Climate change, culture and marriage timing in Malawi

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Abstract

This paper examines how climate-induced shocks interact with cultural norms to shape marriage timing and spousal age gaps in Malawi, addressing the broader question of climate change's social consequences in vulnerable communities. Using data from Malawi, a country highly vulnerable to the adverse effects of climate change, I employ survival analysis to show that drought and flood shocks differentially influence the hazard into first marriages and husband-wife age gaps, with nuanced variations across bride price and non-bride price societies. Notably, droughts delay marriage among young men in bride price societies due to the binding transfer at marriage, while this effect is muted for older men who are more self-insured and resilient to the shock, thereby widening spousal age gaps and pushing more young women into polygynous unions as junior wives. In contrast, floods have little impact on marriage timing, as their localized nature makes them less spatially correlated as droughts, enabling households to cope more effectively. From a policy standpoint, policies and interventions that generate windfall revenue during adverse economic shocks could have unintended consequences especially for women, if the type of shock and cultural setting is not taken into account. Cash transfers, for example, during droughts may have larger effects in bride price societies if targeted at households with marriage-age girls.

Keywords: climate shocks, bride price, marriage hazard, Malawi

1. Introduction

Cultural norms and traditions are significant determinants of economic development and the effectiveness of policy interventions (Collier, 2017; Ashraf et al., 2020; Lowes, 2022). The traditional custom of bride price – a transfer made from the groom's family to the bride's family at marriage – is prevalent in Sub-Saharan Africa, and constitutes an important component of the marriage agreement (Mbaye and Wagner, 2017). In the context of marriage behavior, particularly the age at which individuals marry, the bride price tradition may have differential implications on the economic outcomes of men and women. The empirical evidence on how income shocks, due to climate change, interacts with cultural norms, in influencing marriage behavior in low-income countries is limited.

Malawi is a culturally diverse country, and ranks as the 27th out of the 185 countries globally that are considered the most vulnerable and exposed to the adverse impacts of climate change, as per the Notre Dame Global Adaptation Initiative (ND-GAIN) Index in 2021. In 2022, the World Bank reported that, at the onset of 2010, Malawi experienced two extended periods of severe drought, sixteen significant occurrences of flooding, a landslide triggered by heavy rainfall, and five storms. Droughts, floods, and extreme temperatures are projected to become more frequent and intensified over time (Intergovernmental Panel on Climate Change (IPCC), 2014).

Given the prevalent lack of access to formal credit and insurance in low-income countries, the fluctuations in aggregate income resulting from adverse climate shocks, may have significant implications for marriage behaviour and marriage markets.[1] The economic literature documents that adverse climate shocks pose significant challenges to poor households especially in agrarian economies. In addition, these households encounter difficulties in effectively responding to such shocks (e.g. Rosenzweig, 1988; Platteau, 1997; Kazianga and Udry, 2006; Dinkelman, 2017). While recent evidence have shown that, due to the bride price transfer, female household members from the supply side of the marriage market, can be exploited as a means of insuring against

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[1]Marriage markets typically assumes a market where supply and demand is simplistically represented by the overall number of men and women in the given country (Tertilt, 2003)

negative climate shocks (e.g. Hoogeveen et al., 2011; Corno et al., 2020; Corno and Voena, 2023), scant attention has been given to how grooms from the demand side of the marriage market may differentially respond to the same shocks. The presence of the bride price custom may impose liquidity constraints for grooms, which are even more pronounced following a contraction in income, and hence could influence marriage timing decisions. In addition, the effect of the custom on grooms' marital decisions may well depend on how they insure against income shocks. Historically and in present times, the size of the bride price in SSA have often been substantial – frequently exceeding a year's household income and sometimes as large as four times that amount (See Anderson (2007) for a review).

In this paper, I provide evidence on how drought and flood shocks interact with cultural norms in influencing the hazard into first marriages for both men and women, and the resulting husband-wife age gap at first marriage. In particular, I explore the differential impact of these shocks across bride price and non-bride price societies in Malawi. First, to estimate the effects of the drought and flood shocks on first marriage hazards for men and women by bride price societies, I conduct a survival analysis using the Cox proportional hazards (PH) model, where the event of interest is the time to first marriage and survival is remaining unmarried. I then examine the outcomes of the marriage hazards (or timing decisions), by estimating the impact of the drought and flood shocks on the husband-wife age gap at first marriage. To carry out these estimations, I exploit the exogenous fluctuations in annual rainfall in Malawi to construct an indicator of drought and flood shocks that are independent of the time-invariant factors that may determine marital decisions, following closely the approach used by Burke et al. (2015) and Corno et al. (2020). Rainfall shocks constitute a primary source of income variability in regions that are dependent on rain-fed agriculture (Corno et al., 2020). I use the Matsuura and Willmott (2009) rainfall data from the University of Delaware, which is combined with information on age at first marriage from the Malawi Demographic and Health Surveys (DHS), as well as data on culture from the Ethnographic Atlas by Murdock (1967) for the measure of bride price custom prevalence.

During periods of low aggregate income caused by rainfall shocks, the bride price transfer serves as a significant means of consumption smoothing (Anderson, 2007; Corno et al., 2020), resulting in an increased supply of brides. However, households and grooms from the demand side of the marriage market also experience the same income shock, leading to a decrease in

the equilibrium bride price (Tapsoba, 2023), as fewer grooms are financially capable of paying the transfer. Despite this price decline, the bride price is still likely to remain a substantial burden for many grooms. The extent to which the marriage market is affected may depend on the insurance mechanisms available to grooms. Young bachelors and older men may have varying capacities in their resilience to the income shocks, due to differences in savings, household wealth, or access to informal insurance networks. Thus, the impact on marriage entry hazards for men and women in societies where the bride price tradition is binding is less clear. In addition, the broader consequences for marital outcomes such as changes in the age gap between spouses, early marriages, and heightened household inequality due to junior and/or senior wives are not fully understood.

First, a key finding in this paper indicate that, the hazard of entering first marriages for both men and women in bride price societies is lower when there is no drought shock. Following exposure to drought shocks, this negative effect is greater, particularly for men. To be specific, men exposed to drought shocks in bride price societies delay the timing of their first marriages by 19.2% relative to men in non-bride price societies. Conversely, in societies without the bride price custom, droughts are associated with a higher hazard of both men and women entering their first marriages. A noticeable outcome of these effects is that, the husband-wife age gap in bride price societies is positive and drought exposure in a given year further increases this gap by 0.051 years.

The widening husband-wife age gap in bride price societies suggest that the presence of the custom plays an influential role in the marriage timing decisions. The practice of the bride price custom imposes liquidity constraints, particularly exacerbated by a decrease in income resulting from the impact of the drought shock. This situation makes it challenging for both young and older grooms to fulfill the transfer payment. However, the financial burden is more pronounced for younger men (Platteau and Gaspart, 2007) than for older men. This is because, older men are relatively more likely to be wealthier and better self-insured to cope with the income shock. I show further evidence in that regard that, due to the liquidity constraints imposed by the bride price custom, young women are more likely to become junior wives in polygynous marriages by marrying older grooms and/or divorced men who are more self-insured and resilient to the drought shock, and hence the higher age gap.

Second, I show that, in the absence of a flood shock, the hazard of entering

first marriages for both gender in bride price societies is also lower. However, exposure to flood shocks increases the hazard and makes it positive, but this positive effect is only statistically and significantly different from zero for women. Specifically, the impact of flood exposure on the hazard of entering first marriages for women is higher in bride price societies by 33.6% relative to women in non-bride price societies. In the case of non-bride price societies, flood exposure is associated with a lower hazard of marriage entry for both gender. If I consider the heterogeneous effects for men by age cohorts, I find that the differential effects for both young adult and older men between the two societies are also not statistically significant. This suggests that, unlike droughts, the nature of flood shocks has less impact on marriage timing decisions for both young and older men in bride price societies. In equilibrium, I see no significant differential outcome of flood shocks on the husband-wife age gap. In a supporting evidence, I find that there is no differential impact of the exposure to flood shocks on the probability of younger or older women marrying as junior wives in polygynous marriages in both societies.

A plausible explanation for the results I obtain on the impact of flood shocks on first marriage hazards and the resulting husband-wife age gap, essentially lies in the nature of flood shocks. In contrast to droughts which occur over broader geographical areas, floods are more localized and less concentrated spatially. As a consequence, flood shocks allow for potential smoothing mechanisms to alleviate their impact, such as short-term migration for work. Specifically, after a flood shock, potential grooms may temporarily move away from their villages to nearby areas for employment, rendering them physically absent to initiate marital unions. The potential for income smoothing following flood shocks effectively reduces the significance of relying on self-insurance mechanisms, such as savings, for both young and older men. As a result, there is no discernible differential effect of the bride price tradition when interacted with flood shocks on the likelihood of entering first marriages for men, and on the husband-wife age gap.

Lastly, the findings in this paper uncover that there is a plausible asymmetry in the effects of drought and flood shocks, via their impact on low aggregate income. In the context of marriage behaviour, the results in this paper suggest that, drought and flood shocks potentially have contrasting effects on the hazard of entering first marriages for both men and women in Malawi. In general, a number of reasons for this asymmetry suffices: Droughts are long-lasting, have a broader impact on economies, and can exert a more enduring influence on agricultural productivity compared to

floods. In particular, I utilize data from FAOStat for Malawi, combined with the climate data, to provide corroborative evidence regarding the differential impact of drought and flood shocks on crop yields. The findings indicate that, while droughts and floods lead to a reduction in maize and rice yields – the primary staple crops in Malawi – this impact is not statistically significant in the case of floods. This implies that agricultural productivity and hence income in Malawi is significantly affected by droughts to a degree not observed in the case of floods, and this may have differential consequences for marriage timing decisions.

