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Pulling together or tearing apart? Ethnic heterogeneity, natural shocks and common pool resources in rural Malawi

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Abstract

This paper examines how ethnic heterogeneity may affect the ability of Malawian rural households to solve collective action problems. The collective action challenges are natural shocks – floods, droughts, and irregular rain – and availability of common pool resources – an irrigation system, a forest, and common pasture land. We measure household welfare through maize harvest and annual consumption. We find that ethnic polarization and fractionalization are unambiguously bad for maize harvest but, under natural shocks, the size of this negative relationship is reduced. This may be due to the way natural shocks cross ethnic lines and facilitate the overcoming of ethnic differences. The bad effects of polarization remain unchanged in the presence of a shock, suggesting that this is a more intransigent problem. With respect to consumption, we find diminishing returns to increased polarization, becoming negative for high levels of polarization. Results are strongest in the presence of a communal forest. This may be due to the repeated and continuous nature of communal forest management, and the way that polarization may facilitate the formation of coherent bargaining factions.

Keywords— collective action, ethnic fractionalization, ethnic polarization, agriculture, natural shocks, common pool resources

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1 Introduction

Why is Africa poor? A rich vein of literature argues that ethnic heterogeneity, that is the proliferation of tribes with different languages, traditions and cultures, co-existing in colonially demarcated national territories, is a major part of the answer. A growing microeconomic literature finds that this heterogeneity can result in reduced trust, misallocation of funds, and reduced efficiency in credit and input markets.

This paper contributes to this literature by exploring the effects of two key indices of ethnic heterogeneity: fractionalization and polarization. While the former measures the probability that any two individuals do not come from the same ethnic group, the latter also accounts for the size of the smallest group. We forge new ground by exploring the effects of these indices in the presence of natural shocks and common pool resources.

We conduct this study using data for Malawi, one of the poorest countries in the world, and a country almost entirely dependent on agriculture and natural resources. Malawi is also one of the more fractionalized countries in Sub-Saharan Africa, and prone to severe droughts. As such the construction of a novel dataset combining census data for ethnicity with rural livelihoods provides a resource which is highly useful. We use this to examine the role of ethnic heterogeneity in poor communities, in particular its role in response to droughts and other natural shocks.

We find that higher fractionalization is associated with poorer maize harvests, but that this effect is less negative in the presence of a natural shock such as a drought or irregular rain. We also find a quadratic relationship between polarization and consumption, strongest in the presence of a communal forest. We hope that this study will lay the ground for further work which could explore in more detail the mechanisms by which ethnic heterogeneity affects outcomes in rural communites in Sub-Saharan Africa.

1.1 Background: ethnic heterogeneity and economic development in Malawi

Malawi became independent from the United Kingdom in 1964 and was largely under one party rule from 1970 until 1993, when a relatively stable democracy took hold. More than half of the population lives in poverty and more than a quarter under extreme poverty. Malawi has experienced an average GDP growth rate of 2.9% in the last twenty years. Nevertheless, poverty in rural areas has been increasing and 85% of the population lives under poverty.

Agriculture is the single most important sector of Malawi's economy, a major reason for focusing our study on harvest and consumption at household level in rural areas. The sector employs about 80% of the country's total workforce, accounts for 39% of Gross Domestic Product, and contributes more than 80% of foreign exchange earnings (Malawi Government [2009]). Malawi has recently suffered from dry spells which in the past year have led to severe droughts, such that a state of national disaster was declared in April

2016 (BBC [2016]).

The people of Malawi belong mainly to various Central Bantu language speaking groups. About 33% belong to the Chewa group and 11% are Lomwe (figure 6). Other indigenous Malawians include the Tumbuka, Tonga, and Ngonde. The Ngoni and Yao arrived in the 19th century; together they constitute about 20% of the population . According to Posner (2004), Malawi is the 12th (out of 42) most ethnically fractionalized nation in Sub-Saharan Africa. Although ethnic conflict is not as severe in Malawi as it was in the past (Posner [2004]), the high level of fractionalization in Malawi makes this country a particularly interesting case study.

The following sections in this paper will set out a review of the main literature around ethnic heterogeneity, shocks and common pool resources, which provides the basis for our theoretical framework. We then set out data, our empirical strategy and our results and checks for robustness. We conclude with a discussion of the issues raised about the mechanisms by which ethnic fractionalization and polarization might affect harvests and consumption, and conclude with a summary of our findings and recommendations for future work.

2 Literature Review

Ethnic divisions were brought to the forefront of the development economics literature by Easterly and Levine [1997] and were conceptualized as "ethnic fractionalization". Easterly and Levine [1997] argue that it is one of the principal barriers to growth in Sub-Saharan Africa. The authors find ethnic fractionalization explains a significant part of the prevalence of poor schooling, political instability, underdeveloped financial systems, distorted foreign exchange markets, high government deficits and lack of infrastructure found in the continent.

In recent years a rich micro-economic literature has been developed which seeks to explore how ethnic heterogeneity could affect economic outcomes from the "bottom up", which includes the effects on collective outcomes, private outcomes, the interaction with common pool resources and the policy implications of ethnic heterogeneity. The remainder of this section will discuss each of these areas.

2.1 Ethnic heterogeneity and collective outcomes

Several theories arise in the literature regarding the mechanisms behind ethnic fractionalization and collective action outcomes. One theory suggests that in more ethnically fractionalized communities, fewer funds are allocated to public goods. The reasons for this are heterogeneous preferences across ethnic groups and a decrease in utility due to public good sharing with a different ethnic group (Alesina and La Ferrara [1999]). Moreover, outcomes may be poorer in communities with higher ethnic division because political actors tend to channel funds to the ethnic group they represent (Alesina and La Ferrara

[1999]). Burgess et al. [2013] find evidence for this in Kenya: those districts that share the ethnicity of the president receive twice as much expenditure on roads. Habyarimana et al. [2007] use lab experiments in Uganda to discern preference explanations for ethnic based discrimination from other plausible mechanisms such as strategy selection. They conclude that preference explanations are less powerful than others such as close linking through social networks. Subsequent work by Berge et al. [2015] use a variety of lab experiments in urban Kenya and shed further doubt into the strength of the ethnic preferences mechanism.

Social sanctions are important to incentivize collective actions. The idea is that better collective outcomes are reached in those communities where social pressure is high and interpersonal ties are strong (Miguel [2004]). Miguel and Gugerty [2005] find empirical support for ethnic fractionalization in Kenya to be associated with not only worse school provisions and well maintenance, but also with lower enforcement of sanctions on parents who do not contribute in any way to the school upkeep. Karlan [2007] finds homogeneous groups more likely to save and repay microfinance loans, a result attributed to the ability to monitor and enforce rules.

Despite the progress in identifying possible mechanisms, incoming studies repeatedly find mixed evidence on coethnic preferences in African settings (Carlson [2015], Michelitch [2015], Dionne [2014], Grossman and Honig [2015], Marx et al. [2015], Loewen et al. [2014], Jeon [2013], Voors et al. [2012]).

Finally, the social capital literature emphasizes the importance of trust for economic outcomes (e.g. Putnam et al. [1993]). Barr [2004] finds that trust of randomly resettled incomers in Zimbabwe is lower than the incumbent population, thus highlighting an important mechanism by which fractionalization might reduce economic outcomes.

2.2 Measures of heterogeneity

There are multiple measures of heterogeneity which are relevant when we consider collective outcomes. Alesina and La Ferrara [2000] investigate not only how ethnic heterogeneity in communities affects the degree and nature of social interactions but also the effect of income and race heterogeneity. They find that participation in community activities has an inverse relationship with community heterogeneity (defined in terms of these three axes) and this effect is stronger when a non-excludable good comes into play. Additionally, preferences matter and, mostly, individuals have preferences for community homogeneity. Therefore, heterogeneity can affect differently individuals within the same community, with individuals who dislike mixing the most bearing more negative effect (Alesina and La Ferrara [2000]).

Garcia-Montalvo and Reynal-Querol [2004] devise an index of ethnic polarization which they argue has more explanatory power in terms of ethnic and religious conflict than the more established fractionalization indexes. While fractionalization increases with the number of groups in a community, polarization is an increasing function of the size of those groups. Garcia- Montalvo and Reynal-Querol take this index to the cross country macro

data, showing that higher ethnic polarization is associated with lower growth through the channels of reduced investment and increased public consumption.

2.3 Common pool resources: empirical literature

The seminal work by Elinor Ostrom (Ostrom [1990]) identifies eight principles for stable common pool resource management. These include clearly defined boundaries, rules regarding appropriation and provision, arrangements that allow for and/or promote that most actors participate in decision-making, a scale of graduated sanctions, and cheap mechanisms for conflict resolution among others. Her research opened the gate for a growing literature on how to maintain long-term sustainable resource yields in human societies. Subsequent works emphasized the need to go beyond rational choice models to study collective action (Ostrom [1998]) and delve into the evolution of social norms that govern community dynamics (Ostrom [2014]).

Some empirical literature exists specifically on the effect of heterogeneity on the maintenance of common pool resources. Dayton-Johnson [2000] finds that irrigation canal maintenance is worse in more socially heterogeneous communities with higher wealth inequality. Khwaja [2009] finds that social fragmentation (ethnic, political and religious) is negatively associated with the maintenance of irrigation projects. He also finds a U-shaped relationship between economic inequality and project maintenance.

2.4 Ethnic heterogeneity and private outcomes

In our paper, we are particularly interested in the effects of heterogeneity on private outcomes. Alesina and La Ferrara [2004] suggest that diversity can be positive in this context by stimulating the innovation process, although they state that this effect will be greater in advanced economies. In a developing country context, Fisman [1999] and Fisman [2003] has explored the role of ethnic networks in allocating supplier credit. Alesina and La Ferrara [2004] suggest that the greater the number of ethnic groups in the business community, the lower the chances that supplier credit is allocated efficiently if the criterion is purely ethnic affiliation. For Malawi, Robinson [2013] finds that market segmentation is increased in locations which coincide with ethnic borders, resulting in lower economic efficiency.

Hjort [2014] uses a clever identification to study the effect of ethnic divisions on firm productivity. His findings point to a negative effect. They also suggest that ethnic rivalries vary with the political environment. In high cost environments, the author finds firms adopt "second best" policies to limit discrimination distortions.

2.5 Policy implications: how the effects of fractionalization might be reduced

Miguel [2004] examines how different policy designs affect inter-ethnic cooperation. He is able to replicate a quasi-natural experiment by comparing nearby rural villages in Kenya and Tanzania and explores the effect of nation-building policies such as the promotion of a common language and the renewal of the public school curriculum so that it stresses the national culture, history and values. He finds that these policies can help to bring together different ethnic groups, which in turn can lead to higher spending for public goods and better economic outcomes. Nation-building policies are successful if they do not refuse to recognize the existence of minority ethnic groups, along with their own traditions, languages and cultural practices (Miguel [2004]).

