Polygyny and the Economic Determinants of Family Formation Outcomes in Sub-Saharan Africa*

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Abstract

This paper examines how local economic conditions affect family formation outcomes in areas with polygyny. It presents a simple equilibrium marriage market framework where polygyny is modeled as sequential one-to-one matching and bride price serves as a crucial source of consumption smoothing. In this framework, young and older men compete for brides, and economic shocks influence their market shares. Empirical tests of the model's predictions confirm that in the polygynous areas of Sub-Saharan Africa, droughts increase the market shares of young men, resulting in more girls marrying younger husbands with smaller age gaps and as first/unique spouses. The paper also finds that droughts have no discernible effect on the timing of marriage and fertility onset of girls in high polygyny areas, despite their positive and significant impact on these outcomes in monogamous markets. Additionally, evidence from global crop price shocks shows that marriage markets react symmetrically to both positive and negative shocks.

JEL Codes: J1, O15

Keywords: Marriage market, local norms, polygyny, bride price, income shocks, informal insurance.

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1 Introduction

Social norms and culture are crucial for economic development, and the efficacy of policy interventions may depend on the local environments in which they are enacted (Ashraf et al., 2020; Collier, 2017; World Bank, 2015). Across Sub-Saharan Africa (SSA), marriage markets (an important determinant of household welfare) are governed by very diverse and persistent local norms regarding polygyny (Fenske, 2015; Tertilt, 2005; Jacoby, 1995). This custom that allows men to have multiple wives simultaneously is still widespread in many areas, while others are essentially monogamous, as shown in Figure 1.[1]

The presence of polygyny changes the structure of the marriage market and potentially the incentives of agents in this market. Young and old men compete for brides in polygynous areas. Women can marry young bachelors as first/unique spouses or marry older men as second spouses. This leads to larger husband-wife age gaps, more child marriages, and more inequality within households with the presence of junior and senior spouses. All these marital outcomes have been shown to influence within-household bargaining power and hence the health and socioeconomic outcomes of women and their offspring.[2] Yet, little is known about how economic conditions can affect these key family formation outcomes in polygynous markets. From the policy perspective, addressing this question is crucial for the design and evaluation of income stabilization programs that are put in place in the culturally diverse areas of SSA when there is an adverse economic shock. It is also crucial for understanding the consequences on household formation of fairly common policy interventions that generate short-term windfall income at local level (such as large-scale cash transfer programs) and how they interact with local norms.

This paper studies how short-term changes in economic conditions affect family formation outcomes in the presence of polygyny. In particular, it investigates the impact of local economic shocks on spousal ranking, husband-wife age gap, and child marriage. Marital outcomes are potentially sensitive to changes in economic conditions because of the bride price (payment from the groom's family to the bride's family at the time of marriage). This custom is common in many parts of SSA. It is an important source of consumption smoothing that influences marital decisions (Corno et al., 2020; Hoogeveen et al., 2011).

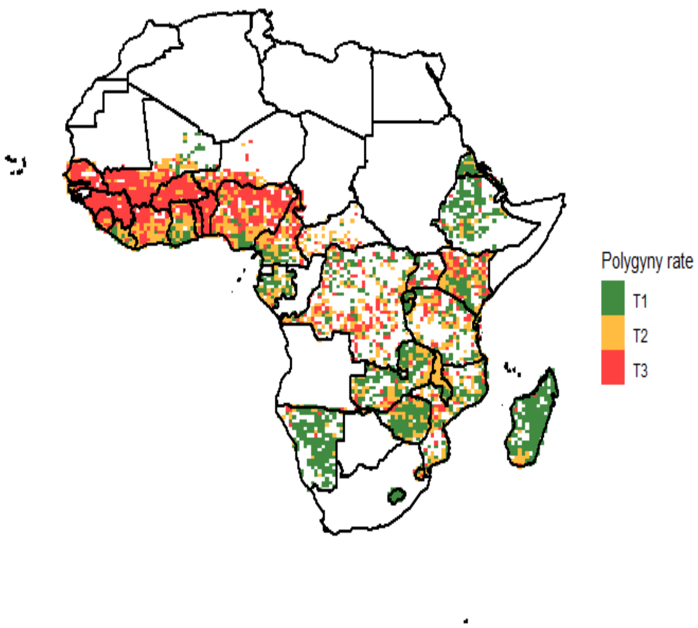
The fact that aggregate shocks affect both the demand and the supply side of the market makes it necessary to look at what happens to marital outcomes in equilibrium when these shocks occur. I start by modeling the key features that characterize marriage markets in SSA. For that, I consider an overlapping generation matching model in which each birth cohort is active on the market for at most two periods. On the supply side, girls leave the market once they marry. Child marriage corresponds to girls getting married during their first period of being active on the market (between ages 12 and 17,

[1] Figure 1 shows that a third of local marriage markets have more than 40% of women living in polygynous households. This proportion is below 15% for markets in the bottom tertile of polygyny levels. Half of the cells in this bottom tertile have a polygyny rate lower than 5%.

[2] Child marriage has been linked to poor health, fertility, and socio-economic outcomes for mothers and children (Corno et al., 2020; Duflo et al., 2015; Save the Children, 2004). Marrying as a first/senior spouse (versus getting matched as a second/junior spouse) leads, on average, to better bargaining power, higher access to household resources, and better outcomes for one's children (Munro et al., 2019; Matz, 2016; Reynoso, 2019). Marrying older men is often associated with having less bargaining power in the union and a higher likelihood of early widowhood (Carmichael, 2011; Atkinson and Glass, 1985; Van de Putte et al., 2009).

for instance). On the demand side, men also leave the market once they get married if polygyny is not allowed. When it is permitted, a certain share of men remains active on the market after being matched during their first participation. Those among them who find it optimal to remarry will have two spouses when they exit the marriage market. Polygyny is therefore modeled as a sequential one-to-one matching.

Figure 1: Practice of Polygyny across Space in SSA



Note: Polygyny rate is the average share of women (aged 25 and older) that are in union with a polygamous male in each 0.5 × 0.5 decimal degree ($\sim$ 50×50 km) weather grid cell. It is computed from Demographic and Health Survey (DHS) data collected between 1994 and 2013. The continuous rate is split in terciles. T1 represents grid cells with low polygyny (less than 16%), T2 is for areas with medium polygyny (between 16 and 40%), and T3 is for areas with high polygyny (more than 40%).

At any given period, two generations of men and women are on the market, which may lead to multiple equilibria in the matching pattern. The most straightforward equilibrium consistent with the data is such that there is an excess quantity of unmarried older men on the market (second participation) compared to unmarried older women. This leads to a substantial number of cross-cohort unions. The market is cleared by the supply and demand of child brides because they have the outside option of waiting one extra period before they agree to a union. In this setting, the aggregate demand for child brides can be decomposed into two independent components: the demand for first/unique spouses from young adult men and the demand for second spouses from older men. In monogamous marriage markets, only the former exists.

When aggregate income is low, many households want to bring forward their daughters' marriage so that they can smooth consumption with the bride price payment. This leads to an increase in the supply of child brides. Households on the demand side of the market are also affected by the same negative shock so the equilibrium bride price will fall. The relative sensitivity of the demand for first/unique spouses to the income and price drop compared to the demand for second spouses will determine which component will see an increase in their market share when aggregate income is low. I show that in settings where polygyny is common, even among relatively poor people (not just the rich elite), the demand for second spouses is more sensitive to income and price changes than the demand for first/unique spouses. This means that adverse economic shocks will decrease the market share of older men (looking for a second spouse) to the benefit of younger men (looking for a first/unique spouse). Negative shocks should therefore increase women's likelihood of marrying younger men with low husband-wife age gaps and as first spouses. This is the model's main prediction.

The second prediction of the model is on how aggregate shocks affect girls' marriage timing. The equilibrium quantity of child marriage will vary depending on which side of the market is more sensitive to income and bride price decline. In the case of monogamous marriage markets, Corno et al. (2020) have shown that negative shocks increase child marriage because the supply of child brides is more sensitive than the demand for unique spouses in patrilocal societies. When polygyny is allowed, the demand for second spouses is more elastic to the income and price drop compared to the demand for first/unique spouses. This means that the overall demand will be more sensitive than when we are in a monogamous market leading to a much smaller rise in the equilibrium quantity of child marriage. The magnitude of this attenuation effect depends on the strength of the polygyny norm. Areas with the strongest polygyny norms will have an even smaller rise (if any) in the equilibrium quantity of child marriage when there is a negative shock.

To test the model's predictions, I examine the effect of rainfall and global food price shocks on the key family formation outcomes in SSA: husband-wife age gap, spousal ranking, and child marriage for girls. Rainfall shocks are a major and plausibly exogenous source of income variability in areas that rely on rain-fed agriculture. Low levels of rainfall reduce annual crop yields by 10 % on average, but there is no clear positive relationship between unusually high rainfall realization and crop yields in SSA (Corno et al., 2020; Burke et al., 2015). To test whether households and markets react in a symmetric way to positive and negative shocks, I also use income variation induced by plausibly exogenous changes in world agricultural commodity prices.[3] These can generate opposite effects for areas that produce crops and those that consume them. A rise in crop price such as the one observed during the last agricultural commodity super cycle (which peaked with the global food price crisis of 2007/2008 and 2010/2011) leads to an increase in real income in crop-producing areas and a decrease in net-consuming areas (Verpoorten et al., 2013). This has also been shown to fuel violence in Africa (McGuirk and Burke, 2020). The variation in aggregate income that comes from global food price shocks is also of a different nature compared to rainfall shocks and serves as an interesting robustness check for the predictions of the model. The former is a real income shock (for a given production level), while the latter is a production shock.

I use Demographic and Health Survey (DHS) data for more than 300,000 women spread across SSA and rainfall data from the University of Delaware Air Temperature and Precipitation project to

[3] Households may move forward the timing of marriage of their daughters when facing a negative shock but fail to delay it when there is a positive shock. This behavior is consistent with mental accounting life cycle models in which households treat different components of wealth as non-fungible (Shefrin and Thaler, 1988; Thaler, 1999). There is evidence of asymmetric consumption smoothing in reaction to income shocks, even for households that are not budget-constrained (Baugh et al., 2021; Christelis et al., 2019; Jappelli and Pistaferri, 2010).

evaluate the impact of droughts on marital outcomes in the presence of polygyny. As predicted by the model, the empirical evidence shows that droughts increase the market shares of young men that are looking for a first/unique spouse at the expense of older men. Exposure to a drought during the prime marriageable age (between ages 12 and 17, for instance) significantly reduces the husband-wife age gap in high polygyny areas by 1.2 years (10 % of the average age gap) and they have no effect in low polygyny markets. Droughts also decrease the likelihood of marrying as a junior spouse by 2.4 percentage points (14 % of the average share of second/higher order spouses). This evidence confirms that the demand for second spouses is more sensitive to the income and price drop from droughts than the demand for first/unique spouses.

The empirical evidence also shows that droughts have a more significant impact on the timing of marriage and on child marriage (unions between ages 12 and 17) in areas with less polygamy. In monogamous markets, a drought raises the average annual hazard of child marriage by 5%.[4] This effect decreases progressively as we move to areas with higher polygyny rates until it vanishes completely. In areas with the strongest polygyny norms, droughts have no detectable impact on the timing of marriage.

For the second source of variation in aggregate income, I follow McGuirk and Burke (2020) and define a producer price index (PPI) by combining high-resolution time-invariant spatial data on where specific crops are grown with annual international price data for each crop to form a cell-year measure. Similarly, a country-year level consumer price index (CPI) is obtained by combining cross-sectional data on food consumption from the United Nations Food and Agriculture Organization (UN FAO) with temporal variation in world prices. I find that a standard deviation rise in PPI decreases the hazard of marriage the same year by 0.6 percentage points (4% of the annual average hazard) for women living in rural areas in low polygyny cell grids. This effect vanishes in high polygyny areas. In these areas, the rise in PPI increases the market shares of older men looking for a second spouse at the expense of younger ones. The rise in CPI has opposite effects on women living in urban areas: A standard deviation rise in CPI increases the hazard of marriage the same year by 1.5 percentage points in low and medium polygyny areas but has no significant effect in high polygyny areas.

These differences in the equilibrium response of marriage outcomes to short-term shocks translate into differences in their effect on fertility onset and levels by age 25. Negative shocks increase the likelihood of early fertility onset in low polygyny areas but have no detectable effect in high polygyny areas (the opposite for positive shocks). Sensitivity and robustness checks show that the documented patterns are present only among women from ethnic groups that practice bride price payments (as predicted by the model). Importantly, they are not driven by other cultural factors that are correlated with polygyny, such as patrilineality, women's traditional role in agriculture, the practice of Islam, or the historic implantation of Christian missions. They are also not driven by differences in the reaction of the market's supply side to the shocks, differential migration, differential sizes of the relevant marriage markets, or differential effects of the shocks on household income.

[4]This represents almost the double of the average effect that Corno et al. (2020)documented. Their estimates show the average impact of droughts across the whole region (not just in monogamous areas), so they do not take into account the fact that polygamous markets may react differently to droughts.

Related Literature

This paper is related to several strands of the economic literature. First, it contributes to our understanding of the economics of polygyny. This practice is associated with underinvestment in physical assets (Tertilt, 2005; Boserup, 1970; Jacoby, 1995), underinvestment in human capital (Gould et al., 2008; Behaghel and Lambert, 2017), and wealth inequality across households (De La Croix and Mariani, 2015). At the household level, polygyny implies making production and consumption decisions in a complex non-nuclear family. This involves some level of cooperation (Reynoso, 2019; Akresh et al., 2012; Boserup, 1970) and competition (Rossi, 2019; Boltz and Chort, 2019) which leads to more within-household inequality and some economic inefficiencies.[5] Compared to junior spouses, senior spouses have better status and bargaining power which translates into better socio-economic outcomes for them and their offspring (Munro et al., 2019; Reynoso, 2019; Mammen, 2019). Munro et al. (2019) show that men allocate more resources to senior spouses in public good games compared to their junior spouses. Reynoso (2019) argues that women sort into marrying as a senior spouse, a unique spouse, or a junior spouse in polygynous markets by ability and this creates a substantial welfare inequality among co-wives. André and Dupraz (2023) study the impact of a school building program in colonial Cameroon and document evidence suggesting the opposite sorting pattern: Educated women prefer to marry rich polygynous men as second spouses rather than being first/unique spouses of poorer men. I contribute to this literature by showing that young bachelors and older men compete for the same brides to a great extent, and their market shares are sensitive to local income fluctuations. In other words, spousal ranking (hence husband-wife age gap) has important economic determinants beyond any potential sorting of women by ability. This finding suggests that economic policies that affect men's incentives to marry in a given year can have lasting effects on women's marital outcomes in polygynous markets.

Second, I contribute to a recent and growing literature on the effect of income shocks on marriage timing in developing countries (Corno and Voena, 2021; Corno et al., 2020; Hoogeveen et al., 2011; Chort et al., 2021). All these papers assume, however, that marriage markets only allow monogamous unions. In particular, Corno et al. (2020) use a supply and demand model to show that the effect of droughts on girls' marriage timing depends on the direction of marriage payments: It increases child marriage in the presence of bride price (paid by groom's family) and decreases it in the presence of dowry (paid by bride's family). The other papers also focus on rainfall shocks as a source of variation in aggregate economic conditions. My paper adds to this literature by extending the one-to-one matching framework to analyze how aggregate economic conditions affect the timing of marriage when polygyny is allowed. Moreover, I also use an additional source of variation in aggregate income that has not been used so far in this literature: changes in real income due to global crop price fluctuations. This variation is used to establish that households and markets react in a symmetric way to both positive and negative aggregate shocks. Another paper related to this literature is Rexer (2022). It shows that young women

[5] In a Lab experiment, Barr et al. (2019) show that spouses' willingness to cooperate to maximize household gains is lower in polygamous unions than in monogamous ones. Similar inefficiencies have been shown for investment in children in polygynous households (Arthi and Fenske, 2018; Kazianga and Klonner, 2009).

delay marriage in response to good pre-marital rainfall, which increases marriage inequality and violence primarily in polygamous areas. The paper explores the potential mechanism behind this effect by treating rainfall variations as supply-side shocks and argues that they increase the cumulative hazard of marriage by age 25 only in polygamous areas. In my paper, rainfall variation is instead treated as an aggregate yearly shock, and it is linked directly to the exact timing of marriage (as in Corno et al. (2020)). My results show that, on the contrary, rainfall shocks have a stronger effect on the timing of marriage in monogamous areas (see Section 4.1.4 for more details). The supply side mechanism suggested in Rexer (2022) plays, therefore, a minor role in how the marriage market clears from one year to another with changing economic conditions.