From a policy standpoint, the findings presented in this paper are important for the formulation and assessment of social safety net programs and other targeted interventions such as cash transfers in Malawi, that may have overlooked the influence of cultural norms and climate fluctuations on household behavior and marital outcomes. Policies and interventions that generate windfall revenue during adverse economic shocks could have unintended consequences especially for women if the type of shock and cultural setting is not taken into account. Cash transfers, for example, during droughts may have larger effects in bride price societies if targeted at households with marriage-age girls. The widening husband-wife age gap and the increased likelihood of young women entering polygynous marriages as junior wives, especially in societies where bride price is customary, could yield adverse long-term consequences. Marital unions with older men are often correlated with diminished bargaining power for women (Browning et al., 1994; Carmichael, 2011) and an elevated risk of early widowhood (Van de Walle, 2013; Lambert et al., 2018). In addition, early marriage for girls have been shown to be associated with adverse health consequences, fertility, and socio-economic outcomes (Field and Ambrus, 2008; Chari et al., 2017; Sunder, 2019).

This paper mainly contributes to three strands of the literature. First, this paper adds to the body of research on aggregate income shocks and individual or household outcomes (e.g. Hoogeveen et al., 2011; Björkman-Nyqvist, 2013; Burke et al., 2015; Dinkelman, 2017; Corno et al., 2020; Branco and Féres, 2021; Corno and Voena, 2023). In relation to marriage outcomes, Corno et al. (2020) for example, find that the impact of droughts on early marriage varies across regions: In India, droughts are associated with a decrease in early marriages, while in Sub-Saharan Africa where bride price is the customary marriage payment, droughts tend to increase the incidence of early marriages. I contribute to this literature by providing evidence that emphasizes how cultural norms at marriage influence the differential response

of societies to aggregate economic conditions due to climate change. I also show that drought and flood shocks are not symmetric in their influence on marriage behavior by individuals and/or households. In addition, I uncover the probable gender-based power dynamics between husbands and wives that could be manifested in the age gap at first marriage in Malawian societies where bride price is customary.

Second, this paper extends the literature on risk management strategies and self-insurance mechanisms in rural economies (e.g. Rosenzweig, 1988; Morduch, 1995; Dercon, 2002; Fafchamps and Lund, 2003; Kazianga and Udry, 2006; Robinson, 2012; Acosta et al., 2021). The contribution to this literature is to show that, in the face of economy-wide covariate shocks, men in bride price societies may strategically delay first marriages to achieve income smoothing. While there is a good understanding of the use of early female marriage as a consumption smoothing strategy by households, less attention in the development economics literature has been paid to the marriage behaviour for men, particularly during periods of adverse income shocks.

Third, this paper fits within the literature on the significance of culture for economic outcomes and decisions (La Ferrara, 2007; Fernández and Fogli, 2009; Anderson and Bidner, 2015; Lowes, 2016; Ashraf et al., 2020; Barker, 2021). I contribute to this literature by showing that the cultural custom of bride price transfer influences the responsiveness of individuals' marriage decisions to income shocks, in a way that has lasting impacts on marital outcomes such as the age gap between spouses. Thus, effective policies and interventions can be achieved by taking into account the cultural nuances of societies, especially in low-income countries.

The rest of the paper is organised as follows. Section 2 provides an overview of the marriage patterns in Malawi and the cultural traditions related to marriage, along with insights into climate change vulnerability. Section 3 presents the data and descriptive statistics. Here, I detail the construction of key variables of interest in the analysis. The empirical strategy is provided in Section 4, and the empirical results presented in Section 5 – including additional results on the asymmetry between droughts and floods, the mechanism underlying the main findings, and robustness checks. Lastly, Section 6 concludes.

2. Contextual Background

2.1. Marriage patterns in Malawi

Marriage in Malawi is almost universal and often geographically localized, as people typically choose partners from within their local villages (Sear, 2008; Cherchye et al., 2018). Malawi is a country that exhibits cultural diversity, where matrilineal and patrilineal systems of kinship coexist, with variations in their traditional marriage customs. Notably, the marriage patterns in Malawi vary significantly across the country's three administrative regions, reflecting the influence of the prevailing kinship systems (Anglewicz and Reniers, 2014). In the southern region of Malawi, matrilineal societies are the most prevalent, and the customary post-marriage living arrangement involves uxorilocal residence, where the husband relocates to reside with or in close proximity to the wife's kinsmen (Berge et al., 2014). In these matrilineal societies, the bride price tradition is less common, and marriage negotiations are generally less extensive and formalised in comparison to patrilineal societies (Reniers, 2003). Additionally, polygamous marriages in matrilineal societies occur infrequently (Angelucci and Bennett, 2017), and marriage decisions are typically made by individual partners with a limited influence by parents or community leaders (Kaler, 2001). In contrast, the northern region of Malawi consists predominantly of patrilineal tribes that adhere to the tradition of bride price and adopt virilocal residence after marriage, wherein the couple resides with or in close proximity to the husband's family (Palamuleni, 2011; Berge et al., 2014). Mwambene (2005) document that the customary validation of marriages in these patrilineal societies in Malawi occurs upon the complete payment of the bride price. The central region exhibits a mixed composition, although it can be mainly classified as matrilineal and uxorilocal (Palamuleni, 2011).

This heterogeneity in marriage customs may have differential implications on the choice of spouse, marriage timing, and the age at first marriage (Makwemba et al., 2019). In particular, the custom of bride price transfers at marriage may impact household behaviour and marriage-related decisions. Households engagement in marriage as a form of insurance strategy can be traced back to the pioneering work of Rosenzweig and Stark (1989), where they provide evidence indicating that households experiencing income fluctuations due to rainfall variations were more inclined to marry off their female members to grooms in more distant locations to improve risk-sharing opportunities. The influence of income variability, due to climate shocks, on the

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marriage decisions of individuals and households, is likely not to be engendered by incentives from just the supply side of the marriage market but also the demand side. Individual grooms and households with sons – representing the demand side – may adjust their marriage decisions in response to income uncertainty. In times of economic hardship caused by adverse weather shocks, these individuals and households may strategically delay marriages due to insufficient resources to afford the bride price or seek brides from households willing to accept lower bride price transfers.

2.2. Climate change vulnerability in Malawi

According to the Notre Dame Global Adaptation Initiative (ND–GAIN) Index in 2021, Malawi is regarded as the 27th out of the 185 countries globally that are most vulnerable and exposed to the adverse impacts of climate change. The World Bank in 2022 documented that, at the onset of 2010 alone, Malawi has encountered two prolonged periods of severe drought, sixteen significant instances of flooding, a landslide due to rainfall, and five storms. Extreme climatic events like droughts, floods, and extreme temperatures are projected to become more frequent and severe over time (Intergovernmental Panel on Climate Change (IPCC), 2014). Malawi's susceptibility to such adverse climate shocks is further worsened by its structural economic conditions and heavy reliance on rainfed agriculture (Asfaw and Maggio, 2018). Adverse climate shocks have the potential to impact agricultural productivity, including crops, livestock, fisheries, and forestry, and can also indirectly impact incomes by reducing labor demand, driving up local prices, and restricting access to markets (Alfani et al., 2019).

Households exposed to severe climate events frequently encounter increased levels of vulnerability due to significant reductions in agricultural income and consumption (Alfani et al., 2019), and given that Malawi is predominantly rural, it is imperative to understand how vulnerable households and individuals make decisions to cope with these climate shocks. In theory, while households can depend on various institutions and coping mechanisms, such as credit, markets, and social safety net programs, these resources are typically only partial, and consumption shortfalls tend to be high (Alderman and Paxson, 1992; Dercon, 2005; Fitzsimons et al., 2018; Malde and Vera-Hernández, 2022). Of particular relevance in this paper is the institution of marriage and the time it occurs. This paper attempts to quantify the ramifications of the interaction of climate change and the traditional custom of

bride price, on the hazard of first marriage timing for both men and women in Malawi and its impact on the age gap at marriage.

3. Data

3.1. Marriage data and summary statistics

The data on marriage is sourced from repeated cross-sections of the Malawi Demographic and Health Surveys (DHS), for the years, 2000, 2004, 2010 and 2015. The Malawi DHS is a nationally representative and population-based survey that elicits information on basic demographic and health indicators. The survey utilizes a stratified two-stage cluster design approach. The sample is stratified into urban and rural areas, and enumeration areas are independently chosen within each stratum. In the first stage, the enumeration areas are chosen with a probability proportional to the size of the enumeration area, which is determined by the number of households it encompasses. In the second stage, a consistent number of households are each selected from both urban and rural clusters, using an equal probability systematic selection method. Men aged $15 - 54$ and women between the ages of $15 - 49$, who are either married or not, are selected from sampled households per cluster and individually interviewed.

In the DHS dataset, data on age at first marriage (or cohabitation) for both men and women are gathered retrospectively through interviews. Both men and women are asked to recall and provide information on their current age, and the month and year when they entered into their first marriage. I use information in both men and women samples on the age and year of first marriage, which is merged with the climate data, to construct a pseudo-panel for each individual and at-risk year of marriage.

Figure 1 depicts the distribution of age at first marriage for both men and women. The average age at first marriage for women is 17.58 years, whereas men tend to marry at the age of 22.19 years on average. Notably, a considerable proportion of women enter their first marriage in their teenage years, whereas a comparatively smaller number of men do so.