In the Malawian context, McCarthy and Kilic [2015] explore the effects of education and wealth inequality on collective and private outcomes and examine policy implications. They find that the negative effects of social heterogeneity can be reduced where there is a good match between a community and its leadership in terms of representation of women, young adults and ethnic minority groups.

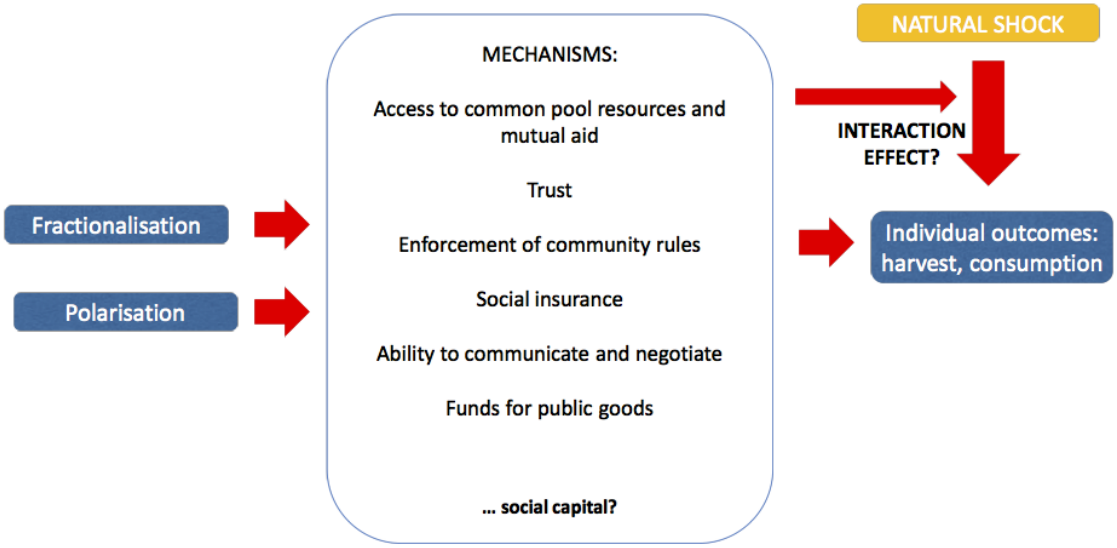
3 Theoretical Framework

Informed by the literature above, we form a testable model by which ethnic fractionalization and polarization might exacerbate the impact of shocks, and reduce the benefits from common pool resources. Figure 1 illustrates this for the impact of shocks. Ethnic fractionalization and polarization are likely to negatively affect those aspects of community interaction which are beneficial to private outcomes such as harvests and consumption. The mechanism for this is that fractionalization will reduce access to common resources, trust, the enforce-ability of common rules, the ability to access social safety nets, and communicate and fund public and communal projects.

Our model combines all of these social interactions, which could be considered collectively as social capital, and posits that ethnic heterogeneity (fractionalization and polarization) will negatively affect their ability to support private outcomes directly. In addition we hypothesize that ethnic heterogeneity will reduce a community's ability to cope with a shock such as a drought, flood or irregular rains through the lack of well functioning social coordination and support mechanisms.

Similarly we posit that ethnic heterogeneity will reduce the economic benefits of common pool resources, as communities which have poor collaboration, trust and ability to enforce sanctions and rules are likely to be less effective at maximizing the value of a common pool resource (Ostrom [1990]). This can be represented diagrammatically by replacing the shock in figure 1 with a common pool resource such as a communal forest, irrigation system or pasture land.

Figure 1: How ethnic fractionalization and polarization might affect the impact of shocks



We take this theory and formulate two hypotheses to be tested with the data:

- H1: Ethnic fractionalization and polarization will negatively affect a community's ability to cope with a natural shock.
- H2: Ethnic fractionalization and polarization will negatively affect the benefits that individuals derive from common pool resources

4 Data

Our data comes from two sources: (1) the second round of the Malawi Integrated Household Panel Survey (IHPS 2013) and (2) the 2008 Malawi Census. In order to conduct our analysis a significant amount of data cleaning and merging was necessary. In this section we describe the process for constructing our household level dataset.

4.1 IHPS Data

The second round of the IHPS contains information on 4,000 households and the fieldwork took place between April and October 2013. It was implemented by Malawi's National Statistical Office. The survey instruments include a Household, Agriculture, Community,

and Geolocation questionnaires. The IHPS data are representative at the national, urban-rural, and regional levels.

The sampling frame for the survey was the information and cartography from the 2008 Malawi Population and Housing Census. A stratified two-stage sample design was used: Enumeration Areas (EAs) at community level were selected in the first stage with probability proportional to the household count from the 2008 Census. In the second stage households were selected randomly from each sampled EA. All sampled households were geo-referenced. Since we are interested in rural communities with natural resource based economies , we drop observations pertaining to urban areas throughout our dataset.

4.1.1 Household level data

The Household questionnaire collected individual-disaggregated information on demographics, anthropometrics, health, education, employment and main sources of income, enterprises, housing, food consumption, and asset ownership among other topics. Household level data also contains a computed household consumption aggregate.

4.1.2 Outcome: consumption

We focus on two outcomes that measure household economic welfare: real annual consumption and maize harvest. Here our interest in consumption lies in its ability to proxy income, especially in rural Malawi where saving is low. The consumption aggregate contains information on food, non-food (utilities such as kerosene and electricity; health; transport; communications; recreation; education; furnishings; personal care; etc), durable goods, and housing (flow of services received by the household from occupying its dwelling). Food expenditure is measured using observations for one week pro-rated to an annual basis. As such this variable is poor for measuring the impact of a shock (which is unlikely to occur during the week in which consumption is measured) but we believe satisfactory for measuring the ongoing effects of common pool resources.

4.1.3 Agricultural data

The Agriculture questionnaire was administered to households involved in agricultural activities. That is, ownership of land, cultivation of land, and/or ownership of livestock. Each land plot was also geo-referenced. The Questionnaire contains information on the physical characteristics of the land plots as well as crop cultivation and production for both rainy and dry seasons.

4.1.4 Outcome: maize harvest

We use as one of our two principal outcome variables the rainy season maize harvest (November-April). Maize is the principal crop in Malawi, grown by approximately 97% of rural households (IHPS data). Furthermore, the rainy season produces the major harvest for the year. In order to construct this variable, quantities provided in non-standard units such as pails and ox-carts had to be converted to kilograms of maize using food conversion factors available from the World Bank. We also amalgamated hybrid and traditional maize varieties into one variable at the household level. For our analysis involving maize harvest, we drop observations for non-maize farmers (3% of rural households).

4.1.5 Community data

The IHPS contains information on 204 Enumerator Areas (EAs). A typical EA in rural Malawi corresponds approximately to 2 or 3 villages and around 250 households. Community level information was collected for each through a focus group. Boundaries of each EA were set through maps produced by Malawi's National Statistical Office. The leader of each survey team was instructed to form focus groups composed of 5 to 15 long-term knowledgeable residents of the community. Team leaders were also instructed to balance focus groups members by sex, age, religion, and ethnicity.

4.1.6 Geospatial data

The IHPS data also contains geospatial data mapped to the 204 EAs in our sample. Geospatial data is presented at the household and plot level and was obtained by linking GPS-based household and plot locations to public geospatial data. A drawback is that the data has varying levels of resolution at the household level.

The data contains information on physical characteristics of the location (potential wetness, elevation, toxicity, rainfall among others), as well as distance to closest road, agricultural market, among other important landmarks.

4.2 Census data

From the 2008 Census data we obtained the ethnic and religious composition of each traditional authority in Malawi. We matched the census data to IHPS data by traditional authority. The administrative divisions of Malawi are as follows: the country is divided into three regions (Northern, Central, and Southern) and further into 28 districts. Figure 9 shows a map of all districts. Beyond these divisions, Malawi is organized into "Traditional Authorities" (TAs). Figure 6 provides a list of all TAs in Malawi.

4.3 Summary statistics

In Table 1 we summarize descriptive statistics. We took the natural logarithm of consumption and maize harvest to normalize them and reduce the variation in the data. Figure 10 and Figure 11 in the Appendix show the histograms of the log of consumption and log of maize harvest.

Table 1: Summary Statistics

	Obs	Mean	Std. Dev.	Min	Max
Outcomes					
Log of total rainy season maize harvest per HH	2880	6.0575	1.0666	0.6931	10.9638
Log of consumption per HH	4000	13.2895	0.6976	10.8123	16.5671
Main variables of interest					
Ethnic heterogeneity indexes					
Ethnic fractionalization index	3737	0.4518	0.2339	0.0360	0.8630
Ethnic polarization index	3737	0.5536	0.1934	0.0710	0.9394
Availability of common pool resources					
Irrigation	3831	0.1360	0.3428	0	1
Forest	3981	0.3027	0.4595	0	1
Pasture	3961	0.1376	0.3445	0	1
Natural shocks					
Drought	4000	0.2432	0.4291	0	1
Irregular Rain	4000	0.427	0.4947	0	1
Flood	4000	0.110	0.3129	0	1
Controls common to both income and harvest regressions					
Age of household head	3993	42.4107	15.7790	16	113
Education of household head	3968	1.8357	1.3435	1	7
How many plots use pesticide and herbicide per HH	3219	0.068	0.30846	0	4
Has any HH member received cash, food, or other aid from Food/Cash-for-Work Programme	4000	0.013	0.1133	0	1
How many plots use inorganic fertilizer per HH	3219	1.1034	0.8969	0	6
How many plots use organic fertilizer per HH	3219	0.2553	0.5691	0	4
Average soil quality of all HH's plots	3060	2.3374	0.6452	1	3
Total area of cultivated/owned land per HH	3219	2.9487	32.7845	0	1447.37
Annual mean temperature	4000	212.88	19.0706	176	262
Annual precipitation	4000	1068.948	237.2534	755	2309
Agro-ecological zones	4000	314.6003	4.19176	312	323
Participation in Free maize programme in last 12 months	4000	0.084	0.2774	0	1
Participation in Free maize programme	4000	0.0578	0.2332	0	1
Participation in Inputs-For-Work programme in last 12 months	4000	0.0135	0.1154	0	1
Participation in School Feeding programme in last 12 months	4000	0.1535	0.3605	0	1
Participation in MASAF Public Works programme in last 12 months	4000	0.1215	0.3267	0	1
Income controls					
Number of heads in the household	4000	4.9758	2.3404	1	18
Sex of the household head	3995	1.2300	0.4209	1	2
Over the past 12 months, did you or anyone else in this household borrow on credit from someone outside the household or from an institution for business or farming purposes, receiving either cash or inputs?	3997	1.7803	0.4140	1	2
Is there a place to make a telephone call in this community - e.g., a public telephone, a telephone bureau, or a vendor offering telephone services	4000	1.6825	0.4657	1	2
Is there a local warehouse that the community members could use to store crops prior sale?	3831	1.9744	0.1579	1	2
Are there any agriculture-based projects operating in the community?	3831	1.7264	0.4458	1	2
Maize Harvest					
Sex of the person who makes the decisions concerning crops to be planted& input use and the timing of cropping activities on the household's plots	3012	0.6839	0.4650	0	1
Gini coefficient of consumption by TA	3828	0.3171	0.0709	0	0.603

