level of food security achieved. Table 2 shows that, for the sample defined only by the first three criteria, the probability of being observed in two consecutive rounds is positively correlated with residing in a Matrilineal-Matrilocal (MM) village and with higher levels of the Spei-6 index which captures climate conditions. However, the same logistic regression

[16]The rainy season goes from November to April. Most of the agricultural production is done during the rainy season, and the reference season for the data collection is the previous one concerning the time of the interview. Households whose consumption is recorded after October 31st would have already entered a new rainy season, potentially affecting their consumption levels.

[17]Therefore, our sample includes households observed both in 2010, 2013, and 2016, and households observed only in two consecutive years.

performed after excluding households that have split over time shows no correlation with climate conditions and a strong correlation with the cultural norm: households in MM communities are more likely to be observed continuously. Column (3) of the same table shows that the probability of splitting, indeed, is positively correlated with being a household whose land is jointly managed by men and women, and negatively correlated with climate conditions and MM traditions. Therefore, one of the reasons why households in MM villages are more likely to be observed at least twice is that they are less likely to split. The use of IHS panel weights provided with the dataset by the World Bank are recalculated for each round considering attrition, therefore, they take into account the partial self-selection of the sample. Moreover, our estimates always include indicators for households who split between the first and second survey rounds and for those who split between the second and third rounds. In the robustness checks, we will also control for the loss of a member who was an income earner before the split and we will repeat the analysis by excluding split households from the sample.

The four conditions above define the so-called Sample 4. We also include an additional criterium based on the land management definition for the main analysis.

Definition of Land management: The IHS collects information about the agricultural production of the households. We know the first manager for each plot owned or cultivated by the household. The plot manager is, according to the definition provided in the MIHS questionnaire, the person who makes decisions about crops to be planted, input use, and timing of cropping activities[18]. Since a household can own or have access to more than one plot[19], we are interested in land management (LM) where a household's land is intended as the sum of all the plots a household manages. Therefore, considering only the first manager of each plot, the following combinations are possible:

- Male land management: all plots cultivated by the household have a man as the first manager (57.6% of Sample 4);
- Female land management: all plots cultivated by the household have a woman as

[18]The plot manager is not necessarily the owner or the person who decides how to spend the income from the sale of the crops produced on that plot.

[19]In our sample, households cultivate or own, on average, 3.8 different plots.

the first manager (32.9% of Sample 4);

- Joint land management: some plots have a man as the first manager and others have a woman (9.5% of Sample 4).

For the main analysis, the households whose land is jointly managed (based on the first manager only) are excluded from the sample: this is the fifth criterion applied, which defines Sample 5 of Table 1. Sample 5 has a total of 2921 observations.

In the data from the second and third survey rounds, we also have information on the second manager of each plot. We built a three-categories variable for the second land manager in a similar way as we did for the first land manager. As shown in Table 3, the gender of the first and second land managers do not coincide in most cases. For almost half of the households, the second decision-maker for all the plots is always a woman, meaning that, even in cases where men are the first manager, it is likely that the second decision-maker is a woman (34.80%). Moreover, when the first land managers are only females, in 85.2% of the cases the second land managers of household plots are also only women. To control for the role of the second land manager, in the robustness check, we replicate the analysis on Sample 4 by also including an indicator for the gender of the second land manager. Finally, to consider first and second managers together, we classify land management considering it male when all plots have men as both first and second manager (30.8% of Sample 4), female when all plots have women as first and second managers (28% of Sample 4), and joint in all other cases. The analysis is again replicated using this new definition.

Definition of Cultural norm: The cultural norm (N) is measured at the village (EA) level. The IHS community questionnaire includes a question about the prevalent type of marriage in the community with the following response options: matrilineal and neolocal, matrilineal and matrilocal, matrilineal and patrilocal, patrilineal and neolocal, patrilineal and patrilocal, or other. Following Lovo (2016), we assume female land managers to be more resilient in Matrilineal-Matrilocal (MM) communities. However, by confronting data from the three-panel rounds, the prevalent marriage type in the community is not always time consistent[20] as shown in the first part of Table 4. Therefore, the indicator of the cultural Norm takes value 1 only for communities where most households follow MM practices in all three rounds, corresponding to 31 EAs. Time-consistent MM communities are compared to any other type of prevalent norm, including the MM ones that are not time-consistent, as we assume that women face lower levels of authority and security in all these other cases. In the robustness checks, we replicate the analysis first by defining the cultural norm without restricting Matrilineal-Matrilocal traditions to time-consistent villages and then by excluding from the control group the non-time-consistent Matrilineal-Matrilocal villages.

The lineage and post-marital residence practices are intergenerationally transmitted, and it is possible to define ethnolinguistic groups sharing the same ancestral cultural norms (Murdock, 1967). Since these groups may share other common characteristics that confound the effect of lineage transmission and post-marital residence, we add language-fixed effects to control for these factors in the robustness checks. In addition, we also control for the language of the person responding to the community questionnaire, as their answer could be biased in favor of the norm practiced by their own group. Finally, we replicate the analysis by replacing the current norm measured by the survey at the village level with the districts' classification based on ethnic prevalence (more than 50% of the villages) proposed by Berge et al. (2014).

Definition of Food Security indicators: Food security, our outcome of interest (W), is measured with two different indicators: Food Consumption Score[21], and Household Dietary Diversity Score[22]. The distribution of the outcome variables is shown in Figure

[20]Transitions between different traditional systems are not uncommon and are well documented in the anthropological literature (Shenk et al., 2019; Holden et al., 2003). The main reasons for these transitions are related to subsistence transition, economic development, and colonialism.

[21]The Household Food Consumption Score (FCS) is the sum for eight food groups (staples; pulses; vegetables; fruits; meat and fish; milk products; sugar; and oils and fats) of the number of days over the past seven that foods from that group were consumed, times the quality weight for the food group (WFP, 2008).

[22]The Household Dietary Diversity Score (HDDS) is calculated as the count of the number of different food groups consumed by any household members in the seven days prior to the survey interview date. We consider 12 groups as proposed by Swindale and Bilinksy (2006): cereals; roots and tubers; pulses/legumes and nuts; vegetables; fruits; meat and poultry; fish and seafood; eggs; milk and dairy products; oil and fats; sugar, honey, and sweets; and miscellaneous.

1: they are both assumed to follow a Gamma distribution[23].

Definition of drought: The IHS provides geographical positioning system (GPS) coordinates for each enumeration area (EA) at the baseline and updates coordinates for households that moved in following waves. To protect the confidentiality of the sampled households and communities, the GPS coordinates are averaged at the enumeration area (EA) level, with a buffer for rural EA of 0-5km. GPS coordinates (latitude and longitude) allow matching household- and community-level variables with climatic data. An indicator for the drought (D) is built on the Standardized Precipitation Evapotranspiration Index (SPEI) provided by the Global Drought Monitor, which is matched with household-level observations through the GPS coordinates. The reference month used for the SPEI is April, the end of the rainy season in Malawi. We use the 6-month SPEI, typically used to capture agricultural droughts, as it also entirely covers the rainy season (November-April). SPEI data is provided with a spatial resolution of 1° (grid). Figure 2 represents the distribution of Spei 6 in the three years for Matrilineal-Matrilocal and Other communities. As we can see from the plot, the drought of 2015-16 was extremely severe and affected most of the population. For this reason, we build the dummy variable for the drought as taking value 1 when $SPEI - 6 < -1.5$ and 0 otherwise.

3.2 Descriptive statistics

Table 5 presents summary statistics for the main variables of interest. Food security indicators worsened in 2016 with respect to the previous survey rounds. In the same year, 36% of households were hit by drought, defined as $SPEI - 6 < -1.5$. About 33% of households have plots whose first manager is always a woman. Female land management seems to increase over time (from 28% in 2010 to 39% in 2016). 35% of our sample live in villages where the prevalent marriage type is Matrilineal-Matrilocal.

Looking at differences between MM communities and the others (Table 6 shows statistics for years 2013 and 2016 only), we see that the former are more severely hit by drought

[23] The Gamma distribution better reproduces the skewness of food security indicators concerning a Normal approximation.

on the intensive and the extensive margin. As expected, female land management is also more common in MM areas (43% of households *vs* 32% in other communities). Households in MM villages cultivate less land and own less livestock[24], but have more crop variety and are more likely to practice intercrop. According to the wealth index[25] dividing our sample into three wealth groups, Matrilineal-Matrilocal households are generally less wealthy and more involved in social assistance programs.

Table 7 presents differences between households with female land management and households with male land management. Households whose land is entirely managed by men present higher scores of food security indicators, are less exposed to droughts, and, on average, are more educated, larger households with younger heads. Households with male land management are wealthier, cultivate more land, and have higher cropping diversity. Interestingly, there are no significant differences in livestock ownership.

4 Empirical strategy

This paper investigates whether kinship norms mediate how climate shocks affect male and female farmers' resilience to food insecurity differently. Considering previous evidence on gendered vulnerability to climate shocks and the mitigating role of female-biased cultural norms, we expect to find similar results also for resilience to food insecurity, namely that: (i) households whose land is managed by women have lower food security (gender gap in food security); (ii) the gender gap in food security is lower in Matrilineal-Matrilocal (MM) communities; (iii) droughts reduce food security for all households; (iv) in case of drought, the gender gap in food security increases, but not (as much) in MM communities.

To summarize, the main hypothesis is that, in Matrilineal-Matrilocal communities,

[24] This is coherent with the anthropological literature on Malawi finding land scarcity in matrilineal areas (Richards, 1987; Holden et al., 2003; Radcliffe-Brown and Forde, 2015).

[25] The wealth index is constructed using the principal component analysis and is based on housing conditions and assets ownership.

households whose land is managed by women should have resilience scores more similar to households with entirely male land management than in any other community, also in cases of droughts. The reason for this expected smaller gender gap is that communities that practice matrilineality and matrilocality guarantee women access to material and immaterial resources (land and productive assets, kin support, etc.), and security over property. In a rural context where farming is the first source of livelihood for the large majority of households (IFPRI, 2022), these elements contribute to creating the conditions for better outcomes in terms of production and well-being. Moreover, as rainfed crop production is the primary economic activity (Benson and De Weerdt, 2023), climate shocks such as drought have potentially devastating effects on agricultural outputs and, in turn, on households' well-being. Access to agricultural inputs, information, innovations, and security over land property and utilization are key to protecting against weather shocks and their consequences. However, whether the higher authority and influence that women have in Matrilineal-Matrilocal communities is actually translating into higher food security resilience for their households when they are in charge of agricultural production is still to be investigated. Especially in case of exogenous shocks affecting farming activities, the probability that they can maintain adequate levels of food consumption and dietary diversity depends not only on access to resources or increased security of returns of investments but also on the ability to mobilize resources, count on support networks, differentiate income sources and, in general, implement effective coping strategies.

The objective of our empirical analysis is thus to explore the food security effect of the possible interactions among three conditions, namely (i) different land management (female vs. male), (ii) the prevalent type of norm in the community (matrilineal-matrilocal vs. any other), and (iii) experiencing or not a drought. As MM communities may be structurally different from other communities, the main specification would use a fully interacted OLS regression. A step-by-step procedure is followed, from the simplest to the most complete specification (i.e. triple interaction).