Third, this paper contributes to the large literature investigating the coping mechanisms that poor households use to deal with income shocks (Rosenzweig and Stark, 1989; Townsend, 1994; Fafchamps and Lund, 2003; Kazianga and Udry, 2006; Jayachandran, 2006; Morten, 2019). Receiving a bride price is an important strategy for coping with such shocks, but this paper shows that their aggregate effect depends on local norms regarding the practice of polygyny. In high polygyny areas, adverse shocks do not change the equilibrium levels of child marriage, but they increase the market shares of young men that are looking for a first spouse at the expense of older men that are looking for a second one.[6] This can improve welfare for two reasons. First, as argued earlier, women who marry in these challenging times may benefit from marrying as first/unique spouses to younger men. Second, the existing evidence suggests that the reallocation of wives to younger men can improve welfare because they become more likely to engage in productive activities at their full potential.[7]

Finally, this paper fits within the body of research on the importance of culture and institutions in shaping economic behavior. Most of this literature has studied the role of cultural values and beliefs, such as marriage payments, polygyny, trust, family ties, and gender norms on economic development (Platteau, 2000; Jacoby, 1995; Tertilt, 2005; La Ferrara and Milazzo, 2017; Jayachandran and Pande, 2017) and on household decision-making (Bishai and Grossbard, 2010; Anderson and Bidner, 2015; Ashraf et al., 2020; Bhalotra et al., 2020; Anukriti et al., 2021). I contribute to this literature by showing that local norms regarding the practice of polygyny significantly influence the equilibrium reaction of the marriage market to aggregate income shocks. Therefore, it is crucial to consider the marriage market structure when designing and implementing policy interventions.

The paper is structured as follows. Section 2 presents the theoretical framework used for the analysis. In Section 3, I discuss the data and some descriptive evidence. Section 4 empirically tests the main predictions of the model. Section 5 discusses the implications of the findings documented in this paper, and Section 6 concludes.

[6] A major implication of this finding is that households who live in high polygyny areas will rely more on other strategies to cope with aggregate shocks, such as liquidating assets/buffer stocks, off-farm employment, etc. This is also the case for those who live in areas where bride price is not practiced.

[7] In polygynous societies and those with a strong gender imbalance, unmarried young men often engage in crime and other violent activities, so marrying earlier means reallocating time to more productive activities such as work and raising offspring (Edlund and Lagerlöf, 2012; Edlund et al., 2013; Cameron et al., 2019; Rexer, 2022; Koos and Neupert-Wentz, 2020).

2 Model

In this section, I propose a simple model to study how marital outcomes react to short-term aggregate economic shocks in the presence of polygyny. It is a simple supply-and-demand marriage market model with sequential one-to-one matching and overlapping generations. This model also encompasses what happens in monogamous markets (studied in Corno et al. (2020)) as a special case.

2.1 Set Up

Market Structure: The marriage market at each period t involves men and women of two consecutive birth cohorts, as shown in Table 1. On the demand side, teenage sons (cohort B_1) are too young to participate in the market. Young adult sons (cohort B_2) are the youngest men on the market, and old adult sons are the oldest (cohort B_3). Each birth cohort is active on the market for up to two periods, leaving it for good afterward. They can marry only once per period.

Men who married young at period $t-1$ (denoted by $\mathcal{M}_o^m$) can be looking for a second spouse at period t.[8] The extent to which this happens in a given market is determined by local social norms that create a shared understanding of what is a desirable/acceptable behavior in a given area. These norms are constant over time and vary from market to market for reasons that are exogenous to the model, as argued in Section 3.2. Let $p \in [0, 1]$ denote the share of men who return to the market for second spouses. $p = 0$ means polygyny is prohibited, and the marriage market is exclusively monogamous. $p = 1$ means all the men return to the marriage market looking for a second spouse. Not everyone looking for a second spouse can find/afford one. The equilibrium share of men that marry a second spouse is therefore determined endogenously within the model. Bigamy is by far the most common form of polygyny in SSA, as shown in Figure A7.

On the market's supply side, teenage daughters (cohort B_1) are already active and can potentially be married off by their parents as child brides.[9] They are the youngest cohort on the marriage market at period t. Young adult daughters (cohort B_2) are the oldest active cohort. Older daughters (cohort B_3) are no longer active on the market because their fertility prospects are too limited at this age. Women leave the market for good upon marriage, and I assume that there is no divorce or remarriage in this setting for simplicity.[10]

The last row of Table 1 shows whether a child is old enough to emancipate economically from his parents and autonomously run his own production and consumption unit. Until young adulthood, sons are part of their parents' production and consumption unit with a positive net contribution $w_y^m > 0$.

[8] All the other market participants are unmarried and denoted by $\mathcal{U}$ in Table 1. The subscripts indicate their cohort (y for young and o for old), and the superscripts their gender (m for male and f for female).

[9] The data shows that 54% of girls are married by age 18 versus less than 1% for men.

[10] Divorce rates are relatively high in SSA compared to other developing regions (around 25%). However, most divorces happen within the first years of union (Villar et al., 2018), while men tend to marry a second spouse on average 10 years after their first union. Divorces are mostly driven by factors other than polygyny, such as urbanization, education, female employment, and kinship systems (Clark and Brauner-Otto, 2015; Takyi and Broughton, 2006; Takyi and Gyimah, 2007; Reniers, 2003). Divorce rates are even higher in monogamous areas compared to polygamous ones.

The parents decide whether to support or not the marriage of their son at this stage. The son then splits/emancipates and creates his own production/consumption unit when he becomes an old adult.[11]

Table 1: Marriage Market Structure at t

Birth cohort	B_1	B_2	B_3
Male Side		$\mathcal{U}_y^m$	$\mathcal{U}_o^m + p\mathcal{M}_o^m$
Female Side	$\mathcal{U}_y^f$	$\mathcal{U}_o^f$	
Emancipation	No	No	Yes

Age bride cohorts: Youngest (12-17); Oldest (18-30)
Groom cohorts: Youngest (15/18-25); Oldest (26-35)

After their economic emancipation, old adult sons still contribute to their parents' household consumption. I assume that this contribution is higher if they got married during young adulthood ($w_o^{m,h} > w_o^{m,l}$). This provides parents with an incentive to marry their sons as soon as possible. Several factors support this assumption. First, being single can prevent the newly emancipated son from producing resources at his full potential. Having a spouse brings indeed socio-emotional stability, extra labor force, and motivation to a young man. Second, this could capture some reciprocity of the son towards his parents since they helped him get married early, and he does not have to pay a bride price right away after his emancipation.

Daughters move from their parents' consumption/production unit to that of their husband's family when they get married (patrilocality).[12] They are no longer active in the marriage market by the time they can emancipate from their parents, so they would have to remain single forever in this case. The net contribution of a daughter to her parent's (or her husband's) production/consumption unit is w_y^f when she is among the youngest cohort on the market and w_o^f when she is among the oldest cohort. The marital decision for daughters is, therefore, always taken by their parents. For sons, this decision is taken by their parents during young adulthood and themselves when they become old adults.

I assume a balanced sex ratio by birth cohort, and the population grows at a constant rate (a) from one cohort to the next. For simplicity, I also assume that each family has only one child (male or female) of marriageable age that they take care of. Monetary markets are incomplete, and there is no borrowing or savings across periods. The next period is discounted at a rate δ.

Marriage and Bride Price: Each marriage involves the payment of a unique bride price (τ_t) that clears supply and demand in a given market. Markets are assumed to be independent of one another.

[11]There is ample evidence that parents are very involved in the first union of their sons (especially the young ones). They provide start-up capital such as land for the new household, arrange and host the marriage ceremony, and often cover most expenses, including bride price payment. Parents can also provide some of this support to old sons that are getting married for the first time. However, the decision to marry a second spouse and the costs involved are paid for by the groom himself with little involvement from his parents (Goldschmidt, 1974; Mondain et al., 2004; Antoine et al., 2002).

[12]Data from the Atlas of Precolonial Societies (Murdock, 1967) shows that patrilocality is the traditional norm in 82% of ethnic groups in SSA. The other groups are either neolocal (couple moves to either family) or matrilocal (husband moves to wife's family).

The equilibrium bride price can be higher in markets with stronger polygyny norms due to the higher demand for brides, as argued by Grossbard (1978) and Goldschmidt (1974). However, this model has no heterogeneity in the market's supply side. This simplifies the equilibrium matching process. It also avoids taking a stand on whether the type of women who marry as first/unique spouses command a higher or lower bride price payment than those who marry as second spouses since all the brides are assumed to be equivalent. In practice, there is some variation in the amount of bride price payments by brides' characteristics, such as education (Ashraf et al., 2020; Lowes and Nunn, 2017). However, these amounts are relatively constant across grooms' families with different characteristics, including those with varying income levels (Anderson, 2007; Borgerhoff-Mulder, 1995; Tapper, 1981; Zhang, 2000). Borgerhoff-Mulder (1995) shows, in particular, that bride price amounts do not vary with the wife's rank in polygynous marriages using data from Kenya. Goldschmidt (1974) studied bride price payments among several ethnic groups in East Africa and also found no difference in the bride price of first/unique spouses and second spouses.

Future Utility: Families derive some utility in future periods from having their child married by the time they leave the marriage market. This captures, for instance, the future net contributions of their child's family to their own resources, the utility of acquiring offspring, or the one they derive from avoiding the stigma of having an unmarried child. Importantly, the groom's family does not derive any extra utility from him having a second spouse in my setting because it does not imply higher contributions for them.[13]

Let $V_M^{m,y}$ denote the discounted sum of expected utility for the father of a young son who marries. $V_M^{m,o}$ is the discounted sum of expected utility for an old son who marries. The decision maker on the supply side is always the girl's father (or household head). V_M^f denotes the discounted sum of expected utility for the parents of a married daughter. V_U^s is the sum of expected utility if a child remains single ($s \in \{m, f\}$) when they exit the market.

Income and Preferences: Household income at period t is the sum of an aggregate income y_t and an idiosyncratic shock ϵ_t: $I_t = y_t + \epsilon_t$. Aggregate income can be high (y^H) or low (y^L) with equal probability each period (depending on aggregate shocks). The idiosyncratic shocks are i.i.d. with pdf f. Households have Constant Relative Risk Aversion Utility (CRRA) over consumption each period: $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$, $\gamma \geq 1$. For simplicity, I also assume that the contributions of children to their parents' budget are not directly affected by aggregate shocks ($\frac{dw_y^s}{dy_t} = \frac{dw_o^s}{dy_t} = 0$).

[13]This is consistent with the view that marrying a second spouse ensures some continuity in the services that a wife provides in the household (sexual/reproductive services, female-specific household chores, etc.) and signals a certain social status in areas where polygyny is endorsed. The alternative view that polygyny is practiced for economic and productive reasons (Jacoby, 1995; Boserup, 1970) has a second-order importance in explaining the historical and current practice of polygyny across SSA (Goody, 1973; Fenske, 2013; Lee, 1979; Goldschmidt, 1974). This point is discussed further in Section 3.2.3.

2.2 Equilibrium Matching Process and Market Clearing

At each period t, the marriage market has two overlapping generations. Therefore, it is essential to establish who matches with whom in equilibrium. Multiple equilibria in the matching pattern are possible in theory, but the data is consistent with the type of equilibria in which:

- There is an excess quantity of unmarried old men on the market (second participation) at t compared to the quantity of unmarried women of the oldest generation ($\mathcal{U}_o^m > \mathcal{U}_o^f$). This is because many women of this generation have already been married off to older men at $t-1$.
- The unmarried old men on the market can marry women from the youngest or the oldest generation as their unique spouses. They are more willing to pay for a bride than the men of the youngest generation.
- Men from the youngest generation can only marry women from the youngest generation on the market.
- All second spouses are from the youngest generation.[14]

There is a rationing of potential brides, given this matching pattern. This is due to the excess demand for brides compared to the supply, despite the marriage age gap and population growth. Bachelors from the oldest generation on the market have the highest willingness to pay a bride price to be matched since they will remain unmarried otherwise. Similarly, unmarried women from the oldest generation are the most willing to accept a bride price to get matched. All the men from the youngest generation are willing to marry, but their families may not have the resources for it, and they have the outside option of waiting for the next period. For a given bride price, many parents of young girls may want to keep them off the marriage market unless forced financially to do otherwise. The market is therefore cleared by the supply and demand of child brides. There will be a unique equilibrium bride price in each period for all the women that marry in that period. Households are price takers in this market. The model is solved using backward induction across the two marital decision periods.

2.3 Phase 2: Young/Old Adulthood

Let us denote marital decision at period t by $b_t = 1$ if the child gets married and $b_t = 0$ otherwise. Marital status at the beginning of period t is given by M_{t-1}. It takes the value 1 if the person is married at the beginning of period t. The payoffs for families of "old" children (second participation to the market) unmarried at the beginning of period t are:[15]

[14]This is the simplest equilibrium supported by the data. The model can easily accommodate other equilibria that are qualitatively equivalent to the one considered here. In particular, it can allow some older women to become second spouses. What matters is that a substantial share of second spouses marries as child brides which is the case in the data. The age of marriage for women that are unique, first, or second spouses are very similar within each country (see Appendix Figure A8). There is also a large age gap between a husband and his first/unique spouse (8 years on average). Moreover, men marry a second spouse on average 10 years after marrying their first spouse (see Appendix Figure A9).

[15]Old adult sons are economically emancipated, so the utility function used here corresponds to their own and not their parents' (unlike for daughters).

$$U^f_{o,t}(b_t|M_{t-1}=0,y_t,\epsilon_{it},\tau_t) = u\big(y_t+\epsilon_{it}+w^f_o+b_t(\tau_t-w^f_o)\big)+b_tV^f_M+(1-b_t)V^f_U$$
$$U^m_{o,t}(b_t|M_{t-1}=0,y_t,\epsilon_{jt},\tau_t) = u\big(y_t+\epsilon_{jt}-w^{m,l}_o-b_t(\tau_t-w^f_g)\big)+b_tV^{m,o}_M+(1-b_t)V^{m,o}_U,$$

where $g \in \{o,y\}$. The payoffs for families of "old" children married at the beginning of t:

$$U^f_{o,t}(b_t|M_{t-1}=1,y_t,\epsilon_{it}) = u\big(y_t+\epsilon_{it}\big)+V^f_M$$
$$U^m_{o,t}(b_t|M_{t-1}=1,y_t,\epsilon_{jt}) = u\big(y_t+\epsilon_{jt}+w^{f,1}_o-w^{m,h}_o-b_t(\tau_t-w^{f,2}_y)\big)+V^{m,o}_M+b_t(V^{m,o}_{M2}-V^{m,o}_M),$$

where $V^{m,o}_{M2}$ is the discounted sum of expected utility for a son who marries a second spouse. All the other terms are defined above. Sons' contribution to their parents' consumption is such that $w^{m,h}_o > w^{m,l}_o$: if unmarried old sons start their own production/consumption unit while being single, they contribute less to their parents' household, as discussed in the previous section.

Any bride price τ_t such that $U^s_{o,t}(b_t=1|M_{t-1}=0,y_t,\epsilon_{st},\tau_t) \geq U^s_{o,t}(b_t=0|M_{t-1}=0,y_t,\epsilon_{st},\tau_t)$, with $s \in \{m,f\}$ is acceptable for a union to happen between a pair of families. The main incentive for not remaining single comes from the high expected lifetime utility that sons (plus their parents) and daughters' parents get when they are married. Old sons already married at the beginning of period t can decide to look for a second spouse with probability p. In this case, they trade-off the extra cost of marrying a second spouse with the expected future utility of having two spouses.