5 Empirical Strategy

Our empirical strategy aims to test whether ethnic heterogeneity, when coupled with a collective action challenge, worsens private outcomes. We look at this through (a) natural shocks and (b) availability of common pool resources. Our econometric specification is:

$$Y_{ik} = \beta_0 + \beta_1 frac\_eth_k + \beta_2 Z * frac\_eth_k + \beta_3 Z_k + \boldsymbol{\gamma} X + u_{ik} \tag{1}$$

where y_{ik} is either total rainy season maize harvest of household i in community k, or total annual consumption of household i in community k and Z_k refers to a natural shock or availability of a common pool resource. Natural shock refers to a dummy capturing one of: irregular rains, droughts, or floods. Common pool resource refers to a dummy capturing the availability of one of: a common pasture, a common forest, or irrigation. The vector X refers to controls relating to household and community characteristics, geography and agricultural practice, summary statistics for which can be found in Table 1, and $\boldsymbol{\gamma}$ is the vector of coefficients.

We are particularly interested in the sign and significance of β_2 which tells us whether the level of ethnic fractionalization worsens the impact of the shock, or for our second specification, worsens the community´s ability to manage the common pool resource.

We also repeated the same specification but instead of using ethnic fractionalization, we use ethnic polarization:

$$Y_{ik} = \beta_0 + \beta_1 pol\_eth_k + \beta_2 Z * pol\_eth_k + \beta_3 Z_k + \boldsymbol{\gamma} X + u_{ik} \tag{2}$$

Montalvo and Reynal-Querol [2005] suggest that the negative effects of polarization will be worse than those of fractionalization. We aim to test this claim by comparing the effects of heterogeneity as measured by each index.

Additionally, we explored a quadratic model for polarization in the presence of common pool resources. The reason for this was the relationship suggested by the Figure 2 and Figure 3, which plot polarization against consumption and the interaction of polarization with the presence of a communal forest against consumption:

The econometric specification for the quadratic model is the following:

$$Y_{ik} = \beta_0 + \beta_1 Z_k + \beta_2 pol\_eth_k + \beta_3 pol\_eth_k^2 + \beta_4 Z * pol\_eth_k + \beta_5 Z * pol\_eth_k^2 + \boldsymbol{\gamma} X + u_{ik} \tag{3}$$

$$Y_{ik} = \beta_0 + \beta_1 Z_k + \beta_2 frac\_eth_k + \beta_3 frac\_eth_k^2 + \beta_4 Z * frac\_eth_k + \beta_5 Z * frac\_eth_k^2 + \boldsymbol{\gamma} X + u_{ik} \tag{4}$$

Here also y_{ik} is either total rainy season maize harvest of household i in community k, or total annual consumption of household i in community k and Z_k refers to a common pool resource. The novelty are the squared terms: the ethnic polarization (fractionalization)

Figure 2: Relationship between ethnic polarization and logged consumption

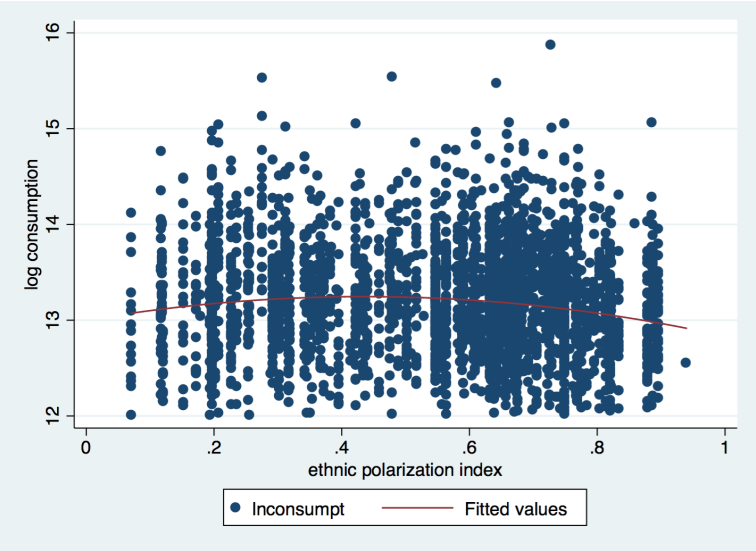


Figure 3: Relationship between ethnic_polarization*forest and logged consumption

index $pol\_eth_k^2$ and the interaction term of one of the two indexes with a common pool resource, $Z * pol\_eth_k^2$.

5.1 Identifying assumption

The identifying assumption for β_2 in equation 1 to represent a causal impact of fractionalization or polarization on the ability to cope with a shock is that both the shock and the ethnic index are exogenous, i.e. for the example of fractionalization:

$$E(u_{ik} \mid shock_k, frac\_eth_k, X) = E(u_{ik}) \tag{5}$$

For this to be true we require that our variables of interest are as a good as random, or more realistically that there are no missing variables correlated with our variables of interest which affect y, that there is no reverse causation from our y variables to our variables of interest, and that measurement error is as good as random.

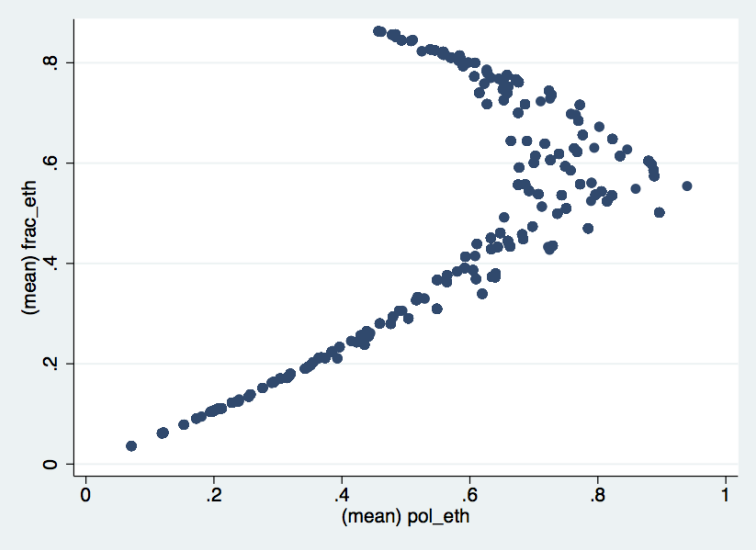
The exogeneity of a natural shock is true by definition, since the weather will be independent of the actions of the individuals in our study. However, the exogeneity of our ethnic measures is harder to establish. We discuss this issue at length in section 6.3, but the best we can hope for is that these indices are stable over time, and that aspects of a community which might cause people of a particular ethnicity to migrate in and out over time are slow acting.

The exogeneity of common pool resources such as forests, pastureland and irrigation schemes is difficult to establish as ethnic heterogeneity could cause these resources to become defunct at a given time (e.g. the over-grazing of common land discussed by Ostrom [1990]). However, forests and irrigation schemes take a long time to establish, so that those that do exist are probably more indicative of past ethnic makeup than that of the present if there is a relationship at all.

5.2 Indices

We use the Malawi census data from 2008 to construct fractionalization and polarization indices at Traditional Authority (TA) level and merge this data with the household data (Malawi Integrated Panel Survey 2012-2013). As discussed in section 5.1, our identifying assumption relies on the fact that the ethnic composition of communities does not change greatly over time (see section 6.3 for more on this).

Figure 4: Scatter plot of ethnic fractionalization against ethnic polarization in Malawian TAs.



Source: authors' calculations using Malawi IHPS and Malawi 2008 census data

A contribution of our study is to explore the impact of fractionalization and polarization on individual outcomes in the face of shocks or in the context of common pool resource

management. We draw our theory on indices of fractionalization and polarization from Montalvo and Reynal-Querol [2005]. Ethnic fractionalization is the probability that two individuals randomly selected do not belong to the same group. It is a measure of diversity in the community. The index of fractionalization can be represented as:

$$FRAC_k = 1 - \sum_{i=1}^{N} \pi_i^2 \tag{6}$$

where π equals the proportion of ethnic group i.

It has been well established in the literature that fractionalization can explain economic development outcomes but ethnic fractionalization falls short of explaining civil war/unrest. When we discuss common pool resource management and the effectiveness of the community in dealing with natural hazards such as floods and droughts, we also need to consider an index which represents the potential for conflict. Polarization, an alternative index, captures how big the minority community is, and thereby the potential for the failure to collaborate due to civil conflict. We use the same polarization index as proposed in Montalvo and Reynal-Querol [2005] :

$$POL_k = 1 - \sum_{i=1}^{N} \left(\frac{0.5 - \pi_i}{0.5} \right)^2 \pi_i \tag{7}$$

It is important to understand the correlation between the two indexes. For example, Montalvo and Reynal-Querol [2005] use the original data of the Atlas Nadorov Mira for a sample of 138 countries and plot ethnic fractionalization against ethnic polarization and find that they are linearly correlated while ethnic polarization is less than 0.4. For intermediate values of ethnic polarization they observe zero correlation and for values higher we observe negative correlation .

When we plot and analyze our data on fractionalization and polarization within TAs we find results very similar to that presented by Montalvo and Reynal-Querol [2005] for the sample of 138 countries Figure 4. Our chart has exactly the boomerang shaped formation found in Montalvo and Reynal-Querol [2005]. Further Montalvo and Reynal-Querol [2005] show theoretically that in the presence of only two groups polarization and fractionalization are linearly correlated, which supports our analytical findings of correlation at low levels of polarization.

6 Results

For all of the regression output tables presented in this section, columns (i) and (ii) pertain to the regressions having as principal covariates ethnic fractionalization, whereas (iii) and (iv) regard ethnic polarization. Additionally, both columns can have as regressors either a

natural shock or the availability of a common pool resource and their interaction term with the index under consideration. Columns (i) and (iii) refer to econometric specifications without control variables, while (ii) and (iv) include the full set of controls described in Table 1. Regression output tables, for parsimony, report only the main coefficients of interest: β_1, β_2, and β_3.