Model (1) is a simple OLS regression with no interactions, where the independent variables are: the lag of the food security indicator (W), an indicator for the drought (D), an indicator for Female Land Management (FLM), and the prevalent type of cultural Norm in the community (N). Model (2) is equivalent to the first one except for introducing the interaction term between Drought and Land Management. Model (3) instead consists of Model 1 with, in addition, the full interaction between the Norm and all other variables. Model (4), which is the main specification of interest, is a fully interacted model with respect to the Norm, as in Model 3, with, in addition, a triple interaction between Norm, Drought, and Land Management. In the model specifications below, for simplicity, the independent variable indicated is the first one on which the model is estimated, namely the food consumption indicators W, where W is, in turn, the Food Consumption Score and the Household Dietary Diversity Score. As explained later, Resilience Scores (RS) will also be regressed on the same explanatory variables. The four models are specified as follows:

Model 1:
$$\begin{aligned} W_{icgmt} =& \beta_1 W_{i,t-1} + \beta_2 D_{gt} + \beta_3 FLM_{it} + \beta_4 N_c + \\ &+ \delta_1 S^{13}_{it} + \delta_2 S^{16}_{it} + \alpha_t + \alpha_m + \alpha_g + \epsilon_{icgmt}, \end{aligned} \tag{1}$$

Model 2:
$$\begin{aligned} W_{icgmt} =& \beta_1 W_{i,t-1} + \beta_2 D_{gt} + \beta_3 FLM_{it} + \beta_4 N_c + \beta_5 \mathbf{D_{gt}} \times \mathbf{FLM_{it}} + \\ &+ \delta_1 S^{13}_{it} + \delta_2 S^{16}_{it} + \alpha_t + \alpha_m + \alpha_g + \epsilon_{icgmt}, \end{aligned} \tag{2}$$

Model 3:
$$\begin{aligned} W_{icgmt} =& \beta_1 W_{i,t-1} + \beta_2 D_{gt} + \beta_3 FLM_{it} + \beta_4 N_c + \\ &+ \beta_6 \mathbf{W_{i,t-1}} \times \mathbf{N_c} + \beta_7 \mathbf{D_{gt}} \times \mathbf{N_c} + + \beta_8 \mathbf{FLM_{it}} \times \mathbf{N_c} + \\ &+ \delta_1 S^{13}_{it} + \delta_2 S^{16}_{it} + \delta_3 S^{13}_{it} \times N_c + \delta_4 S^{16}_{it} \times N_c + \\ &+ \alpha_t + \alpha_m + \alpha_g + \sum_t \gamma_t N_c + \sum_m \gamma_m N_c + \sum_g \gamma_g N_c + \epsilon_{icgmt}, \end{aligned} \tag{3}$$

Model 4:
$$\begin{aligned} W_{icgmt} =& \beta_1 W_{i,t-1} + \beta_2 D_{gt} + \beta_3 FLM_{it} + \beta_4 N_c + \beta_5 D_{gt} \times FLM_{it} + \\ &+ \beta_6 W_{i,t-1} \times N_c + \beta_7 D_{gt} \times N_c + \beta_8 FLM_{it} \times N_c + \\ &+ \beta_9 \mathbf{D_{gt}} \times \mathbf{FLM_{it}} \times \mathbf{N_c} + \\ &+ \delta_1 S^{13}_{it} + \delta_2 S^{16}_{it} + \delta_3 S^{13}_{it} \times N_c + \delta_4 S^{16}_{it} \times N_c + \\ &+ \alpha_t + \alpha_m + \alpha_g + \sum_t \gamma_t N_c + \sum_m \gamma_m N_c + \sum_g \gamma_g N_c + \epsilon_{icgmt} \end{aligned} \tag{4}$$

where i denotes households, c indicates the community (enumeration area), g is a spatial indicator (grid), m denotes the month in which (food) consumption is measured, and t indicates the year. The inclusion of the lag of the dependent variable W follows Cissé and Barrett (2018), as this dynamic approach aims at calculating the resilience score as the probability of being above an adequacy threshold conditioning to the previous level of food security achieved and other factors of interest (look at Annex B for further clarification). The variable D is an indicator equal to 1 if there is a drought and 0 otherwise. The variable FLM is equal to 1 if all land owned or cultivated by the household is managed by women (first manager) and 0 if it is all managed by men. N is the binary variable for cultural norm, defined as the prevalent marriage type in the community, and is equal to 1 if the community in which the household resides is Matrilineal-Matrilocal and 0 otherwise. N is the variable that fully interacts with other independent ones in models (3) and (4). S^{13} and S^{16} are dummy variables indicating if the household split between 2010 and 2013 or between 2013 and 2016. The terms α_t, α_m, and α_g are year, consumption month, and spatial (grid) fixed effects, respectively. Identification of the effect of drought and social norms relies on their temporal and spatial variability in our sample upon controlling for time and spatial fixed effects. As for the social norms, in Malawi, they are generally spatially polarised (Dessy et al., 2023), so grid-fixed effects should capture all time-invariant factors that may correlate with them. Nonetheless, we also conducted robustness checks to eliminate potential confounders (see Section 5.2). In models (3) and (4), $\sum_t \gamma_t N_c$, $\sum_m \gamma_m N_c$, and $\sum_g \gamma_g N_c$ allow the three effects to depend on whether the community is prevalently Matrilineal-Matrilocal. The error term is represented by ϵ. All models are estimated clustering standard errors at two levels: enumeration areas (EA) to capture village effects and household level, considering the parent-household for split-offs. Observations are weighted with panel weights.

For Model (4), which is the main specification of interest, our main hypothesis would imply that $\beta_8 > 0$, meaning that, in MM communities, households with female land management have food security (and resilience) levels more similar to households with male land management than in non-MM villages. In other words, we expect the gender gap in resilience to food insecurity to be smaller in MM communities. At the same time, droughts are expected to worsen households' food security. The coefficient of the triple interaction, β_9, is expected to be positive if, when hit by a drought, households with female land managers in MM communities are more resilient than similar households in other communities and negative if they are less resilient.

Each model is estimated for each outcome W (i.e., FCS and HDDS) and its related resilience score (RS). RS is estimated by adopting the methodology proposed by Cissé and Barrett (2018)[26], which consists of a three-step procedure applied to panel data to estimate the conditional probability of satisfying some normative standards of well-being. The resilience scores are computed against different indicator-specific thresholds, namely: (i) $FCS > 35$ and $FCS > 44$ are used, as the first is the official threshold defining "borderline" food consumption status (WFP, 2008) while the second corresponds to the adequacy limit for rural Malawi according to Lovon and Mathiassen (2014); (ii) $HDDS > 5$ and $HDDS > 7$, where five corresponds to the five groups (fruits, vegetables, pulses, nuts, and whole grains) which make a healthy diet according to the WHO Healthy Diet Fact Sheet (WHO, 2020), and seven is instead associated with the lowest risk of micronutrient adequacy in Zhao et al. (2017).

5 Results

5.1 Main results

The four models are estimated separately for each outcome and its relative resilience scores, measured against different thresholds. As expected, RSs measured against the lower thresholds for both indicators are higher. This is particularly true for the HDDS, as, on average, the probability of being above the threshold of 5 is 97%. Considering the national-specific threshold for the Food Consumption Score (44), the estimated average probability of having sufficient food consumption is only 41% in the whole sample. Resilience to loss in dietary diversity is generally higher than resilience to loss in terms of food consumption scores, which captures both access and nutritional quality of food consumed.

[26]For details on how the resilience score is estimated, see Annex B.

Table 9, reporting results of Model 1, shows that, as expected, drought negatively affects food security outcomes and resilience to food insecurity, while female land management is negatively associated with the same outcomes. Apparently, also residing in a MM area is associated with lower resilience to food insecurity. As expected, the dynamic path of resilience captured by the lagged indicator of food security has a positive correlation with all the outcomes. Table 10 reports the results for the model with the single interaction between Drought and Female Land Management (Model 2). In the case of drought, households with female land management present higher food security (and resilience to food insecurity) than households with male land management. Other coefficients have signs and statistical significance consistent with findings from Model 1.

In order to take into account possible structural differences between MM and non-MM communities, in Model 3 we interact the norm with all other covariates. Table 11 shows that food security and resilience in case of droughts are higher in MM communities than in others. Interestingly, we find mixed results for female land management in MM communities: while it is associated with a higher probability of having adequate dietary diversity with respect to households with female land management in other villages, the correlation with the FCS-based resilience is negative. Therefore, it seems that women farmers in MM communities are more able to preserve the dietary diversity of their households when hit by a drought, but probably at the expense of the amount of food consumed. As we explored in the descriptive statistics, households in MM areas have, on average, higher crop diversification and are more likely to practice intercropping, which might explain both why droughts threaten less food security in these areas and why MM households are more likely to achieve good levels of dietary diversity. Indeed, even if crop diversification does not directly translate into higher dietary diversity (maybe because different crops grown still belong to the same food groups), droughts might differently damage the crops, thus diversifying the risk associated with climate shocks.

Finally, results from the last model (Table 12) allow us to understand the combined effects of droughts, the gender of the land manager, and cultural norms better. Findings from the previous models are confirmed. To summarize: MM areas present higher levels of food security; drought reduces resilience to food insecurity in non-MM communities more than in MM communities; in non-MM villages, female land management is weakly correlated with lower resilience scores with respect to male land management, while in MM communities, female land management is correlated with a higher probability of having adequate dietary diversity than male land management. The latter result shows the importance of considering different food security dimensions when assessing people's resilience to food insecurity. In addition, the interaction between female land management and drought shows that, when experiencing a drought, households with female land management in non-MM communities are more resilient than households with male land management. Table 8 provides some suggestive evidence showing that, in the case of drought, households in non-MM villages have wider outside options than their counterparts in MM communities. Indeed, men in non-MM villages increase wage work, while women report a higher labor supply in household agricultural activities. This mechanism would explain why households in non-MM villages show higher food security when drought occurs with respect to households in MM communities.

On the other hand, the coefficient of the triple interaction between Norm, Female Land Management, and Drought shows that households with female land management in MM communities, when hit by drought, report lower resilience scores, both in terms of food consumption and dietary diversity, than similar households in other villages. The graphical representation of the distribution of Resilience Scores for different groups defined by these three variables in the interaction term (Figure 3) shows exactly that the gender gap in resilience, concerning dietary diversity, is lower in MM than in other communities in normal times. However, when there is a drought, most of the households with female land management in MM areas present low resilience scores, while the distribution of resilience scores is skewed on the right (towards higher resilience levels) for households with male land management in MM communities and for households with female land management in non-MM communities. As a support to this result, Table 8 shows that in MM villages, there are no significant changes in women's work time allocation, while men tend to work more but only in the informal, less remunerative sector (casual and part-time labor).

5.2 Robustness checks

Several robustness checks are presented to show whether the correlation of our main variables of interest with resilience scores changes if we control for additional variables or modify the sample selection or the definition of our main variables. In particular, we replicate the analysis by: (i) adding demographic, agricultural, and social safety net controls; (ii) controlling for possible interactions between the effect of the cultural norm and ethnicity, changing the definition of the indicator for Matrilineal-Matrilocal villages based on time-consistency, and replacing the current norm with the ancestral one; (iii) controlling for the gender of the second land manager, including households with joint land management in the sample, and using a definition of land management that considers first and second plot's manager together; (iv) controlling for split households who lost an income earner and excluding all households that ever split from the sample. All these additional estimations are based on Model 4 and measuring resilience scores for the two indicators as the conditional probability of being above the higher threshold (44 for FCS and 7 for HDDS).

Richer model: Our base specification is extremely parsimonious. So far, we have measured households' resilience to food insecurity as a probability conditioned only to the lagged value of food security, having experienced a drought, having female (vs. male) land management, and living in a community that prevalently follows Matrilineal-Matrilocal traditions vs any other prevalent norm. However, there are several other characteristics that can contribute to shaping a household's resilience. To control for the potential omitted variable bias, we replicate the estimation of our main model, the one with the triple interaction between Drought, Female Land Management, and cultural Norm, by adding, in turn (and then all together), the following set of controls: (i) demographic characteristics such as household size, age of the household head, average education of adult members, and demographic dependency ratio; (ii) characteristics of the agricultural activities such as the total extension of land cultivated, diversification of crops grown[27], whether the household practice intercropping, and the amount of livestock owned[28];

[27]Crop diversification is measured with the Simpon's Diversity Index.
[28]Livestock holdings are measured in Tropical Livestock Units (TLU).

(iii) relative wealth[29], and participation in the following social assistance programs: Free Maize Programme, Free Food (other than maize) Programme, Food or Cash for Work Programmes[30], and child feeding programs[31]. Figure 4 compares coefficients of the main variables of interest obtained by estimating the original Model 4 without additional controls and then adding each set of control variables separately and then all together. As Model 4 is characterized by the full interaction of covariates with the Norm, additional control variables also interact with the Norm, allowing us to isolate potential structural differences in the contribution of each element to households' resilience in Matrilineal-Matrilocal communities with respect to others. We can see that results are very robust to the inclusion of additional variables, with no variation in the direction of the correlations and small changes in the magnitude of coefficients and width of the confidence intervals. The negative effect of drought decreases in magnitude when controlling for social safety nets and relative wealth.

Ethnicity and cultural Norm: Cultural traditions transmitted from one generation to the other are likely to correlate with other ethnic-specific traits. The IHS survey collects information about the main language spoken by the household that indicates the ethno-linguistic group to which they belong and with which they share values and traditions. Table 13 reports the percentage of languages households speak in Matrilineal-Matrilocal vs. other communities. The largest ethnic group in the country, Chewa, representing almost 65% of our sample, is the largest group both in MM and other areas. Indeed, whether the Chewa are known to follow Matrilineal systems traditionally, they do not necessarily practice Matrilocality (Berge et al., 2014). Other ethnic groups instead are prevalently found in MM villages, such as the Yao and Ngoni. To control for possible confounding factors linked with ethnic group characteristics, we replicate the analysis by adding to Model 4 language fixed effects and interacting them with the Norm. Ta-

[29]Relative wealth is measured with a wealth index constructed with Principal Component Analysis applied to households' housing condition, domestic durable assets owned, agricultural productive assets and ownership of land. The first principal component is assumed to be the wealth score, and the wealth index is then based on the tertiles of the score. The PCA is performed separately for each survey round and using only our selected sample of rural agricultural households observed at least in two rounds (Sample 4).