Proposition 1: There exists a non-empty interval $[\underline{\tau}_t,\bar{\tau}_t]$ such that with bride price $\tau^*_t \in [\underline{\tau}_t,\bar{\tau}_t]$, everyone who is single at the beginning of their second participation to the market gets married. Moreover, there is a threshold of idiosyncratic shock $\epsilon^*_{m,2}$ which determines the decision to take a second spouse or not for all the men on the market for a second spouse. Those with $\epsilon_{jt} > \epsilon^*_{m,2}$ are willing to marry again.
Proof: See Appendix Section A.1.1.

The intuition behind the second part of this proposition is that under the concavity assumption in the utility function, richer men have a higher willingness to pay a bride price for a second spouse. Importantly, the threshold $\epsilon^*_{m,2}$ is a decreasing function of the extra utility that men derive from marrying a second spouse $(V^{m,o}_{M2}-V^{m,o}_M)$.

2.4 Phase 1: Adolescence/Young Adulthood

Parents are the decision-makers at this stage. For a given bride price τ_t, their payoffs are:

$$U^f_{y,t}(b_t|M_{t-1}=0,y_t,\epsilon_{it},\tau_t) = u\big(y_t+\epsilon_{it}+w^f_y+b_t(\tau_t-w^f_y)\big)+\delta E[\bar{V}^f_{o,t+1}(M_t)]$$
$$U^m_{y,t}(b_t|M_{t-1}=0,y_t,\epsilon_{jt},\tau_t) = u\big(y_t+\epsilon_{jt}+w^m_y-b_t(\tau_t-w^f_y)\big)+\delta E[\bar{V}^m_{o,t+1}(M_t)],$$

where $\bar{V}^s_{o,t+1}$ represents the sum of future utility for parents ($s \in \{m,f\}$). The expectation terms are taken with respect to the future realizations of aggregate income and idiosyncratic shocks. These expectation terms are independent of current aggregate shocks y_t as explained in the proof in Section A.1.2. A family with a potential young bride and a family with a potential young groom will want to marry them off if $U^s_{y,t}(b_t = 1|M_{t-1} = 0, y_t, \epsilon_{st}, \tau_t) \geq U^s_{y,t}(b_t = 0|M_{t-1} = 0, y_t, \epsilon_{st}, \tau_t)$. For any union to happen during stage 1 for a family with a daughter, the bride price has to be higher than the net contribution of their daughter: $\tau_t > w^f_y$. With these constraints, two threshold rules on ϵ_{it} and ϵ_{jt} will determine the quantity of people who find it optimal to marry given aggregate income y_t and bride price τ_t.

Proposition 2: There exist two thresholds of idiosyncratic temporary income, $\epsilon^*_f(\tau_t, y_t)$ and $\epsilon^*_m(\tau_t, y_t)$, which determine the marital decision during the first period of participation in the market. All families on the supply side with $\epsilon_{it} < \epsilon^*_f(\tau_t, y_t)$ and all families on the demand side with $\epsilon_{jt} > \epsilon^*_m(\tau_t, y_t)$ will want to marry off their children.

Proof: See Appendix Section A.1.2

Same intuition as before: Under concavity, the richest families on the demand side want to pay the bride price, and the poorest families on the supply side want to receive it.

2.5 Supply and Demand of Child Brides

The demand for child brides comes from three sources, given the equilibrium matching pattern described earlier:

- Old single men who cannot find an adult spouse because a significant portion of women in their marriage cohort have already married older men in the previous period $(t-1)$.

$$D^{(1,old)}(\tau^*_{t-1}, y_{t-1}) = \frac{1}{1+a}\left[F(\epsilon^*_m(\tau^*_{t-1}, y_{t-1})) - (1 - F(\epsilon^*_f(\tau^*_{t-1}, y_{t-1}))\right]$$

- Potential young grooms whose families have experienced a shock of sufficient magnitude $(\epsilon_{jt} > \epsilon^*_m)$ to enable them to marry a bride.

$$D^{(1,young)}(\tau_t, y_t) = 1 - F(\epsilon^*_m(\tau_t, y_t))$$

- Married men who are seeking a second spouse and have experienced a shock of sufficient magnitude $(\epsilon_{jt} > \epsilon^*_{m,2})$ to allow them to enter into a second marriage.

$$D^{(2,old)}(\tau_t, y_t, \tau^*_{t-1}, y_{t-1}) = \frac{p}{(1+a)}\Big[\big(1 - F(\epsilon^*_m(\tau^*_{t-1}, y_{t-1})\big) \times \big(1 - F(\epsilon^*_{m,2}(\tau_t, y_t)\big)\Big]$$

The supply for child brides comes from households with a low enough shock ϵ_{it} for them to marry off their daughters as child brides. This demand and supply of child brides will determine an equilibrium bride price that clears the market: $Q^*(y_t) \equiv D(y_t, \tau^*_t) = S(y_t, \tau^*_t)$.

Proposition 3: The demand for child brides is increasing in aggregate income ($D_y = \frac{\partial D(\tau_t, y_t)}{\partial y_t} > 0$), and the supply of child brides is decreasing in aggregate income ($S_y = \frac{\partial S(\tau_t, y_t)}{\partial y_t} < 0$). Moreover, the demand for child brides is decreasing in bride price ($D_\tau = \frac{\partial D(\tau_t, y_t)}{\partial \tau_t} < 0$) and the supply of child brides is increasing in bride price ($S_\tau = \frac{\partial S(\tau_t, y_t)}{\partial \tau_t} > 0$).

Proof: See Appendix Section A.1.3

Proposition 4:

- If the extra utility that men derive from marrying a second spouse ($V_{M2}^{m,o} - V_{M}^{m,o}$) is high enough, lower aggregate income will increase the market shares of young men that are looking for first/unique spouses at the expense of older ones that are looking for second spouses.

- This also leads to a weaker rise in the equilibrium quantity of child marriage in response to the shock as p increases: $Q_y^* = \frac{dQ^*(y_t)}{dy_t} < 0$ when $p = 0$ and $\frac{dQ_y^*}{dp} > 0$

Proof: See Appendix Section A.1.4.

The threshold for marrying a second spouse ($\epsilon_{m,2}^*$) is a decreasing function of $V_{M2}^{m,o} - V_{M}^{m,o}$. When the latter is high enough, concavity implies that the demand for second spouses will be more sensitive to income and price changes when aggregate income is low compared to the demand for first/unique spouses. In other words, the demand for second spouses is more elastic to income and price changes when the marginal man who finds it optimal to marry a second spouse is not too "rich" ($\epsilon_{m,2}^*$ low enough). This is likely to be the case in many areas of SSA, where polygamy is not just practiced by the rich elite but is also almost equally common among less rich and poorer men. Appendix Figure A4 and A5 show, for instance, a stable proportion of polygamous households across all the wealth quintiles in my sample. It has also been documented in the literature that many polygamous men are relatively poor. They tend to face even higher economic stress and anxiety levels than monogamous men (Heath et al., 2020; Boltz and Chort, 2019; Antoine et al., 2002). Marrying a second spouse still requires resources, and some of the poorest men will not be able to afford it throughout their life. Polygamy being common even among relatively poor men is also consistent with the view that those men remarry mostly because of social pressure and because they value having some continuity in the services that women provide in the household (sexual, reproductive, and other domestic services).[16]

In monogamous markets ($p = 0$), the overall effect of a negative shock on the equilibrium quantity of child marriage depends on the differences in income and price elasticity of supply and demand for child brides. As shown in the proof (following similar arguments as in Corno et al. (2020)), $sgn\left(Q_y^* = \frac{dQ^*(y_t)}{dy_t}\right) = sgn\left(\frac{S_y}{S_\tau} - \frac{D_y}{D_\tau}\right) < 0$. The increase in child marriage comes from the fact that the ratio of income to price-elasticity of the supply is higher (in absolute value) than the ratio of income to price-elasticity of the demand since $\epsilon_m^* > \epsilon_f^*$ when $w_o^{m,l}$ is high enough. This is likely the case in patrilocal societies.

I show that when $p > 0$ (polygamous markets):

[16] Goldschmidt (1974) documents some strong peer pressure in favor of polygyny in many ethnic groups of East Africa, and this often takes the form of mockery and derision. This is well captured in popular sayings such as this one from the Sebei ethnic group (present in Uganda): "a man with one wife is a neighbor to a bachelor," which means that if the wife is unavailable (sickness, death, etc.), he must do the household chores himself.

$$sgn\Big(\frac{dQ_y^*}{dp}\Big) = sgn\Big[\frac{dD_y}{dp}(S_\tau - D_\tau) - \frac{dD_\tau}{dp}(S_y - D_y)\Big] > 0.$$

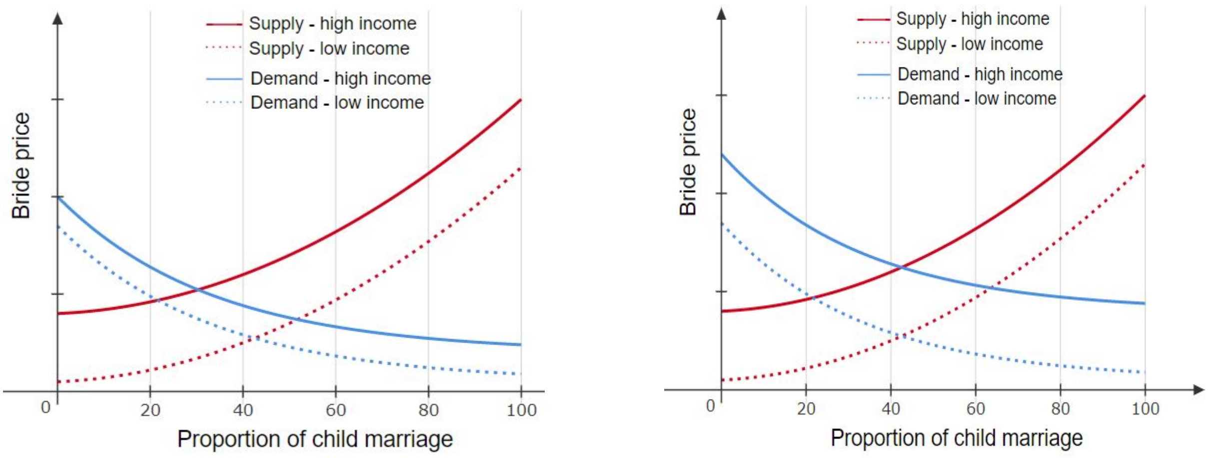
The threshold for marrying a second spouse $\epsilon_{m,2}^*$ is a decreasing function of the extra utility that men derive from having a second spouse ($V_{M2}^{m,o} - V_M^{m,o}$). When this difference is high enough, the income-to-price-elasticity ratio is higher (in absolute value) for the demand for second spouses compared to the demand for first/unique spouses, which explains the positive sign.[17] This leads to an attenuation of the overall effect of an income shock on the equilibrium quantity of child marriage. A higher share of men on the market for second spouses (captured by higher p) will translate into more weight for the demand for second spouses leading to more attenuation in the overall effect.

Figure 2 illustrates the comparative statics regarding child marriage. Price-elasticity corresponds to the slope of the curves, and the income-elasticity corresponds to the horizontal shift that happens to each curve when income is low or high. Panel (a) shows the case of monogamy. Child marriage increases when aggregate income is low because the supply curve is more income-elastic than the demand (both curves have similar price-elasticities here). When polygyny is allowed (panel (b)), the income-elasticity of the overall demand is much higher than in the case of monogamy because of the demand for second spouses. This elasticity is, therefore, closer to the one of the supply curve, leading to a much weaker increase in the equilibrium quantity of child marriage when there is a negative shock. Panel (b) shows a particular case in which the supply and demand have the same income elasticity (on top of having the same price elasticity), so there is no change in the equilibrium quantity of child marriage.

Testable Predictions: The main testable predictions of the model are stated in Proposition 4. A third testable (implicit) implication of the model is that households and markets should react symmetrically to positive and negative aggregate shocks. To test these three predictions, I exploit the persistent spatial

[17] In the presence of polygyny, the overall elasticity of the demand to the income and price drop that comes with low aggregate income is, therefore, closer to the overall elasticity of the supply.

Figure 2: Illustration of the Comparative Statics



(a) Monogamy (b) Polygamy

variation in the extent to which polygyny is practiced in SSA. The variation in p across space is assumed to be orthogonal to any potential variation in the extra utility that men derive from marrying a second spouse ($V_{M2}^{m,o} - V_{M}^{m,o}$). One can think of it as having similar geographic areas, with the only difference being that some of these areas have high p because of a combination of persistent factors such as traditional norms, religion, colonial institutions, and other historical events, as argued in Section 3.2.3.[18]

3 Data and Descriptive Evidence on Polygyny Norms

3.1 Household Data

The main data source is the Demographic and Health Survey data (DHS). DHS surveys are nationally-representative household-level surveys carried out regularly in several developing countries worldwide. The final dataset assembles all the publicly available DHS surveys in SSA between 1994 and 2013, where geocoded data are available, resulting in a total of 73 surveys across 31 countries. In all the surveys, the information on a woman's age at first marriage is collected retrospectively during the interview. Validation studies have suggested that these measures are rather accurate (Pullum, 2006) which limits concerns about the effect of measurement error. All the women between the ages of 15 and 49 are interviewed in the survey.

The analysis is restricted to the sample of women who are at least 25 years old at the time of the interview. Women exposed to major civil conflicts in the ages relevant for each empirical specification are also dropped in the main analysis. UCDP/PRIO Armed Conflict Dataset is used to identify the onset and the end of the main conflicts in SSA. The GPS coordinates of each DHS household cluster are used to match it with its corresponding 0.5×0.5 decimal degree weather cell grid. This is then used to measure each survey respondent's exposure to droughts and crop price shocks over time.

Information on whether each woman is married to a polygynous husband or not and her rank in this union (first spouse, second spouse, etc.) is also collected in most DHS surveys. I use this information in the analysis to construct a measure of the extent to which polygyny is practiced in each weather grid cell. This measure is the polygyny rate, defined as the share of women aged 25 or older who are married to a polygynous husband. I also use the information on religion, which is available for most DHS surveys. There is a link between religious beliefs and the practice of polygyny. Polygyny is formally forbidden in most Christian religions and accepted/tolerated (sometimes even encouraged) in Islam and most traditional religions in SSA.

Data on pre-colonial ethnic characteristics that have been shown to also affect the practice of polygyny such as the presence of bride price payment and the kinship system come from the Atlas of Precolonial Societies (Murdock, 1967; Nunn, 2008; Müller et al., 2010). Data on the location of Catholic and Protestant missions plus several geographic controls collected from various primary sources are taken from Fenske (2015).

[18]The rural-urban divide is, for instance, one source of variation in p that may be linked to differences in $V_{M2}^{m,o} - V_{M}^{m,o}$ but the empirical exercise in this paper does not rely on this kind of variation.

3.2 Polygyny in SSA

3.2.1 Practice of Polygyny over Time

I first investigate the evolution of country-level polygyny rates over time. Appendix Figure A10 shows the share of women (aged 25 and older) in union with a polygynous husband. I restrict the sample only to unions that happened within the last 10 years before each DHS survey wave .[19] Most countries have more than one wave, and the graph shows some stability in the practice of polygyny. The proportion of polygynous unions within the last 10 years is constantly low in countries like Madagascar (below 5%) and, to a lesser extent, in Rwanda, Zambia, Zimbabwe, and Namibia (below 10%). Monogamy is by far the norm in these countries, and polygyny is rather marginal or practiced in very few areas within each of them. Polygyny rates are also fairly constant (or decline very slightly) for countries with intermediate levels of polygyny (between 10 and 25 %), such as Cameroun, the Democratic Republic of Congo (former Zaire), Ethiopia, and Kenya. There is, at best, a slow decline in the proportion of polygynous unions that occurred within the last 10 years for countries with high levels of polygyny, such as Benin, Burkina Faso, Mali, and Guinea. This decline (when there is one) is such that these countries still have higher levels of polygyny around 2015 than what those with a medium level of polygyny had around 1995.