6.1 Heterogeneity, natural shocks, and private outcomes

Table 2 reports regression output for how maize harvest may be affected by community ethnic heterogeneity and polarization in the presence of a drought. In both column (i) and (ii) the estimated coefficients for the interaction terms are statistically significant at the five percent significance level, although the sign is not as expected. The estimates suggest that when communities are faced with a drought, being more ethnically fractionalized reduces the impact of the drought on harvest.

Table 2: Ethnic fractionalization and polarization on maize harvest in the presence of drought

Dependent Var.: Log rainy season maize harvest at household level 2012-13 (kg)				
Variables	i	ii	iii	iv
frac_eth	-0.553***	-0.699***		
	(0.183)	(0.184)		
frac_eth_drought	0.701**	0.560**		
	(0.291)	(0.254)		
drought	-0.579***	-0.406***	-0.519***	-0.357**
	(0.147)	(0.124)	(0.188)	(0.160)
pol_eth			-0.665***	-0.695***
			(0.230)	(0.231)
pol_eth_drought			0.424	0.344
			(0.297)	(0.259)
Constant	6.374***	5.607***	6.516***	5.559***
	(0.0994)	(0.722)	(0.138)	(0.723)
Observations	1,463	1,426	1,463	1,426
Adjusted R-squared	0.021	0.238	0.024	0.237
Control Variables	NO	YES	NO	YES

Note: Robust standard errors in parentheses, Clustering at TA level. $^{***}p < 0.01$, $^{**}p < 0.05$,$^{*}p < 0.1$. Ethnic fractionalization is defined as the probability that any two randomly chosen individuals do not belong to the same ethnic group; polarization takes into account the size of the smallest group.

In the absence of a drought, a 0.1 increase in the fractionalization index reduces harvest by around 6.8 percent [1], significant at the 1 percent level. However, in the presence of a drought the overall effect of a 0.1 unit increase in the index of ethnic fractionalization is a reduction of 1 percent of mean harvest [2] . Given an estimated mean maize harvest of 427 kg [3] (Table 1), this effect amounts to around 4.3 kg of maize per household lost for each 0.1 unit increase in fractionalization in the presence of a drought. Compare this with in the absence of a drought, where a 0.1 increase in fractionalization is estimated to result in the loss of around 28.9 kg of maize. In the absence of fractionalization or

[1] calculated as exp(-0.699/10) -1 = 0.068.
[2] exp(0.56/10)-1= 0.058, then 5.8 - 6.99 = - 1.
[3] exp(6.06)=427.

polarization, the estimated coefficients on drought suggest that the presence of a drought on average reduces maize harvest by 40.6 (specification (ii)) to 35.7 percent (specification (iv)). The interaction term of ethnic polarization with drought in column (iv) seems not to affect harvest, with the coefficient being statistically insignificant and positive. Ethnic polarization on its own is statistically significant at the one percent significance level, and has the expected sign. A 0.1 increase in the polarization index may reduce harvest by, roughly, 6.95 percent.

Table 3: Ethnic fractionalization and polarization on maize harvest in the presence irregular rain

Dependent Var: Log rainy season maize harvest at household level 2012-13 (kg)				
VARIABLES	i	ii	iii	iv
frac_eth	-0.616***	-0.762***		
	(0.187)	(0.182)		
frac_eth_irregular_rain	0.499*	0.410*		
	(0.257)	(0.242)		
irregular_rain	-0.361***	-0.361***	-0.324*	-0.331*
	(0.125)	(0.115)	(0.174)	(0.171)
pol_eth			-0.736***	-0.761***
			(0.217)	(0.201)
pol_eth_irregular_rain			0.323	0.285
			(0.295)	(0.297)
Constant	6.400***	5.866***	6.548***	5.771***
	(0.0981)	(0.730)	(0.132)	(0.736)
Observations	1,463	1,426	1,463	1,426
Adjusted R-squared	0.010	0.240	0.013	0.239
Control Variables	NO	YES	NO	YES

Note: Robust standard errors in parentheses, Clustering at TA level. $^{***}p < 0.01$, $^{**}p < 0.05$,$^{*}p < 0.1$. Ethnic fractionalization is defined as the probability that any two randomly chosen individuals do not belong to the same ethnic group; polarization takes into account the size of the smallest group.

Table 3 displays regression output for how community heterogeneity may influence maize harvest in the presence of irregular rain shocks. Across all specifications irregular rain is significant and has an adverse effect on harvest: experiencing an irregular rain shock decreases harvest by 33-36 percent, if there is no ethnic heterogeniety and holding all else constant. Both ethnic fractionalization and polarization are statistically significant and detrimental for harvest. With regard to the main coefficients of interest, that is, the interaction terms, they are unexpectedly positive and significant in specification (ii) only at the 10 percent level. Our estimates suggest that, in the presence of an irregular rain shock, a 0.1 increment in ethnic fractionalization decreases harvest by 3.1 percent [4]. Given an estimated mean maize harvest of 427 kg, this amounts to a loss of 13.2 kg. In the absence of an irregular rain shock, maize harvest is reduced by 7.3 percent when ethnic fractionalization or polarization increases by 0.1. This translates to an overall effect on mean harvest of 31.2 kg lost.

We also ran a regression to explore the effect of ethnic heterogeneity in the presence of floods (Table 10 in the Appendix). Although the results affirm the negative effect of fractionalization and polarization in the absence of a shock, we do not find a significant

[4]calculations go as follows: exp(-0.762/10)-1 = -0.073 and exp(0.41/10)-1 = 0.042, which summed together yield -0.031.

interaction effect, suggesting that floods do not significantly change the effect of ethnic heterogeneity.

6.2 Heterogeneity, common pool resources, and private outcomes

Table 4 reports estimated coefficients for the quadratic model. In these regressions we seek to understand how having a common pool resource and being more or less fractionalized (polarized) may affect farmers' consumption. Ethnic fractionalization appears not to have an impact on consumption and this is so even in the linear specification (see Appendix Table 7, Table 8 and Table 9 for the specific regression outputs). On the other hand, polarization seems to play a role in those communities that have to manage a common pool resource. We find a quadratic relationship such that polarization is beneficial for income, but with decreasing marginal returns. That is, communities can cope with polarization when managing a forest in a constructive way only up to a certain degree of polarization. When polarization reaches a degree that is high enough, it starts to have a detrimental effect. This turning point occurs when the ethnic polarization index is equal to 0.45 and can be calculated by taking the derivative of equation 3 and setting it to zero. We obtain:

$$pol\_eth_k = -\frac{1}{2}\left(\frac{\beta_2 + \beta_4 Z_{ik}}{\beta_3 + \beta_5 Z_{ik}}\right) \tag{8}$$

then, plugging in the values for the coefficients from specification (iv), we get 0.45.

We also explored non-linear specifications for the effects of ethnic heterogeneity in the presence of common pasture and irrigation (see in the Appendix Table 12 and Table 13). The significant coefficients on our heterogeneity variables and their squared terms support our finding that the effect of polarization on consumption is quadratic and concave. However the interaction variables were not significant at the 10% level. This suggests that there may not be a differential effect for ethnic heterogeneity in the presence of these common pool resources.

Finally, we regressed our ethnic heterogeneity indices on our harvest variable in the presence of an irrigation scheme. We again find a negative and significant relationship of fractionalization and polarization with harvest, but no significant effect of irrigation on harvest (Table 11).

Table 4: Quadratic specification: Ethnic fractionalization and polarization on consumption when the community owns a forest

Dependent Var.: Log consumption at household level 2012-2013				
VARIABLES	i	ii	iii	iv
frac_eth	-0.225	-0.343		
	(0.474)	(0.346)		
frac_eth2	0.141	0.454		
	(0.501)	(0.374)		
forest	-0.0138	0.0733	-0.228	-0.233
	(0.155)	(0.118)	(0.226)	(0.148)
frac_eth_forest	-0.213	-0.501		
	(0.750)	(0.599)		
frac_eth2_forest	0.360	0.541		
	(0.795)	(0.643)		
pol_eth			0.747	0.338
			(0.566)	(0.443)
pol_eth2			-0.929	-0.419
			(0.567)	(0.431)
pol_eth_forest			0.941	1.265**
			(0.905)	(0.612)
pol_eth2_forest			-0.894	-1.361**
			(0.843)	(0.584)
Constant	13.24***	13.43***	13.09***	13.16***
	(0.0961)	(0.274)	(0.134)	(0.281)
Observations	2,849	2,529	2,849	2,529
Adjusted R-squared	-0.000	0.316	0.011	0.322
Control Variables	NO	YES	NO	YES

Note: Robust standard errors in parentheses, Clustering at TA level. ***$p < 0.01$, **$p < 0.05$,*$p < 0.1$. Ethnic fractionalization is defined as the probability that any two randomly chosen individuals do not belong to the same ethnic group; polarization takes into account the size of the smallest group.

6.3 Robustness checks

One of the major concerns of our study is potential endogeneity of ethnic heterogeneity due to migration. We identified several approaches in order to discuss and establish the exogeneity of our indexes:

1. Checking whether income inequality at the TA level is correlated with our ethnic index;
2. Use census data from several decades ago to check whether the ethnic composition by TA has changed over this time;
3. Use historical data of ethnic groups in Malawi from centuries ago (compiled by

George Peter Murdoch in the Ethnographic Atlas) to check whether they have changed over the centuries;

4. Correlation between community characteristics and the indexes (insert correlation table).

Unfortunately, it was only possible to fully complete (1) and (4). For (2) we only had data on the proportions of ethnic groups in the population at the country level, not at the TA level. For (3) were unable to obtain the Ethnographic Atlas data.

To complete robustness check (1) we use consumption as a proxy for income and construct a Gini coefficient for it at the level of the traditional authority. The Gini coefficient is found to be largely uncorrelated with ethnic fractionalization and polarization, as shown in Table 5.

Table 5: Correlation between Gini and Ethnic fractionalization & Polarization

	Ethnic fractionalization	Ethnic polarization
Gini (household consumption)	-0.0423	-0.1342

The idea for (2) follows what Glennerster et al. [2013] did: they use census data for Sierra Leone from 1963 to construct indexes of polarization and fractionalization and use them as an IV for current ethnic heterogeneity. In our case, the oldest census data available for Malawi dates from 1987 and it does not contain data on ethnicity. As a substitute, we used data on the proportion of each ethnic group at the country level from the Composition of Religious and Ethnic Groups Project (CREG). Figure 5 shows the evolution of the proportion of each ethnic group in 1964, 2008, and 2012. We can observe that the composition has not significantly changed over these years. We must note, as mentioned above, that we only have ethnic composition at the country level and we cannot see whether there was significant variation in ethnic composition at the level of the TA. Nevertheless, our data show that 80% of IHPS respondents have always lived in the same village or urban location. This suggests there will be a low degree of change in ethnic makeup over time.