[30]From 2013, they include both the Malawi Social Action Fund (MASAF) of the Government and non-MASAF programs.

[31]Child feeding programs include: School Feeding Programmes, Targeted Nutrition Programmes, and Supplementary Feeding for the Malnourished Programme.

ble 5 compares the coefficients estimated with the original Model 4 with the estimates obtained by adding ethnicity fixed effects. Results for the main variables of interest are stable, but the positive correlation between living in a MM community and resilience measured with the FCS is lower in magnitude, suggesting that part of the positive effect of living in an area prevalently Matrilineal-Matrilocal is actually driven by other characteristics of the ethnic groups living in those areas but not strictly correlated with the prevalent marriage type in the community. However, there is no change in the resilience scores measured on the HDDS.

As the community norm is derived from the community questionnaire of the IHS, in order to control for possible reporting bias due to the respondent's preferences for the traditions handed down by their group, we estimate Model 4 by adding fixed effects for the language of the respondent to the community questionnaire, interacted with the cultural Norm[32]. Again from Table 5, we see that the sign of the correlation coefficients from Model 4 estimated with respondent's languages fixed effects does not change with respect to the base estimation in most of the cases.

To deal with the time inconsistency of reported community norms in the IHS, we initially defined MM villages as those where Matrilineal-Matrilocal was the prevalent marriage type in all three survey rounds. We test for the robustness of our results by excluding from the control group all villages that have been identified as Matrilineal-Matrilocal only in some survey rounds but not always. The correlation between Matrilineality-Matrilocality and resilience to food insecurity becomes not statistically significant, while changes in the effect of drought on FCS-based resilience must be attributed to the low number of villages affected by droughts in the non-MM group. Despite these changes, female land management in MM areas is still associated with lower resilience to food insecurity in times of drought, with a negative correlation that is even stronger for HDDS-based resilience.

Finally, we substitute the current norm measured at the community level with the ancestral norm defined at the district level by Berge et al. (2014)[33]. They classify districts

[32]Based on our calculations from the sample used for the analysis, the correlation between households' language and own community respondent's language is only 38.5%, suggesting that the community respondent does not necessarily belong to the largest ethnic group in the community.

[33]Using the 2007 National Census of Agriculture and Livestock, Berge et al. (2014) identify for each

into three groups: (i) Patrilineal, (ii) Matrilineal-Virilocal, and (iii) Matrilineal. In this case, therefore, districts are classified mostly based on the prevalent lineage/inheritance norm, except for the second group, which also considers post-marital residence (in favor of men) since it is opposed to the inheritance norm (in favor of women). Following Asfaw and Maggio (2018), we build an indicator for the ancestral norm that takes value 1 when the district has been considered Matrilineal, and 0 otherwise. The correlation between the ancestral norm and the current norm is 61%. With this definition, 60% of our sample is considered Matrilineal. Larger confidence intervals of estimated coefficients are due to the ancestral norm classifying a larger number of households as Matrilineal. The positive correlation between resilience and Matrilineality holds for what concerns dietary diversity. Non-matrilineal households with female land management are still less resilient than households with male land management belonging to the same cultural traditions. Using the ancestral norm, we find a small positive effect of Matrilineal-Matrilocal traditions on the resilience of households with female land management for what concerns dietary diversity, and no effect on FCS-based resilience. The negative effect of droughts on resilience scores for Matrilineal households with female land management is confirmed only for HDDS-resilience, while the coefficient for the FCS-based resilience is not statistically different from zero (however, it maintains the negative direction).

Land Management: As we also have information on the second manager of each plot, we can control for the gender of the second land manager (male, female, or joint). Therefore, we can estimate Model 4 by controlling for the gender of the second land manager. Results are consistent with those obtained with the original specification.

The base results presented so far were based on a sample that excluded households with joint land management (concerning the first manager of each household plot). To check for the possible bias induced by excluding these households (despite the small number), we reintroduce them in the sample and estimate again Model 4 on Sample 4. In this case, we add a dummy variable for joint land management and let it interact with the Norm. Table 6 shows that including households with joint land management does not significantly affect our initial results.

district the prevalent norm and the larger ethnic group.

Finally, we replace our initial land management definition, based only on the first plots' managers, with one based on the first and second managers. Namely, the new indicator for land management now takes the value of 0 when all plots have both first and second managers male (which will be the reference level), and 1 when all plots have both first and second manager female (908 households as shown in Table 3). For all other (joint) combinations, the indicator takes the value of 2. Results are confirmed only for the HDDS-based resilience.

Split households: As already discussed, joint land management and residence in non-MM communities are positively correlated with households' probability to split (Table 2). The decision to split is also affected by climatic conditions. Table 14 shows that 20% of the households in our sample split between 2010 and 2013, while 25.5% between 2013 and 2016. Of these households, 37.8% lost an income earner in 2013, and 30% in 2016 (Table 15). To control for the possible effect of the characteristics of members who left on household composition, we add to Model 4 an indicator equal to 1 if the household lost a member who was an income earner in the previous round. The coefficient estimates for the variables of interest are not affected by the inclusion of this new covariate (Table 7).

We also replicate the analysis excluding households that ever split (and their split-off) from the sample. Households with female land management in MM areas are now more resilient regarding Food Consumption Score than similar households in other communities, meaning that the negative correlation previously found was probably driven by households that split. Also, the positive effect of Matrilineality-Matrilocality on the correlation between female land management and HDDS-based resilience is now stronger. This might suggest that, in normal times (no climate shock), households with female land management with lower resilience to food insecurity are those observations more likely to split. On the other hand, in times of drought, households with female land management in MM communities that do not split are even less resilient, suggesting that splitting (due mainly to marriage and migration) can be an effective coping strategy in case of climate shocks. Other results are consistent with previous estimates.

Model without the lag of the dependent variable: Including the lag of the dependent variable in the estimation of the resilience score might induce biased estimates, particularly for the first moment condition used to calculate the household-specific probability of being above the threshold. To check for this potential bias, we replicate the analysis estimating Model 4 without the lag of the food security indicator. Comparison of coefficients in Table 8 shows that the inclusion of the lagged dependent variable in the estimation of the first-moment condition does not lead to different estimates for the main coefficients of interest. Drought's negative effect on resilience is smaller and more similar between MM and other communities. Matrilineal-Matrilocal communities are still more resilient than others but less than before regarding the Food Consumption Score.

6 Concluding remarks

Climate shocks affect disproportionately more women than men, further widening the existing gender gaps. Cultural practices prescribe different roles and powers in a society based on gender, contributing to such gaps and making women more vulnerable to shocks. The interaction between climate shocks and social norms can negatively affect household and individual well-being and must be carefully understood. This study aims to investigate the interplay between cultural norms, gender gaps in food resilience, and the effects of climate shocks on agricultural households' well-being in rural Malawi. This intersectional approach to resilience highlights how social and cultural institutions interact with environmental and individual factors in shaping people's ability to cope with exogenous shocks. To our knowledge, this is the first study that assesses the combined effect of gender differences in land management, kinship norms of land inheritance and post-marital residence, and climate shocks (i.e., drought) on development resilience.

The objective of our empirical analysis is thus to explore how resilience to food insecurity is affected by the interaction of three conditions, namely (i) different land management (female vs. male), (ii) the prevalent type of Norm in a community (matrilineal-matrilocal vs. any other), and (iii) experiencing or not a drought. We exploit household and community information available in three rounds (2010, 2013, and 2016) of the Malawi Integrated Household Survey (MIHS), spatially matched with an exogenous measure of drought. We adopt the normative condition approach to resilience as proposed by Barrett and Constas (2014), and we measure development resilience with the estimation strategy developed by Cissé and Barrett (2018) by using two different indicators of food security (Food Consumption Score and Household Dietary Diversity Score) and considering two different normative thresholds of each indicator. In Matrilineal-Matrilocal (MM) areas, food security levels are generally higher, while droughts have a stronger negative impact on non-MM communities. Moreover, gender dynamics interact with resilience: female land management in non-MM communities is associated with lower resilience scores than male land management; in MM communities, female land management correlates with a higher probability of achieving dietary diversity.

When experiencing a drought, households with female land management in MM communities, when hit by drought, are less resilient than similar households in other communities. We find suggestive evidence that households in non-MM villages have wider outside options than their counterparts in MM communities in case of drought. Our results generally survive several robustness checks, namely: controlling for demographic and agricultural characteristics of the households and access to social safety nets; controlling for possible confounding factors of the cultural Norm (i.e., ethnicity) and using the districts' lineage classification from Berge et al. (2014); changing the sample of analysis by, in turn, introducing households with joint land management, eliminating villages whose norm change over time, and dropping split households.

In summary, our research provides additional evidence that resilience capacity concerning climate-induced food insecurity is not gender-neutral. Moreover, we show the pivotal role of cultural norms in shaping gender-specific resilience levels and their changes in response to climate shocks. We provide new evidence that gender gaps in food security and vulnerability to shocks are driven by sociocultural factors that contribute to determining different access to resources and decision-making power for men and women. There are reasonable concerns that these gaps might be even aggravated by gender disparities in resilience to climate shocks.

The synergetic effects of gender gaps in vulnerability and resilience might have devastating consequences on the well-being of female farmers and their households. As economic development tends to modify cultural traditions in a more male-oriented way (i.e., livestock ownership and intensive agriculture), such as documented in the anthropological literature (Holden et al., 2003; Shenk et al., 2019), it is important to guarantee outside options for women and increase support for their agricultural activities. Empowering female farmers, improving their access to resources, and enhancing their skills are crucial steps in building resilience against food insecurity. In addition, fostering the creation of off-farm jobs would allow households to use income diversification as a strategy to improve their absorptive, adaptive, and transformative capacity, thus enhancing their resilience to climate shocks. However, such efforts might be ineffective if these policy interventions do not account for local social norms. These results indicate how the combination of cultural and economic factors may be used to improve policies targeted at vulnerable households. Nonetheless, future research should focus on the individual-level food security outcomes to disentangle possible gender-differentiated consequences hidden in the intra-household allocation process. Finally, in light of the evidence of transitions between different traditional systems also found in the MIHS, further investigation is needed to assess what is more relevant between ancestral and current norms in determining sociocultural factors relevant in the resilience framework.

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Annex A: Tables and Figures

Table 1: *Number of observations after the application of each selection criteria*

Criteria applied	Survey round				Name
	2010	2013	2016	Total	
Original panel	1619	1990	2508	6117	SAMPLE 0
1. Rural households	1144	1434	1841	4419	SAMPLE 1
2. Agricultural households[a]	1085	1312	1672	4069	SAMPLE 2
3. Consumption recorded by 31Oct[b]	1085	1312	1381	3778	SAMPLE 3
4. Observed in 2 rounds[c]	1006	1216	1020	3242	SAMPLE 4
5. No Joint Land Management[d]	907	1099	915	2921	SAMPLE 5

[a] Agricultural households are those who report to own or cultivate some land.
[b] Consumption recorded after October 31 following the reference (previous) rainy season (November-April) would fall into the new rainy season.
[c] Households not observed in at least two consecutive rounds are eliminated because exploiting lagged variables would not be possible.
[d] Keep only households whose whole land (meaning every plot) has either men or women as first managers.