3.2.2 Spatial Variation in the Practice of Polygyny

Here I investigate the spatial variation in the practice of polygyny. I aggregate all available waves of the household survey data in the main sample into cell-level data. For each 0.5 × 0.5 decimal degree cell grid in the sample, I compute the share of females aged 25 and older that report being in union with a polygynous husband. Figure A1 shows the kernel density of the distributions of all the grid cells by polygyny rate. It shows a substantial variation in the practice of polygyny across cells. The bottom tercile (T1) is the group of low polygyny grid cells (less than 16%), and the top tercile is the group of high polygyny grid cells (more than 40%). The cells with polygyny rates between 16 and 40% are areas with medium polygyny rates. More than 15% of the grid cells have zero polygyny rate, and the rest of the bottom tercile have a polygyny rate between 0 and 16%. Monogamy is the local norm in the marriage markets in these cells. On the other side of the spectrum, around 18% of all cells have a polygyny rate higher than 50%. Murdock's Ethnographic Atlas provides some historical information on the practice of polygyny in Africa. Polygyny is reported for 95% of ethnic groups, and there is no information on the intensity at which it occurred in those societies. This historical information is, therefore, not enough to capture the substantial spatial variation in the contemporary practice of polygyny across SSA.

Figure 1 shows the spatial dispersion of grid cells with low, medium, or high polygyny rates based on DHS data. These levels are represented in green, yellow, and red, respectively. It shows substantial variation across regions. Polygyny is more common in West Africa, as shown by the red corridor that

[19] This is a flow variable since DHS waves are at least 5 years apart from each other and there is a minimum of 10 years between first and last DHS waves for most countries. The levels are lower than what we get with the stock variable because this ratio mostly counts second spouses in the numerator by construction.

goes from Senegal and Guinea to Nigeria through countries like Mali, Burkina Faso, Benin, and Togo. Polygyny is less prevalent in Central, Eastern, and Southern African countries. There are, however, important variations within each country.

3.2.3 The Origins and Correlates of Polygyny Norms

The determinants of polygyny have been the focus of an extensive literature in anthropology and economics. The main factors considered in the literature include traditional ethnic customs, female productivity, income inequality (male competition), slave trade, colonial missions and schools, religion, and education. (Boserup, 1970; Becker, 1974; Jacoby, 1995; Gould et al., 2008; Fenske, 2015; De La Croix and Mariani, 2015; Alger, 2021). In particular, Fenske (2015) has shown that historical factors explain more the spatial variation in the practice of polygyny than contemporary ones. It shows, for instance, that modern female education does not reduce polygamy, but colonial schooling does. Fenske (2013) also shows that past inequality (historic class stratification) predicts polygamy today but not current inequality, and polygamy varies smoothly over country borders along ethnic lines despite national bans in some countries. It also argues that the positive link between women's productivity in agriculture and polygamy hypothesized in the literature (see Boserup (1970); Jacoby (1995)) plays a minor role in explaining the spatial variation in polygyny norms in Africa. Polygamy is least common in those parts of Africa where women have historically been most influential in agriculture.[20]

The documented variation in the practice of polygyny can only be explained by a combination of most (if not all) of the historic factors mentioned above. No single factor can explain all the variations in the practice of polygyny. Table A1 shows the main correlates of polygyny in my sample. Each column of the table reports estimates from a regression where the dependent variable is a dummy equal to one if a woman is married to a polygamous husband. The results confirm that women from patrilineal ethnic groups and groups that practice bride price payments are more likely to be in a polygamous marriage. It also shows that Polygamy and the historical importance of women in agriculture are negatively correlated. This is consistent with results in Fenske (2013). Women who live in areas that received more catholic and protestant missions are less likely to be in a polygamous union. Table A1 also confirms the relationships between polygyny and religion, rural residence, and education. Christian women, women that live in rural areas, and women that are not educated are more likely to be in a polygamous marriage. All these correlations are robust to adding additional geographic controls (malaria endemism, ruggedness, elevation, distance to the coast, absolute latitude, constraints on rainfed agriculture, fixed effects for a variety of geographic regions), country fixed effects, respondents' birth year dummies and their age in a quadratic term. In the analysis below, I account for all these correlates of polygyny to rule out the possibility that

[20]Anthropologists have made this claim much earlier by noting, for instance, that the level of polygyny is highest in West Africa, and yet it is in East Africa that women engage more in agriculture (Goody, 1973). Fenske (2013) argues that a plausible explanation for this ambiguous effect is that women have better bargaining power in societies where they contribute more to agricultural production. In addition, taking into account the general equilibrium effects of higher female productivity in agriculture may lead to less polygamy.

they could be driving the documented results.[21]

3.3 Construction of Rainfall Shocks

Rainfall data produced by geographers at the University of Delaware ("UDel data") is used to construct a measure of local rainfall shocks. The UDel data set provides estimates of monthly precipitation on a 0.5×0.5 decimal degree grid cell covering terrestrial areas across the globe for the 1900–2010 period. The long-run time series of rainfall observations are used to fit a gamma distribution of calendar year rainfall for each location. Following the literature, a drought is defined as a calendar year rainfall below the 15th percentile of a grid cell's long-run rainfall distribution (Corno et al., 2020; Burke et al., 2015). I also explore robustness around that threshold and using a continuous rainfall measure. The GPS information in the DHS data matches each cluster to a weather grid cell. The final sample contains over 3,000 individual grid cells.

This drought measure has two key properties that help in identifying the impact of rainfall shocks on family formation outcomes. First, it has a sizable impact on crop yields, and rainfall variation essentially generates a negative aggregate income shock. As shown in Appendix Figure A13, the lowest deciles of rainfall realizations are associated with a substantial drop in crop yield (10% on average). Still, there is no clear positive relationship between higher rainfall realizations and country-level crop yields. Second, this measure of rainfall shock is orthogonal to permanent local characteristics that are likely to influence family formation outcomes. If rainfall realizations are i.i.d., all locations will have the same probability (15%) of experiencing a shock in any given year. The identifying variation comes only from the random timing of the shocks.

3.4 Construction of Commodity Price Shocks

Following McGuirk and Burke (2020), I construct local price series that combine plausibly exogenous temporal variation in global crop prices with spatial variation in crop production and consumption patterns. The price data comes from the IMF (International Monetary Fund) *International Finance Statistics series* and the World Bank *Global Economic Monitor*. Figure A2 shows the evolution of the price index for the three main food crops (maize, wheat, and rice) and cash crops (coffee, cocoa, and tobacco) for African consumers and producers. There is substantial variation in prices for the period 1989–2013, with notable spikes around 1995 and during the recent world food price crisis in 2007-2008 and 2010-2011. Africa accounts for less than 6% of global cereal production, and it is unlikely that local phenomena happening on the continent would affect world prices. Global commodity prices tend to go through several years of boom and bust during commodities supercycles. The recent spikes in global food prices around 2007 and 2010 were, for instance, driven by factors such as weather shocks in main supplier

[21] Some studies have suggested a link between exposure to the slave trade and the practice of polygyny today (Dalton and Leung, 2014; Edlund and Ku, 2011). However, this result hinges mostly on broad comparison of West Africa to the rest of the continent. For instance, Teso (2019) and Fenske (2013) show that the positive correlation between the slave trade and polygyny that is found in micro-level data disappears once country fixed effects are included.

countries (Australia, China, Latin America, etc.) and demand shocks from booming economies (China, Latin America, etc.) (World Bank, 2014). It is unlikely that any of these factors would drive aggregate income and marital outcomes in opposite directions for rural and urban areas, as predicted in the model, other than through their effect on world food prices.

Producer Price Index (PPI): The PPI is obtained by combining the temporal variation in world prices with rich, high-resolution spatial variation in crop-specific agricultural land cover around the year 2000 from the M3-Cropland project (see Ramankutty et al. (2008) for more details). This is mostly driven by variation in land suitability for different crops. Appendix Figure A3 presents the crop-specific geographic distribution for a selection of six major commodities (maize, rice, wheat, sorghum, cocoa, and coffee). The PPI in year t for cell g located in country c is given by:

$$PPI_{gct} = \sum_{j=1}^{n} \Big(\pi_{jt} \times N_{jgc}\Big) \tag{1}$$

where $j = 1, .., n$ represents a crop in a list of 11 major traded crops that are in the M3-Cropland dataset and for which international prices exist. N_{jgc} represents crop j's share of land in cell g and π_{jt} the global price index for this crop in year t. The index varies over time only because of plausibly exogenous international price changes. Following McGuirk and Burke (2020), I also define PPI^{food}_{gct} as a producer price index for food crops (those that constitute more than 1% of calorie consumption in the entire sample) and PPI^{cash}_{gct} as an index of prices for cash crops (the rest).

Consumer Price Index (CPI): The CPI is constructed in a similar spirit, but the spatial variation comes from country-level data on food consumption in the FAO food balance sheets (see McGuirk and Burke (2020) for more details). The CPI in year t for country c is given by:

$$CPI_{ct} = \sum_{j=1}^{n} \Big(\pi_{jt} \times S_{jc}\Big), \tag{2}$$

where crops $j = 1, ..n$ are contained in a set of 18 crops consumed in Africa and for which world prices exist, making up 56% of calorie consumption in the sample. The list includes important staples such as maize, wheat, rice, and sorghum, as well as sugar and palm oil, which are used to process other foods.

4 Testing the Predictions of the Model

4.1 Evidence from Rainfall Shocks

4.1.1 Prediction 1: Droughts and Market Shares of Men in Polygnynous Markets

Empirical Specification: The model's main prediction (prediction 1) states that in the presence of polygyny, adverse aggregate shocks should increase the market shares of young men that are looking for first/unique spouses at the expense of older men looking for second spouses. This means that women exposed to droughts during their prime marriageable age should be more likely to marry younger men with lower husband-wife age gaps and as first/unique spouses only in polygynous markets. I test this prediction using the following specifications:

$$Y_{i,g,k,\tau} = \alpha^l D^l_{i,g,k} + \alpha^m D^m_{i,g,k} + \alpha^h D^h_{i,g,k} + \omega_g + \zeta_k + \delta_\tau + \epsilon_{i,g,k,\tau}, \quad (3)$$

$$Y_{i,g,k,\tau} = \alpha D_{i,g,k} + \theta D_{i,g,k} \times P_g + \omega_g + \zeta_k + \delta_\tau + \epsilon_{i,g,k,\tau}. \quad (4)$$

$Y_{i,g,k,\tau}$ represents the marital outcomes: woman i's age gap with her husband and whether she got married as a junior spouse (second spouse or higher order spouse) as opposed to getting married as a first/unique spouse. The variable $D_{i,g,k}$ is a dummy equal to 1 if a woman i born in cell g in year k has been exposed to drought between ages 12 and 24 (peak marriageable years). Robustness to splitting this time window is shown below. P_g is the average polygyny rate of the cell g in which female i lives. It captures the long-term social norm in the practice of polygyny for a given area. To simplify the interpretation of the coefficients of interest and stress the fact that identification relies only on the substantial spatial variations in polygyny rates, I discretize the continuous variable P_g into terciles that I interact with $D_{i,g,k}$ as shown in Equation 3. The superscript l on $D_{i,g,k}$ stands for low polygyny areas (bottom tercile), m for medium and h for high polygyny areas (top tercile). The variation over time in polygyny rates is such that almost all the cells remain in the same tercile over the 20 years of survey data used in this paper. ω_g is a set of location fixed effects included to account for time-invariant local unobservable characteristics such as geographic, economic, and cultural factors. ζ_k and δ_τ are year-of-birth fixed effects and marriage year fixed effects.[22] They account for cohort effects and marriage year effects, such as exposure to any common shock at a specific time.

Sampling weights reweighted by each country's population in the survey year are used to make the results representative of the countries included in the analysis. Standard errors are clustered at the grid-cell level to allow for serial correlation in the error terms across women in the same area. Larger

[22]Exposure to drought may affect the timing of marriage for girls, but women from different birth cohorts can get married the same year. δ_τ captures all the common factors in a given marriage year that could affect marital outcomes. Nonetheless, I show, robustness to not accounting for marriage year fixed effects below.

clustering units at regional and country levels are also used as robustness below.

A drought is defined as a calendar year rainfall below the 15th percentile of each location's historical rainfall distribution and I also show robustness to varying this threshold. This implies that all the locations have the same probability of experiencing a drought in any given year, but its timing is random. Therefore, Exposure to a drought within a fixed time window is plausibly exogenous in this setting. The time-invariant variation in polygyny norms (P_g) is absorbed by the location fixed effects and orthogonal to time-varying shocks. The variation in the extent to which polygyny is practiced across SSA is due to a combination of several cultural and slow-moving socio-economic factors, as argued in Section 3.2.3. I check below that the documented results are not driven by any of the main correlates of polygyny norms.

Main Results: The estimates of Equations 3 and 4 are reported in Table 2. It uses the sample of married women aged 25 or older in their first union at the time of the survey. 77 % of married women are still in their first union in my sample. Columns (1) and (2) show estimates without marriage year fixed effects. Columns (3) and (4) include the marriage year fixed effects, while columns (5) and (6) add birth year fixed effects interacted with polygyny tercile dummies. Marriage year fixed effects interacted with polygyny tercile dummies are included in columns (7) and (8). These additional fixed effects control for potential differential trends between polygynous and non-polygynous markets. Odd columns show estimated effects when exposure to droughts is split into the three polygyny terciles (Equation 3). The even columns use the continuous polygyny rate interacted with the drought variable (Equation 4).

Panel A displays the estimates of the impact of drought exposure on the husband-wife age gap. All the specifications show that girls exposed to drought between 12 and 24 are more likely to marry a spouse with a lower husband-wife age gap, only in high polygyny areas. The point estimates in the main specification (column 3) show that exposure to a drought decreases husband-wife age gap by 1.15 years in high polygyny areas ($p<0.01$), which represents 9% of the average age gap in these areas. This effect is small and not statistically different from zero in low and medium polygyny areas (-0.05 and -0.04 years, respectively). The Wald test of equality of the effect of droughts on husband-wife age gap for low versus high polygyny areas and medium versus high polygyny areas are both rejected at 5% significance level ($p=0.0112$ and $p=0.0048$, respectively). The point estimates of Equation 4 displayed in column (4) confirm this finding with an estimated coefficient close to zero for the drought variable ($\alpha = 0.24$, $p>0.1$) and an interaction term with the polygyny rate that is negative and significant ($\theta = -2.17$, $p<0.05$). High polygyny areas have an average polygyny rate of 50%, so this coefficient is roughly consistent with the one year decrease in the husband-wife age gap found in column (3).

Panel B looks at the impact of exposure to droughts on the likelihood of marrying as a junior spouse. Again, all the specifications show that girls exposed to drought between the age of 12 and 24 are more likely to marry as junior spouses in high polygyny areas, as opposed to getting married as first/unique spouses. The point estimates in column (3) suggest a decrease in the likelihood of marrying as a junior spouse by 3.6 percentage points ($p<0.01$), which represents 16% of the average proportion of junior spouses. The equivalent coefficients for low and medium polygyny areas are close to zero and not statistically significant (0.8 and -0.4 percentage points, respectively, p>0.1 for both). The Wald test of equality of the effect of droughts on spousal ranking for low versus high polygyny areas and medium versus high polygyny areas are both rejected at a 5% significance level.