Table A.3 in the Appendix shows the summary statistics for the sample, categorized by societal groups (i.e. bride price vs non-bride price societies). Panel A shows the statistics for unique individuals while Panel B describes the survival data. The sample comprises of 68,074 unique individuals, with 12,559 men and 55,515 women. First, the mean age at first marriage for men in bride price societies (i.e. 22.56) is marginally greater than the mean for
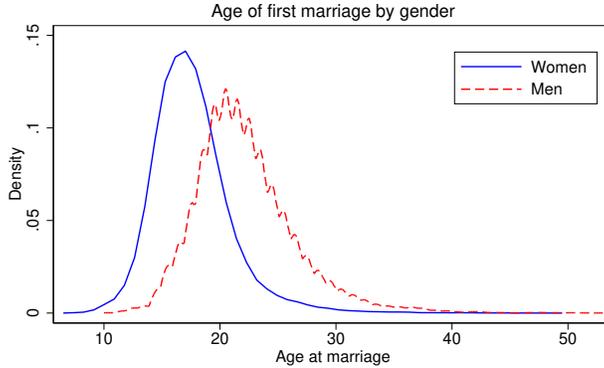
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Figure 1: Age at first marriage, by gender

Note: The Figure illustrates the kernel density distribution of ages at first marriage for men and women in Malawi. The distributions are presented separately for men and women (as indicated by the legend). Data is from the pooled 2000, 2004, 2010, and 2015 Malawi DHS.

their counterparts in non-bride price societies (i.e. 22.12), and this mean difference is statistically significant. Similarly, the average age at which women have their first marriage is marginally higher in bride price societies (i.e. 17.76) compared to non-bride price societies (i.e. 17.59) but this difference is statistically significant. If I consider the age at first marriage by age cohort, I see a significant mean difference between the two societies for women who enter their first marriages before turning 18, and those that marry after the age of 40 (but this is a very small sample). For men, I do not observe significant mean difference between the two societies for early marriages before the age of 18, but rather I see a significant difference for marriages that occur between the ages of 18 and 25, and those that marry after turning 40. The age gap at first marriage between husbands and wives, on average, is greater in bride price societies (i.e. 6.73 in bride price societies and 5.72 in non-bride price societies), and this difference is statistically significant. In Panel B, the data is restructured for survival analysis, and the summary statistics obtained are consistent with the original sample of unique individuals.

In Figures B.7 and B.8 in the Appendix, I plot the Kaplan-Meier survival curves and the Nelson-Aalen cumulative hazards. The survival curve represents the likelihood of an event not having occurred up to a given point in time, while the hazard rate measures the instantaneous risk of an event

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occurring. The curves compare the survival of remaining unmarried and the cumulative hazard of entering a first marriage in bride price versus non-bride price societies in Malawi, for both men and women samples. The survival curves for men at various ages in bride price and non-bride price societies are reasonably similar, as is the case for the women sample. However, in both samples, it appears that the survival rates are slightly higher in bride price societies. A similar pattern emerges for the cumulative hazards, although the contrast in hazard rates becomes more pronounced in the later years.

3.2. Climate data and construction of shocks

To investigate the impact of extreme climate events on the hazard of first marriage for men and women in Malawi, I adopt a commonly used approach in the extant literature to construct climate shocks. This approach utilizes weather fluctuations as a proxy for changes in economic conditions (e.g. Burke et al., 2015; Corno et al., 2020), as adverse rainfall patterns have been shown to significantly reduce agricultural productivity especially in African societies that are predominantly agrarian.

I use the Matsuura and Willmott (2009) data based on the University of Delaware dataset to construct a measure of climate shocks which consist of drought and flood shocks. Historically, droughts and floods have been the most severe of climate hazards in Malawi (World Bank, 2021). The Matsuura and Willmott data provides global coverage of monthly precipitation and air temperature on a 0.5×0.5 degree grid, spanning the period $1900 - 2015$. The 0.5 degrees approximately corresponds to a distance of 50km at the equator.

In constructing the climate shock variables, I first utilize the GPS information available in the Malawi DHS data to establish a match between the individual DHS clusters and their corresponding weather grid cells. This procedure yields a total of 38 distinct grid cells from the Matsuura and Willmott data which is matched to the Malawi DHS. Second, I then exploit the relative rainfall patterns at the grid cell level to construct the measure of the climate shocks. To do this for both the drought and flood shocks, I adapt the approach by Burke et al. (2015) and Corno et al. (2020) where weather shocks are characterized by rainfall observations that fall below or above a specific threshold, based on a location's local rainfall distribution.[2]

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[2]Other approaches to measuring shocks in the economic literature include the calcu-

In principle, the approach fits a gamma distribution to the historical annual rainfall data at each grid cell and assigns the respective rainfall observation per year to its associated percentile within the distribution. The choice of the gamma distribution is motivated by its significant adaptability in terms of both shape and scale (Burke et al., 2015). Following Burke et al. (2015) and Corno et al. (2020), I use the historical annual rainfall data from 1950 – 2015 to characterize the climate shocks in the following ways: a drought is an annual rainfall observation that is less than the 15th percentile of a grid cell's historical long-run rainfall distribution, while a flood is defined as rainfall observations that are in excess of the 85th percentile of a grid cell's historical long-run rainfall distribution.

By design, both measures of drought and flood shocks are expected to be independent of other confounding factors that may be related to marriage, such as education and economic prosperity. This is because, the definition of the drought or flood shock in a given grid cell utilizes the same percentile threshold and historical rainfall distributions, ensuring that all grid cells have an equal chance of exposure annually (Burke et al., 2015). However, due to the natural variation in rainfall over time, drought and flood shocks across years may occur randomly, and it is this plausibly random variation that I leverage for the analysis. Figure 2 shows the percentage of grid cells in Malawi that are exposed to drought and flood shocks in a specific calendar year. Crucially, the figure depicts that, in each calendar year, these shocks are independent of the long-term trends, as indicated by the long-run averages for the drought and flood shocks. This independence mitigates concerns about a spurious relationship influencing the results. Figure B.9 also shows the long run (1950 – 2015) spatial distribution of rainfall in Malawi.

3.3. Culture

For the data on culture, I mainly use information provided in the Ethnographic Atlas by Murdock (1967). The Ethnographic Atlas dataset compiles

lation of a deviation from the local mean rainfall in a specific year. Previous studies such as Fafchamps et al. (1998), Jayachandran (2006) and Dercon (2004) have utilized this method in various forms including absolute levels, percentages or standard deviation units. However, a limitation of these methods is their inability to effectively sum shocks over multiple years, as the high years tend to counterbalance the low years (Burke et al., 2015)
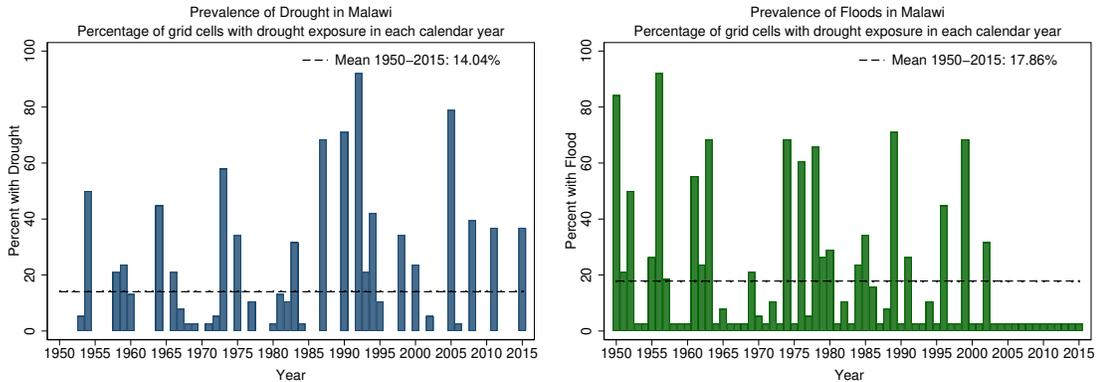
Figure 2: Prevalence of drought and flood shocks in Malawi

The figure illustrates the occurrence of drought and flood shocks in Malawi, depicted as the percentage of grid cells experiencing these events in a given calendar year. The black dashed line represents the long-term average of droughts and floods spanning the period 1950 to 2015.

information at the ethnicity level on traditional cultural practices across a vast majority of ethnic societies globally, encompassing a wide spectrum of social structures, from those characterized by advanced agricultural economies and intricate political systems to smaller hunter-gatherer communities.

The analysis uses data pertaining to the customary marriage traditions of the distinct ethnic groups in Malawi. In particular, I focus on the traditional custom of bride price and classify ethnic groups in Malawi that engages in this custom or not. Ethnic groups in the Ethnographic Atlas are classified on their engagement in one of the following marriage transfer customs, according to Murdock (1981):

a) Bride price or bride wealth: the transfer of a significant offering, whether in the form of livestock, commodities, or money, from the groom or his family to the bride's kinsmen.

b) Token bride price: a small or symbolic payment only.

c) Bride service: a substantial material exchange where the groom provides labor or various services to the bride's family.

d) Gift exchange: a mutual exchange of valuable gifts between the families of the bride and groom, or an ongoing exchange of goods and services, roughly of equal worth, involving the groom or his relatives and the bride's family.

e) Female relative exchange: an exchange of the groom's sister or another female relative in return for the bride.

f) Dowry: the transfer of a significant quantity of assets from the bride's

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family to either the bride, the groom, or the groom's kinsfolk.

g) No significant consideration: the absence of any substantial exchange, or bridal gifts only

The bride price measure comprises an ethnicity-level binary variable, indicating whether an ethnic group (or society) engages in the traditional custom of bride price payment (i.e. category (a) above). There are 10 unique ethnic groups reported in the Malawi DHS. To construct the bride price variable, I first match, by hand, each of these distinct ethnic groups from the DHS to the ethnic groups from the Ethnographic Atlas. This procedure matches 9 of the ethnic groups from both sources, which is also consistent with the previous matching done by Alesina et al. (2013) where 1,265 ethnic groups documented in the Ethnographic Atlas were matched to their respective marriage customs, in addition to other cultural practices. Information on the remaining ethnic group was based on a concordance between the sources, Ibik (1970) and Roberts (1964). From the matching procedure, I find that 30% of ethnic groups in the sample engages in the bride price custom, while the remaining 70% do not.

4. Empirical Strategy

4.1. Empirical specification

To assess the impact of climate shocks on the hazard of first marriage timing decisions of both men and women in bride price and non-bride price societies in Malawi, I conduct a survival analysis using the Cox proportional hazard (PH) regression model (Cox, 1972). The event of interest is the time to first marriage for both men and women, and survival is remaining unmarried. The Cox PH model is a semi-parametric model that allows for constant or time-varying covariates.