To carry out robustness check (4), we looked at the correlation between community characteristics (at the EA level) and the ethnic heterogeneity indexes. Table 6 shows this correlation matrix. The results cast doubt on the exogeneity of our fractionalization and polarization indices on the one hand, since they show that for example ethnic heterogeneity is correlated negatively with better school construction and availability of agricultural input supplies. On the other hand, given the slow moving nature of our indices as demonstrated in robustness check (1), it could be that the causal effect in fact runs in the opposite direction, i.e. these correlations may explain some of the mechanisms by which fractionalization might affect harvests and consumption. We will discuss this further in the following section.

Figure 5: Ethnic composition of Malawi over time

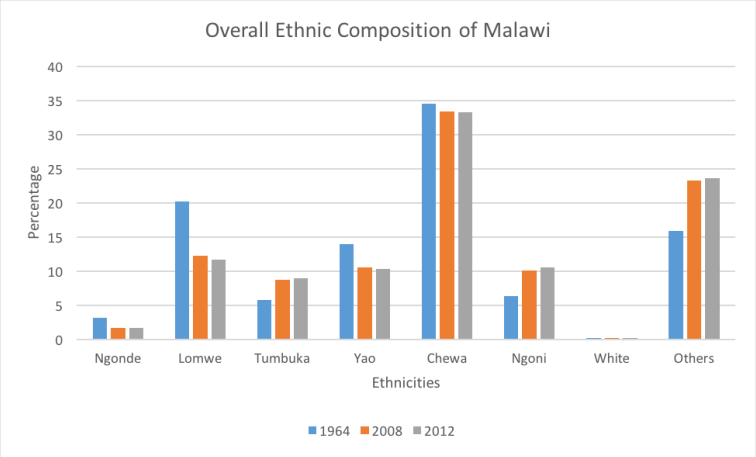


Table 6: Correlation matrix

	frac_eth	pol_eth	Access to Roads	Weekly Market	No. of Church
Fractionalization	1	0.6505	-0.1921	0.1664	-0.1056
Polarization		1	0.0865	-0.108	-0.2095
	Mosques	Telephones	No. of Teachers at nearest Primary School	No. pupils at nearest govt prim school	Nearest govt prim school, solid construction?
Fractionalization	0.0421	0.117	0.0697	-0.0202	-0.3219
Polarization	-0.1588	0.1315	-0.1615	-0.2587	-0.2674
	No. of teachers at nearest 2ndary school	Electrification at 2ndary school	Place to purchase common medicines	Health facility has electrification	Microfinance Institution
Fractionalization	0.4505	-0.101	0.0078	0.0357	0.2268
Polarization	0.0737	0.0574	0.1315	0.1433	0.3572
	Development officer lives in this community	Irrigation	No. of sellers of fertilizer in this community	no. of Sellers of hybrid maize	Local warehouse for ag storage
Fractionalization	0.2057	0.1176	-0.	-0.1603	0.0201
Polarization	0.1112	0.2754	-0.1082	-0.1107	0.0034
	HH in community	How many households practice agroforest	Forest	Pasture	Waterbody
Fractionalization	-0.1558	-0.2186	-0.1709	-0.306	0.1287
Polarization	-0.2499	-0.2315	-0.0169	-0.3027	0.0222
	Community resource ever taken over by the government	Activegroup			
Fractionalization	0.0238	-0.065			
Polarization	-0.078	-0.0347			

7 Discussion

7.1 Ethnic heterogeneity and natural shocks: a cloud with a silver lining?

In our paper we find evidence which counters our hypothesis that fractionalization and polarization will negatively affect a community´s ability to cope with shocks. However we find support for theories which suggest that overall, fractionalization and polarization are bad for agricultural output.

Table 2 and Table 3 provide evidence that fractionalization and polarization both individually have a negative relationship with harvests. This is in support of our initial hypothesis that ethnic heterogeneity is a bad thing for a community, and supports the findings of for example Robinson [2013] and Alesina and La Ferrara [2004] who find that fractionalization is associated with lower market efficiency in developing countries; in the former case for Malawi specifically. We also find that polarization has a significant negative effect on harvests, a finding in the spirit of Montalvo and Querol´s work. The effects of fractionalization and polarization are similar in size, and are not significantly different from each other at the 1 percent level.

However as discussed in our literature review and theoretical framework, to the best of our knowledge, there is very little existing work on the impact of fractionalization in the presence of natural shocks such as droughts and irregular rains. Here our results run counter to our initial hypothesis that fractionalization would worsen the community's response to a shock. Specifically, Table 2 and Table 3 suggest that not only does fractionalization not worsen the impact of a drought or irregular rain, but that the effect of fractionalization on harvest is less negative in the presence of these shocks than it is under normal circumstances. It should be noted nevertheless that the combined effect of fractionalization, calculated by adding the individual coefficient on fractionalization and the coefficient on fractionalization interacted with the shock, is still negative in both regressions. This suggests that overall, fractionalization is bad for agricultural output, even in the presence of a shock.

Why should this be the case? An intuitive explanation would be that although fractionalization might be a bad thing for a community overall, in the presence of a shock which requires a concerted coordination effort on the part of a large part of the community, ethnic differences can be overcome to some extent. Our results suggest that this is the case in the presence of both droughts and irregular rains. We argue in section 5 that these shocks are exogenous with respect to the ethnic makeup of a community. So could it be that if the impact of a drought spans multiple ethnic boundaries within a community it promotes sharing and collaboration across those boundaries in a way which would not otherwise occur? Our findings provide tentative evidence that this may be the case and further work, both theoretical and empirical, could help to establish this connection in more detail.

In contrast, we find no evidence that ethnic polarization worsens the impact of shocks. We conclude this from the fact that in all of our regressions involving shocks the interaction term of polarization with the shock is not significant. This begs the question: why would the negative effects of polarization be unchanged in the presence of a shock, while the impact of fractionalization was significantly reduced? Here we refer to the literature by Montalvo and Reynal-Querol [2005] which compared the effects of the two indices and found that the effects of polarization were more significant in explaining civil conflict and low growth in developing countries. Perhaps our finding here supports theirs, that polarization is indeed worse for economic development than fractionalization, as it cannot be overcome even in the presence of a shock that would require the community to work together.

7.2 Common pool resources and ethnic heterogeneity: a polarization Kuznet's curve

Our findings for common pool resources are somewhat less conclusive. The scatter plots Figure 2 and Figure 3; and Table 4, Table 13, and Table 12 provide some evidence at the 5% level of significance of a quadratic relationship between ethnic polarization and logged consumption. This suggests a slight positive contribution of polarization to consumption, except for at high levels of polarization (above 0.45) where the overall contribution of polarization appears to become negative.

Moreover, Table 4 indicates that it is only in the presence of a communally managed forest that this relationship is really significant. We infer this from the observation that when the quadratic interaction of forest and polarization is included as a regressor, the non-interacted polarization terms lose significance. This suggests that there is something about ethnic polarization which is important for communal forest management. One potential explanation is that unlike in the case of shocks, the management of a communal forest is a continuous process, analogous to an endlessly repeated game. Perhaps in these circumstances a certain degree of polarization, by generating coherent bargaining factions, can help slightly in the process of agreeing common rules and enforcement discussed by Miguel [2004] and Miguel and Gugerty [2005]. However, beyond values of the polarization index of around 0.45, the marginal contribution of additional polarization to consumption becomes negative, suggesting that very high levels of polarization are unequivocally bad. Here our paper extends previous literature, which had focused on fractionalization and other measures of heterogeneity but not polarization.

7.3 How do fractionalization and polarization work in communities?

The above discussion has sought to explain our results in terms of existing theories and posit tentative steps in the construction of new ones. However it could be argued that our specification is to some extent a "black box" indicating the net results of ethnic heterogeneity on our outcome variables but without generating insight as to how ethnic

heterogeneity works in rural smallholder communities.

The correlation matrix 6 which shows our indices on a number of community characteristics does provide some non-causal clues as to why ethnic heterogeneity may be bad for harvests and consumption. In particular, we find evidence in support of Miguel and Gugerty [2005]'s work which found that ethnic fractionalization was associated with worse school provisions and maintenance. More specifically, fractionalization is negatively correlated with solid primary school construction (as measured by the presence of brick walls and an iron sheet roof) and regular primary school attendance. It is also negatively correlated with the presence of fertilizer and hybrid maize sellers, potentially supporting the findings of Fisman [1999], Fisman [2003] and Alesina and La Ferrara [2004] who found fractionalization worsens the provision of supplier credit. Perhaps for this reason we find a positive correlation between fractionalization and the presence of community microfinance institutions and agricultural extension officers.

Here of course we are not forgetting that these are mere correlations and are in no way causal estimates. Further work could seek to develop fully specified models for each of these phenomena, controlling for the other factors which might affect for example school construction. A robust estimate would likely require some form of randomized trial or natural experiment due to the endogeneity of fractionalization with respect to these outcome measures.

8 Conclusion

In this paper we explored the effects of ethnic fractionalization and polarization in the presence of natural shocks and common pool resources. Our hypotheses were that ethnic heterogeneity would worsen the impact of shocks, and affect detrimentally the economic benefit derived from common pool resources. We sought to test these hypotheses by constructing a novel dataset for Malawi which combines indices of ethnic fractionalization and polarization calculated at the Territorial Authority level using the 2008 census and the Malawi Integrated Household Panel Survey for the year 2013. We argue for the exogeneity of our heterogeneity indices based on the low level of change in the ethnic makeup of Malawi over the past four years and the low level of migration within the country.

In the first part of our analysis we regress the log of maize harvest on the presence of shocks such as drought, flood and irregular rain interacted with our ethnic heterogeneity indices and a set of agricultural, climate, household and community controls. We find that ethnic polarization and fractionalization are unambigiously bad for maize harvest. Counter to our expectations, we find that fractionalization appears to lessen the impact of a drought or irregular rain on harvest, although the net effect of increases in fractionalization remains bad for harvests. We posit tentatively the reduction in the effect of fractionalization in the presence of a shocks may be due to the way natural shocks may cross ethnic lines and facilitate the overcoming of ethnic differences. The bad effects of polarization remain unchanged in the presence of a shock, suggesting that this is a more intransigent problem, and potentially a cause of enduring local level conflict.

In the second part of our analysis we regress the log of consumption [5] on the presence of common pool resources such as forests, irrigation systems and common pasture land. We find no significant relationship between consumption and fractionalization after testing both linear and quadratic specifications. For polarization we find a quadratic relationship with consumption, which is strongest in the presence of a communal forest. This suggests that a certain degree of polarization could help communal forest management, with diminishing returns to increased polarization, becoming negative for high levels of polarization. We posit that this may be due to the repeated and continuous nature of communal forest management, and the way that polarization may facilitate the formation of coherent bargaining factions.