Table 2: Polygyny, Exposure to Droughts, and Types of Unions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Dependent variable: Husband-wife age gap								
Any drought ages 12-24 × low polygyny rate	0.0504		-0.0531		-0.0232		-0.0260	
	(0.3694)		(0.3421)		(0.3373)		(0.3382)	
Any drought ages 12-24 × medium polygyny rate	-0.0311		-0.0428		-0.0967		-0.0807	
	(0.2892)		(0.2894)		(0.2913)		(0.2914)	
Any drought ages 12-24 × high polygyny rate	-1.0747***		-1.1499***		-1.1775***		-1.1193***	
	(0.2683)		(0.2719)		(0.2768)		(0.2761)	
Any drought ages 12-24		0.2942		0.2353		0.2241		0.2153
		(0.3500)		(0.3343)		(0.3347)		(0.3347)
Any drought ages 12-24 × polygyny rate		-2.1610**		-2.1668**		-2.1827**		-2.0721**
		(0.8747)		(0.8547)		(0.8712)		(0.8698)
Marriage year FE	NO	NO	YES	YES	YES	YES	YES	YES
Birth year FE × polygyny tercile FE	NO	NO	NO	NO	YES	YES	YES	YES
Marriage year FE × polygyny tercile FE	NO	NO	NO	NO	NO	NO	YES	YES
Observations	176209	176209	176209	176209	176209	176209	176209	176209
Adjusted R-squared	0.154	0.154	0.160	0.159	0.161	0.161	0.162	0.162
Number of clusters	2994	2994	2994	2994	2994	2994	2994	2994
P-value: low versus high	0.0130		0.0112		0.00811		0.0123	
P-value: medium versus high	0.00748		0.00480		0.00714		0.00965	
P-value: low versus medium	0.861		0.981		0.868		0.902	
Mean dependent variable	9.903	9.903	9.903	9.903	9.903	9.903	9.903	9.903
Panel B. Dependent variable: Junior wife indicator								
Any drought ages 12-24 × low polygyny rate	0.0097		0.0087		0.0119*		0.0117*	
	(0.0070)		(0.0071)		(0.0070)		(0.0067)	
Any drought ages 12-24 × medium polygyny rate	-0.0053		-0.0044		-0.0070		-0.0071	
	(0.0087)		(0.0088)		(0.0087)		(0.0087)	
Any drought ages 12-24 × high polygyny rate	-0.0392***		-0.0360***		-0.0360***		-0.0346***	
	(0.0130)		(0.0126)		(0.0133)		(0.0131)	
Any drought ages 12-24		0.0117		0.0100		0.0105		0.0098
		(0.0089)		(0.0088)		(0.0090)		(0.0087)
Any drought ages 12-24 × polygyny rate		-0.0796**		-0.0709**		-0.0722**		-0.0685**
		(0.0326)		(0.0317)		(0.0329)		(0.0320)
Marriage year FE	NO	NO	YES	YES	YES	YES	YES	YES
Birth year FE × polygyny tercile FE	NO	NO	NO	NO	YES	YES	YES	YES
Marriage year FE × polygyny tercile FE	NO	NO	NO	NO	NO	NO	YES	YES
Observations	171846	171846	171846	171846	171846	171846	171846	171846
Adjusted R-squared	0.079	0.078	0.080	0.080	0.080	0.080	0.081	0.081
Number of clusters	2991	2991	2991	2991	2991	2991	2991	2991
P-value: low versus high	0.000975		0.00201		0.00147		0.00164	
P-value: medium versus high	0.0293		0.0387		0.0685		0.0794	
P-value: low versus medium	0.179		0.245		0.0895		0.0836	
Mean dependent variable	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142

OLS regressions with observations at the individual level. All the regressions include birth year FE, grid-cell FE, and country FE. The full regression sample includes married women aged 25 or older at the time of the survey that have been married only once. The dependent variables are the husband-wife age gap (Panel A) and whether a woman married as a junior wife (Panel B). Robust standard errors clustered at the cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. The average husband-wife age gap is 6.57, 9.41, and 12.93 years in low, medium, and high polygyny areas, respectively. The proportion of junior wives is 1.71%, 9.3%, and 22.8% in low, medium, and high polygyny areas, respectively. All regressions are weighted using country population-adjusted survey sampling weights.

Sensitivity and Robustness Checks: Various historic and slow-moving socio-economic factors influence the prevalence of polygyny across space. The first set of robustness checks looks at whether the differential effects of droughts documented above are driven by any of the main correlates of polygyny. For that, I augment Equations 3 and 4 with controls for each correlate of polygyny discussed in Section 3.2.3 plus an interaction term of these correlates with the drought variable. This allows the impact of droughts on the two marital outcomes considered here to differ depending on whether a girl comes from an ethnic group that traditionally has a matrilineal kinship system, practices bride price, or has significant female participation in agriculture. Columns (1) and (2) of Table A2 show that including these variables leaves the coefficients of interest virtually unchanged. This is also the case when I add similar controls for the number of Catholic and Protestant missions per unit area in columns (3) and (4). Columns (5) and (6) replace the "Christian missions" controls with controls for the current religion of women in my sample and the results remain the same. Table A3 shows robustness to controlling similarly for the fact of living in a rural area in columns (1) and (2) for the husband-wife age gap outcome and columns (5) and (6) for the spousal ranking outcome. The results also remain qualitatively unchanged after adding controls for being educated or not to the previous specification (other columns).

The second set of sensitivity checks looks at whether the documented differential effects of droughts are present only for a particular time window within the age 12-24 window considered so far. In particular, I check whether these differential effects are present during the child marriage time window (age 12-17) and how it compares with marital outcomes for unions that occur after age 18. The main specification of the model makes the simplifying assumption that adult women only marry as first/unique spouses but some of them can also match as second spouses in practice. Young and old adult men also compete for girls in that age group, so their marital outcomes could be affected by local shocks. The results in columns (1), (2), (5), and (6) of Table A4 confirm that the documented effects are present for women exposed to drought in either period. In columns (3) and (4) of Table A4, I use the husband's age as outcome variable instead of husband-wife age gap to check that the documented effects on this outcome are indeed driven by the age of the husbands that women get married to, and not a potential co-movement of their own age at marriage.[23]

Table A5 shows that the documented differential effect of droughts on the husband-wife age gap and spousal ranking are robust to including birth year fixed effects interacted with country fixed effects (column 1-4) to account for differential time trends by country. The results are also robust and to using only the most recent survey wave for each country (columns 5-8). I also cluster the standard errors over larger geographical units to account for potential correlation in error terms across space between different grid cells. Columns 1-4 of Table A6 show that clustering at the region level (there are more than 400 regions in the sample) or at the country level (30 countries) does not affect the statistical significance of the estimates.[24] The results are also qualitatively robust to not using survey weights as shown in columns 5-6 of Table A6.[25]

Finally, I also show robustness to varying the threshold used so far to define a drought year. For that, I reestimate the main regression from Equation 4 varying cutoff levels to define a drought from the

[23]The model predicts that in monogamous markets, droughts reduce girls' marriage age, but those girls get married to younger men, so the husband-wife age gap should not change substantially. This is not the case in polygynous markets since women can also be induced to marry older men. I also confirm empirically that droughts do not affect the timing of marriage for girls in the high polygyny areas below.

[24]Few observations are dropped in the mapping of household GPS coordinates into the within country regions. This explains the slightly reduced sample size in columns (1) and (2).

[25]The estimated impact of droughts on spousal ranking looses significance when survey weights are ignored but the magnitudes of the estimated coefficients remain consistent with the main estimates.

5th percentile to the 30th percentile. Figure A11a and A11b plot the estimated coefficients for different cutoff percentiles, along with 95% confidence intervals. The estimated impact for both outcomes is stable around the 15th percentile threshold used in the main specification.

4.1.2 Prediction 2: Effect of Rainfall shocks on the timing of Marriage and on Child Marriage in the presence of Polygyny

Main Empirical Strategy: The second prediction of the model is that droughts should have a weaker impact on the timing of marriage and on child marriage in more polygamous areas. This also confirms the model's first prediction because this attenuation effect is a direct consequence of the higher elasticity of the demand for second spouses to income and bride price changes. I test this prediction of the model using a simple discrete approximation of a duration model adapted from Currie and Neidell (2005) following Corno et al. (2020). The duration of interest is the time between age $t_0 = 12$, when a woman is first at risk of getting married, and age t_m, when she enters her first marriage. The original data is converted into a person-year panel format. A woman married at age t_m contributes $(t_m - t_0 + 1)$ observations to the sample: one observation for each at-risk year until she is married, after which she exits the data. To test the impact of droughts on the timing of marriage, I consider the period between ages 12 and 24 (peak marriageable years). In the case of child marriage, I restrict the data to the period before age 18. The data is right-censored for females that marry after age 24 for the timing of marriage specification and age 17 for the child marriage specification. This data is then merged with the yearly rainfall data. Marriages occur uniformly during a given year in SSA, so the merge is done considering the calendar year in which a woman is of a given age. This person-year sample allows us to estimate a discrete approximation of a duration model (using simple OLS) to study how rainfall shocks can affect the timing of unions and the hazard into a child marriage with the following specifications:

$$M_{i,g,k,a(t)} = \beta^l D^l_{g,k,a(t)} + \beta^m D^m_{g,k,a(t)} + \beta^h D^h_{g,k,a(t)} + Z_a + \omega_g + \zeta_k + \epsilon_{i,g,k,a(t)}, \tag{5}$$

$$M_{i,g,k,a(t)} = \beta D_{g,k,a(t)} + \gamma D_{g,k,a(t)} \times P_g + Z_a + \omega_g + \zeta_k + \epsilon_{i,g,k,a(t)}. \tag{6}$$

The dependent variable $M_{i,g,k,a(t)}$ is a binary variable coded as 1 in the year the woman gets married. $D_{g,k,a(t)}$ is a time-varying measure of weather conditions (dummy for a drought) in location g during the calendar year t in which the woman born in year k is of age a. Equation 5 includes a separate drought dummy for women living in low, medium and high polygyny areas which correspond to the tertiles of the continuous polygyny rate variable P_g (as defined in Equation 3). Z_a is a vector of age fixed effects that control for the fact that marriage hazard varies by age. ω_g is a set of location fixed effects, and ζ_k is a set of year-of-birth fixed effects. The impact of weather shocks on the hazard of child marriage is identified from within-location and within-year-of-birth variation in weather shocks and marriage outcomes. As discussed in Section 4.1.1, the timing of droughts is plausibly random in a given location. The main specification uses sample weights and clusters standard errors at the grid cell level similarly to what was done to test prediction 1. I also show robustness to alternative choices below. The model predicts $\beta^l \geq \beta^m \geq \beta^h$ and at least $\beta^l > 0$ (or equivalently $\beta > 0$ and $\gamma < 0$).

To study the impact of droughts on child marriage, an alternative approach is to analyze individual-level data and examine the probability of marriage before turning 18. This second empirical strategy is discussed below.

Main Results: I test droughts' impact on marriage timing using Equations 5 and 6. The results are reported in Table 3. Column (1) shows that girls who experience a drought in low polygyny areas are 0.64 percentage points ($p<0.01$) more likely to get married that same year, which corresponds to an increase of 7.5% in the average annual hazard of marriage in these areas. This is twice the average effect for SSA that is documented in Corno et al. (2020) which underestimates substantially the true impact of droughts on the timing of marriage in monogamous markets (see replication in Table A18). This effect is fading out substantially as we move to areas with higher rates of polygyny. In medium polygyny areas, droughts increase the hazard of marriage by 0.38 percentage points ($p<0.5$). The estimated effect for women living in high polygyny areas is close to zero and statistically insignificant. There is no discernable link between droughts and the timing of marriage in these areas. The Wald test of equality of the effects of droughts on the timing of marriage for low versus high polygyny areas is rejected at 10% level ($p=0.06$). Column (2) shows the results of the estimates of Equation 6 which uses the interaction term between droughts and the continuous polygyny rate variable. The coefficients of interest are both significant with expected signs and their magnitudes are consistent with the estimates in column (1). Column (3) shows that the estimates of the main specification are robust to accounting for potential differential trends for polygynous and non-polygynous areas with the inclusion of birth year fixed effects interacted with polygyny tercile dummies. The differential effect of droughts on the timing of marriage is also confirmed by running the regression analysis separately for low, medium, and high polygyny areas in columns (4), (5), and (6), respectively. These separate regressions illustrate the importance of considering local polygyny norms when conducting an impact evaluation exercise on marital outcomes. An evaluator who would be looking at the impact of local economic shocks on the timing of marriage for girls using data from polygynous areas would find no effect, while the same exercise would yield strong effects in monogamous markets.

I then split the sample of women according to whether bride price is traditionally practiced in their ethnic group in columns (7) and (8). The results confirm the documented attenuation pattern only in ethnic groups that traditionally require some form of bride price payment to celebrate a union. The Wald test of equality of the effects of droughts on the timing of marriage for low versus high polygyny areas is rejected at 1% level ($p=0.006$) in this sample. The one for equality of effects of droughts in medium versus low polygyny areas cannot be rejected ($p=0.16$). There is no effect of droughts on the timing of marriage among women from ethnic groups that do not practice bride price payments, irrespective of whether polygyny is common or not. This is consistent with the model's predictions since bride price is the reason why the demand and supply of brides are sensitive to changes in economic conditions.

Table 4 repeats a similar analysis to look at how droughts affect the hazard of child marriage (unions between age 12 and 17). It shows that droughts significantly increase the hazard of child marriage only in low polygyny areas. Girls exposed to a drought between the ages 12 and 17 are 0.45 to 0.65 percentage points (p<0.05) more likely to marry that same year. This coefficient drops to 0.14-0.24 percentage points (p>0.1) in medium polygyny areas and is even smaller and insignificant in high polygyny areas. The Wald test of equality of the effects of droughts on the hazard of child marriage for low versus high polygyny areas is rejected at 5% level (p=0.026) when I restrict the analysis to bride price ethnic groups (column 3).[26]

Table 3: Polygyny, Droughts, and Timing of Marriage in SSA

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: binary variable coded as 1 in the year the woman gets married (by age 24)							
Sample	All			Low polygyny	Medium polygyny	High polygyny	Bride price	No bride price
Drought x low polygyny	0.0064***		0.0063***				0.0078***	-0.0028
	(0.0021)		(0.0020)				(0.0024)	(0.0030)
Drought x medium polygyny	0.0038**		0.0037**				0.0036*	0.0024
	(0.0016)		(0.0016)				(0.0019)	(0.0031)
Drought x high polygyny	0.0004		0.0003				-0.0008	0.0016
	(0.0024)		(0.0024)				(0.0021)	(0.0058)
Drought		0.0075***		0.0060***	0.0038**	0.0006		
		(0.0021)		(0.0019)	(0.0016)	(0.0024)		
Drought x polygamy rate		-0.0137**						
		(0.0065)						
Birth year FE × polygyny tercile FE	NO	NO	YES	NO	NO	NO	NO	NO
Observations	2459177	2459177	2459177	941771	812391	705015	1344360	369241
Adjusted R-squared	0.062	0.062	0.062	0.050	0.053	0.067	0.064	0.064
Number of clusters	3101	3101	3101	1133	963	1005	2135	1062
P-value: low versus high	0.0613		0.0568				0.00598	0.501
P-value: medium versus high	0.241		0.236				0.112	0.907
P-value: low versus medium	0.320		0.314				0.167	0.233
Mean dependent variable	0.112	0.112	0.112	0.0858	0.113	0.146	0.118	0.127

OLS regressions with observations are at the person x age level (from 12 to 24 or age of first marriage). All regressions include age FE, birth year FE, grid-cell FE, and country FE. The dependent variable is a dummy equal to one if the woman gets married at the age corresponding to a given observation. The full sample includes women aged 25 or older at the time of the interview. Observations with missing information on the practice of bride price payment in their ethnic group are dropped in columns (7) and (8). A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. All regressions are weighted using country population-adjusted survey sampling weights. Robust standard errors clustered at a cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Sensitivity and Robustness Checks: I first check whether the differential effects of droughts on the timing of marriage and on the hazard of child marriage are driven by any of the correlates of polygyny discussed in Section 3.2.3. I follow the same strategy as the one used to conduct this exercise for prediction 1. Table A7 and A8 show that the results are robust to allowing the impact of droughts on the timing of marriage and the hazard of child marriage to differ depending on: (i) whether a girl comes from an ethnic group that has matrilineal kinship system, practices bride price, has significant female participation in agriculture; (ii) whether she lives in an area that has been exposed to Christian missions; (iii) whether she reports being Christian at the time of the survey; (iv) whether she lives in a rural area; and (v) whether she has some education or not.

I then check the time structure of the effect of droughts by examining lagged and future rainfall shocks to see if they can explain the documented differential effect of droughts on marriage timing. Because these shocks are assumed to be i.i.d across time, the model predicts that only contemporaneous droughts

[26]This is the group of people whose marital decisions are influenced by economic shocks as argued earlier. The results are noisier with the whole sample because of women that come from areas that do not practice bride price payment. I cannot reject this test in the whole sample but the estimated coefficient is three times larger for low polygyny areas (and statistically different from zero) compared to the one for high polygyny areas.