In the Cox PH model, the hazard rate of an event of interest for an individual i at time t, conditional on covariates $\mathbf{X_i}$, is specified as:

$$h_i(t|\mathbf{X_i}) = h_0(t)\exp(\mathbf{X_i'}\beta) \tag{1}$$

where $h_0(t)$ is the unspecified baseline hazard for individuals at $\mathbf{X_i} = 0$. The relative risk of the event associated with the set of covariates $\mathbf{X_i}$ is denoted by $\exp(\mathbf{X_i'}\beta)$, and also known as the hazard ratio. Conceptually, the estimation of the regression coefficients, as demonstrated in Cox (1972) is based on the

maximization of a partial likelihood function (assuming that event times do not exhibit ties) as follows:

$$\mathbf{L}(\beta) = \prod_{i=1}^{n} \left[\frac{\exp(\mathbf{X_i'}\beta)}{\sum_{j \in R(t_i)} \exp(\mathbf{X_j'}\beta)} \right]^{d_i} \tag{2}$$

where $R(t_i)$ represent the group of individuals susceptible to risk at time t_i. Similarly, the partial log-likelihood function obtains as:

$$\ln(\mathbf{L}(\beta)) = \sum_{i=1}^{n} d_i \left\{ \mathbf{X_i'}\beta - \ln \sum_{j \in R(t_i)} \exp(\mathbf{X_j'}\beta) \right\} \tag{3}$$

and inferences about the regression parameters are thus drawn from the maximum log-likelihood function.

In this paper, the set of covariates $\mathbf{X_i}$ is characterized by the climate-related economic conditions at the time of marriage and the cultural custom of bride price transfer. Specifically, I consider the climate-induced income shocks due to droughts and floods, and the bride price custom, to estimate the hazard rate of first marriage for individuals at time t in bride price relative to non-bride price societies as follows:

$$h_i(t|x_1, x_2, x_3) = h_0(t) \exp \left\{ \beta_1 Shocks + \beta_2 Brideprice + \beta_3 Shocks \times Brideprice + \delta_s \right\} \tag{4}$$

The covariate *Shocks* denotes the drought and flood shocks. I can respecify equation 4 for each climate shock variable as:

$$h_i(t|x_1, x_2, x_3) = h_0(t) \exp \left\{ \beta_1 Drought + \beta_2 Brideprice + \beta_3 Drought \times Brideprice + \delta_s \right\} \tag{5}$$

$$h_i(t|x_1, x_2, x_3) = h_0(t) \exp \left\{ \beta_1 Flood + \beta_2 Brideprice + \beta_3 Flood \times Brideprice + \delta_s \right\} \tag{6}$$

Equations 5 and 6 are estimated separately for the men and women samples. The covariate *Drought* or *Flood* is a time-varying measure of droughts or floods respectively in a geographical location (grid cell) during a given year, between 1950 and 2015, when an individual is at age t. To be specific, the *Drought* variable is a binary indicator coded as 1 in a particular year when a drought occured and 0 otherwise, and similarly the *Flood* variable is also a binary indicator coded as 1 when a flood occurs in a given year and 0 otherwise. The time-invariant covariate, *Brideprice*, is a dummy indicator for

whether an individual belongs to a bride price society. β_3 in both equations 5 and 6 is the main coefficient of interest defined by the interaction between the climate shock variables and the bride price tradition, which measures the effect of a drought or flood on the timing of first marriage for men and women in bride price societies relative to non-bride price societies. I include survey (DHS) year fixed effects (δ_s) in the estimations and cluster the standard errors at the level of grid cells to accommodate the potential serial correlation of error terms among individuals residing in the same geographic area.

In a further analysis, I examine the equilibrium outcomes of the marriage timing decisions, due to the climate shocks, from both the grooms' side (demand) and brides' side (supply) of the marriage market. To do this, I investigate the impact of the drought and flood shocks on the age gap between husbands and wives at first marriage, and its variation across bride price societies, by estimating the following equation:

$$Agegap_{ig} = \alpha_0 + \alpha_1 Shocks_{g,t} + \alpha_2 Brideprice + \alpha_3 Shocks_{g,t} \times Brideprice + \delta_s + \gamma_g + \epsilon_g \tag{7}$$

where the outcome variable, $Agegap_{ig}$ is the age difference at first marriage between spouses i (husband and wife) in a location g. The climate shocks and bride price tradition covariates are as defined from equations 5 and 6. Women who have never been married are excluded from the sample. The main coefficient of interest, α_3, measures the impact of the drought or flood shocks on the age gap between husbands and wives at first marriage in bride price societies. This ascertains whether prospective brides get married to relatively older grooms in bride price societies relative to non-bride price societies. I discuss this further in the results section. I include survey year fixed effects (δ_s), as well as grid fixed effects (γ_g) to account for time-invariant grid attributes. The standard errors in the estimations are clustered at the grid cell level.

4.2. Identification strategy and potential threats

A major assumption for the identification strategy in the analysis stems from the construction of the climate shocks within each grid cell. The drought and flood covariates are independent of potential confounding factors. This is because, I follow Burke et al. (2015) and Corno et al. (2020) to construct the drought and flood shock variables in a way that each grid cell has an equal likelihood of encountering a shock in any particular year. As a result, the climate fluctuations across grid cells are distinct through the random

occurrences of these shocks. Given the number of unobservables, including the wealth and educational history of parents at the time of an individual's first marriage as well as the quantity of their siblings which may impact the timing of marriage (e.g. Vogl, 2013), the significance of the exogeneity of the climate shocks in the analysis is vital.

Secondly, the DHS dataset only provides information on an individual's current place of residence, as reported during the surveys, but it does not indicate where they lived at the time of their first marriage. Given that the climate shocks considered in the analysis may not have occurred at a location (grid cell) where an individual initially got married, this may potentially pose a challenge to the identification strategy. As a consequence, the measurement of the climate shocks may be erroneous due to the possibility that an individual's current place of residence might vary or be significantly distant from their original location at the time of first marriage. A number of reasons can suffice for this potential threat to identification. As in Corno et al. (2020), first, the traditional customs of patrilocality (residence with or near the husband's kin) and matrilocality (residence with or near the wife's kin) may determine migration at first marriage. Hence, the location (village, town, or city) where an individual currently resides during the survey interviews may vary from their pre-marital residence. A second reason is that an individual and their families could relocate after getting married, but prior to the administration of the surveys.

In the context of the analysis, I find that, migration following marriage, does not seem to pose a significant challenge to the effectiveness of the identification strategy. This is because, I exploit information in the DHS on the number of years ever-married individuals have lived in their current place of residence at the time of the survey interviews and the number of years since they first got married, to determine those who migrated to their current residence within a year of their first marriage. I find that more than 71% and 64% of men and women respectively reported not to have migrated at the time of their first marriage. When marriage-related migration occurs in SSA, it typically involves relatively short distances (Mbaye and Wagner, 2017), with most spouses, on average in Malawi, residing within 5 kilometers of each other prior to marriage (Cherchye et al., 2018).

Finally, another plausible challenge to identification in the analysis is the potential inaccuracies from individual's recollection of their age and year of first marriage, as reported in the DHS dataset. The errors in men and women's ability to accurately recall the age and year of their initial marriage

could result in less precise estimates in the analysis. Fortunately, studies such as Pullum (2006) have validated the reliability of age-related information in the DHS, thereby alleviating the potential impact of such measurement errors in the analysis.

5. Results

5.1. Main Results

Effect of drought shocks on first marriage hazards, and age gap at first marriage

Table 1 shows the estimates for the impact of drought shocks on the hazard of first marriages for both men and women in Malawi, as well as the age gap at first marriage. The sign of the coefficients in Columns (1) and (2) indicate a high or low risk of the marriage hazard, while the hazard ratios in Columns (2) and (4) provide the effect sizes of the covariates. The hazard ratios can be interpreted as multiplicative effects on the marriage hazards.

First, I find that, for non-bride price societies, droughts are associated with an increase in the hazard of entering first marriages for both men and women in Malawi. In particular, I show that, at age t, drought exposure increases the hazard into first marriages in a given year for men by 28.1% (i.e. (1.281 - 1) $\times$ 100) or a factor of 1.28 (p < 0.01). For women in these non-bride price societies, drought exposure in a given year also increases the hazard of getting into their first marriages within that same year by 24.3% (i.e. (1.243 - 1) $\times$ 100) or a factor of 1.24 (p < 0.01).

Second, for men and women in bride price societies, the hazard of entering their first marriages in the absence of a drought shock is lower, and these effects are statistically significant. However, when they are exposed to a drought shock, I find that this negative effect (from the interaction term) is even stronger for men. Specifically, I show that men in bride price societies who experience a drought shock in a given year are more likely to delay the timing of their first marriages (thus a lower hazard into marriage) by 19.2% (i.e. (1 - 0.808) $\times$ 100) or a factor of 0.81 (p < 0.05), relative to men in non-bride price societies. The average age at first marriage for men in the sample is 22.19 years, and hence this effect of drought exposure corresponds to a delay of 4.26 years. For women, on the other hand, I find no effect for the interaction term.