Through an exploration of the correlations between our ethnic heterogeneity indices and a set of community characteristics we find that greater heterogeneity is negatively correlated with school quality and the availability of agricultural inputs. These results cast some doubt on the exogeneity of ethnic heterogeneity. However given that the ethnic indices are slow moving over time, these correlations may also suggest some of the mechanisms by which fractionalization and polarization affect economic development in rural Malawi. Further work might seek to explore further these mechanisms, and whether the empirical findings of this paper can be replicated in other countries and contexts.

[5] as a proxy for income

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APPENDIX: Tables and Figures

Figure 6: TA list

Area Name	Population	Households
MALAWI	**9,933,868**	**2,273,837**
Northern Region	*1,233,560*	*243,060*
Chitipa District	126,799	25,748
TA Mwabulambya	49,443	10,000
TA Mwenemisuku	22,970	4,819
TA Mwenewenya	13,650	2,700
TA Nthalire	18,660	3,575
TA Kameme	14,419	3,099
Nyika NP-Chitipa	21	6
Chitipa Boma	7,636	1,549
Karonga District	194,572	39,880
TA Kilupula	47,445	10,024
SC Mwakaboko	15,377	3,645
TA Kyungu	46,063	9,554
TA Wasambo	37,725	6,979
SC Mwirang'ombe	20,151	4,066
Nyika NP-Karonga	0	0
Karonga Town	27,811	5,612
Nkhata Bay District	164,761	33,374
TA Kabunduli	30,130	6,718
TA Fukamapiri	11,287	2,225
TA Malenga Mzoma	8,441	1,622
SC Malanda	16,767	3,215
SC Zilakoma	10,229	2,198
TA Mankhambira	17,118	3,474
SC Fukamalaza	7,867	1,271
SC Mkumbira	7,653	1,588
TA Musisya	12,851	2,332
SC Nyaluwanga	5,239	962
SC Mkondowe	1,677	331
TA Timbiri	24,911	5,258
TA Boghoyo	1,158	245
Nkhata Bay Boma	9,433	1,935
Rumphi District	128,360	25,353
TA Chikulamayembe	45,510	9,170
TA Mwamlowe	7,356	1,188
SC Mwahenga	9,822	2,011
SC Mwalweni	16,209	3,138
SC Kachulu	6,709	1,290
SC Chapinduka	2,389	427
SC Mwankhunikira	13,203	2,635
TA Katumbi	9,206	1,872
TA Zolokere	3,156	583
Nyika NP- Rumphi	516	111
Vwaza Marsh GR-Rumphi	215	32
Rumphi Boma	14,069	2,896
Mzimba District	524,014	98,571
TA M'Mbelwa	85,470	14,486
TA Mtwalo	99,230	19,888
SC Kampingo Sibande	38,370	7,426
SC Jaravikuba Munthali	10,314	2,066
TA Chindi	94,250	18,451
TA Mzikubola	49,709	8,285
TA Mabulabo	45,905	8,250
SC Khosolo Gwaza Jere	26,045	5,013
TA Mpherembe	37,413	7,785
TA Mzukuzuku	23,194	4,065
Vwaza Marsh GR-Mzimba	372	77
Mzimba Boma	13,742	2,779
Mzuzu City	86,980	18,607
Nkhorongo Ward	2,385	465
Lupaso Ward	10,084	2,169
Zolozolo Ward	6,687	1,370
Chiputula Ward	15,867	3,617
Chibanja Ward	6,440	1,490
Mchengautuwa Ward	16,112	3,742
Katoto Ward	3,920	715
Jombo Ward	1,333	244

Area Name	Population	Households
Muzilawayingwe Ward	2,779	603
Chasefu Ward	1,596	275
Katawa Ward	2,876	610
Masasa Ward	1,175	235
Kaning'ina Ward	3,701	646
Viphya Ward	6,752	1,427
Msongwe Ward	1,540	268
New Airport Site	3,733	731
Likoma District	8,074	1,527
TA Mkumpha	8,074	1,527
Central Region	*4,066,340*	*908,943*
Kasungu District	480,659	96,787
TA Kaluluma	29,823	5,768
SC Simlemba	23,241	4,305
SC M'nyanja	19,346	3,408
SC Chisikwa	4,636	851
TA Kaomba	31,943	6,623
SC Lukwa	26,397	5,666
SC Kawamba	40,537	7,858
SC Njombwa	24,539	5,184
SC Chilowamatambe	30,196	5,995
TA Chulu	43,327	7,861
TA Santhe	64,544	13,007
TA Wimbe	73,954	15,778
TA Kapelula	21,866	4,535
TA Mwase	18,171	4,009
Kasungu NP	385	98
Kasungu Boma	27,754	5,841
Nkhotakota District	229,460	50,031
TA Kanyenda	74,932	15,647
SC Kafuzila	11,995	2,812
TA Malenga Chanzi	41,501	9,401
SC Mphonde	18,767	4,111
TA Mwadzama	45,997	10,226
SC Mwansambo	16,918	3,589
Nkhotakota GR	88	17
Nkhotakota Boma	19,262	4,228
Ntchisi District	167,880	35,947
TA Kasakula	10,895	2,567
TA Chikho	19,568	4,290
TA Kalumo	66,998	14,144
SC Nthondo	17,103	3,680
SC Chilooko	47,543	10,182
Ntchisi Boma	5,773	1,084
Dowa District	411,387	90,379
TA Dzoole	53,902	11,384
SC Chakhaza	93,813	19,951
SC Kayembe	61,484	13,256
TA Chiwere	61,773	14,427
SC Mkukula	52,524	12,196
TA Msakambewa	48,159	10,662
SC Mponela	25,393	5,695
Dowa Boma	4,493	844
Mponela Urban	9,846	1,964
Salima District	248,214	58,491
TA Maganga	35,688	7,958
TA Karonga	42,498	9,484
TA Pemba	15,440	3,940
SC Kambwiri	20,117	4,636
TA Ndindi	27,190	6,710
SC Kambalame	10,590	2,619
TA Khombedza	45,765	11,269
SC Mwanza	12,609	2,871
TA Kuluunda	9,372	2,261
SC Msosa	4,418	1,211
Lake Malawi NP-Salima	186	55
Salima Town	20,355	4,526
Chipoka Urban	3,986	951

Source:Benson, Todd. "Malawi: an atlas of social statistics." (2015).

Figure 7: TA list (continued)

Area Name	Population	Households
Lilongwe Rural	905,889	209,536
TA Chadza	79,900	19,173
TA Kalolo	104,939	23,457
TA Chiseka	173,468	40,371
TA Mazengera	75,018	18,358
SC Chitekwele	26,750	6,632
TA Khongoni	76,121	15,954
TA Chimutu	64,236	15,403
TA Chitukula	21,900	4,824
SC Mtema	35,652	7,648
TA Kalumbu	44,519	11,321
SC Tsabango	19,627	4,885
TA Kalumba	17,739	4,289
SC Njewa	22,044	4,891
TA Malili	63,445	14,895
TA Kabudula	80,531	17,435
Lilongwe City	440,471	98,406
Area 1	10,922	2,201
Area 2	2,774	540
Area 3	4,658	1,094
Area 4	42	2
Area 5	225	34
Area 6	1,365	66
Area 7	31,686	7,005
Area 8	23,310	5,116
Area 9	1,529	430
Area 10	3,987	956
Area 11	1,075	315
Area 12	2,629	517
Area 13	37	3
Area 14	861	175
Area 15	1,872	278
Area 16	0	0
Area 17	0	0
Area 18	10,677	1,767
Area 19	0	0
Area 20	0	0
Area 21	35,314	7,746
Area 22	19,622	3,979
Area 23	33,664	7,000
Area 24	13,602	3,250
Area 25	39,132	8,184
Area 26	3,892	1,008
Area 27	1,434	378
Area 28	321	61
Area 29	658	114
Area 30	2,914	486
Area 31	0	0
Area 32	247	48
Area 33	1,938	151
Area 34	0	0
Area 35	5,176	859
Area 36	16,164	4,013
Area 37	0	0
Area 38	2,591	626
Area 39	3,886	1,081
Area 40	0	0
Area 41	0	0
Area 42	0	0
Area 43	1,651	391
Area 44	13,203	3,205
Area 45	414	61
Area 46	2,244	500
Area 47	5,497	1,098
Area 48	0	0
Area 49	13,501	2,728
Area 50	8,178	2,016
Area 51	14,499	4,411
Area 52	2,843	652

Area Name	Population	Households
Area 53	11,947	2,534
Area 54	3,469	898
Area 55	10,867	2,687
Area 56	22,369	5,698
Area 57	34,692	8,244
Area 58	16,893	3,800
Mchinji District	324,941	70,792
TA Mlonyeni	27,181	5,659
SC Mavwere	68,202	15,006
TA Zulu	63,054	13,483
SC Mduwa	58,363	12,070
TA Mkanda	61,454	13,949
SC Dambe	35,214	7,993
Mchinji Boma	11,473	2,632
Dedza District	486,682	113,544
TA Pemba	105,343	24,681
SC Chilikumwendo	46,282	11,165
TA Kaphuka	103,622	24,253
TA Tambala	51,711	12,179
SC Chauma	16,389	4,009
TA Kasumbu	56,115	12,841
TA Kachindamoto	68,092	16,041
SC Kamenya Gwaza	23,720	5,097
Dedza Boma	15,408	3,278
Ntcheu District	370,757	85,030
TA Phambala	47,238	11,041
TA Mpando	37,275	7,868
TA Kwataine	35,322	8,093
SC Makwangwala	66,339	15,159
SC Champiti	13,584	3,183
TA Njolomole	45,867	10,269
TA Chakhumbira	21,685	4,944
SC Goodson Ganya	77,078	18,576
TA Masasa	17,586	4,014
Ntcheu Boma	8,783	1,883
Southern Region	*4,633,968*	*1,121,834*
Mangochi District	610,239	151,316
TA Mponda	87,426	20,754
TA Chimwala	87,024	21,020
TA Nankumba	79,419	19,248
TA Jalasi	58,406	15,358
SC Mbwana Nyambi	59,695	15,009
SC Chowe	83,204	20,878
TA Katuli	47,106	12,540
TA Makanjila	47,919	12,298
SC Namabvi	22,721	5,910
Lake Malawi NP- Mangochi	0	0
Mangochi Town	26,570	5,915
Monkey Bay Urban	10,749	2,386
Machinga District	369,614	90,138
TA Liwonde	63,798	15,247
SC Sitola	31,488	7,578
TA Kawinga	84,648	20,570
SC Chamba	16,526	3,876
SC Mposa	17,655	4,551
SC Mlomba	28,045	7,073
SC Chikweo	39,108	9,748
SC Ngokwe	20,476	5,153
SC Chiwalo	12,101	2,878
TA Nyambi	38,593	9,407
Liwonde NP	206	43
Machinga Boma	1,269	293
Liwonde Town	15,701	3,721
Zomba Rural	480,746	120,425
TA Kuntumanji	61,076	14,928
TA Mwambo	96,106	24,378
SC Mkumbira	5,074	1,269
TA Chikowi	45,650	11,329

Source:Benson, Todd. "Malawi: an atlas of social statistics." (2015).