Table 4: Polygyny, Droughts, and Hazard of Child Marriage

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Dependent variable: binary variable coded as 1 in the year the woman gets married (by age 17)								
Sample	**All**		**Bride price**		**No bride price**		**Low polygyny**	**Medium polygyny**	**High polygyny**
Drought x low polygyny	0.0045**		0.0065***		-0.0054				
	(0.0020)		(0.0024)		(0.0033)				
Drought x medium polygyny	0.0024		0.0015		0.0032				
	(0.0017)		(0.0020)		(0.0032)				
Drought x high polygyny	0.0015		-0.0002		0.0029				
	(0.0025)		(0.0019)		(0.0054)				
Drought		0.0055***		0.0066***		-0.0045	0.0060**	0.0014	-0.0003
		(0.0021)		(0.0023)		(0.0038)	(0.0024)	(0.0020)	(0.0020)
Drought x polygamy rate		-0.0094		-0.0133**		0.0177			
		(0.0068)		(0.0061)		(0.0143)			
Observations	1700672	1700672	945722	945722	269930	269930	195434	338193	412095
Adjusted R-squared	0.073	0.073	0.078	0.078	0.064	0.064	0.037	0.056	0.091
Number of clusters	3101	3101	2135	2135	1062	1062	536	728	871
P-value: low versus high	0.352		0.0269		0.194				
P-value: medium versus high	0.775		0.538		0.966				
P-value: low versus medium	0.422		0.106		0.0604				
Mean dependent variable	0.0856	0.0856	0.0929	0.0929	0.0968	0.0968	0.0497	0.0812	0.123

OLS regressions with observations are at the person x age level (from 12 to 17 or age of first marriage). All regressions include age FE, birth year FE, grid-cell FE, and country FE. The dependent variable is a dummy equal to one if the woman gets married at the age corresponding to a given observation. The full sample includes women aged 25 or older at the time of the interview. Observations with missing information on the practice of bride price payment in their ethnic group are dropped in columns 3-6. A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. All regressions are weighted using country population-adjusted survey sampling weights. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1.

should affect the timing of unions.[27] Appendix Table A8 shows that past and future shocks do not affect the timing of marriage, irrespective of whether we are in areas with low, medium, or high polygyny. Only current shocks have an effect on marriage hazard in a given year in low polygyny areas (an increase of 0.6 percentage points, $p<0.01$) and medium polygyny areas (an increase of 0.38 percentage points, $p<0.05$). This exercise is also a placebo test for the identification strategy. It confirms that it is the exact and random timing of droughts that drives the results and not other alternative factors.

Table A9 shows that clustering at larger units that allows for potential correlations in error terms between different grid cells does not affect the statistical significance of the results. Figure A12 shows robustness to varying the 15th percentile threshold. Table A10 examines the association between the level of rainfall and the timing of marriage. It shows that an increase in annual rain by 1 meter is associated with a decline in the marriage hazard by 10.4 percentage points in low polygyny areas ($p<0.5$) and has no significant effect in high and medium polygyny areas (column 1).

The documented difference in the impact of droughts on the timing of marriage is also robust to using only the most recent survey wave by country in the analysis (columns 1-2 of Table A11). Columns (3) and (4) of Table A11 show robustness to including calendar year fixed effect to the main specifications. Columns (5) and (6) add country-specific time trends on top of that. Columns (7) and (8) show a very demanding specification in which I add country-specific calendar year fixed effects. The "country × calendar year" fixed effects kill most of the variation in the drought dummy variable since many cells within the same country (especially the relatively small ones) will experience extreme rainfall realizations together in some years due to exogenous regional meteorological factors. The estimates of this specification

[27]Markets clear independently from one period to another even though overlapping generations are involved in them. This comes from the fact that these markets are cleared by the youngest generations that enter each period with the outside option of waiting to marry the next one as discussed in Section 2 and A.1.2. Past shocks can also matter for current marital outcomes if households can borrow but vulnerable households have very limited access to credit markets in SSA.

should therefore be taken with caution for the case of rainfall shocks. The estimated coefficient for low polygyny areas is positive but becomes smaller (+ 1.7 percentage points) and is not statistically different from zero. It remains however significantly different from the one for high polygyny areas which turns negative with a magnitude of -5.6 percentage points. The Wald test of equality of these two coefficients has a p-value of 0.029. This persistent difference in the impact of droughts on the timing of marriage is consistent with the model's second prediction: The overall demand for brides is more sensitive to income and bride price changes in polygynous markets than in monogamous ones. Columns (9) and (10) show that the main results are also robust to allowing country-specific cohort effects with the inclusion of birth year fixed effects interacted with country dummies.

Alternative Empirical Strategy for Child Marriage: To study the impact of droughts on child marriage, an alternative approach to the duration model is to look at the impact of exposure to any drought between age 12 and 17 on the likelihood of marrying before age 18 using the following specifications:

$$Y_{i,g,k} = \beta^l D^l_{i,g,k} + \beta^m D^m_{i,g,k} + \beta^h D^h_{i,g,k} + \omega_g + \zeta_k + \epsilon_{i,g,k}, \quad (7)$$

$$Y_{i,g,k} = \beta D_{i,g,k} + \gamma D_{i,g,k} \times P_g + \omega_g + \zeta_k + \epsilon_{i,g,k}. \quad (8)$$

$Y_{i,g,k}$ is a dummy equal to 1 if woman i gets married before age 18. The variable $D_{i,g,k}$ is a dummy equal to 1 if a woman i born in cell g in year k has been exposed to drought between ages 12 and 17 (child marriage window). All the other variables and indices are defined as in Equation 3 and 4.

This approach is agnostic about the exact timing structure of the link between yearly rainfall shocks and child marriage. I split the age 12-17 time window into unions that happen at age 12-14 (happens for 13% of women on average) and unions that occur at age 15-17 (happens for 36% of women that are not married by age 15). The results are displayed in Table A12. Columns (1) and (2) show that there is no detectable impact of droughts on the probability of getting married before age 15. There are relatively few unions in that age window in any case. Column (3) shows that exposure to droughts between age 15 and 17 increases the probability of being married before age 18 by 1.7 percentage points (p<0.01) in high polygyny areas. The estimated effect is close to zero and statistically insignificant in low and medium polygyny areas. Columns (5) and (6) confirm that this effect is present only among women from bride price ethnic groups. Column (5) also shows that the Wald test of equality of the effect of droughts in low versus high polygyny areas is rejected at 10% level (p=0.077). Columns (7), (8), and (9) split the sample and estimate a separate regression for women in low, medium, and high polygyny areas, respectively. The prevalence of child marriage increases substantially across these three samples with polygyny norms. 25% of unmarried girls by age 15 do get married before age 18 in low polygyny areas versus 36% in medium and 49% in high polygyny areas. The results confirm that droughts significantly affect the probability of marriage before age 18 only in low polygyny areas.

4.1.3 Consequences on Fertility Onset

This section investigates a direct and dramatic consequence of early marriage: early female fertility. This is one of the most critical risks facing teenage girls in developing countries (Duflo et al., 2015; Chari et al., 2017). Adolescent pregnancy is associated with increased risks of maternal and fetal complications, including premature delivery, and worse health and socioeconomic outcomes for the next generation. Pregnancy complications and childbirth are the leading causes of death for girls aged 15 to 19 in developing countries (Save the Children, 2004). Fertility is, therefore, one of the main channels through which temporary shocks such as droughts can have long-term consequences when they affect the timing of unions. I am especially interested in testing whether the documented differences in the equilibrium effect of aggregate shocks on the marriage market lead to differences in their impact on fertility outcomes.

I study the effect of droughts on the onset of fertility, substituting marriage with birth as the outcome variable in Equations 7 and 8.[28] Columns (3) and (4) of Table 5 show that women exposed to drought at age 15-17 are 2.2 percentage points (10 % of the mean dependent variable, $p<0.01$) more likely to give birth to their first child before age 18 in low polygyny areas.[29] The estimated coefficient is close to zero and insignificant in medium (0.39 percentage points) and high polygyny areas (0.37 percentage points). The Wald test of equality of the effect of droughts in low versus high polygyny areas is rejected at 10% level ($p=0.076$).

Early fertility onset often translates into more births in SSA due to the limited practice of family planning. Columns (5) and (6) of Table 5 show that exposure to drought between ages 12 and 24 is positively related to fertility levels by age 25 only in low polygyny areas. Women exposed to droughts have 0.2 more children compared to the other women in low polygyny areas (10 % percent of the average number of children in these areas, $p<0.01$). Droughts have no significant effect on the number of children by age 25 in medium and high polygyny areas. The Wald test of equality of the impact of droughts in low versus high polygyny areas is rejected at 1% level ($p=0.004$).

4.1.4 Supply Side Mechanism

The equilibrium quantity of child marriage responds less to aggregate shocks in polygynous markets because the demand for second spouses is more sensitive to income and bride price changes than the demand for first spouses. The model does not assume any differential reaction of the supply side of the market across monogamous and polygamous markets. The presence of polygyny could also affect women's incentives on the supply side of the market. Rexer (2022) argues that women can match with wealthier already-married men if polygyny is allowed, yielding a greater option value of waiting when they are exposed to good rainfall conditions. His paper treats rainfall shocks as idiosyncratic shocks during pre-marital adolescence that affect the market's supply side and ignores their effect on the demand side.

[28]This specification is more suitable to study the impact of droughts on fertility onset compared to the duration model. Rainfall shocks are i.i.d. over time and a drought that occurs in a given year might also affect fertility the following year, given the time lag between marriage, conception, and first birth.

[29]Very few women have their first child before age 15 in my sample (5% versus 27% between age 15 and 17). Droughts have no detectable effect on fertility onset in that age range (see columns (1) and (2) of Appendix Table 5).

Table 5: Consequences on Early Fertility

Dependent variable	(1) First child before 15	(2)	(3) First child at 15-16-17	(4)	(5) Total births by 25	(6)
Any drought ages 12-14 x low polygamy	-0.0022					
	(0.0026)					
Any drought ages 12-14 x medium polygamy	-0.0015					
	(0.0028)					
Any drought ages 12-14 x high polygamy	0.0020					
	(0.0038)					
Any drought ages 12-14		-0.0017				
		(0.0028)				
Any drought ages 12-14 x polygamy rate		0.0036				
		(0.0098)				
Any drought ages 15-17 x low polygamy			0.0202***			
			(0.0064)			
Any drought ages 15-17 x medium polygamy			0.0039			
			(0.0052)			
Any drought ages 15-17 x high polygamy			0.0037			
			(0.0065)			
Any drought ages 15-17				0.0200***		
				(0.0064)		
Any drought ages 15-17 x polygamy rate				-0.0373**		
				(0.0184)		
Any drought ages 12-24 x low polygamy					0.2117***	
					(0.0660)	
Any drought ages 12-24 x medium polygamy					0.0433	
					(0.0354)	
Any drought ages 12-24 x high polygamy					-0.0269	
					(0.0451)	
Any drought ages 12-24						0.2049***
						(0.0625)
Any drought ages 12-24 x polygamy rate						-0.4395***
						(0.1605)
Observations	326361	326361	308547	308547	326361	326361
Adjusted R-squared	0.042	0.042	0.058	0.058	0.152	0.152
Number of clusters	3101	3101	3099	3099	3101	3101
P-value: low versus high	0.373		0.0762		0.00351	
P-value: medium versus high	0.461		0.988		0.214	
P-value: low versus medium	0.860		0.0502		0.0243	
Mean dependent variable	0.0545	0.0545	0.266	0.266	2.413	2.413

OLS regressions with observations are at an individual level. All regressions include age FE, birth year FE, grid-cell FE, and country FE. The full sample includes women aged 25 or older at the time of the interview. Columns 3-6 only include women who did not give birth by age 15. The dependent variable is a dummy equal to one if the woman gets her first child between age 12 and 14 in columns 1-2 and between age 15 and 17 in columns 3-4. In columns 5-6 it is the total number of births by age 25. The average proportion of women that have their first child at age 15-17 is 21.39% in low polygyny areas, 27.16% in medium polygyny areas, and 31.26 % in high polygyny areas. The total number of children by age 25 is 2.03, 2.45, and 2.74 in low, medium, and high polygyny areas, respectively. Robust standard errors clustered at grid cell level in parentheses *** p<0.01, ** p<0.05, * p<0.1. All regressions are weighted using country population-adjusted survey sampling weights.

This supply-side mechanism implies, however, that income shocks will have a more significant effect on the equilibrium quantity of child marriage in polygamous markets. The empirical evidence documented in this paper supports the opposite: income shocks have stronger effects on child marriage in monogamous markets than in polygamous ones. Table A13 shows that my main results are robust to using only the survey data from Nigeria, the country studied in Rexer (2022).[30] The supply side mechanism suggested in Rexer (2022) plays therefore a minor role in how the marriage market clears from one year to another

[30]Note that the interaction between conflict and marital decisions is a very complex one that I abstract from in this paper. I only focus on cohorts of girls who have not been exposed to conflict by the time they turn 25 (i.e., before or during their prime marital age).

with changing economic conditions.

4.2 Evidence from Global Crop Price Shocks

4.2.1 Prediction 3: Symmetric Reaction to Positive and Negative Shocks

Droughts reduce annual crop yields by 10 % on average, but there is no clear positive relationship between unusually high rainfall realization and crop yields in SSA (Corno et al., 2020; Burke et al., 2015). To test whether households and markets react in a symmetric way to positive and negative shocks, I also use income variation induced by the plausibly exogenous changes in world agricultural commodity prices. As argued above, a spike in crop prices on the international market will positively affect income in crop-producing areas and negatively affect crop-consuming areas. Moreover, how households and markets react to positive shocks is informative of how they will respond to policy interventions that generate short-term local economic stimuli such as large-scale cash transfer programs, public works programs, etc. Finally, the variation in aggregate income that comes from global food price shocks is also of a different nature compared to rainfall shocks and serves as an interesting robustness check for the predictions of the model. The former is a real income shock (for a given production level), while the latter is a production shock.

Empirical Strategy: I focus on the impact of crop price shocks on the timing of marriage and on child marriage (prediction 2). This prediction is a direct consequence of the fact that aggregate shocks affect the market shares of young and older men in polygynous markets (prediction 1).[31] I use the following specifications to study the impact of crop price shocks on the timing of marriage and the hazard into child marriage:

$$M_{i,g,k,a(t)} = \sum_{j=l,m,h} \beta_P^j PPI_{g,k,a(t)}^j + \sum_{j=l,m,h} \beta_C^j CPI_{c,k,a(t)}^j + \alpha_a + \omega_g + \zeta_k + \mu_t + \epsilon_{i,g,k,a(t)}, \tag{9}$$

$$M_{i,g,k,a(t)} = \beta_P^l PPI_{g,k,a(t)}^l + \beta_P^m PPI_{g,k,a(t)}^m + \beta_P^h PPI_{g,k,a(t)}^h + \alpha_a + \omega_g + \zeta_k + \eta_{c,t} + \epsilon_{i,g,k,a(t)}. \tag{10}$$

PPI is the producer price index, and CPI is the consumer price index. μ_t are calendar year fixed effects and $\eta_{c,t}$ are country-specific calendar year fixed effects. All the other indices and variables are defined as in Equation 5 and 6. In Equation 9, the identifying assumption is that, after accounting for all the fixed effects and common trending factors, PPI and CPI shocks are not correlated with unobserved factors that could be affecting marital decisions. A more demanding specification is to replace calendar year fixed effects by country × calendar year fixed effects as shown in Equation 10. The coefficients are estimated

[31] There is not much variation in the crop price data to test prediction 1 directly. The window of interest for testing this prediction is the prime marriageable age (age 12-24). The global crop price data covers a period of 25 years (1989-2013) and there is little variation at cohort level to properly test whether women who have been exposed to crop price shocks between age 12-24 have different likelihood of marrying younger men with low age gap as first/unique spouses.

in this case from the within-country-year variation in prices and marriage timing (preferred specification). This comes at the cost of not being able to include the CPI term since it only varies at the country level.[32] Accounting for common trending factors is important here because the price index displays some clear trends that can easily be correlated with other confounders.