The negative interaction term – i.e the differential effect of drought exposure – realized for men could be primarily driven by the custom. The presence

Table 1: Droughts, First Marriage Hazards, and Age Gap at First Marriage in Malawi

	Men Sample		Women Sample		Husband-wife Age Gap
	Coefficients[a] (1)	Hazard Ratios (2)	Coefficients[a] (3)	Hazard Ratios (4)	OLS Estimates (5)
Drought	0.248*** (0.032)	1.281*** (0.041)	0.218*** (0.016)	1.243*** (0.020)	-0.013** (0.006)
Brideprice	-0.066* (0.038)	0.936* (0.035)	-0.031* (0.017)	0.969* (0.017)	0.353** (0.148)
Drought × Brideprice	-0.213** (0.100)	0.808** (0.080)	0.021 (0.045)	1.021 (0.046)	0.051* (0.029)
Survey Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Grid Fixed Effects	No	No	No	No	Yes
R-Squared					0.016
Observations	725,387	725,387	3,331,820	3,331,820	2,698,823

[a] Coefficient = ln (hazard ratio)
Note: *** p<0.01, ** p<0.05, * p<0.10. Cox PH estimates for Columns (1) – (4) on the timing of first marriages, and OLS regression for the husband-wife age gap in Column (5). A drought is characterized by a calendar year's rainfall observation that falls below the 15th percentile of a grid cell's historical long-run (1950-2015) rainfall distribution. A flood is characterized by a calendar year's rainfall observation that is in excess of the 85th percentile of a grid cell's historical long-run (1950-2015) rainfall distribution. Standard errors are in parenthesis and clustered at the grid-cell level.

of the bride price custom imposes liquidity constraints which are even more pronounced following a contraction in income caused by the drought shock, making it difficult for grooms (young and old) to make the payment. However, the bride price transfer causes a bigger financial duress for younger men (Platteau and Gaspart, 2007), while older men who are relatively more likely to be landowners and wealthier, may be better placed to cope with the income shock following the drought. The opportunity costs of entering into marital unions following adverse income shocks would be high in these bride price societies, as resources may have to be diverted away from other non-income generating activities to fulfill the bride price obligation. I investigate whether the differential impact of drought exposure on first marriage hazards for men in bride price societies are likely to vary by the age cohort of grooms in Figure 3: young adult grooms (men aged ≤ 25) and older grooms (men aged > 25).[3] The estimated coefficients in Figure 3 show that, in bride price

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[3]I categorize men aged below 25 as young adult grooms, given that the United Nations

societies, younger men have a lower hazard of entering their first marriages relative to older men. However, while the marriage hazard is negative for both set of grooms following a drought shock, it is not clear whether the effects are relatively stronger for younger grooms.
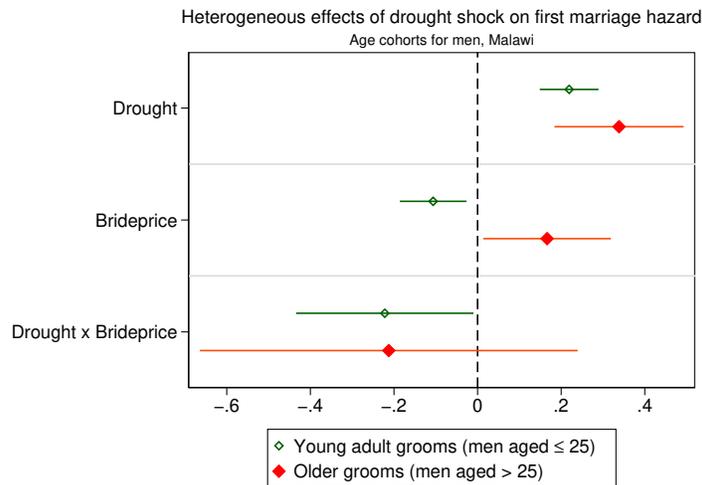

Figure 3: Drought shock: Heterogeneous effects by age cohort of men

I next explore the equilibrium outcome of the hazard into first marriages for both men and women following drought shocks on the age gap at first marriage. I show this in Column (5) of Table 1 which reports the estimation result from a version of the OLS regression in equation 7 that considers the effect of drought shock on the husband-wife age gap at first marriage, and the differential impact by bride price societies. The results are obtained using the women's sample (but excluding women who have never been married), and information on the age of their respective partners at the time of first marriage.

I find that the husband-wife age gap in bride price societies is positive and statistically significant. Drought exposure increases this effect even fur-

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(UN) and the World Health Organization (WHO) considers individuals aged 15 to 24 as youth. In addition, the median age at first marriage for men in the sample is approximately 23.

ther – in particular, I find that, on average, the husband-wife age gap at first marriages in a given year of drought exposure is increasing in bride price societies by 0.051 years. Conversely, exposure to droughts in non-bride price societies is associated with a decline in the age gap at first marriages and this effect is also statistically significant. The widening husband-wife age gap observed in societies that engage in the custom of bride price transfer in Malawi suggests that the presence of the custom plays an influential role in marriage timing decisions. As a result, the bride price transfer, which can be a significant constraint, is likely to influence women to marry grooms who are better able to meet this obligation, potentially contributing to an increased prevalence of polygynous marriages and larger husband-wife age gaps in bride price societies. I provide evidence on this later in subsection 5.3.

Effect of flood shocks on first marriage hazards, and age gap at first marriage

The estimates for the impact of flood shocks on the first marriage hazards for men and women in Malawi is reported in Table 2. I find that, in non-bride price societies, exposure to floods is associated with a decrease in the hazard of first marriages for both men and women, and these effects are statistically significant. Specifically, floods decrease the probability of men and women entering their fist marital unions by 27.9% (i.e. (1 - 0.721) × 100) or a factor of 0.72 and 29.6% (i.e. (1 - 0.704) × 100) or a factor of 0.70 respectively.

In the case of bride price societies, the hazard of entering first marriages is negative (and hence lower) for both men and women. However, following a flood shock in these bride price societies, this effect becomes positive for both gender but only statistically significant for women. In particular, I find that the hazard of entering first marriages is higher for women in bride price societies following a flood shock in a given year, as they are more likely to enter their first marital unions by 33.6% relative to women in non-bride price societies.

In Figure 4, I show the heterogeneous effects for the sample of men by age cohort. The marriage hazard is negative for young adult grooms in bride price societies but no effect for older grooms. I also find that, while the main coefficient of interest – the interaction term – is positive, it is not statistically different from zero for both young adults and older grooms. This imply that, unlike droughts, the nature of flood shocks make it less influential for marriage timing decisions for both set of grooms in bride price societies.

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Table 2:   Floods, First Marriage Hazards, and Age Gap at First Marriage in Malawi

	Men Sample		Women Sample		Husband-wife Age Gap
	Coefficients[a]	Hazard Ratios	Coefficients[a]	Hazard Ratios	OLS Estimates
	(1)	(2)	(3)	(4)	(5)
Flood	-0.327***	0.721***	-0.350***	0.704***	0.005
	(0.037)	(0.027)	(0.020)	(0.014)	(0.009)
Brideprice	-0.121***	0.886***	-0.067***	0.935***	0.372**
	(0.038)	(0.034)	(0.019)	(0.018)	(0.147)
Flood × Brideprice	0.133	1.142	0.290***	1.336***	-0.052
	(0.113)	(0.129)	(0.040)	(0.053)	(0.069)
Survey Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Grid Fixed Effects	No	No	No	No	Yes
R-Squared					0.016
Observations	725,387	725,387	3,331,820	3,331,820	2,698,823

[a] Coefficient = ln (hazard ratio)
Note: *** p<0.01, ** p<0.05, * p<0.10. Cox PH estimates for Columns (1) – (4) on the timing of first marriages, and OLS regression for the husband-wife age gap in Column (5). A drought is characterized by a calendar year's rainfall observation that falls below the 15th percentile of a grid cell's historical long-run (1950-2015) rainfall distribution. A flood is characterized by a calendar year's rainfall observation that is in excess of the 85th percentile of a grid cell's historical long-run (1950-2015) rainfall distribution. Standard errors are in parenthesis and clustered at the grid-cell level.

Column (5) of Table 2 reports the equilibrium outcome of the husband-wife age gap at first marriage, following the marriage hazards for both men and women after exposure to floods. I find that, the age gap between spouses at first marriage is positive and statistically significant in bride price societies relative to non-bride price societies. However, exposure to flood shocks have no impact on the age gap in both societies. This suggest that the constraints faced during drought shocks, particularly by the demand side of the market, are not true in the case of flood shocks. Hence, in contrast to drought shocks, the bride price transfer is less binding in bride price societies following a flood shock. A plausible reason for this could be attributed to the nature of flood shocks.

Flood shocks are more localized and less spatially concentrated, relative to droughts which occur over a wider geographical area. Thus, flood shocks allow for potential smoothing mechanisms to mitigate their impact, such as work-related short-term migration. Specifically, following a flood shock, both young adults and older men may temporarily migrate out of their villages to less distant areas for work, making them physically absent to initiate marital unions. The potential income smoothing opportunities following
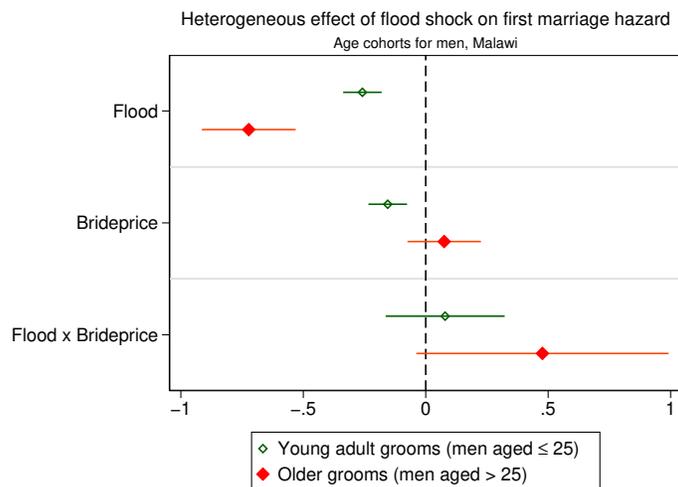
Figure 4: Flood shock: Heterogeneous effects by age cohort of men

flood shocks effectively diminishes the significance of relying on self-insurance mechanisms, such as savings, for both young and older men. As a result, I see no differential effect of the bride price custom interacted with the flood shocks on the hazard into first marriages for men, and on the husband-wife age gap. The positive hazard of entering first marriages observed for women may possibly involve migration from these bride price societies. I discuss in detail the asymmetric effect of drought and flood shocks in the next section.