Table 2: *Endogeneity of sample selection*

	(1)	(2)	(3)
	Sample 3	Never split only	Sample 3
Dependent variable:	**Observed in 2 rounds**		**Split**
Food Consumption Score (FCS)	0.007	-0.008	0.007
	(0.008)	(0.016)	(0.005)
Household Dietary Diversity Score (HDDS)	-0.085*	-0.065	-0.014
	(0.052)	(0.114)	(0.031)
Female Land Management	-0.163	-0.147	0.133
	(0.161)	(0.318)	(0.115)
Joint Land Management	-0.418*	-0.586	0.300**
	(0.239)	(0.404)	(0.143)
SPEI-6	0.553***	0.094	-0.123***
	(0.086)	(0.195)	(0.046)
Norm (1=Matrilineal-Matrilocal)	0.390**	0.899**	-0.272**
	(0.171)	(0.374)	(0.129)
N. obs.	3776	1822	3776
N. clusters	1728	703	1728
Pseudo R^2	0.03	0.03	0.01

Author's calculations from pooled Sample 3 (rural, agricultural households with consumption recorded by 31st October after the reference rainy season) selected from the IHS panel. In column (2), we restrict to never split households from Sample 3. Logit model whose the dependent variable is, in turn, an indicator equal to 1 when the household is observed at least in 2 consecutive survey rounds and an indicator equal to 1 if the household split at least once. Female and Joint land management are measured with respect to the first manager of each household's plot: female if every plot has a woman as the first manager. The 6-month SPEI (Standardized Precipitation Evapotranspiration Index) captures climate shocks. Standard errors in parentheses: errors are clusterized at the household level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: *Land Management*

		Second Land Manager			
		Male	Female	Joint	Total
First Land Manager	Male	999	780	66	1845
		61.82	34.80	3.38	100.00
		88.08	41.28	17.61	57.57
	Female	152	908	16	1076
		13.48	85.24	1.28	100.00
		10.98	57.85	3.81	32.93
	Joint	11	14	296	321
		3.97	4.47	91.56	100.00
		0.93	0.87	78.58	9.49
	Total	1162	1702	378	3242
		40.40	48.53	11.06	100.00
		100.00	100.00	100.00	100.00

Author's calculations from Sample 4 selected from the IHS panel, pooled for 2013 and 2016. Gender of the first and second land managers refers to the gender of the manager of all household plots: if all plots have a man (woman) as the first manager, the first land manager is "Male" ("Female"); if some plots have the first manager male and others are primarily managed by women, the first land manager is "Joint". Similarly, for the second land manager.

Table 4: *Number of EAs per prevalent type of norm in the community*

	Survey round			
	2010	2013	2016	Total
First type of marriage in the community:				
Matrilineal and neolocal	14	6	9	29
Matrilineal and matrilocal	49	56	63	68
Matrilineal and patrilocal	27	36	9	72
Patrilineal and neolocal	6	2	7	15
Patrilineal and patrilocal	5	1	6	12
Other / Not reported	1	1	8	10
Time-consistent Norm:				
Matrilineal-Matrilocal	31	31	31	93
Any other	71	71	71	213
Total	102	102	102	306

Enumeration areas corresponding to the original sample of the Malawi IHS panel. Communities whose prevalent Norm is Matrilineal-Matrilocal in every round (time-consistent) are pitted against any other community where either the prevalent norm is not Matrilineal-Matrilocal or where Matrilineal-Matrilocal is the first type of marriage only in some rounds.

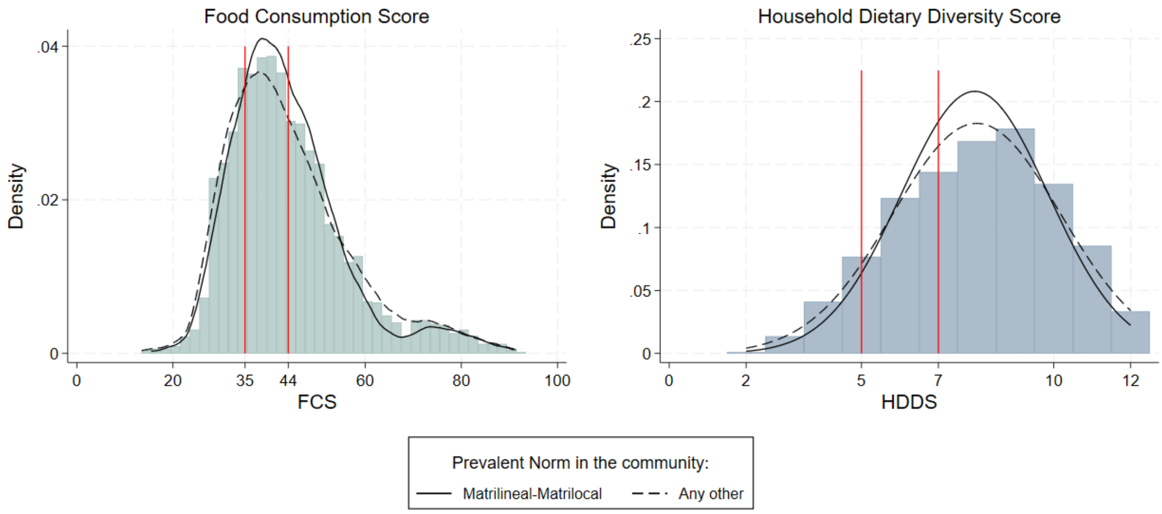

Figure 1: *Distribution of Food Security indexes*

Source: authors' elaboration from Sample 4 selected from the Malawi IHS panel. Vertical red lines indicate the threshold chosen to calculate Resilience Scores. Black solid and dashed lines indicate the distribution of each outcome in the sample population living in Matrilineal-Matrilocal and other villages, respectively: Kernel density is used for FCS, while Normal distribution is used for HDDS to approximate the density of discrete data better.

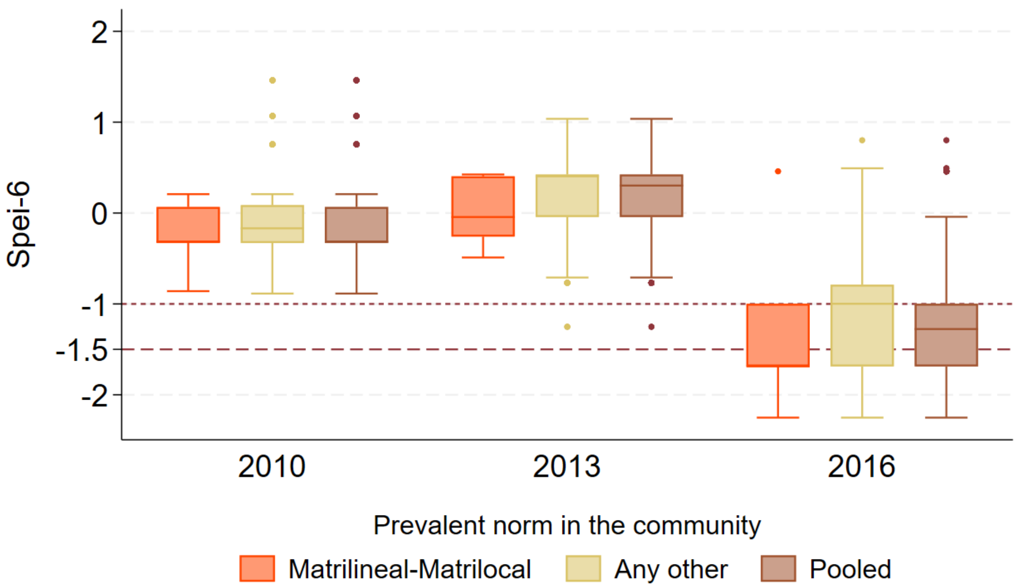

Figure 2: *Distribution of SPEI 6 by year and prevalent norm in the community*

Source: authors' elaboration from Sample 4 selected from the Malawi IHS panel. Observations are weighted with IHS panel weights. The horizontal lines correspond to the two SPEI values most used to define droughts.

Table 5: *Summary statistics*

	2010			2013			2016			Pooled		
	N.	mean	sd	N.	mean	sd	N.	mean	sd	N.	mean	sd
Food Consumption Score	1006	45.38	12.68	1216	45.72	12.26	1020	42.11	13.28	3242	44.54	12.82
Household Dietary Diversity Score	1006	8.18	2.14	1216	8.35	2.13	1020	7.43	1.90	3242	8.01	2.10
Spei-6	1006	-0.16	0.45	1216	0.18	0.50	1019	-1.22	0.69	3241	-0.37	0.78
Drought (Spei-6 < -1.5)	1006	0.00	0.00	1216	0.00	0.00	1020	0.36	0.48	3242	0.10	0.31
Land Management:												
Female LM (1st manager)	1006	0.28	0.45	1216	0.34	0.47	1020	0.39	0.49	3242	0.33	0.47
Joint LM (1st manager)	1006	0.10	0.29	1216	0.09	0.28	1020	0.10	0.30	3242	0.09	0.29
Female LM (1st and 2nd manager)	0	.	.	1216	0.27	0.45	1020	0.29	0.45	2236	0.28	0.45
Joint LM (1st and 2nd manager)	0	.	.	1216	0.55	0.50	1020	0.56	0.50	2236	0.55	0.50
Norm (1=Matrilineal-Matrilocal)	1006	0.37	0.48	1216	0.35	0.48	1020	0.32	0.47	3242	0.35	0.48
Household size	1006	4.91	2.16	1216	5.10	2.23	1020	5.10	2.17	3242	5.02	2.19
Dependency ratio	1006	0.50	0.23	1216	0.51	0.23	1020	0.48	0.23	3242	0.50	0.23
Employed ratio	0	.	.	1178	0.08	0.21	979	0.07	0.17	2157	0.07	0.19
Casual workers ratio	0	.	.	1178	0.35	0.48	979	0.57	0.53	2157	0.46	0.52
Female headed household	1006	0.24	0.43	1216	0.28	0.45	1020	0.29	0.46	3242	0.27	0.44
Household head's age	1006	43.07	16.35	1216	46.22	16.11	1020	47.77	15.74	3242	45.36	16.23
Average adults' education	1006	4.69	3.13	1215	5.02	3.06	1020	5.21	2.87	3241	4.94	3.04
Wealth Index	1006	2.01	0.82	1216	2.04	0.82	1020	2.06	0.82	3242	2.03	0.82
Arable land (ha)	1006	0.75	0.62	1216	0.70	0.62	1020	0.77	0.69	3242	0.74	0.64
Number of plots	0	.	.	1200	3.65	2.34	1013	3.90	2.75	2213	3.78	2.55
SDI for crops[a]	0	.	.	1200	5.06	5.90	1013	7.12	9.51	2213	6.08	7.96
Intercropping	0	.	.	1200	0.41	0.49	1013	0.36	0.48	2213	0.38	0.49
Livestock (TLU)[b]	1006	0.19	0.75	1216	0.26	1.36	1020	0.19	0.67	3242	0.21	0.96
Free Maize Programme	1006	0.01	0.12	1216	0.14	0.35	1020	0.13	0.34	3242	0.09	0.28
Free Food Programme[c]	1006	0.02	0.14	1216	0.11	0.31	1020	0.08	0.28	3242	0.06	0.24
Food/Cash for Work Proggramme[d]	1006	0.03	0.16	1216	0.17	0.38	1020	0.08	0.27	3242	0.08	0.28
Child feeding Programmes[e]	1006	0.13	0.34	1216	0.18	0.38	1020	0.14	0.35	3242	0.15	0.36

Author's calculations from Sample 4 selected from the IHS panel. The table reports the number of observations, mean values, and standard deviations. Observations are weighted with panel sampling weights provided by LSMS-ISA.

[a] Simpson Diversity Index (SDI) for crop diversification.

[b] Livestock holdings are measured in Tropical Livestock Units (TLU).

[c] Food other than maize.

[d] Food/Cash-for-Work Programme from 2013 includes both MASAF and non-MASAF programs.

[e] Child feed Programmes include School Feeding, Targeted Nutrition, and Supplementary feeding for the malnourished.

Table 6: *Differences between Matrilineal-Matrilocal and Other communities*

	MM comm.		Other comm.		T-test (MM-Other)	
	mean	sd	mean	sd	diff.	t
Food Consumption Score	43.27	11.51	43.67	13.07	-0.40	(-0.75)
Household Dietary Diversity Score	7.83	1.86	7.95	2.16	-0.12	(-1.32)
Spei-6	-0.63	0.85	-0.32	0.93	-0.31***	(-7.81)
Drought (Spei-6 < -1.5)	0.23	0.42	0.12	0.32	0.11***	(6.37)
Land Management:						
Female LM (1st manager)	0.43	0.49	0.32	0.47	0.11***	(5.06)
Joint LM (1st manager)	0.09	0.28	0.11	0.31	-0.02	(-1.49)
Female LM (1st and 2nd manager)	0.34	0.47	0.25	0.43	0.09***	(4.19)
Joint LM (1st and 2nd manager)	0.54	0.50	0.56	0.50	-0.02	(-1.01)
Household size	5.08	2.17	5.29	2.27	-0.21*	(-2.14)
Dependency ratio	0.51	0.23	0.50	0.23	0.01	(1.27)
Employed ratio	0.05	0.16	0.07	0.18	-0.02**	(-2.83)
Casual workers ratio	0.45	0.50	0.48	0.54	-0.03	(-1.23)
Female-headed household	0.33	0.47	0.25	0.43	0.08***	(3.76)
Household head's age	45.95	16.39	45.15	15.80	0.81	(1.12)
Average adults' education	4.66	2.79	5.38	2.98	-0.71***	(-5.60)
Wealth Index	1.96	0.80	2.04	0.83	-0.08*	(-2.29)
Arable land (ha)	0.64	0.46	0.82	0.77	-0.18***	(-7.03)
Number of plots	4.03	2.67	3.62	2.57	0.41***	(3.48)
SDI for crops	6.84	8.72	5.57	7.72	1.27***	(3.40)
Intercropping	0.53	0.50	0.28	0.45	0.24***	(11.17)
Livestock (TLU)	0.12	0.46	0.28	1.42	-0.16***	(-3.90)
Free Maize Programme	0.21	0.40	0.11	0.31	0.10***	(5.73)
Free Food Programme	0.14	0.35	0.08	0.26	0.07***	(4.76)
Food/Cash for Work Proggramme	0.15	0.36	0.12	0.33	0.03*	(2.08)
Child feeding Programmes	0.21	0.41	0.13	0.33	0.08***	(4.93)
Split household	0.45	0.50	0.52	0.50	-0.07**	(-3.27)
Observations	773		1463		2236	

Author's calculations from the sample selected from the IHS survey, pooled for 2013 and 2016. The table reports mean values and standard deviations for the two groups defined by the prevalent norm and the difference between means. * p<0.05, ** p<0.01, *** p<0.001. t statistics in parentheses.