Main Results: The estimates of Equation 10 are displayed in Table 6. Columns (1) and (2) use the whole sample and show that a rise in PPI significantly decreases the hazard of marriage the same year in monogamous areas. This effect is fading out as we move to areas where polygyny is more commonly practiced. The impact of PPI shocks is concentrated in rural areas where most agricultural production occurs (columns 3-6). Estimates in column (3) suggest that a standard deviation rise in PPI decreases the hazard of marriage the same year by 0.6 pp ($p<0.05$) in low polygyny areas, 0.26 pp ($p<0.1$) in medium polygyny areas and has no detectable effect in high polygyny areas. The Wald test of equality of the effect of PPI in low versus high polygyny areas is rejected at 5% level ($p=0.018$). In columns (5) and (6), I focus on the hazard of child marriage by looking at unions that occur between ages 12 and 17. Column (5) shows that a standard deviation rise in PPI decreases the hazard of marriage the same year by 0.27 pp ($p<0.05$) in low polygyny areas, 0.32 pp ($p<0.1$) in medium polygyny areas and has no detectable effect in high polygyny areas (magnitude of +0.12 pp, $p>0.1$).[33] There is no detectable effect of PPI shocks and timing of marriage in urban areas, irrespective of whether they are located in high or low polygyny areas (columns 7 and 8).

Table A14 shows the estimates of Equation 9. Columns (1) and (2) confirm that PPI shocks decrease the hazard of marriage in the same year only in low polygyny markets that are located in rural areas. CPI shocks have the opposite effect in low polygyny markets that are located in urban areas. The estimates in columns (3) and (4) show that a standard deviation rise in CPI increases the hazard of marriage the same year by 1.6 pp ($p<0.01$) in low polygyny areas, 1.4 pp ($p<0.05$) in medium polygyny areas and has no detectable effect in high polygyny areas. The Wald test of equality of the effect of PPI in low versus high polygyny areas is rejected at 10% level ($p=0.068$).

Robustness and Sensitivity Checks: I first check whether the differential effects of crop price shocks on the timing of marriage and on the hazard of child marriage are driven by any of the correlates of polygyny discussed in Section 3.2.3. I follow the same strategy as the one used to conduct this exercise for rainfall shocks. Columns 1-4 of Table A15 show that the results are robust to allowing the impact of PPI shocks on the timing of marriage to differ depending on: (i) whether a girl comes from an ethnic group that traditionally has matrilineal kinship system, practices bride price, has significant female participation in agriculture; (ii) whether she lives in an area that has been exposed to Christian missions; (iii) whether

[32]PPI shocks offer more cross-sectional variation for studying how global crop prices affect local economies. This variation provides stronger identification arguments compared to the ones from CPI.

[33]The Wald test of equality of the effect of PPI in low versus high polygyny areas is not rejected in this specification ($p=0.2$) but the magnitude and sign of the estimated coefficients are consistent with the model's prediction.

Table 6: Polygyny, PPI, and Timing of Marriage

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	**Binary variable coded as 1 in the year the woman gets married**							
Sample	**All: unions by age 24**		**Rural: unions by age 24**		**Rural: unions by age 17**		**Urban: unions by age 24**	
PPI × low polygyny	-0.0028***		-0.0060***		-0.0027**		0.0001	
	(0.0010)		(0.0020)		(0.0011)		(0.0011)	
PPI × medium polygyny	-0.0012		-0.0026*		-0.0032**		0.0010	
	(0.0008)		(0.0014)		(0.0016)		(0.0012)	
PPI × high polygyny	0.0005		0.0006		0.0012		-0.0018	
	(0.0018)		(0.0023)		(0.0035)		(0.0022)	
PPI		-0.0033***		-0.0071***		-0.0039**		0.0006
		(0.0013)		(0.0023)		(0.0015)		(0.0014)
PPI × polygyny rate		0.0076*		0.0157**		0.0080		-0.0030
		(0.0045)		(0.0066)		(0.0080)		(0.0056)
Observations	1630520	1630520	974426	974426	635162	635162	647716	647716
Adjusted R-squared	0.063	0.063	0.070	0.070	0.083	0.083	0.047	0.047
Number of clusters	3046	3046	2896	2896	2849	2849	1304	1304
P-value: low versus high	0.0724		0.0181		0.234		0.375	
P-value: medium versus high	0.321		0.164		0.169		0.207	
P-value: low versus medium	0.0987		0.101		0.777		0.494	
Mean dependent variable	0.116	0.116	0.134	0.134	0.0993	0.0993	0.0884	0.0884

All regressions include age FE, birth year FE, grid-cell FE, and country × calendar year FE. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. The table shows OLS regressions for SSA. Observations are at the level of person x age. The dependent variable is a binary variable for marriage, coded to one if the woman married at the age corresponding to the observation. The PPI is measured in terms of average temporal standard deviations. All Regressions are weighted using country population-adjusted survey sampling weights.

she reports being Christian at the time of the survey; (iv) whether she has some education.

Columns 5 and 6 of Table A15 show that the impact of PPI shocks on marriage timing is driven by food crops. There is no detectable effect of PPI for cash crops on the timing of marriage, irrespective of the extent to which polygyny is practiced. Table A16 shows that the main results are also robust to using only the most recent survey wave for each country to run the analysis (columns 1-2), clustering standard errors at region level (columns 3-4), or country level (columns 5-6). Columns (7) and (8) show robustness to weighting the PPI crop components by the extent to which they are traded by a each country.

4.2.2 Consequences on Fertility Onset

I study the effect of crop price shocks on the onset of fertility, substituting marriage with birth as the outcome variable in Equation 10. The estimates are displayed in Table A17. Columns 1-4 look at the link between PPI and fertility onset during the prime age for marriage (age 12-24), while columns 5-8 focus on the window for child fertility (age 12-17). Column (1) shows that a standard deviation rise in PPI decreases the hazard of first birth the same year by 0.2 pp ($p<0.01$) and has no significant effect in medium and high polygyny areas. The Wald test of equality of the effect of PPI in low versus high polygyny areas is rejected at 1% level ($p=0.0008$). Columns 3-6 show that this effect is driven by women living in rural areas. There is no link between PPI and fertility onset in urban areas. Columns 7-10 confirm the same pattern when I focus on the hazard of fertility onset before age 18. Column (7) shows that the estimated impact of PPI on the hazard of fertility onset between age 12 and 17 is -0.12 pp in low polygyny areas ($p<0.1$), -0.09 pp ($p>0.1$) in medium polygyny areas and +0.12 pp ($p>0.1$) in high polygyny areas. The Wald test of equality of the effect of PPI in low versus high polygyny areas is rejected at 10% level ($p=0.06$).

4.3 Threats to Identification

This section discusses the potential threats to identification that may affect the documented results. It shows that such threats are not likely to play an important role in this setting. Each potential threat could challenge the evidence presented in support of a specific prediction of the model, but none is consistent with all three predictions taken together. They cannot offer a plausible alternative explanation for why aggregate shocks (both positive and negative) would have a strong impact on marriage timing for girls only in monogamous areas and at the same time have a strong effect on the age of the men they marry to only in polygynous areas precisely in the directions predicted by the model.

4.3.1 Potential Differential Effect of Aggregate Shocks?

The first threat to the identification is whether the aggregate shocks considered here differ in polygamous and monogamous areas. This analysis defines a drought year in a given location as a calendar year with rainfall below the 15th percentile of that location's historical distribution. It means that all locations have the same probability of experiencing a drought in any given year. By construction, this measure of rainfall shocks will be orthogonal to observable and unobserved permanent local characteristics, such as the extent to which polygyny is practiced. Similarly, PPI and CPI shocks are also defined in a relative term. They are measured in terms of temporal standard deviation from their historical mean in a given location.

The second concern is whether a given shock has the same effect on household economic conditions in monogamous and polygynous areas. The global commodity price shocks affect real income for a given level of output. There is no obvious reason for the value of this output to be different between monogamous and polygynous areas. Rainfall shocks, however, affect agricultural production and there is evidence suggesting that polygamous and monogamous households have different production technologies (Akresh et al., 2012; Damon and McCarthy, 2019). Droughts could, in theory, lead to a larger drop in household resources in monogamous areas compared to polygamous ones. However, the empirical evidence suggests that this is not the case. First, Appendix Table A21 shows the relationship between droughts and agricultural output using country-level data. I split the sample of countries into countries with low and high polygyny, and the results show that droughts have the same effect on household resources in both groups. They reduce the average cereal yield by 14 % in low polygyny countries versus 11% in high polygyny countries (column 2, $p<0.01$ for each), and these coefficients are not statistically different from each other. Similarly, they reduce household consumption by 4 % versus 8 % (column 4) and per capita GDP by 4 % versus 9 %, respectively.[34] None of these two pairs of coefficients are statistically different from each other. Second, Dessy et al. (2021) use household-level production data and also find that the extent to which polygyny is practiced in rural communes of Mali does not affect the (contemporaneous) impact of droughts on crop yield. They only find that polygyny improves farm households' capacity to recover from droughts in subsequent years in their data. Moreover, such alternative explanations based

[34] Columns (1), (3), and (5) show the overall effect without any sample split following Corno et al. (2020).

on the idea that polygamous households are more resilient to droughts cannot explain why these shocks increase the likelihood of marrying younger men with a lower age gap only in polygynous areas. This alternative story also fails to explain the symmetric (opposite) effect of positive aggregate shocks.

4.3.2 Differential Marriage Market Size and Migration?

Differential Migration Behavior: A potential concern for identifying the documented attenuation effect is whether marriage migration happens more (or less) often during droughts and whether this occurs differentially in polygamous and monogamous areas. Table A19 shows that this is not the case. Columns (1) and (2) show that women who got married during droughts do not appear less likely to have remained in their village/city of birth compared to the others, and this is irrespective of the extent to which polygyny is practiced. Columns (3) and (4) also show that they are not more likely to have migrated for marriage during a drought in both monogamous and polygamous areas. Differential migration behavior during droughts does not threaten the identification strategy and cannot explain the documented pattern of empirical evidence. Table A20 shows the results of the same exercise using PPI as a source of variation in aggregate income. Women living in rural areas who marry in high PPI years are slightly more likely to migrate after marriage but in both low and high polygyny areas (columns 1 and 2). This means that there is no systematic pattern that would suggest that differential migration behavior during PPI shocks is a threat to the identification.

Differential Market Size: One could argue that the weaker effect of aggregate shocks on the timing of marriage in polygamous areas is due to the fact that marriage markets are broader in these areas, therefore weakening this relationship. Mbaye and Wagner (2017) conducted a large-scale survey in rural Senegal to collect information on the distance between the natal home and the current location of married women. Senegal has very high polygyny rates, and the average distance is 20 km for girls, so it still fits easily within the 50 $\times$ 50 km cell grids. Moreover, I find a strong effect of aggregate shocks on the likelihood of marrying younger men only in high polygyny areas and on the likelihood of being a first/unique spouse as opposed to being a second spouse. This also suggests that there is no systematic attenuation bias in polygamous areas due to women marrying and moving outside the 50 $\times$ 50 km cell grids considered here.

5 Discussion

5.1 Welfare Consequences in Polygynous Areas

The findings in this paper have important welfare implications. The fact that adverse economic shocks induce a reallocation of brides from old men to young bachelors can improve welfare, as mentioned in the literature section. First, Young bachelors who find a spouse earlier can reallocate time from leisure and crime/violence to more productive activities such as work and raising their offspring (Edlund and Lagerlöf, 2012; Edlund et al., 2013; Cameron et al., 2019; Rexer, 2022; Koos and Neupert-Wentz, 2020). Second, adverse shocks improve the husband-wife age gap and the spousal ranking of girls. These two marital outcomes have been shown to affect bargaining power in polygynous households leading to significant welfare effects for women and their offspring. Another important welfare effect of spousal ranking is that since polygyny is a sequential one-to-one matching, the first spouse has a first-mover advantage and is married for 10 years on average as a unique spouse before the arrival of a potential second spouse. This means making consumption, production, and fertility decisions for a decade before facing the potential inefficiencies of cooperation/competition of polygynous households. On the downside, being exposed to adverse aggregate shocks when entering the marriage market can have bad and persistent effects on household welfare and bargaining power, similar to the documented negative effect of entering the labor market in bad years such as recession years (Schwandt and Von Wachter, 2019; Oreopoulos et al., 2012; Kahn, 2010).

The DHS survey data contains a wide range of measures of female bargaining power and welfare outcomes for their children. Testing the welfare implications of findings documented in this paper is not a straightforward exercise and is left for future research. The link between income shocks at the time of marriage and these welfare outcomes conflates indeed two effects that will often go in opposite direction: (i) the causal effect of the shocks themselves (i.e. the fact that getting matched during a drought year may lead to different long-term outcomes, as argued above), and (ii) the causal impact of the changes in marital outcomes documented in this paper. There are also potential selection effects of who gets matched in these hard years or not. The findings in this paper show nonetheless that adverse shocks have some welfare-enhancing effects in polygynous areas that can at least soften their negative effects.

5.2 Implications for Coping Strategies

This paper has crucial implications for the coping strategies that households use when facing local adverse shocks. Households in monogamous areas where bride price is practiced can rely on marrying off their daughters to cope with adverse shocks. The findings in this paper show that this is not the case for those who live in polygynous areas. Because of the equilibrium market effects, these shocks do not increase the quantity of child marriages. This suggests that households in these areas rely more on other coping strategies such as asset depletion, migration, off-farm work, or simply reducing their consumption. This is also the case for all households living in areas with no bride price custom. Understanding how social norms such as polygyny and bride price interact with the type of coping strategies that households choose to rely on when they are facing aggregate shocks is another crucial question that is left for future research.

5.3 Policy Implications

In addition to improving our understanding of the role of polygyny in the complex relationship between marital outcomes and economic conditions, this paper has important policy implications. First, it shows that policies that generate windfall aggregate income can reduce child marriage in monogamous areas, but they may have unintended negative consequences for marital outcomes in polygynous areas. This happens because such policies will fund more second unions in equilibrium without necessarily decreasing child marriage. Therefore, it is crucial to accompany these policies with support measures in polygamous areas to ensure that they do not deteriorate family formation outcomes. This is potentially the case for fairly common policy interventions such as large-scale unconditional cash transfer programs, public works programs, or programs that improve farm-gate prices.

Second, aggregate income stabilization policies are more efficient or needed in monogamous areas if we only focus on their impact on marital outcomes. These policies can help counteract the increase in child marriage that may otherwise occur in these areas. In contrast, the presence of polygyny creates a sort of inertia in the equilibrium quantity of child marriage, making such interventions less effective in this context. As explained earlier, adverse shocks can create opportunities for young men to find spouses and for women to marry younger men as their first spouses. Therefore, it is essential to consider the structure of the marriage market when designing policy interventions that could affect family formation outcomes.

This paper also makes a broad point on policy design and evaluation in culturally diverse settings. An evaluator that tries to study the impact of short-term economic shocks on marital outcomes would get dramatically different answers depending on whether their data consist of people living predominantly in monogamous or polygynous areas. This echoes findings in Ashraf et al. (2020), who show that the impact of school building programs on female education was different across ethnic groups depending on whether they practiced bride price payments or not. Moreover, the extent to which polygyny is practiced across space provides an observable characteristic that can be used when designing and evaluating the effects of these types of policies. This is particularly valuable tool for spatial targeting of alternative policy interventions.

6 Concluding Remarks

This paper has documented how aggregate shocks affect family formation outcomes in the presence of polygyny. The key marital outcomes for girls in polygynous marriage markets are the timing of marriage, the husband-wife age gap, and whether they marry as first/unique spouses instead of marrying as second spouses. Polygyny is modeled as a sequential one-to-one matching in a simple supply and demand framework where bride price acts as an important source of consumption smoothing. The market's demand side has two independent components: a demand for first/unique spouses from young men and a demand for second spouses from older men. Importantly, the paper has shown that the latter is more sensitive to income and price changes in settings where polygyny is practiced, even among relatively poor men (not just the wealthy elite).

As predicted by the model, I found that droughts increase the market shares of young men that are looking for first/unique spouses at the expense of older men in the polygynous areas of SSA. Moreover, these adverse shocks have a much weaker impact on marriage timing in polygynous areas than in monogamous ones. I also tested the effects on marital outcomes of global crop price shocks that affect food-producing and food-consuming areas in opposite directions. I found that households and markets react in a symmetric way to positive and negative shocks.

These findings have important policy implications. Polygyny is not a mere cultural curiosity but has important ramifications for economic development in SSA. This norm is present and persistent in many parts of this region. Millions of young men and women live in polygynous areas that are subject to common policy decisions. Understanding how these interventions may be affected by polygyny norms is therefore crucial for policy design and evaluation.

The findings in this paper also imply that polygamous and monogamous markets may require different types of policy interventions in order to improve marital outcomes. In the case of child marriage, for instance, policies that affect both sides of the market can improve marital outcomes in monogamous markets, but this is not the case in polygynous ones. These areas will likely require interventions targeting only one market side.