5.2. Asymmetry between Drought and Flood Shocks

   Drought and flood shocks have been shown to be a significant source of income variability, particularly in rural economies that are heavily reliant on rain-fed agriculture. The adverse effect of these extreme weather events on household income, particularly in agricultural economies, has been validated and well-documented in existing economic literature. To confirm that in this paper, Table A.4 in the Appendix shows the estimated effect of drought and flood shocks on total annual household consumption per capita (a proxy for household income) using data from the World Bank's Integrated Household Survey for Malawi, and combined with the climate data. The estimations involve an OLS regression with grid fixed effects and standard errors clustered at the grid cell level. I also include controls in the estimations. From Table A.4, I find a negative impact of droughts and floods on household con-

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sumption: specifically, droughts and floods reduce household consumption by 6.2% and 13.2% respectively, and are both statistically significant at the 1% level.

However, there exist a plausible asymmetry in the economic and social impacts of droughts and floods. In the previous section, I show that drought and flood shocks, via their impact on low aggregate income, potentially have contrasting effects in the context of marriage behaviour for men and women in Malawi. Here, I discuss in general, a number of reasons for the asymmetry between drought and flood shocks.

First, droughts are long-lasting and can exert a more persistent impact on agricultural productivity compared to floods. As a result, droughts can lead to sustained negative impacts on crop failures and livestock deaths (e.g. Ding et al., 2011). While floods, on the other hand, are capable of causing damage to crops and livestock, they can also deposit fertile silt on farmlands, contributing to improved crop yields (e.g. Pauw et al., 2010; Shah and Steinberg, 2017). Table A.5 in the Appendix present evidence supporting the apparent variation in the impact of drought and flood shocks on crop yields in Malawi. I estimate the effect of the drought and flood shocks on the natural logarithm of maize and rice yields, the two main staple crops in Malawi. Maize is the main staple food in Malawi, which is grown in 80% of all Malawian farms, and also an income-generating crop that accounts for about 25% of agricultural employment (FAO, 2020). To carry out the estimations, I use data from FAOStat for Malawi over the period 1961 – 2017 together with the climate data [4]. The results from Table A.5 show that droughts and floods reduce maize and rice yields in Malawi, but this effect is insignificant in the case of floods. Droughts in particular reduce both maize and rice yields by 21.5% (Column 3). These findings suggest that agricultural productivity in Malawi is substantially impacted by droughts to an extent not true for floods.

Second, droughts can have a more widespread impact on an economy than floods. This distinction arises from the localized nature of floods, which are less spatially concentrated and typically occurs on short time scales due to heavy rainfall. In contrast, droughts are extensive and can affect large

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[4]The drought and flood shocks are as defined in the previous sections but the long-run distribution used in the calculations are from 1961 – 2017, to ensure consistency with the period from the FAOStat dataset

regions or entire countries (Trenberth, 2005; Intergovernmental Panel on Climate Change (IPCC), 2014). Additionally, unlike floods, drought conditions are relatively slower to develop, until precipitation shortages reach a critical level, implying that it already has a significant impact on households and the economy by the time it is detected (Ding et al., 2011).

5.3. Mechanism: Junior Wives in Polygynous Marriages

I investigate the mechanism that explains the main findings of this paper. I show in the previous section that: First, men exposed to drought shocks in bride price societies delay the timing of their first marriages whereas women in these same societies do not, leading to higher husband-wife age gaps. This suggests that, women in these societies marry men who are still able to meet the bride price obligation in spite of income shocks. Second, following a flood shock, I find no differential effect for the hazard of entering first marriages for men, due to the potential income smoothing of flood shocks, and the bride price transfer which is less binding in this instance. On the other hand, I see that the differential effect of the hazard into first marriages for women is significant when exposed to flood shocks. In equilibrium, I find no significant differential impact of the flood shock on the husband-wife age gap.

In what follows, I examine the potential mechanism for the above findings, by investigating whether women in bride price societies are more likely to enter their first marital unions as junior wives (i.e. second or higher order wives) in polygynous marriages, rather than as a first or sole wife. To do this, I use the women sample to estimate a version of equation 7 given as:

$$Juniorwife_{ig} = \alpha_0 + \alpha_1 Shocks_{g,t} + \alpha_2 Brideprice + \alpha_3 Shocks_{g,t} \times Brideprice + \delta_s + \gamma_g + \epsilon_g \tag{8}$$

where the dependent variable is an indicator for whether a woman i in location g marries as a junior wife in her first marriage, as opposed to being the first and/or only wife. The covariates representing climate shocks and the bride price custom are defined in the same manner as in equation 7, as well as the survey and grid fixed effects.

I show in Figures 5 and 6 that, the effects are likely to differ by the age cohorts of women. I find that, potential brides – particularly young adults (aged between 18 and 29) and older brides (aged above 30) – in societies that engage in the bride price custom have a higher likelihood of entering their first marriages as junior wives, compared to their counterparts in non-bride price societies. However, I observe no effects for the same age cohort

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of brides in these bride price societies following a drought shock. The only effects observed are concentrated among child brides, where the interaction term is statistically significant at the 5 percent level. In particular, girls below the age of 18 who are exposed to a drought in bride price societies have a higher likelihood to be married as junior wives in polygynous unions by 1.1 percentage points, which constitute 16.4% of the mean proportion of junior wives in the sample. This suggest that, following drought shocks in societies where liquidity constraints for initiating marriage are binding due to the bride price custom, older women are less desirable on the market by grooms and particularly as second/higher order wives. As a result, younger women have a higher likelihood to marry older men (relative to younger men) who are perhaps already married, wealthier and more self-insured and resilient to the drought shock. This result confirms the higher husband-wife age gap, following droughts in bride price societies, that I find in section 5.1. In a related evidence, Tapsoba (2023) document that, following a negative income shock, the demand for second wives exhibits a higher sensitivity to reductions in income and bride price than the demand for first wives.
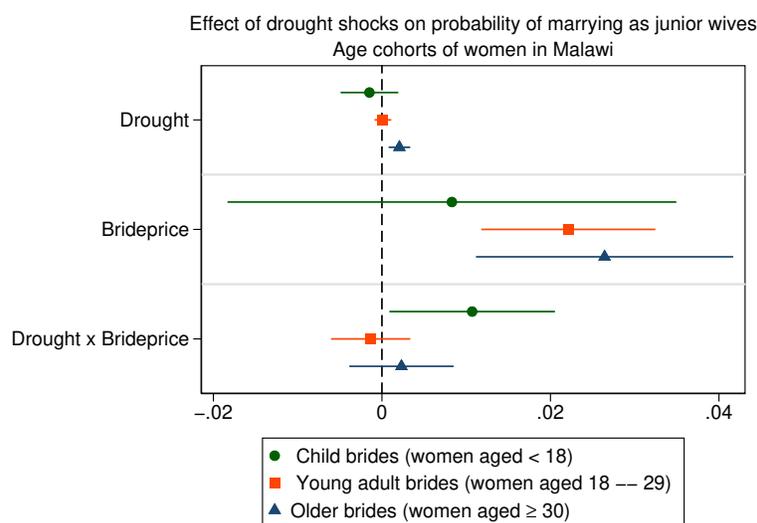

Figure 5: Drought shocks and junior wives, by age cohorts

In the case of floods, I find that the differential effects are not significantly different from zero for the different age cohorts of women. This suggest that
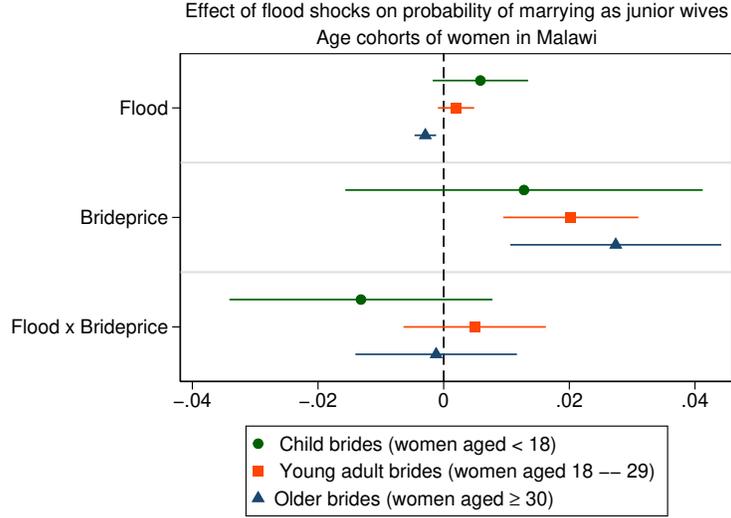
Figure 6: Flood shocks and junior wives, by age cohorts

Coefficients of regressions: The indicator for junior wives on climate shocks and interaction with bride price societies. A drought is characterized by a calendar year's rainfall observation that falls below the 15th percentile of a grid cell's historical long-run (1950-2015) rainfall distribution. A flood is characterized by a calendar year's rainfall observation that is in excess of the 85th percentile of a grid cell's historical long-run (1950-2015) rainfall distribution. All the regressions include survey year FE and standard errors are clustered at the grid-cell level.

there is no differential impact of the exposure to flood shocks on the probability of younger or older women marrying as junior wives in both societies. This finding is consistent with the results I find for the husband-wife age gap following flood shocks, which is not statistically significant. A plausible explanation that suffices here is the previously mentioned nature of flood shocks, which have important implications on the demand for brides. In particular, the potential smoothing opportunities such as short-term migration by both young and older men, as well as the notion that the bride price, in effect, may not bind as much following a flood shock.

5.4. Robustness Checks

I consider various robustness checks to affirm the validity of the main findings. First, I re-estimate the impact of the drought and flood shocks on the marriage timing for men and women, by adjusting the threshold levels for the measure of drought and flood. For the drought measure, I vary the cut-off for rainfall realization that falls below the 20th and 45th percentile of a grid cell's historical long-run rainfall distribution. For floods, I consider rainfall

observations that are in excess of the 75th and 90th percentiles. Tables A.6 and A.7 in the Appendix show the outcomes of the Cox PH and OLS estimations using the revised measures for drought and flood, for both men and women samples respectively. In principle, I find that the hazard ratios for the main variable of interest – the interaction between droughts or floods and the indicator for bride price societies – remain relatively consistent in comparison to the default cut-offs used in the main analysis. I also show the results for the age gap at first marriage using the revised cut-offs for the drought and flood measure. The results are very similar to the default cut-off from the main analysis, albeit I find no significant point estimate for the interaction term for drought.