Table 7: *Differences between male and female land management*

	Male LM		Female LM		T-test (Male-Female)	
	mean	sd	mean	sd	diff.	t
Food Consumption Score	44.40	12.85	41.83	11.84	2.57***	(4.61)
Household Dietary Diversity Score	8.10	2.06	7.56	2.03	0.55***	(5.86)
SPEI-6	-0.34	0.88	-0.58	0.92	0.24***	(5.89)
Drought (Spei-6 < -1)	0.22	0.41	0.33	0.47	-0.11***	(-5.37)
Drought (Spei-6 < -1.5)	0.12	0.33	0.20	0.40	-0.08***	(-4.69)
Female LM (1st and 2nd manager)	0.00	0.00	0.79	0.41	-0.79***	(-54.20)
Joint LM (1st and 2nd manager)	0.69	0.46	0.21	0.41	0.48***	(24.45)
Norm (1=Matrilineal-Matrilocal)	0.31	0.46	0.42	0.49	-0.11***	(-4.87)
Household size	5.36	2.20	4.82	2.24	0.53***	(5.24)
Dependency ratio	0.49	0.21	0.53	0.25	-0.04***	(-3.93)
Employed ratio	0.06	0.16	0.06	0.18	0.00	(0.32)
Casual workers ratio	0.43	0.49	0.55	0.58	-0.12***	(-4.58)
Female-headed household	0.01	0.10	0.74	0.44	-0.73***	(-45.61)
Household head's age	43.74	15.38	48.21	16.90	-4.47***	(-6.01)
Average adults' education	5.29	2.85	4.70	2.96	0.59***	(4.42)
Wealth index	2.10	0.80	1.79	0.79	0.31***	(8.62)
Arable land (ha)	0.86	0.77	0.57	0.45	0.29***	(10.62)
Number of plots	3.88	2.63	3.43	2.48	0.45***	(3.88)
SDI for crops	6.29	8.35	5.21	7.28	1.08**	(3.07)
Intercropping (mixed stand)	0.33	0.47	0.45	0.50	-0.12***	(-5.48)
Livestock (TLU)	0.25	0.82	0.18	1.67	0.08	(1.23)
Free Maize Prog.	0.14	0.34	0.17	0.38	-0.03*	(-2.07)
Free food Prog.	0.09	0.28	0.13	0.33	-0.04**	(-2.78)
Food/Cash-for-work Prog.	0.14	0.35	0.13	0.34	0.01	(0.67)
Child feed Prog.	0.14	0.35	0.18	0.38	-0.04*	(-2.20)
Split household	0.48	0.50	0.49	0.50	-0.01	(-0.53)
Observations	1222		792		2014	

Author's calculations from Sample 4 selected from the IHS panel, pooled for 2013 and 2016. The table reports mean values and standard deviations for the two groups defined by the gender of the land manager (1st land manager of household's plot) and the difference between means. * p<0.05, ** p<0.01, *** p<0.001. t statistics in parentheses.

Table 8: *Differences in work-time with and without drought in Matrilineal-Matrilocal and Other communities*

	MM comm.						Other comm.					
	No drought		**Drought**		**T-test** (No-Yes)		**No drought**		**Drought**		**T-test** (No-Yes)	
	mean	sd	mean	sd	diff.	t	mean	sd	mean	sd	diff.	t
Avg. hours/week worked by a male adult:												
Household agricultural activities	4.99	10.49	5.26	10.51	-0.28	(-0.22)	6.64	12.03	8.57	12.27	-1.93	(-1.64)
Household business (non agr.)	2.04	6.43	3.53	8.86	-1.49	(-1.65)	2.45	8.00	1.78	6.06	0.67	(1.06)
Work for wage, salary, or in-kind payment	1.54	8.30	2.71	10.68	-1.16	(-1.04)	2.82	9.80	6.32	15.39	-3.51*	(-2.54)
Casual, part-time or ganyu labour	2.20	5.96	6.17	11.81	-3.97***	(-3.67)	2.94	8.68	2.34	6.48	0.60	(0.88)
Avg. hours/week worked by a female adult:												
Household agricultural activities	3.14	5.80	3.43	6.98	-0.30	(-0.42)	5.53	9.43	7.52	9.46	-1.99*	(-2.34)
Household business (non agr.)	2.02	11.92	1.98	5.83	0.04	(0.04)	1.36	6.07	1.75	5.76	-0.39	(-0.75)
Work for wage, salary, or in-kind payment	0.00	0.00	0.09	0.76	-0.09	(-1.51)	0.60	3.79	0.69	4.44	-0.09	(-0.24)
Casual, part-time or ganyu labour	1.81	3.95	1.55	4.59	0.27	(0.57)	1.53	4.41	1.60	4.60	-0.07	(-0.16)
Avg. hours/week worked by a child (5-14 y.o.):												
Household agricultural activities	1.44	8.86	0.89	3.88	0.55	(0.65)	1.07	3.15	1.17	2.39	-0.10	(-0.37)
Household business (non agr.)	0.07	0.71	0.10	0.87	-0.03	(-0.29)	0.11	0.66	0.51	2.39	-0.41	(-1.94)
Work for wage, salary, or in-kind payment	0.33	3.70	0.00	0.00	0.33	(1.00)	0.02	0.24	0.03	0.27	-0.01	(-0.49)
Casual, part-time or ganyu labour	0.32	1.35	0.45	3.61	-0.13	(-0.37)	0.23	0.90	0.32	1.38	-0.09	(-0.67)

Author's calculations from the sample selected from the IHS survey, for 2016 only. The table reports mean values and standard deviations for households not experiencing or experiencing the drought ($Spei-6 < -1.5$) and the difference between means for the two groups, separately for Matrilineal-Matrilocal and other types of communities. * p<0.05, ** p<0.01, *** p<0.001. t statistics in parentheses.

Table 9: *Estimation results for Model 1*

	(1)	(2)	(3)	(4)	(5)	(6)
	Food Consumption Score (W = FCS)			**Household Dietary Diversity Score** (W = HDDS)		
Dependent variable:	FCS	RS: p(FCS>35)	RS: p(FCS>44)	HDDS	RS: p(HDDS>5)	RS: p(HDDS>7)
Mean of dependent var.:	43.78	0.85	0.41	7.94	0.97	0.70
Lagged W	0.306***	0.006***	0.014***	0.338***	0.016***	0.086***
	(0.029)	(0.001)	(0.000)	(0.025)	(0.002)	(0.002)
Drought	-6.167***	-0.117***	-0.336***	-1.339***	-0.033***	-0.286***
	(1.377)	(0.029)	(0.020)	(0.274)	(0.009)	(0.031)
Female Land Management	-1.952***	-0.084***	-0.096***	-0.353***	-0.019***	-0.092***
	(0.580)	(0.007)	(0.004)	(0.094)	(0.003)	(0.006)
Norm (1=Matrilineal-Matrilocal)	-0.559	-0.029***	-0.029***	-0.268	-0.013*	-0.079***
	(1.403)	(0.010)	(0.007)	(0.199)	(0.007)	(0.011)
N obs.	1688	1688	1688	1688	1688	1688
N cluster EA	90	90	90	90	90	90
N cluster HHID	974	974	974	974	974	974
R^2	0.219	0.741	0.935	0.269	0.508	0.902
R^2 adjusted	0.192	0.732	0.932	0.243	0.491	0.899
RMSE	11.08	0.10	0.08	1.78	0.05	0.09

Authors' calculation from SAMPLE 5 (rural agricultural households observed at least in two consecutive rounds, joint land management excluded) from the Malawi IHS panel. Pooled OLS regression. The threshold used for each Resilience Score (RS) is specified in the parenthesis expressing the RS as the probability to be above the threshold. Drought is =1 when SPEI-6<-1.5. The base level for Female Land Management (1st land manager) is Male. Norm is =0 for all communities where the prevalent marriage type is other than Matrilineal-Matrilocal steadily over time. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Constant term and fixed effects for the year, consumption month, and grid are included in all models. To control for splits, dummy variables (=1 if the household split) are included separately for each year. Standard errors clustered at the EA and household (considering the parent household, meaning the same id for all split-offs belonging to the same initial household) levels.

Table 10: *Estimation results for Model 2*

	(1)	(2)	(3)	(4)	(5)	(6)
	Food Consumption Score (W = FCS)			**Household Dietary Diversity Score** (W = HDDS)		
Dependent variable:	FCS	RS: p(FCS>35)	RS: p(FCS>44)	HDDS	RS: p(HDDS>5)	RS: p(HDDS>7)
Mean of dependent var.:	43.78	0.85	0.41	7.94	0.97	0.70
Lagged W	0.306***	0.006***	0.014***	0.337***	0.016***	0.085***
	(0.029)	(0.001)	(0.000)	(0.025)	(0.002)	(0.002)
Drought	-7.855***	-0.183***	-0.426***	-1.529***	-0.036***	-0.332***
	(1.485)	(0.029)	(0.022)	(0.319)	(0.008)	(0.032)
Female Land Management	-2.538***	-0.101***	-0.129***	-0.419***	-0.022***	-0.104***
	(0.638)	(0.009)	(0.007)	(0.103)	(0.004)	(0.007)
Drought x Female LM	3.186**	0.127***	0.163***	0.358	0.015**	0.085***
	(1.589)	(0.019)	(0.010)	(0.254)	(0.007)	(0.015)
Norm (1=Matrilineal-Matrilocal)	-0.601	-0.029***	-0.034***	-0.273	-0.013**	-0.082***
	(1.396)	(0.010)	(0.007)	(0.199)	(0.006)	(0.011)
N obs.	1688	1688	1688	1688	1688	1688
N cluster EA	90	90	90	90	90	90
N cluster HHID	974	974	974	974	974	974
R^2	0.221	0.731	0.933	0.270	0.509	0.901
R^2 adjusted	0.194	0.721	0.930	0.244	0.492	0.897
RMSE	11.07	0.10	0.08	1.78	0.05	0.09

Authors' calculation from SAMPLE 5 (rural agricultural households observed at least in two consecutive rounds, joint land management excluded) from the Malawi IHS panel. Pooled OLS regression. The threshold used for each Resilience Score (RS) is specified in the parenthesis expressing the RS as the probability to be above the threshold. Drought is =1 when SPEI-6<-1.5. The base level for Female Land Management (1st land manager) is Male. Norm is =0 for all communities where the prevalent marriage type is other than Matrilineal-Matrilocal steadily over time. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Constant term and fixed effects for the year, consumption month, and grid are included in all models. To control for splits, dummy variables (=1 if the household split) are included separately for each year. Standard errors clustered at the EA and household (considering the parent household, meaning the same id for all split-offs belonging to the same initial household) levels.