Figure 8: TA list (continued)

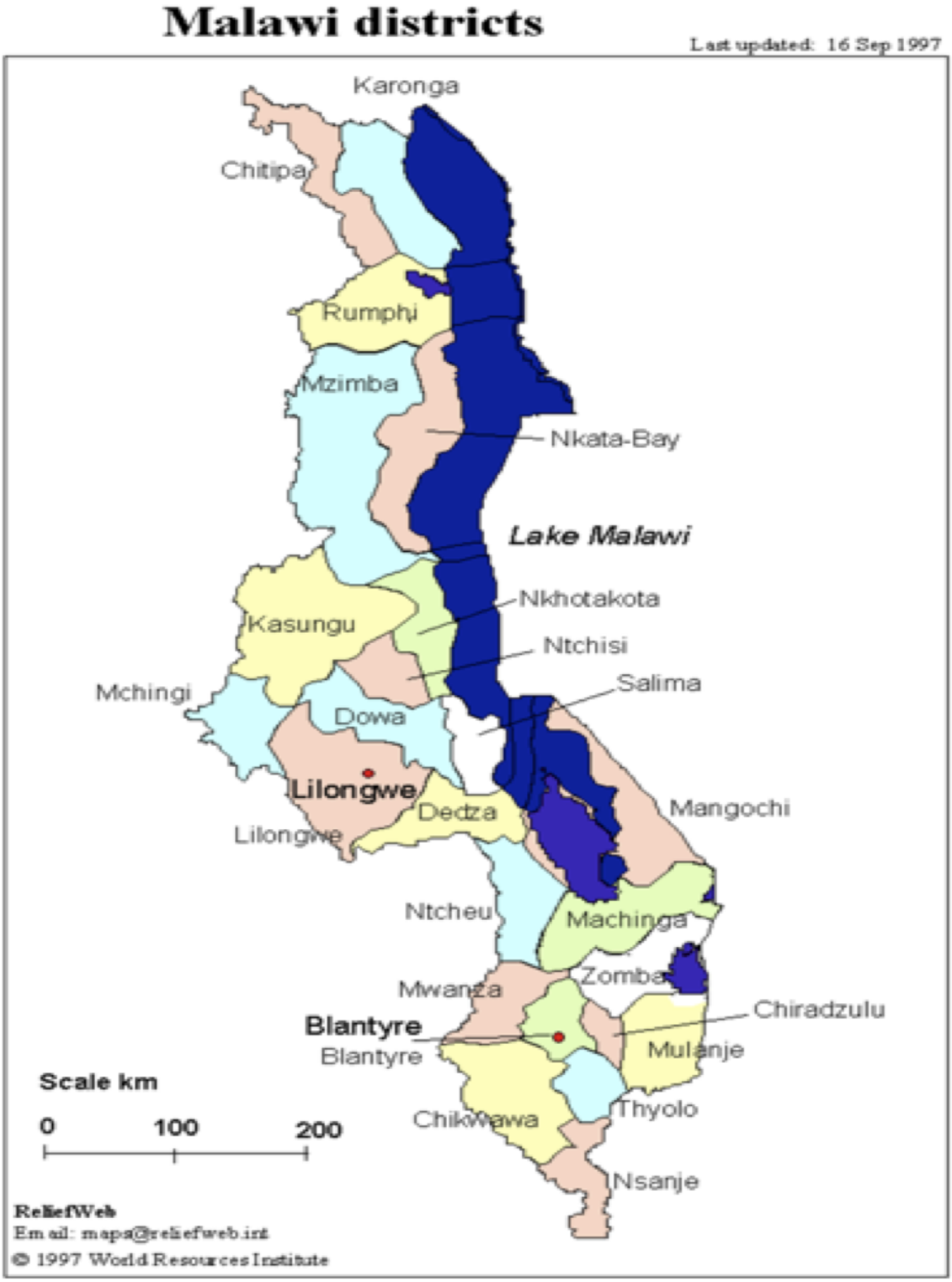
Area Name	Population	Households
SC Mbiza	108,967	28,112
TA Mlumbe	116,283	29,152
TA Malemia	47,590	11,257
Zomba Municipality	65,915	14,944
Mbedza Ward	3,246	770
Mtiya Ward	10,176	1,705
Masongola Ward	1,732	396
Chikamveka Ward	2,542	605
Chikamveka North Ward	8,851	2,211
Chirunga East Ward	4,324	1,046
Chirunga Ward	1,591	368
Likangala Ward	9,575	2,659
Zakazaka Ward	5,417	1,144
Zomba Central Ward	2,684	485
Chambo Ward	4,310	757
Sadzi Ward	5,722	1,413
Likangala Central Ward	4,822	1,136
Likangala South Ward	923	249
Chiradzulu District	236,050	58,529
TA Mpama	46,914	11,675
TA Likoswe	46,527	11,160
TA Kadewere	62,198	15,754
TA Nkalo	34,381	8,555
TA Chitera	15,789	3,944
TA Nchema	27,542	6,862
Chiradzulu Boma	2,699	579
Blantyre Rural	307,344	74,860
TA Kapeni	73,055	17,570
TA Lundu	20,184	5,276
TA Chigaru	33,243	8,249
TA Kunthembwe	26,703	6,810
TA Makata	13,656	3,384
TA Kuntaja	64,025	15,678
TA Machinjili	21,430	5,147
TA Somba	55,048	12,746
Blantyre City	502,053	120,923
Michiru Ward	28,303	7,149
South Lunzu Ward	24,366	5,140
Mapanga Ward	17,265	4,990
Nkolokoti Ward	23,703	5,941
Ndirande North Ward	20,009	5,066
Ndirande South Ward	61,638	15,281
Ndirande West Ward	13,795	3,300
Nyambadwe Ward	7,272	1,787
Likhubula Ward	48,966	12,632
Chilomoni Ward	23,223	5,131
Blantyre West Ward	18,458	4,477
Blantyre Central Ward	3,668	925
Blantyre East Ward	3,578	368
Chichiri Ward	5,708	1,163
Mzedi Ward	9,177	2,107
Bangwe Ward	35,723	8,761
Namiyango Ward	13,367	3,212
Limbe East Ward	32,780	8,388
Limbe Central Ward	2,558	583
Limbe West Ward	10,865	1,952
Soche East Ward	14,793	2,566
Soche West Ward	33,453	7,337
Nancholi Ward	10,876	2,740
Misesa Ward	18,893	5,135
Chigumula Ward	17,002	4,030
Msamba Ward	2,614	762
Mwanza District	138,015	32,177
TA Dambe	19,262	4,214

Area Name	Population	Households
TA Mlauli	17,153	4,174
TA Kanduku	23,735	5,496
TA Nthache	31,296	7,397
TA Symon	25,130	5,985
TA Ngozi	13,133	3,049
Majete GR-Mwanza	117	25
Mwanza Boma	8,189	1,837
Thyolo District	458,976	112,135
TA Nsabwe	28,417	6,177
SC Thukuta	11,771	2,836
SC Mbawela	31,072	6,811
TA Changata	27,960	6,522
SC Mphuka	36,021	9,207
SC Kwethemule	37,016	9,391
TA Kapichi	39,642	9,286
TA Nchilamwela	52,187	14,350
TA Chimaliro	83,281	20,317
TA Bvumbwe	72,643	17,839
TA Thomas	24,811	6,152
Thyolo Boma	5,313	1,098
Luchenza Town	8,842	2,149
Mulanje District	428,322	103,973
TA Mabuka	133,118	30,919
SC Laston Njema	50,181	13,040
TA Chikumbu	60,466	13,535
TA Nthiramanja	34,688	8,581
TA Nkanda	76,056	19,420
SC Juma	61,207	15,582
Mulanje Mountain Reserve	58	11
Mulanje Boma	12,548	2,885
Phalombe District	231,990	59,292
TA Mkhumba	152,909	38,845
TA Nazombe	76,503	19,827
Phalombe Boma	2,578	620
Chikwawa District	356,682	79,074
TA Ngabu	114,336	22,245
TA Lundu	42,511	10,157
TA Chapananga	64,993	14,806
TA Maseya	19,216	4,442
TA Katunga	16,429	3,975
TA Kasisi	25,362	6,340
TA Makhwira	59,022	14,055
Lengwe NP	304	49
Majete GR-Chikwawa	59	11
Chikwawa Boma	7,474	1,648
Ngabu Urban	6,976	1,346
Nsanje District	194,924	43,491
TA Ndamera	23,550	5,298
TA Chimombo	8,844	1,947
TA Nyachikadza	4,366	1,003
TA Mlolo	47,663	11,098
TA Tengani	25,076	5,731
SC Mbenje	34,254	7,508
TA Malemia	16,009	3,340
TA Ngabu	9,094	2,109
SC Makoka	5,037	1,024
Mwabvi GR	4,044	784
Nsanje Boma	16,987	3,649
Balaka District	253,098	60,557
TA Nsamala	145,048	34,410
TA Kalembo	93,752	22,969
Balaka Town	14,298	3,178

TA *Traditional authority.*
SC *Sub-chief (Historically, sub-chiefs governed under the authority of the local traditional authority. The sub-chiefdoms are used in order to create reasonably sized administrative units within large TAs.)*
NP *National park.*
GR *Game reserve.*
Boma *District administrative headquarters.*
Urban *Urbanized areas within rural districts.*
Town *Urbanized areas within rural districts.*
Ward *Administrative ward - the urban equivalent of a rural traditional authority or sub-chief area.*
Area *Numbered administrative wards in Lilongwe city.*

Source:Benson, Todd. "Malawi: an atlas of social statistics." (2015).

Figure 9: Districts of Malawi



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations. These maps may be freely distributed. If more current information is available, please update the maps and return them to ReliefWeb for posting.