Second, I show in Appendix Tables A.8 and A.9 that the effect of drought and flood shocks on the hazard into first marriages and husband-wife age gaps are robust to the inclusion of year fixed effects to account for differential trends over time.

Finally, I assess the robustness of the main findings by excluding communities near the lake, which are the most vulnerable to flooding. The Lower Shire Valley, located in the flood-prone southern region of Malawi, is drained by the Shire River – the only outlet of Lake Malawi. This valley spans two administrative districts, Chikwawa and Nsanje, both of which have poverty rates (defined as living on less than \$0.40 per person per day) exceeding 80%, the highest in the country (Mwale et al., 2015). After excluding communities from these districts, I show in Appendix Tables A.10 and A.11 that the key results on the impact of drought and flood hazards on first marriage entry and age gaps remain consistent, albeit the interaction term for the age gap analysis in the case of drought shocks is not statistically significant.

6. Conclusion

This paper provide empirical evidence on the interplay between climate shocks, cultural norms, and marriage behaviour in Malawi. It sheds light on how drought and flood shocks differentially impact the hazard into first marriages and husband-wife age gaps, with distinct implications for men and women across bride price and non-bride price societies. Droughts result in delayed first marriages for men in bride price societies due to the financial burden of the binding bride price custom, while there is no differential effects realized for women, leading to a higher husband-wife age gap in these societies. Flood shocks, on the other hand, do not exhibit a similar differential

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effect on marriage hazards for men, due to its localized nature and potential smoothing mechanisms. However, women in bride price societies experience a higher likelihood of marrying early after exposure to flood shocks, indicating a unique gendered response to different climate shocks. The widening husband-wife age gap in bride price societies in Malawi, following a drought, is manifested in the increased likelihood of young women entering polygynous marriages as junior wives. This merits attention, as it may have adverse long-term consequences for women's empowerment, socio-economic outcomes, and health.

The findings in this paper provide insight for policy makers, researchers, and practitioners working towards sustainable and inclusive development in the face of climate change and evolving cultural landscapes. It underscores the need for nuanced policy interventions and effective safety net programs which takes into account cultural norms and climate fluctuations to address socio-economic disparities and promote sustainable development.

Appendix A. Tables

Table A.3: Summary Statistics

	Bride Price Societies		Non-Bride Price Societies		Mean Difference	Observations
	Mean	SD	Mean	SD		
Panel A: Unique Individuals						
Men Sample						
Age at first marriage	22.56	4.76	22.12	4.21	0.45***	12,559
First marriage, by age cohort:						
< 18	16.10	1.20	15.99	1.16	0.11	1,255
18 − 25	21.47	2.41	21.26	2.01	0.20***	9,039
26 − 30	27.53	1.59	27.48	1.32	0.05	1,713
31 − 35	32.36	1.63	32.38	1.27	-0.02	389
36 − 40	37.27	1.56	37.43	1.35	-0.17	125
> 40	42.55	1.25	45.02	3.48	-2.47***	38
Women Sample						
Age at first marriage	17.76	3.77	17.59	3.30	0.17***	55,515
First marriage, by age cohort:						
< 18	15.57	1.61	15.32	1.58	0.25***	30,395
18 − 25	19.73	2.14	19.71	1.78	0.02	23,673
26 − 30	27.33	1.46	27.43	1.28	-0.01	1,099
31 − 35	32.79	1.68	32.34	1.22	0.45	241
36 − 40	36.81	1.25	37.24	1.42	-0.43	79
> 40	41.53	1.19	43.62	2.52	-2.10*	28
Panel B: Survival Data						
Age at first marriage (men)	22.59	4.80	22.11	4.24	0.48***	725,387
Age at first marriage (women)	17.76	3.78	17.59	3.30	0.17***	3,331,820
Drought exposure, ever-married men (=1, 0 otherwise)	0.15	0.41	0.14	0.34	0.01***	725,387
Drought exposure, ever-married women (=1, 0 otherwise)	0.12	0.37	0.14	0.34	-0.02***	3,331,820
Flood exposure, ever-married men (=1, 0 otherwise)	0.15	0.41	0.17	0.37	-0.02***	725,387
Flood exposure, ever-married women (=1, 0 otherwise)	0.30	0.52	0.18	0.37	0.12***	3,331,820

Note: *** p<0.01, ** p<0.05, * p<0.10. Survey sampling weights for both men and women samples are applied in the computation of the summary statistics.

Table A.4: Climate Shocks and Household Consumption in Malawi

	HH consumption (1)		HH consumption (2)
Drought	-0.062***	Flood	-0.132***
	(0.011)		(0.019)
Controls	Yes	Controls	Yes
Grid Fixed Effects	Yes	Grid Fixed Effects	Yes
R-squared	0.365	R-squared	0.644
Observations	12,171	Observations	12,171

Note: *** p<0.01, ** p<0.05, * p<0.10. Controls include household size, number of male and female household children, age and education of household head, region of residence, an interaction term between the climate shocks and region, as well as a dummy for poor households below the national poverty line. A drought is defined as a calendar year's rainfall observation that falls below the 15th percentile of a grid cell's historical long-run (1950-2017) rainfall distribution. A flood is defined as a calendar year's rainfall observation that is in excess of the 85th percentile of a grid cell's historical long-run (1950-2017) rainfall distribution. Robust standard errors are in parenthesis and clustered at the grid cell level.

Table A.5: Climate Shocks and Crop Yields in Malawi

	Maize (1)	Rice (2)	Both crops (3)		Maize (4)	Rice (5)	Both crops (6)
Drought	-0.329**	-0.101	-0.215**	Flood	-0.072	-0.026	-0.049
	(0.127)	(0.106)	(0.093)		(0.081)	(0.140)	(0.083)
R-squared	0.124	0.011	0.050	R-squared	0.007	0.001	0.003
Observations	57	57	114	Observations	57	57	114

Note: *** p<0.01, ** p<0.05, * p<0.10. A drought is defined as the average annual rainfall observation that falls below the 15th percentile of Malawi's historical long-run (1961-2017) average rainfall distribution. A flood is defined as the average annual rainfall observation that is in excess of the 85th percentile of Malawi's historical long-run (1961-2017) average rainfall distribution. Robust standard errors are in parenthesis.

Table A.6: Robustness in revised cut-offs: Droughts, First Marriage Hazards, and Age Gap at First Marriage

	Men Sample		Women Sample		Husband-wife Age Gap	
	20th perc. Hazard Ratios (1)	45th perc. Hazard Ratios (2)	20th perc. Hazard Ratios (3)	45th perc. Hazard Ratios (4)	20th perc. Age gap (5)	45th perc. Age gap (6)
Drought	1.227**	1.126***	1.221**	1.160***	-0.009*	-0.015***
	(0.037)	(0.027)	(0.017)	(0.014)	(0.005)	(0.005)
Brideprice	0.942	0.973	0.978	1.001	0.352**	0.338**
	(0.037)	(0.043)	(0.018)	(0.022)	(0.142)	(0.146)
Drought × Brideprice	0.823**	0.860**	0.978	0.957	0.042	0.052
	(0.079)	(0.065)	(0.041)	(0.035)	(0.032)	(0.043)
Survey Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Grid Fixed Effects	No	No	No	No	Yes	Yes
Observations	725,387	725,387	3,331,820	3,331,820	2,698,823	2,698,823

Note: *** p<0.01, ** p<0.05, * p<0.10. A drought is characterized by a calendar year's rainfall observation that falls below the 20th or 45th percentile of a grid cell's historical long-run (1950-2015) rainfall distribution. Standard errors are in parenthesis and clustered at the grid-cell level. Data is from the pooled 2000, 2004, 2010, 2015 Malawi DHS.

Table A.7: Robustness in revised cut-offs: Floods, First Marriage Hazards, and Age Gap at First Marriage

	Men Sample		Women Sample		Husband-wife Age Gap	
	75th perc. Hazard Ratios (1)	90th perc. Hazard Ratios (2)	75th perc. Hazard Ratios (3)	90th perc. Hazard Ratios (4)	75th perc. Age gap (5)	90th perc. Age gap (6)
Flood	0.720***	0.797***	0.691***	0.762***	0.007	0.008
	(0.024)	(0.033)	(0.012)	(0.016)	(0.008)	(0.013)
Brideprice	0.892***	0.889***	0.936***	0.942***	0.373***	0.373***
	(0.034)	(0.033)	(0.019)	(0.017)	(0.135)	(0.135)
Flood × Brideprice	1.076	1.177	1.277***	1.301***	-0.044	-0.064
	(0.107)	(0.143)	(0.050)	(0.054)	(0.074)	(0.107)
Survey Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Grid Fixed Effects	No	No	No	No	Yes	Yes
Observations	725,387	725,387	3,331,820	3,331,820	2,698,823	2,698,823

Note: *** p<0.01, ** p<0.05, * p<0.10. A flood is characterized by a calendar year's rainfall observation that is in excess of the 75th or 90th percentile of a grid cell's historical long-run (1950-2015) rainfall distribution. Standard errors are in parenthesis and clustered at the grid-cell level. Data is from the pooled 2000, 2004, 2010, 2015 Malawi DHS.

Table A.8: Robustness to inclusion of year fixed effects: Droughts, First Marriage Hazards, and Age Gap at First Marriage

	Men Sample		Women Sample		Husband-wife Age Gap
	Coefficients[a]	Hazard Ratios	Coefficients[a]	Hazard Ratios	OLS Estimates
	(1)	(2)	(3)	(4)	(5)
Drought	0.088**	1.092**	0.011	1.012	-0.020*
	(0.049)	(0.053)	(0.023)	(0.023)	(0.011)
Brideprice	-0.053	0.948	-0.023	0.977	0.352**
	(0.039)	(0.037)	(0.017)	(0.017)	(0.142)
Drought × Brideprice	-0.278***	0.757***	-0.055	0.947	0.054*
	(0.102)	(0.077)	(0.044)	(0.042)	(0.034)
Survey Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Grid Fixed Effects	No	No	No	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
R-Squared					0.016
Observations	725,387	725,387	3,331,820	3,331,820	2,698,823

Note: *** p<0.01, ** p<0.05, * p<0.10. A drought is characterized by a calendar year's rainfall observation that falls below the 20th or 45th percentile of a grid cell's historical long-run (1950-2015) rainfall distribution. Standard errors are in parenthesis and clustered at the grid-cell level. Data is from the pooled 2000, 2004, 2010, 2015 Malawi DHS.