Table 11: *Estimation results for Model 3*

	(1)	(2)	(3)	(4)	(5)	(6)
	Food Consumption Score (W = FCS)			**Household Dietary Diversity Score** (W = HDDS)		
Dependent variable:	FCS	RS: p(FCS>35)	RS: p(FCS>44)	HDDS	RS: p(HDDS>5)	RS: p(HDDS>7)
Mean of dependent var.:	43.78	0.84	0.41	7.94	0.97	0.70
Lagged W	0.332***	0.007***	0.015***	0.352***	0.018***	0.084***
	(0.034)	(0.001)	(0.001)	(0.029)	(0.003)	(0.004)
Drought	-7.482***	-0.154***	-0.369***	-1.848***	-0.062**	-0.335***
	(1.879)	(0.048)	(0.027)	(0.416)	(0.025)	(0.049)
Female Land Management	-1.486*	-0.072***	-0.072***	-0.410***	-0.026***	-0.107***
	(0.819)	(0.009)	(0.006)	(0.117)	(0.005)	(0.008)
Norm (1=Matrilineal-Matrilocal)	8.618*	0.429***	0.736***	2.391***	0.163***	0.445***
	(4.930)	(0.084)	(0.054)	(0.654)	(0.043)	(0.083)
Lagged W x Norm	-0.122**	-0.002**	-0.005***	-0.074	-0.008**	-0.006
	(0.061)	(0.001)	(0.001)	(0.056)	(0.003)	(0.005)
Drought x Norm	4.570*	0.196***	0.160***	1.508***	0.087***	0.302***
	(2.669)	(0.072)	(0.055)	(0.551)	(0.027)	(0.066)
Female LM x Norm	-1.538	-0.035**	-0.075***	0.101	0.021***	0.037***
	(1.062)	(0.017)	(0.011)	(0.199)	(0.006)	(0.013)
N obs.	1688	1688	1688	1688	1688	1688
N cluster EA	90	90	90	90	90	90
N cluster HHID	974	974	974	974	974	974
R^2	0.253	0.765	0.932	0.302	0.522	0.894
R^2 adjusted	0.213	0.753	0.929	0.265	0.497	0.888
RMSE	10.94	0.11	0.08	1.76	0.05	0.10

Authors' calculation from SAMPLE 5 (rural agricultural households observed at least in two consecutive rounds, joint land management excluded) from the Malawi IHS panel. Pooled OLS regression. The threshold used for each Resilience Score (RS) is specified in the parenthesis expressing the RS as the probability to be above the threshold. Drought is =1 when SPEI-6<-1.5. The base level for Female Land Management (1st land manager) is Male. Norm is =0 for all communities where the prevalent marriage type is other than Matrilineal-Matrilocal steadily over time. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Constant term and fixed effects for the year, consumption month, and grid are included in all models. To control for splits, dummy variables (=1 if the household split) are included separately for each year. Standard errors clustered at the EA and household (considering the parent household, meaning the same id for all split-offs belonging to the same initial household) levels.

Table 12: *Estimation results for Model 4*

	(1)	(2)	(3)	(4)	(5)	(6)
	Food Consumption Score (W = FCS)			Household Dietary Diversity Score (W = HDDS)		
Dependent variable:	FCS	RS: p(FCS>35)	RS: p(FCS>44)	HDDS	RS: p(HDDS>5)	RS: p(HDDS>7)
Mean of dependent var.:	43.78	0.84	0.41	7.94	0.97	0.69
Lagged W	0.330***	0.007***	0.015***	0.350***	0.018***	0.083***
	(0.034)	(0.001)	(0.001)	(0.029)	(0.003)	(0.004)
Drought	-10.104***	-0.286***	-0.500***	-2.348***	-0.090***	-0.481***
	(1.881)	(0.057)	(0.036)	(0.462)	(0.027)	(0.047)
Female Land Management	-2.252**	-0.100***	-0.109***	-0.557***	-0.036***	-0.136***
	(0.876)	(0.012)	(0.009)	(0.132)	(0.007)	(0.009)
Drought x Female LM	5.338**	0.213***	0.254***	1.017***	0.056***	0.275***
	(2.269)	(0.034)	(0.022)	(0.222)	(0.013)	(0.017)
Norm (1=Matrilineal-Matrilocal)	8.161	0.428***	0.727***	2.335***	0.153***	0.450***
	(4.971)	(0.085)	(0.054)	(0.667)	(0.042)	(0.080)
Lagged W x Norm	-0.121*	-0.003**	-0.005***	-0.072	-0.008**	-0.008
	(0.061)	(0.001)	(0.001)	(0.056)	(0.003)	(0.005)
Drought x Norm	7.149**	0.376***	0.266***	2.336***	0.122***	0.574***
	(2.844)	(0.075)	(0.059)	(0.584)	(0.028)	(0.059)
Female LM x Norm	-0.791	0.014	-0.047***	0.389*	0.036***	0.107***
	(1.173)	(0.022)	(0.015)	(0.200)	(0.008)	(0.012)
Drought x Female LM x Norm	-5.260	-0.296***	-0.211***	-1.607***	-0.094***	-0.497***
	(3.238)	(0.052)	(0.031)	(0.423)	(0.021)	(0.036)
N obs.	1688	1688	1688	1688	1688	1688
N cluster EA	90	90	90	90	90	90
N cluster HHID	974	974	974	974	974	974
R^2	0.256	0.761	0.931	0.307	0.531	0.899
R^2 adjusted	0.215	0.748	0.927	0.269	0.505	0.893
RMSE	10.92	0.11	0.08	1.75	0.06	0.10

Authors' calculation from SAMPLE 5 (rural agricultural households observed at least in two consecutive rounds, joint land management excluded) from the Malawi IHS panel. Pooled OLS regression. The threshold used for each Resilience Score (RS) is specified in the parenthesis expressing the RS as the probability to be above the threshold. Drought is =1 when SPEI-6<-1.5. The base level for Female Land Management (1st land manager) is Male. Norm is =0 for all communities where the prevalent marriage type is other than Matrilineal-Matrilocal steadily over time. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Constant term and fixed effects for the year, consumption month, and grid are included in all models. To control for splits, dummy variables (=1 if the household split) are included separately for each year. Standard errors clustered at the EA and household (considering the parent household, meaning the same id for all split-offs belonging to the same initial household) levels.

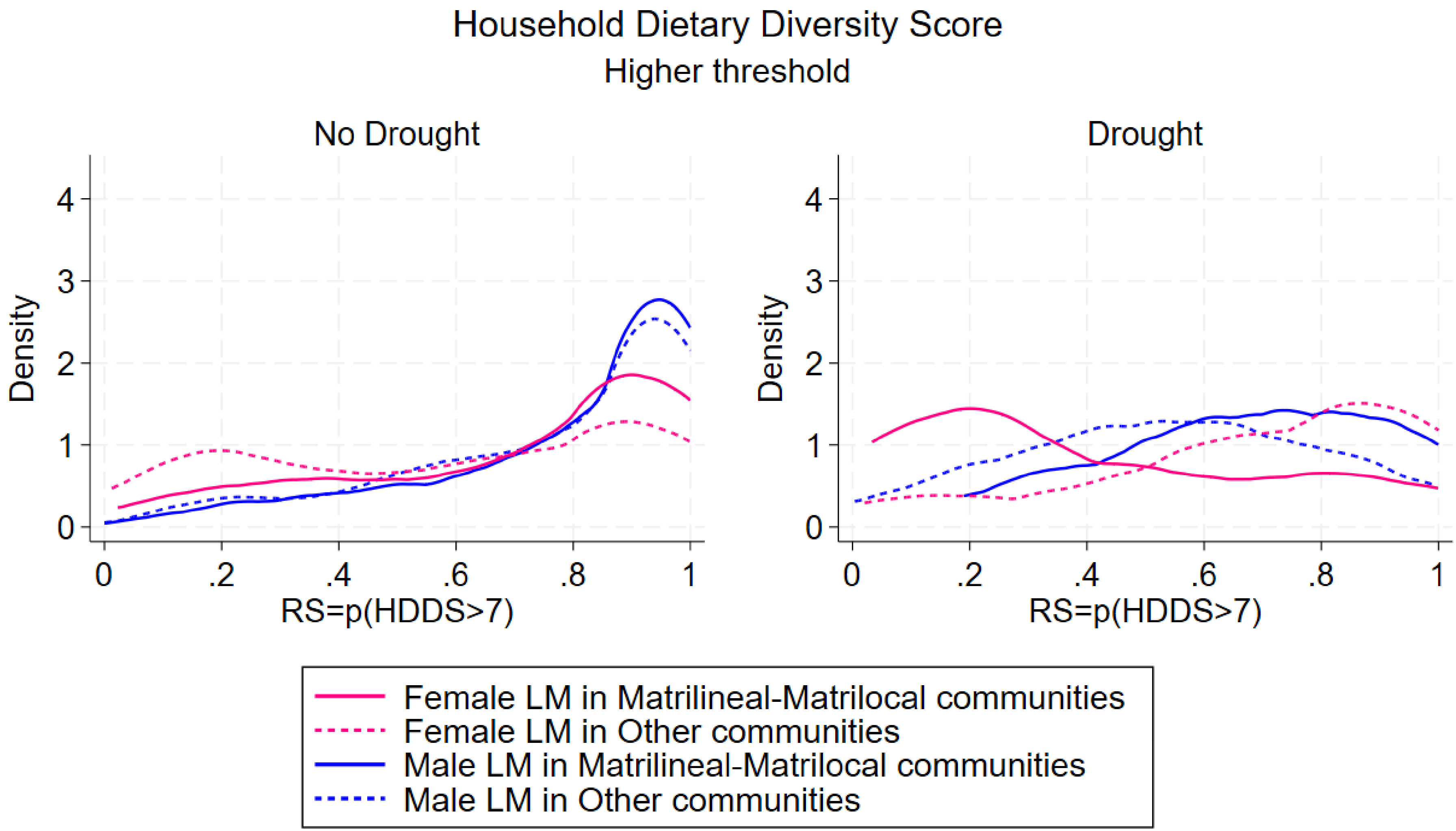

Figure 3: *Kernel distribution of Resilience Scores from Model 4*

Resilience scores from estimates presented in Table 12.

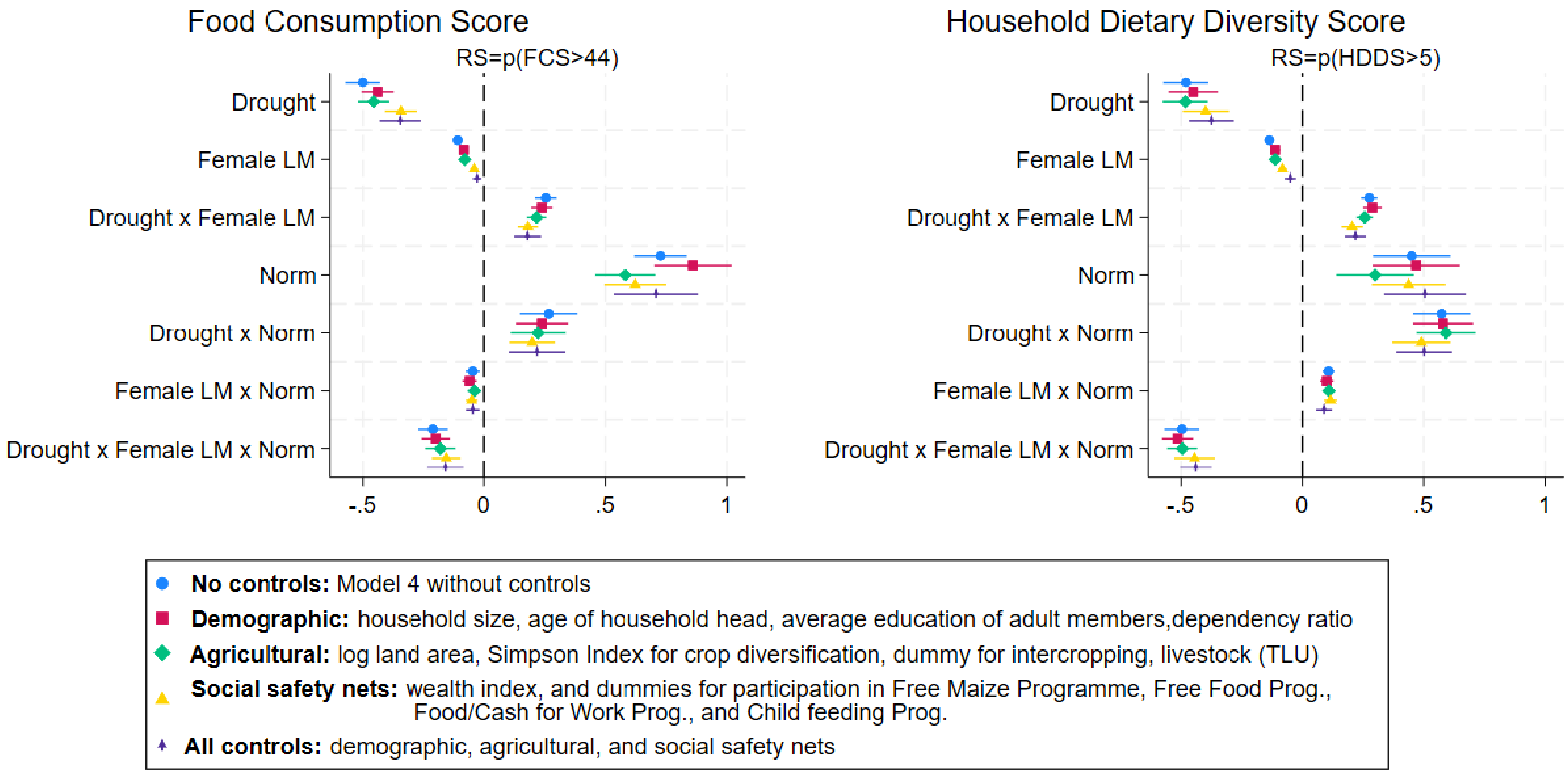

Figure 4: *Coefficient plot of estimates from Model 4 with additional controls*

Authors' calculation from SAMPLE 5 (rural agricultural households observed at least in two consecutive rounds, joint land management excluded) from the Malawi IHS panel. Pooled OLS regression. The dependent variables are the Resilience Scores (RS) measured as the probability for both Food Security Indicators of being above the higher threshold: 44 for the Food Consumption Score (FCS), and 7 for the Household Dietary Diversity Score (HDDS). The model without controls reports the estimation coefficients presented in Table 12. Other models include the controls specified in the legend. Constant term and fixed effects for the year, consumption month, and grid are included in all models. To control for splits, dummy variables (=1 if the household split) are included separately for each year. Standard errors clustered at the EA and household (considering the parent household, meaning the same id for all split-offs belonging to the same initial household) levels. 95% confidence intervals are reported in the graph.