Figure 10: Histogram of log(consumption)

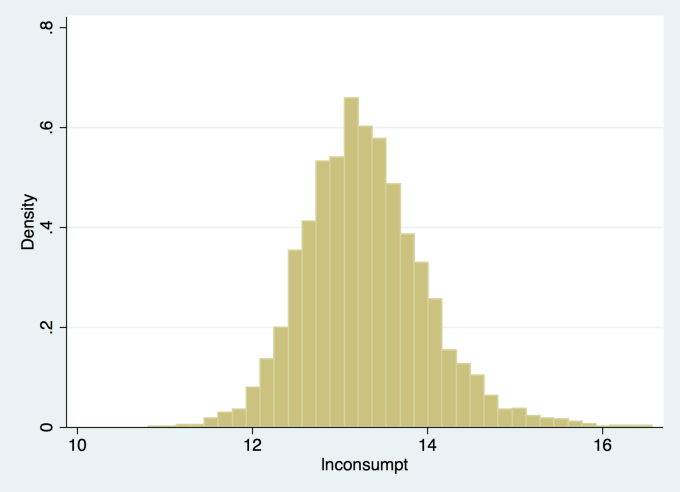


Figure 11: Histogram of log(maize harvest)

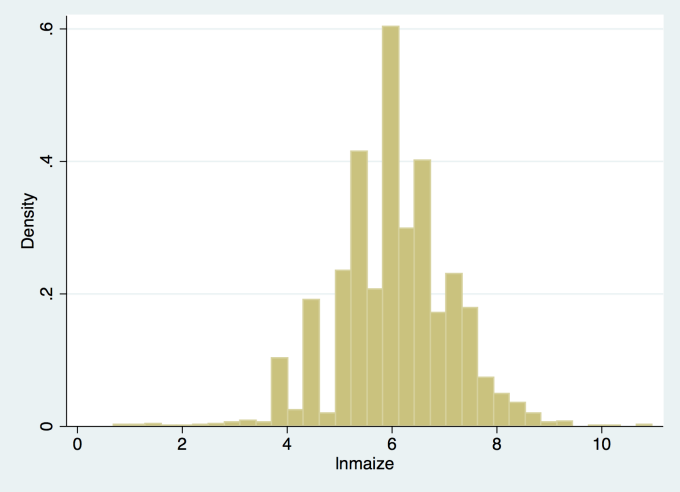


Table 7: Ethnic fractionalization and polarization on log consumption when the community owns a forest

Dependent Var.: Log consumption at household level 2012-2013				
VARIABLES	i	ii	iii	iv
frac_eth	-0.105	0.0447		
	(0.113)	(0.0908)		
frac_eth_forest	0.0828	-0.0666		
	(0.183)	(0.151)		
forest	-0.0586	0.0111	-0.0260	0.0552
	(0.0890)	(0.0691)	(0.121)	(0.0929)
pol_eth			-0.180	-0.0953
			(0.134)	(0.0955)
pol_eth_forest			-0.000925	-0.129
			(0.194)	(0.153)
Constant	13.22***	13.37***	13.28***	13.22***
	(0.0537)	(0.280)	(0.0777)	(0.275)
Observations	2 849	2 529	2 849	2 529
Adjusted R-squared	0.000	0.314	0.003	0.317
Control Variables	NO	YES	NO	YES

Note: Robust standard errors in parentheses, Clustering at TA level. ***$p < 0.01$, **$p < 0.05$,*$p < 0.1$. Ethnic fractionalization is defined as the probability that any two randomly chosen individuals do not belong to the same ethnic group; polarization takes into account the size of the smallest group.

Table 8: Ethnic fractionalization and polarization on log consumption when the community has irrigation

Dependent Var.: Log consumption at household level 2012-2013				
VARIABLES	i	ii	iii	iv
frac_eth	-0.109	-0.00428		
	(0.0995)	(0.0887)		
frac_eth_irrigation	0.270	0.172		
	(0.227)	(0.179)		
irrigation	-0.194*	-0.139	-0.209	-0.0942
	(0.115)	(0.0925)	(0.184)	(0.142)
pol_eth			-0.208*	-0.158*
			(0.108)	(0.0872)
pol_eth_irrigation			0.242	0.0679
			(0.305)	(0.231)
Constant	13.22***	13.32***	13.29***	13.18***
	(0.0466)	(0.282)	(0.0622)	(0.276)
Observations	2 825	2 547	2 825	2 547
Adjusted R-squared	0.002	0.317	0.005	0.318
Control Variables	NO	YES	NO	YES

Note: Robust standard errors in parentheses, Clustering at TA level. ***$p < 0.01$, **$p < 0.05$,*$p < 0.1$. Ethnic fractionalization is defined as the probability that any two randomly chosen individuals do not belong to the same ethnic group; polarization takes into account the size of the smallest group.

Table 9: Ethnic fractionalization and polarization on log consumption when the community owns a pasture

Dependent Var.: Log consumption at household level 2012-2013				
VARIABLES	i	ii	iii	iv
frac_eth	-0.0120	0.0480		
	(0.112)	(0.0886)		
frac_eth_pasture	-0.220	-0.0193		
	(0.288)	(0.276)		
pasture	0.115	0.0760	0.0263	-0.0150
	(0.108)	(0.0946)	(0.133)	(0.110)
pol_eth			-0.167	-0.175*
			(0.141)	(0.0980)
pol_eth_pasture			0.00877	0.142
			(0.240)	(0.225)
Constant	13.17***	13.24***	13.26***	13.12***
	(0.0565)	(0.308)	(0.0866)	(0.306)
Observations	2 83	2 511	2 83	2 511
Adjusted R-squared	0.001	0.317	0.003	0.319
Control Variables	NO	YES	NO	YES

Note: Robust standard errors in parentheses, Clustering at TA level. ***$p < 0.01$, **$p < 0.05$,*$p < 0.1$. Ethnic fractionalization is defined as the probability that any two randomly chosen individuals do not belong to the same ethnic group; polarization takes into account the size of the smallest group.

Table 10: Ethnic fractionalization and polarization on log harvest when the community faces flood

Dependent Var.: Log harvest at household level 2012-2013				
VARIABLES	i	ii	iii	iv
frac_eth	-0.300	-0.528***		
	(0.186)	(0.186)		
frac_eth_flood	-0.0986	0.173		
	(0.562)	(0.453)		
flood	-0.0461	-0.0687	-0.279	-0.367
	(0.355)	(0.272)	(0.449)	(0.320)
pol_eth			-0.543**	-0.623**
			(0.240)	(0.245)
pol_eth_flood			0.308	0.598
			(0.628)	(0.443)
Constant	6.193***	5.626***	6.375***	5.568***
	(0.0960)	(0.728)	(0.141)	(0.730)
Observations	1 463	1 426	1 463	1 426
Adjusted R-squared	0.003	0.231	0.009	0.233
Control Variables	NO	YES	NO	YES

Note: Robust standard errors in parentheses, Clustering at TA level. ***$p < 0.01$, **$p < 0.05$,*$p < 0.1$. Ethnic fractionalization is defined as the probability that any two randomly chosen individuals do not belong to the same ethnic group; polarization takes into account the size of the smallest group.

Table 11: Ethnic fractionalization and polarization on log harvest when the community has irrigation

Dependent Var.: Log harvest at household Level 2012-2013				
VARIABLES	i	ii	iii	iv
frac_eth	-0.362*	-0.545***		
	(0.200)	(0.198)		
frac_eth_irrigation	-0.0304	-0.0112		
	(0.330)	(0.242)		
irrigation	0.0332	0.154	-0.0702	-0.0102
	(0.181)	(0.131)	(0.252)	(0.185)
pol_eth			-0.567**	-0.642**
	(0.255)	(0.260)		
pol_eth_irrigation			0.167	0.260
			(0.395)	(0.287)
Constant	6.200***	5.560***	6.367***	5.522***
	(0.104)	(0.748)	(0.149)	(0.735)
Observations	1,447	1,411	1,447	1,411
Adjusted R-squared	0.003	0.235	0.008	0.237
Control Variables	NO	YES	NO	YES

Note: Robust standard errors in parentheses, Clustering at TA level. ***$p < 0.01$, **$p < 0.05$,*$p < 0.1$. Ethnic fractionalization is defined as the probability that any two randomly chosen individuals do not belong to the same ethnic group; polarization takes into account the size of the smallest group.

Table 12: Quadratic specification: Ethnic fractionalization and polarization on log consumption when the community has irrigation

Dependent Var.: Log consumption at household level 2012-2013				
VARIABLES	i	ii	iii	iv
frac_eth	-0.391	-0.489		
	(0.421)	(0.305)		
frac_eth2	0.339	0.578*		
	(0.464)	(0.334)		
irrigation	-0.333	-0.0460	-0.784***	-0.412*
	(0.248)	(0.221)	(0.251)	(0.238)
frac_eth_irrigation	1.103	-0.361		
	-1.266	-1.082		
frac_eth2_irrigation	-0.963	0.582		
	-1.303	-1.121		
pol_eth			0.827*	0.698**
			(0.442)	(0.339)
pol_eth2			-1.048**	-0.843**
			(0.426)	(0.323)
pol_eth_irrigation			2.600**	1.377
			-1.182	-1.069
pol_eth2_irrigation			-2.050*	-1.120
			-1.186	-1.051
Constant	13.27***	13.38***	13.08***	13.07***
	(0.0792)	(0.279)	(0.105)	(0.285)
Observations	2 825	2 547	2 825	2 547
Adjusted R-squared	0.003	0.318	0.015	0.323
Control Variables	NO	YES	NO	YES

Note: Robust standard errors in parentheses, Clustering at TA level. ***$p < 0.01$, **$p < 0.05$,*$p < 0.1$. Ethnic fractionalization is defined as the probability that any two randomly chosen individuals do not belong to the same ethnic group; polarization takes into account the size of the smallest group.

Table 13: Quadratic specification: Ethnic fractionalization and polarization on log consumption when the community owns a pasture

Dependent Var.: Log consumption at household level 2012-2013				
VARIABLES	i	ii	iii	iv
frac_eth	-0.194	-0.684*		
	(0.541)	(0.375)		
frac_eth2	0.206	0.836**		
	(0.553)	(0.379)		
pasture	-0.0173	-0.125	0.226	-0.0424
	(0.187)	(0.156)	(0.260)	(0.222)
frac_eth_pasture	0.829	1.414		
	-1.251	-1.089		
frac_eth2_pasture	-1.538	-1.945		
	-1.787	-1.717		
pol_eth			1.344**	0.788*
			(0.613)	(0.449)
pol_eth2			-1.465***	-0.913**
			(0.545)	(0.394)
pol_eth_pasture			-0.826	0.389
			-1.168	-1.058
pol_eth2_pasture			0.762	-0.328
			-1.183	-1.141
Constant	13.20***	13.38***	12.93***	13.00***
	(0.114)	(0.312)	(0.165)	(0.312)
Observations	2 83	2 511	2 83	2 511
Adjusted R-squared	0.001	0.320	0.011	0.323
Control Variables	NO	YES	NO	YES

Note: Robust standard errors in parentheses, Clustering at TA level. $^{***}p < 0.01$, $^{**}p < 0.05$,$^{*}p < 0.1$. Ethnic fractionalization is defined as the probability that any two randomly chosen individuals do not belong to the same ethnic group; polarization takes into account the size of the smallest group.