Table A.9: Robustness to inclusion of year fixed effects: Floods, First Marriage Hazards, and Age Gap at First Marriage

	Men Sample		Women Sample		Husband-wife Age Gap
	Coefficients[a]	Hazard Ratios	Coefficients[a]	Hazard Ratios	OLS Estimates
	(1)	(2)	(3)	(4)	(5)
Flood	0.067	1.069	-0.057**	0.945**	0.007
	(0.053)	(0.056)	(0.025)	(0.024)	(0.016)
Brideprice	-0.099***	0.906***	-0.048***	0.954***	0.373***
	(0.037)	(0.034)	(0.019)	(0.018)	(0.135)
Flood × Brideprice	0.004	1.004	0.086**	1.090**	-0.054
	(0.114)	(0.114)	(0.039)	(0.042)	(0.092)
Survey Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Grid Fixed Effects	No	No	No	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
R-Squared					0.016
Observations	725,387	725,387	3,331,820	3,331,820	2,698,823

Note: *** p<0.01, ** p<0.05, * p<0.10. A flood is characterized by a calendar year's rainfall observation that is in excess of the 75th or 90th percentile of a grid cell's historical long-run (1950-2015) rainfall distribution. Standard errors are in parenthesis and clustered at the grid-cell level. Data is from the pooled 2000, 2004, 2010, 2015 Malawi DHS.

Table A.10: Robustness to exclusion of communities near the lake: Droughts, First Marriage Hazards, and Age Gap at First Marriage

	Men Sample		Women Sample		Husband-wife Age Gap
	Coefficients[a]	Hazard Ratios	Coefficients[a]	Hazard Ratios	OLS Estimates
	(1)	(2)	(3)	(4)	(5)
Drought	0.245***	1.277***	0.214***	1.239***	-0.014**
	(0.033)	(0.042)	(0.016)	(0.020)	(0.006)
Brideprice	-0.067*	0.935*	-0.031*	0.970*	0.353**
	(0.038)	(0.035)	(0.017)	(0.017)	(0.142)
Drought × Brideprice	-0.208**	0.812**	0.025	1.025	0.052
	(0.010)	(0.081)	(0.045)	(0.046)	(0.033)
Survey Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Grid Fixed Effects	No	No	No	No	Yes
R-Squared					0.016
Observations	708,063	708,063	3,260,328	3,260,328	2,638,494

Note: *** p<0.01, ** p<0.05, * p<0.10. A drought is characterized by a calendar year's rainfall observation that falls below the 20th or 45th percentile of a grid cell's historical long-run (1950-2015) rainfall distribution. Standard errors are in parenthesis and clustered at the grid-cell level. Data is from the pooled 2000, 2004, 2010, 2015 Malawi DHS.

Table A.11: Robustness to exclusion of communities near the lake: Floods, First Marriage Hazards, and Age Gap at First Marriage

	Men Sample		Women Sample		Husband-wife Age Gap
	Coefficients[a]	Hazard Ratios	Coefficients[a]	Hazard Ratios	OLS Estimates
	(1)	(2)	(3)	(4)	(5)
Flood	-0.321***	0.725***	-0.344***	0.709***	0.006
	(0.038)	(0.027)	(0.020)	(0.014)	(0.010)
Brideprice	-0.121***	0.886***	-0.067 6***	0.936***	0.373***
	(0.038)	(0.034)	(0.019)	(0.018)	(0.135)
Flood × Brideprice	0.129	1.138	0.285***	1.329***	-0.054
	(0.113)	(0.129)	(0.040)	(0.053)	(0.091)
Survey Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Grid Fixed Effects	No	No	No	No	Yes
R-Squared					0.016
Observations	708,063	708,063	3,260,328	3,260,328	2,638,494

Note: *** p<0.01, ** p<0.05, * p<0.10. A flood is characterized by a calendar year's rainfall observation that is in excess of the 75th or 90th percentile of a grid cell's historical long-run (1950-2015) rainfall distribution. Standard errors are in parenthesis and clustered at the grid-cell level. Data is from the pooled 2000, 2004, 2010, 2015 Malawi DHS.
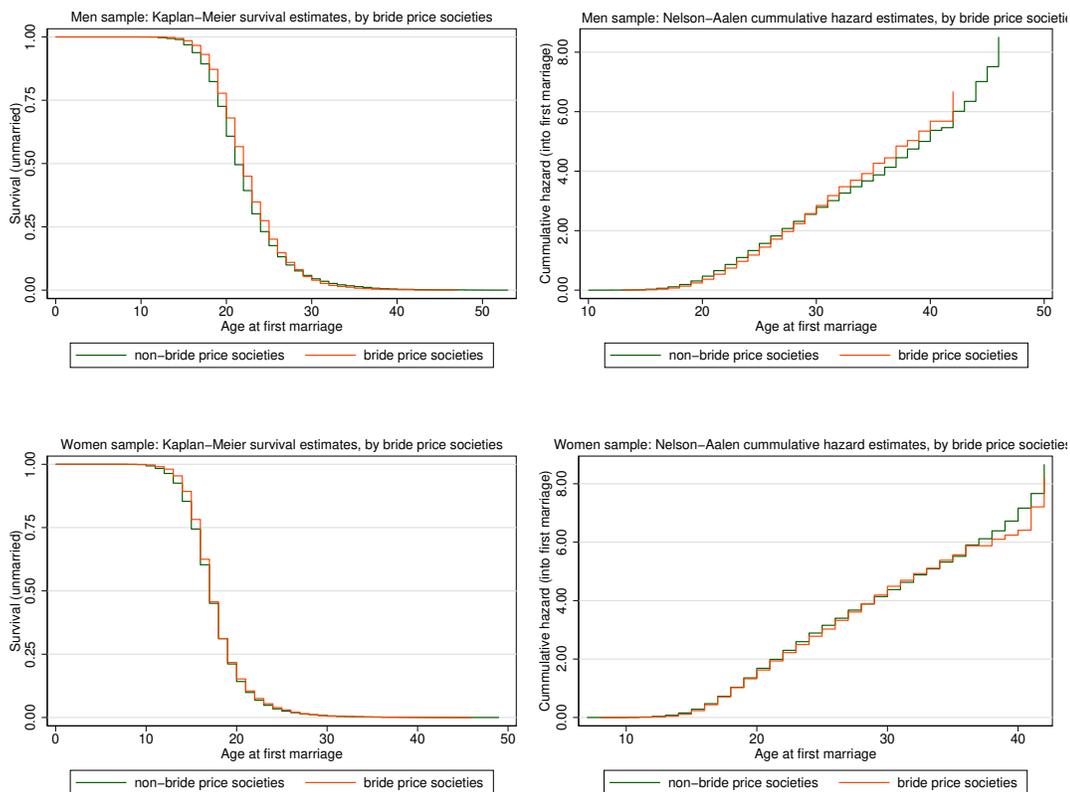
Appendix B. Figures

Figure B.8: Survival and Hazard into First Marriages, Men and Women sample

Note: The Kaplan-Meier curves depict the proportion of individuals who are still unmarried at a given age, while the Nelson-Aalen cumulative hazards represent the risk of entering first marriages. Data is from the pooled 2000, 2004, 2010, and 2015 Malawi DHS.
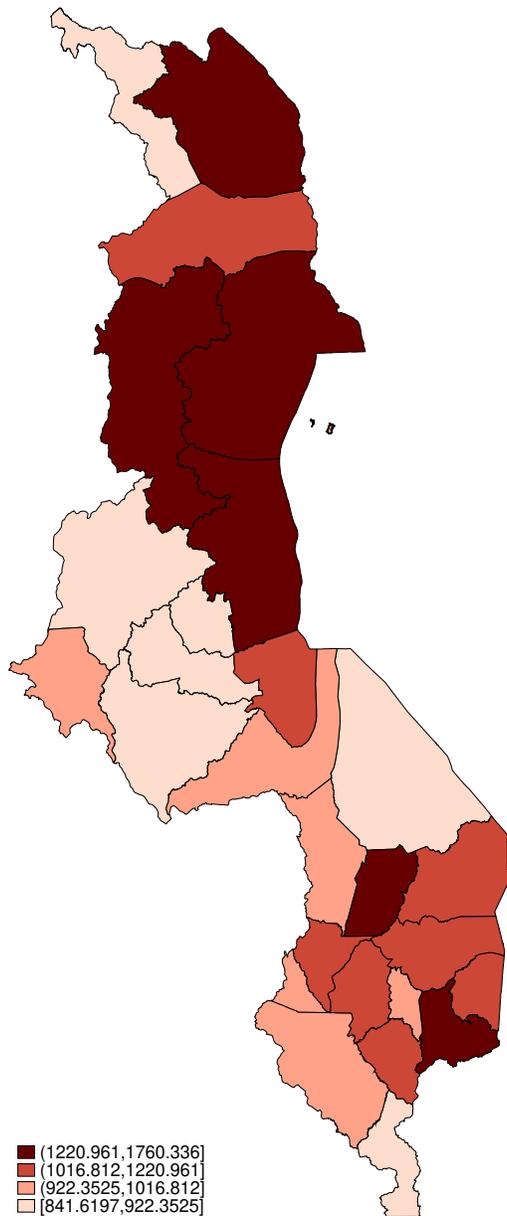
Figure B.9: Rainfall distribution, long-run average (1950 – 2015) for Malawi

Author's elaboration using the climate data from Matsuura and Willmott and the district map of Malawi. The long-run averages are calculated at each grid cell.

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