Table 13: *Households' languages by prevalent norm in the community*

	Current Norm (community)		
Language	Matrilineal-Matrilocal	Any Other	Total
Chewa	35.01	64.99	100.00
	63.60	65.49	64.82
Yao	60.39	39.61	100.00
	22.69	8.26	13.41
Tambuka	0.30	99.70	100.00
	0.06	11.42	7.37
Makhuwa	51.17	48.83	100.00
	5.90	3.12	4.11
Ngoni	78.90	21.10	100.00
	7.17	1.06	3.24
Ngonde	0.00	100.00	100.00
	0.00	0.24	0.15
Safwa	0.00	100.00	100.00
	0.00	2.96	1.90
Sena	0.00	100.00	100.00
	0.00	2.72	1.75
Tonga	0.00	100.00	100.00
	0.00	1.83	1.18
Nyakyusa	0.00	100.00	100.00
	0.00	0.63	0.41
Other	12.21	87.79	100.00
	0.57	2.27	1.66
Total	35.68	64.32	100.00
	100.00	100.00	100.00

First row has row percentages and second row has column percentages.
Author's calculations from pooled Sample 5 selected from the IHS survey. Languages reported in the IHS are aggregated into the language groups available in the *Ethnographic Atlas* (Murdock, 1967). Observations are weighted with IHS panel weights.

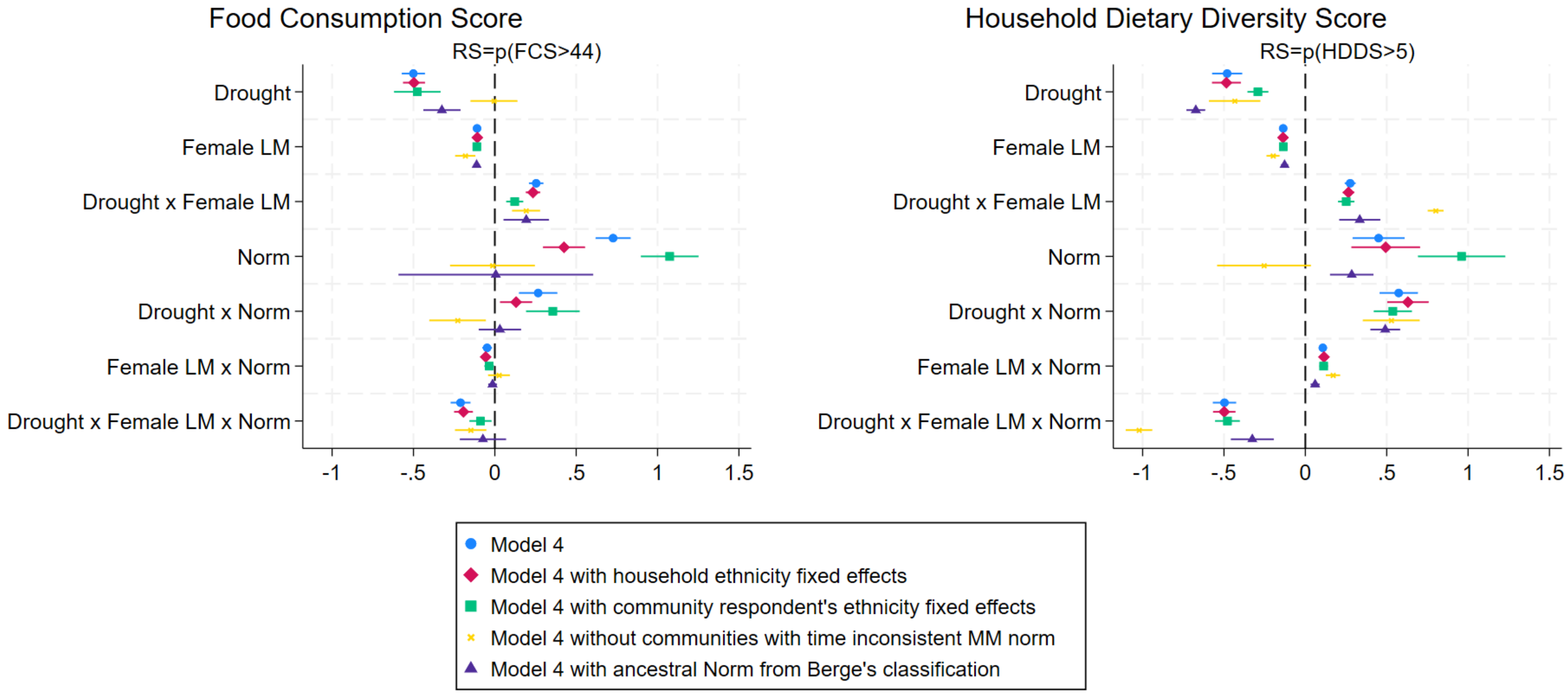

Figure 5: *Coefficient plot of estimates from Model 4 with ethnicity fixed effects and alternative Norm definition*

Authors' calculation from SAMPLE 5 (rural agricultural households observed at least in two consecutive rounds, joint land management excluded) from the Malawi IHS panel. Pooled OLS regression. The dependent variables are the Resilience Scores (RS) measured as the probability for both Food Security Indicators of being above the higher threshold: 44 for the Food Consumption Score (FCS), and 7 for the Household Dietary Diversity Score (HDDS). The model without controls reports the estimation coefficients presented in Table 12. Model 4 with household ethnicity fixed effects includes dummies for the main language spoken by the household (a proxy for ethnicity), interacted with the Norm. Languages are grouped into the main languages available in the Ethnographic Atlas (Murdock, 1967). The model with community respondents' fixed effects includes dummies for the language spoken by those who answered the question about the prevalent norm in the community. In the model with ancestral Norm, the current norm reported in the IHS community questionnaire is replaced with the district-level lineage classification by Berge et al. (2014). Constant term and fixed effects for the year, consumption month, and grid are included in all models. To control for splits, dummy variables (=1 if the household split) are included separately for each year. Standard errors clustered at the EA and household (considering the parent household, meaning the same id for all split-offs belonging to the same initial household) levels. 95% confidence intervals are reported in the graph.

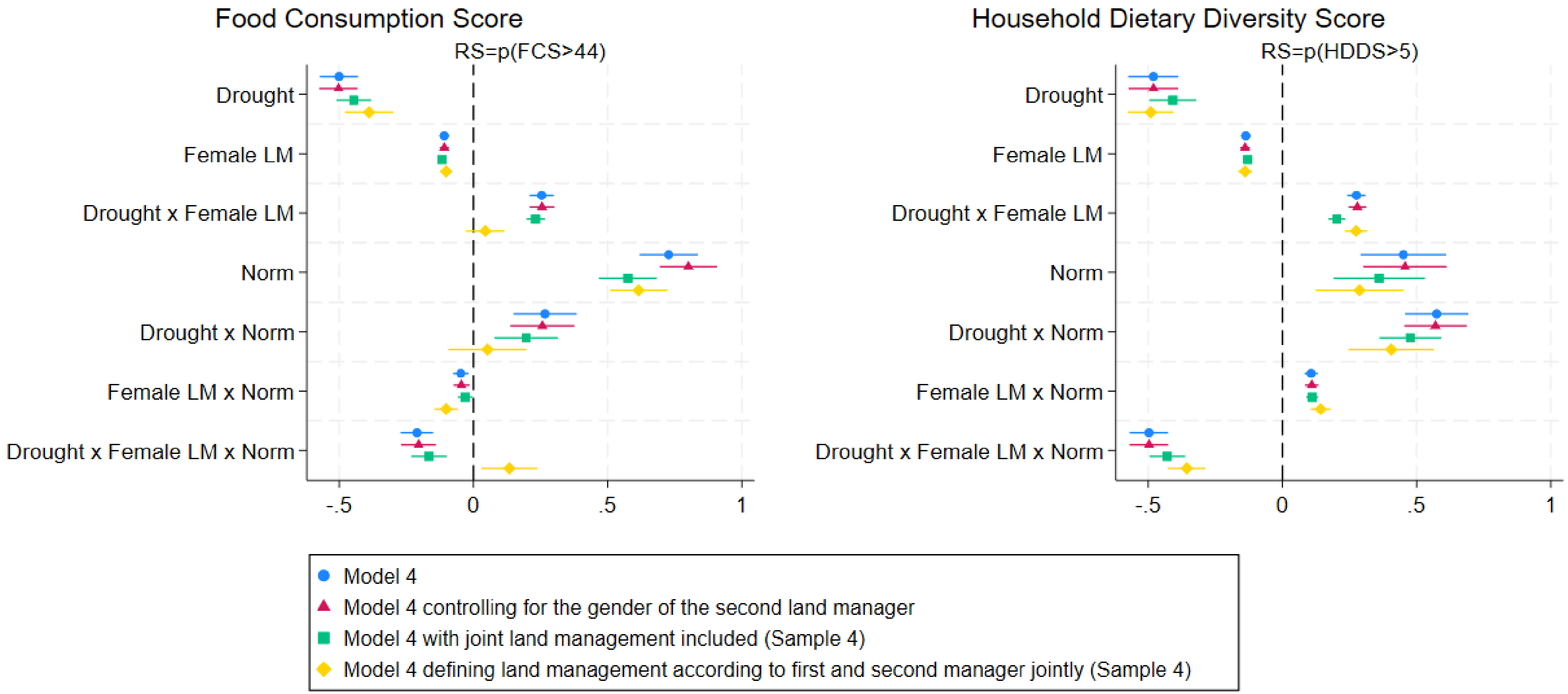

Figure 6: *Coefficient plot of estimates from Model 4 controlling for the gender of the second land manager*

Authors' calculation from SAMPLE 5 (rural agricultural households observed at least in two consecutive rounds, joint land management excluded) and SAMPLE 4 (including households with joint land management) from the Malawi IHS panel. Pooled OLS regression. The dependent variables are the Resilience Scores (RS) measured as the probability for both Food Security Indicators of being above the higher threshold: 44 for the Food Consumption Score (FCS), and 7 for the Household Dietary Diversity Score (HDDS). The model without controls reports the estimation coefficients presented in Table 12. Then Model 4 is estimated also controlling for the gender of the second land manager (indicator =1 if all household plots have a woman as second manager). In the model with joint land management, households whose land management, defined according to the first manager of each plot, is partly male and partly female are reintroduced in the sample, and the model is estimated with an additional dummy variable =1 if the household has joint land management. In the last model, we consider a more strict definition of female land management, where the indicator is =1 if all households' plots have a woman as both the first and second manager. Constant term and fixed effects for the year, consumption month, and grid are included in all models. To control for splits, dummy variables (=1 if the household split) are included separately for each year. Standard errors clustered at the EA and household (considering the parent household, meaning the same id for all split-offs belonging to the same initial household) levels. 95% confidence intervals are reported in the graph.

Table 14: *Number of split households*

	N. obs	Perc.
Sample 5 pooled		
Split at least once	1340	39.88
Never split	1581	60.12
Total	2921	100.00
Parent households from Sample 5 observed in 2013		
Split between 2010 and 2013	178	20.82
Not split between 2010 and 2013	677	79.18
Total	855	100.00
Parent households from Sample 5 observed in 2016		
Split between 2013 and 2016	212	25.45
Not split between 2013 and 2016	621	74.55
Total	833	100.00

Author's calculations from pooled Sample 5 selected from the IHS survey. Parent households are the original households from which split-offs originate. Observations are weighted with IHS panel weights.

Table 15: *Number of split households that left an income earner*

	2013		2016	
	N.	Perc.	N.	Perc.
No income earner left	111	62.15	147	69.91
Income earner left	67	37.85	65	30.09
Total split households	178	100.00	212	100.00

Author's calculations from pooled Sample 5 selected from the IHS survey, considering only households that split between 2010-2013 and 2013-2016. Observations are weighted with IHS panel weights.

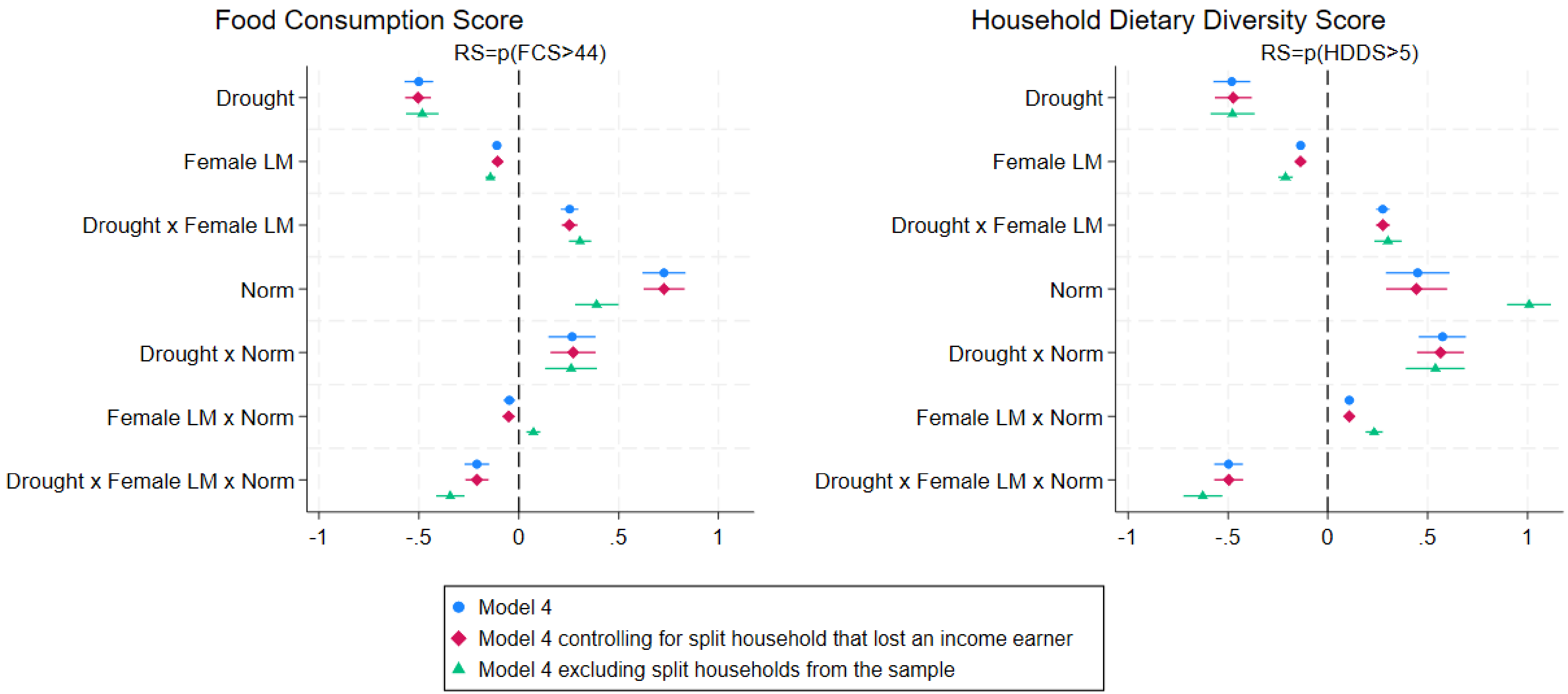

Figure 7: *Coefficient plot of estimates from Model 4 controlling for splits*

Authors' calculation from SAMPLE 5 (rural agricultural households observed at least in two consecutive rounds, joint land management excluded) from the Malawi IHS panel. Pooled OLS regression. The dependent variables are the Resilience Scores (RS) measured as the probability for both Food Security Indicators of being above the higher threshold: 44 for the Food Consumption Score (FCS), and 7 for the Household Dietary Diversity Score (HDDS). The model without controls reports the estimation coefficients presented in Table 12. To control for loss of an income earner, the second model includes dummy variables =1 if one of the members that left the household was previously employed on-farm or in a waged job. The third model is estimated after excluding from the sample all households that ever split (the number of observations used for estimation is 941). Constant term and fixed effects for the year, consumption month, and grid are included in all models. To control for splits in the first two models, dummy variables (=1 if the household split) are included separately for each year. Standard errors clustered at the EA and household (considering the parent household) levels. 95% confidence intervals are reported in the graph.

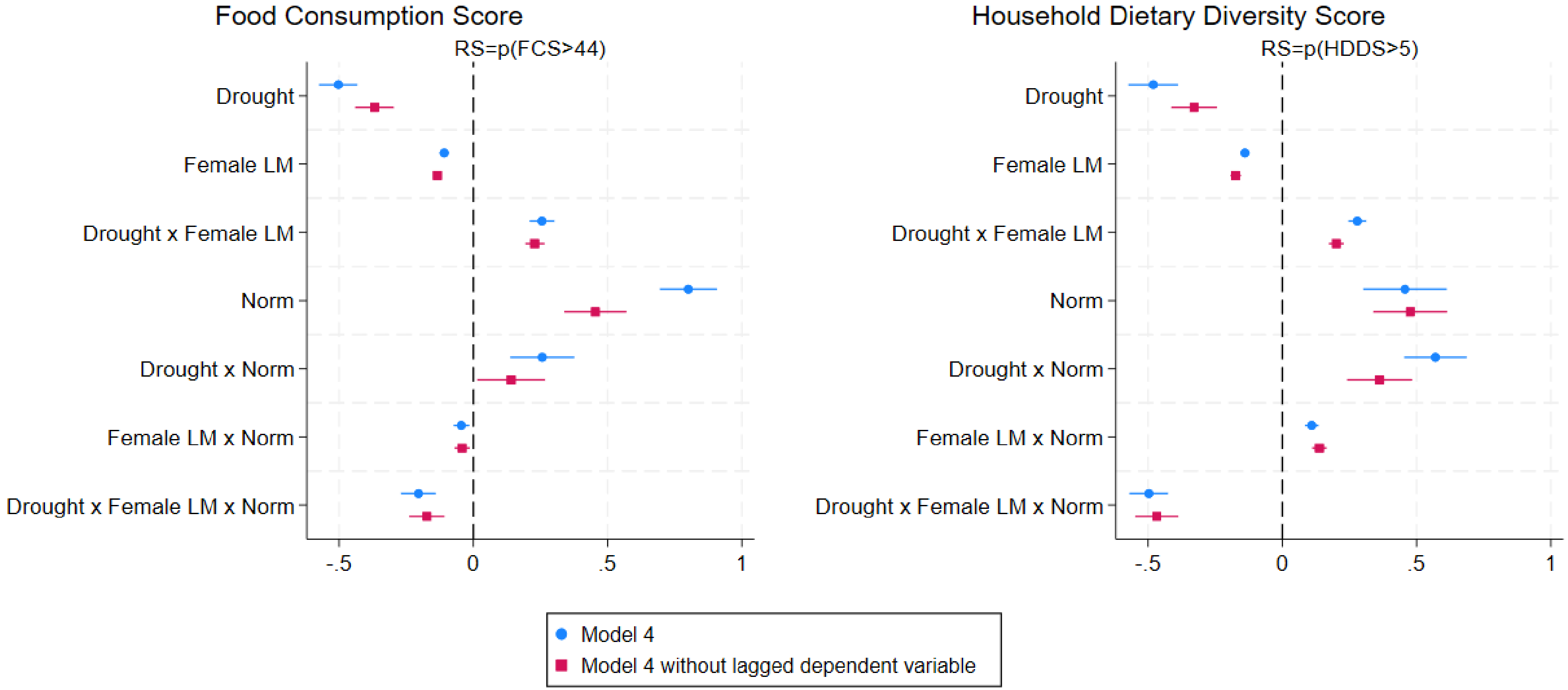

Figure 8: *Coefficient plot of estimates from Model 4 with resilience scores not conditioned on the previous level of food security achieved*

Authors' calculation from SAMPLE 5 (rural agricultural households observed at least in two consecutive rounds, joint land management excluded) from the Malawi IHS panel. Pooled OLS regression. The dependent variables are the Resilience Scores (RS) measured as the probability for both Food Security Indicators of being above the higher threshold: 44 for the Food Consumption Score (FCS), and 7 for the Household Dietary Diversity Score (HDDS). Model 4 reports the estimation coefficients presented in Table 12. The other refers to the same model but excludes the lag of the food security indicator from explanatory variables. Constant term and fixed effects for the year, consumption month, and grid are included in all models. To control for splits in the first two models, dummy variables (=1 if the household split) are included separately for each year. Standard errors clustered at the EA and household (considering the parent household) levels. 95% confidence intervals are reported in the graph.

Annex B: Measurement of development resilience

The empirical method proposed by Cissé and Barrett (2018) to measure development resilience uses a three-step procedure applied to panel data to calculate "*individual-specific conditional probabilities of satisfying a normative minimum standard of living*" (p.1). First, the household-specific conditional well-being mean is estimated with an OLS regression. Then, the residuals are used to estimate the household-specific conditional variance in a similar OLS regression using the same independent variables. Finally, assuming a two-parameter distribution, the two estimated conditional moment functions are used to estimate the conditional probability of satisfying some normative well-being standard, which is the Resilience Score.

For simplicity of notation, the estimation strategy of the resilience scores is reported only for Model (1)[34]. The first step consists of estimating exactly equation (1), where the independent variable is the food security indicator:

$$W_{icgmt} = \beta_{M1} W_{i,t-1} + \beta_{M2} D_{gt} + \beta_{M3} LM_{it} + \beta_{M4} N_c + \alpha_{Mt} + \alpha_{Mm} + \alpha_{Mg} + \epsilon_{Mitmgc}. \tag{5}$$

In this way, we obtain the estimated first conditional moment (lineal prediction of the outcome): $\hat{\mu}_{1icgmt} = \hat{W}_{icgmt}$. The subscript M indicates that each element refers to the estimation of the first moment (mean) equation.

The second step consists in estimating the conditional variance (σ^2_{icgmt}) by regressing the same independent variables on the squared residuals from the first regression ($\hat{\epsilon}^2_{Micgmt}$):

$$\hat{\epsilon}^2_{Micgmt} = \beta_{V1} W_{i,t-1} + \beta_{V2} D_{gt} + \beta_{V3} FLM_{it} + \beta_{V4} N_c + \alpha_{Vt} + \alpha_{Vm} + \alpha_{Vg} + \epsilon_{Vitmgc}. \tag{6}$$

The subscript V indicates that each element refers to the estimation of the second moment (variance) equation. In this way, we estimate the second conditional moment ($\hat{\mu}_{2icgmt} = \hat{\sigma}^2_{icgmt}$). Therefore, the household-specific conditional probability to satisfy the food security threshold

[34] Also, to simplify the notation, the specification used in this Appendix excludes from the covariates the indicators for split households.

(indicator-specific) is:

$$RS_{icgmt} = \hat{\rho}_{icgmt} \equiv P(W_{icgmt} \geqslant \underline{W} \mid W_{i,t-1}, D_{gt}, FLM_{it}, N_c, X_{icgmt}) = \overline{F}_{W_{icgmt}}\left(\underline{W}; \hat{\mu}_{1icgmt}(\cdot), \hat{\mu}_{2icgmt}(\cdot)\right), \tag{7}$$

where $F(\cdot)$ is the assumed complementary cumulative density function associated with the household-and-period-specific conditional well-being probability density function. X represents any additional covariate that participated in the estimation of the first and second conditional moment (i.e., fixed effects, but also other independent variables used as control variables in the robustness checks).

Finally, we can estimate each factor's contribution to resilience by regressing the resilience scores on the independent variables of interest:

$$RS_{icgmt} = \beta_{R1} W_{i,t-1} + \beta_{R2} D_{gt} + \beta_{R3} FLM_{it} + \beta_{R4} N_c + \alpha_{Rt} + \alpha_{Rm} + \alpha_{Rg} + \epsilon_{Ricgmt}, \tag{8}$$

where the subscript R indicates that each element refers to the estimation of correlation coefficients for the Resilience Scores.