References

Akresh, Richard, Joyce J Chen, and Charity T Moore, "Productive efficiency and the scope for cooperation in polygynous households," *American Journal of Agricultural Economics*, 2012, *94* (2), 395–401.

Alger, Ingela, "On the evolution of male competitiveness," *Journal of Economic Behavior & Organization*, 2021, *190*, 228–254.

Anderson, Siwan, "The economics of dowry and brideprice," *Journal of economic perspectives*, 2007, *21* (4), 151–174.

— **and Chris Bidner**, "Property rights over marital transfers," *The Quarterly Journal of Economics*, 2015, *130* (3), 1421–1484.

André, Pierre and Yannick Dupraz, "Education and polygamy: Evidence from Cameroon," *Journal of Development Economics*, 2023, *162*, 103068.

Antoine, Philippe et al., "Les Complexités de la Nuptialité: de la Précocité des Unions Féminines á la Polygamie Masculine en Afrique," *Démographie: analyse et synthéses*, 2002, *2*, 75–102.

Anukriti, S, Sungoh Kwon, and Nishith Prakash, "Saving for dowry: Evidence from rural India," *Journal of Development Economics*, 2021, p. 102750.

Arthi, Vellore and James Fenske, "Polygamy and child mortality: Historical and modern evidence from Nigeria's Igbo," *Review of Economics of the Household*, 2018, *16* (1), 97–141.

Ashraf, Nava, Natalie Bau, Nathan Nunn, and Alessandra Voena, "Bride Price and Female Education," *Journal of Political Economy*, 2020, *128* (2), 591–641.

Atkinson, Maxine P and Becky L Glass, "Marital age heterogamy and homogamy, 1900 to 1980," *Journal of Marriage and the Family*, 1985, pp. 685–691.

Barr, Abigail, Marleen Dekker, Wendy Janssens, Bereket Kebede, and Berber Kramer, "Cooperation in polygynous households," *American Economic Journal: Applied Economics*, 2019, *11* (2), 266–83.

Baugh, Brian, Itzhak Ben-David, Hoonsuk Park, and Jonathan A Parker, "Asymmetric consumption smoothing," *American Economic Review*, 2021, *111* (1), 192–230.

Becker, Gary S, "A theory of marriage: Part II," *Journal of political Economy*, 1974, *82* (2, Part 2), S11–S26.

Behaghel, Luc and Sylvie Lambert, "Polygamy and the intergenerational transmission of education in Senegal," *Manuscript. https://www. parisschoolofeconomics. eu/docs/lambertsylvie/dyneg_feb17_4. pdf*, 2017.

Bhalotra, Sonia, Abhishek Chakravarty, and Selim Gulesci, "The price of gold: Dowry and death in India," *Journal of Development Economics*, 2020, *143*, 102413.

Bishai, David and Shoshana Grossbard, "Far above rubies: Bride price and extramarital sexual relations in Uganda," *Journal of Population Economics*, 2010, *23* (4), 1177–1187.

Boltz, Marie and Isabelle Chort, "The risk of polygamy and wives' saving behavior," *The World Bank Economic Review*, 2019, *33* (1), 209–230.

Borgerhoff-Mulder, Monique, "Bridewealth and its correlates: quantifying changes over time," *Current Anthropology*, 1995, *36* (4), 543–572.

Boserup, Ester, *Woman's role in economic development*, Allen and Unwin, 1970.

Burke, Marshall, Erick Gong, and Kelly Jones, "Income shocks and HIV in Africa," *The Economic Journal*, 2015, *125* (585), 1157–1189.

Cameron, Lisa, Xin Meng, and Dandan Zhang, "China's sex ratio and crime: Behavioural change or financial necessity?," *The Economic Journal*, 2019, *129* (618), 790–820.

Carmichael, Sarah, "Marriage and power: Age at first marriage and spousal age gap in lesser developed countries," *The History of the Family*, 2011, *16* (4), 416–436.

Chari, AV, Rachel Heath, Annemie Maertens, and Freeha Fatima, "The Causal Effect of Maternal Age at Marriage on Child Wellbeing: Evidence from India," *Journal of Development Economics*, 2017, *127*, 42–55.

Chort, Isabelle, Rozenn Hotte, and Karine Marazyan, "Income shocks, bride price and child marriage inTurkey," 2021.

Christelis, Dimitris, Dimitris Georgarakos, Tullio Jappelli, Luigi Pistaferri, and Maarten Van Rooij, "Asymmetric consumption effects of transitory income shocks," *The Economic Journal*, 2019, *129* (622), 2322–2341.

Clark, Shelley and Sarah Brauner-Otto, "Divorce in sub-Saharan Africa: Are unions becoming less stable?," *Population and Development Review*, 2015, *41* (4), 583–605.

Collier, Paul, "Culture, Politics, and Economic Development," *Annual Review of Political Science*, 2017, *20*, 111–125.

Corno, Lucia and Alessandra Voena, "Selling daughters: Child Marriage, Income Shocks and the Bride Price Tradition," 2021.

__ , Nicole Hildebrandt, and Alessandra Voena, "Age of marriage, weather shocks, and the direction of marriage payments," *Econometrica*, 2020, *88* (3), 879–915.

Croix, David De La and Fabio Mariani, "From polygyny to serial monogamy: a unified theory of marriage institutions," *The Review of Economic Studies*, 2015, *82* (2), 565–607.

Currie, Janet and Matthew Neidell, "Air Pollution and Infant Health: What can we Learn from California's Recent Experience?," *The Quarterly Journal of Economics*, 2005, *120* (3), 1003–1030.

Dalton, John T and Tin Cheuk Leung, "Why is polygyny more prevalent in Western Africa? An African slave trade perspective," *Economic Development and Cultural Change*, 2014, *62* (4), 599–632.

Damon, Amy L and Aine Seitz McCarthy, "Partnerships and production: Agriculture and polygyny in Tanzanian households," *Agricultural Economics*, 2019, *50* (5), 527–542.

Dessy, Sylvain, Luca Tiberti, Marco Tiberti, and David Zoundi, "Polygyny and Farm Households' Resilience to Climate Shocks," 2021.

Duflo, Esther, Pascaline Dupas, and Michael Kremer, "Education, HIV, and Early Fertility: Experimental Evidence from Kenya," *American Economic Review*, 2015, *105* (9), 2757–97.

Edlund, Lena and Hyejin Ku, "The African slave trade and the curious case of general polygyny," 2011.

— **and Nils-Petter Lagerlöf**, "Polygyny and its discontents: Paternal age and human capital accumulation," 2012.

— **, Hongbin Li, Junjian Yi, and Junsen Zhang**, "Sex ratios and crime: Evidence from China," *Review of Economics and Statistics*, 2013, *95* (5), 1520–1534.

Fafchamps, Marcel and Susan Lund, "Risk-sharing networks in rural Philippines," *Journal of development Economics*, 2003, *71* (2), 261–287.

Fenske, James, "African polygamy: Past and present," 2013.

— , "African Polygamy: Past and Present," *Journal of Development Economics*, 2015, *117*, 58–73.

Goldschmidt, Walter, "The economics of brideprice among the Sebei and in East Africa," *Ethnology*, 1974, *13* (4), 311–331.

Goody, Jack, "Polygyny, economy, and the role of women," *The character of kinship*, 1973, pp. 175–190.

Gould, Eric D, Omer Moav, and Avi Simhon, "The mystery of monogamy," *American Economic Review*, 2008, *98* (1), 333–57.

Grossbard, Amyra, "Towards a marriage between economics and anthropology and a general theory of marriage," *The American Economic Review, Papers and Proceedings*, 1978, *68* (2), 33–37.

Heath, Rachel, Melissa Hidrobo, and Shalini Roy, "Cash transfers, polygamy, and intimate partner violence: Experimental evidence from Mali," *Journal of Development Economics*, 2020, *143*, 102410.

Hoogeveen, Johannes, Bas Van Der Klaauw, and Gijsbert Van Lomwel, "On the timing of marriage, cattle, and shocks," *Economic Development and Cultural Change*, 2011, *60* (1), 121–154.

Jacoby, Hanan G, "The Economics of Polygyny in Sub-Saharan Africa: Female Productivity and the Demand for Wives in Côte d'Ivoire," *Journal of Political Economy*, 1995, *103* (5), 938–971.

Jappelli, Tullio and Luigi Pistaferri, "The consumption response to income changes," *Annu. Rev. Econ.*, 2010, *2* (1), 479–506.

Jayachandran, Seema, "Selling labor low: Wage responses to productivity shocks in developing countries," *Journal of political Economy*, 2006, *114* (3), 538–575.

— **and Rohini Pande**, "Why are Indian children so short? The role of birth order and son preference," *American Economic Review*, 2017, *107* (9), 2600–2629.

Kahn, Lisa B, "The long-term labor market consequences of graduating from college in a bad economy," *Labour economics*, 2010, *17* (2), 303–316.

Kazianga, Harounan and Christopher Udry, "Consumption smoothing? Livestock, insurance and drought in rural Burkina Faso," *Journal of Development economics*, 2006, *79* (2), 413–446.

— **and Stefan Klonner**, "The Intra-household Economics of Polygyny: Fertility and Child Mortality in Rural Mali," 2009.

Koos, Carlo and Clara Neupert-Wentz, "Polygynous neighbors, excess men, and intergroup conflict in rural Africa," *Journal of Conflict Resolution*, 2020, *64* (2-3), 402–431.

La Ferrara, Eliana and Annamaria Milazzo, "Customary norms, inheritance, and human capital: evidence from a reform of the matrilineal system in Ghana," *American Economic Journal: Applied Economics*, 2017, *9* (4), 166–85.

Lee, Gary R, "Marital structure and economic systems," *Journal of Marriage and the Family*, 1979, pp. 701–713.

Lowes, Sara and Nathan Nunn, "Bride price and the wellbeing of women," *Towards gender equity in development*, 2017, *117.*

Mammen, Kristen, "All For One Or Each For Her Own: Do Polygamous Families Share and Share Alike?," *Journal for the Advancement of Developing Economies*, 2019, *8* (1).

Matz, Julia Anna, "Productivity, rank, and returns in polygamy," *Demography*, 2016, *53* (5), 1319–1350.

Mbaye, Linguère Mously and Natascha Wagner, "Bride price and fertility decisions: Evidence from rural Senegal," *The Journal of Development Studies*, 2017, *53* (6), 891–910.

McGuirk, Eoin and Marshall Burke, "The economic origins of conflict in Africa," *Journal of Political Economy*, 2020, *128* (10), 3940–3997.

Mondain, Nathalie, Thomas Legrand, and Valérie Delaunay, "L'évolution de la Polygamie en Milieu Rural Sénégalais: Institution en Crise ou en Mutation?," *Cahiers québécois de démographie*, 2004, *33* (2), 273–308.

Morten, Melanie, "Temporary migration and endogenous risk sharing in village india," *Journal of Political Economy*, 2019, *127* (1), 1–46.

Müller, HP, C Kock Marti, E Seiler Schiedt, and B Arpagaus, "Atlas of precolonial societies: Cultural heritage and social structures of African, Asian and Melanesian States," *Dietrich Reimer Verlag GmbH Berlin*, 2010.

Munro, Alistair, Bereket Kebede, Marcela Tarazona, and Arjan Verschoor, "The lion's share: An experimental analysis of polygamy in northern Nigeria," *Economic Development and Cultural Change*, 2019, *67* (4), 833–861.

Murdock, George Peter, "Ethnographic Atlas," *Pittsburgh, Pennsylvania*, 1967.

Nunn, Nathan, "The long-term effects of Africa's slave trades," *The Quarterly Journal of Economics*, 2008, *123* (1), 139–176.

Oreopoulos, Philip, Till Von Wachter, and Andrew Heisz, "The short-and long-term career effects of graduating in a recession," *American Economic Journal: Applied Economics*, 2012, *4* (1), 1–29.

Platteau, Jean-Philippe, *Institutions, social norms, and economic development*, Vol. 1, Psychology Press, 2000.

Pullum, Thomas W, *An assessment of age and date reporting in the DHS Surveys, 1985-2003*, Vol. 5, Macro International, 2006.

Ramankutty, Navin, Amato T Evan, Chad Monfreda, and Jonathan A Foley, "Farming the planet: 1. Geographic distribution of global agricultural lands in the year 2000," *Global biogeochemical cycles*, 2008, *22* (1).

Reniers, Georges, "Divorce and Remarriage in Rural Malawi," *Demographic Research Special Collections*, 2003, *1* (6), 175–206.

Rexer, Jonah, "The brides of Boko Haram: Economic shocks, marriage practices, and insurgency in Nigeria," *The Economic Journal*, 2022.

Reynoso, Ana, "Polygamy, co-wives' complementarities, and intra-household inequality," 2019.

Rosenzweig, Mark R and Oded Stark, "Consumption smoothing, migration, and marriage: Evidence from rural India," *Journal of political Economy*, 1989, *97* (4), 905–926.

Rossi, Pauline, "Strategic choices in polygamous households: Theory and evidence from Senegal," *The Review of Economic Studies*, 2019, *86* (3), 1332–1370.

Save the Children, *Children Having Children: State of the World's Mothers 2004*, Save the Children, 2004.

Schwandt, Hannes and Till Von Wachter, "Unlucky cohorts: Estimating the long-term effects of entering the labor market in a recession in large cross-sectional data sets," *Journal of Labor Economics*, 2019, *37* (S1), S161–S198.

Shefrin, Hersh M and Richard H Thaler, "The behavioral life-cycle hypothesis," *Economic inquiry*, 1988, *26* (4), 609–643.

Takyi, Baffour K and Christopher L Broughton, "Marital stability in sub-Saharan Africa: Do women's autonomy and socioeconomic situation matter?," *Journal of Family and Economic Issues*, 2006, *27*, 113–132.

_ **and Stephen Obeng Gyimah**, "Matrilineal family ties and marital dissolution in Ghana," *Journal of Family Issues*, 2007, *28* (5), 682–705.

Tapper, Nancy, "Direct exchange and brideprice: alternative forms in a complex marriage system," *Man*, 1981, pp. 387–407.

Tertilt, Michele, "Polygyny, Fertility, and Savings," *Journal of Political Economy*, 2005, *113* (6), 1341–1371.

Teso, Edoardo, "The long-term effect of demographic shocks on the evolution of gender roles: Evidence from the transatlantic slave trade," *Journal of the European Economic Association*, 2019, *17* (2), 497–534.

Thaler, Richard H, "Mental accounting matters," *Journal of Behavioral decision making*, 1999, *12* (3), 183–206.

Townsend, Robert M, "Risk and insurance in village India," *Econometrica: Journal of the Econometric Society*, 1994, pp. 539–591.

Van de Putte, Bart, Frans Van Poppel, Sofie Vanassche, Maria Sanchez, Svetlana Jidkova, Mieke Eeckhaut, Michel Oris, and Koen Matthijs, "The rise of age homogamy in 19th century Western Europe," *Journal of Marriage and Family*, 2009, *71* (5), 1234–1253.

Verpoorten, Marijke, Abhimanyu Arora, Nik Stoop, and Johan Swinnen, "Self-reported food insecurity in Africa during the food price crisis," *Food Policy*, 2013, *39*, 51–63.

Villar, Paola, Sylvie Lambert, and Dominique van de Walle, "Marital trajectories and women's wellbeing in Senegal," in "Towards Gender Equity in Development" 2018.

World Bank, "Food Price Watch, May 2014," 2014.

_ , "World Development Report 2015: Mind, Society, and Behavior," 2015.

Zhang, Weiguo, "Dynamics of marriage change in Chinese rural society in transition: A study of a northern Chinese village," *Population Studies*, 2000, *54* (1), 57–69.

Appendix

A.1 Proofs

A.1.1 Proposition 1

Part 1:

A household i wants to marry off their adult daughter (oldest generation) by the end of period t if and only if:

$$\begin{aligned}
& U^f_{o,t}(b_t = 1 | M_{t-1} = 0, y_t, \epsilon_{it}, \tau_t) > U^f_{o,t}(b_t = 0 | M_{t-1} = 0, y_t, \epsilon_{it}) \\
\iff\quad & \frac{(y_t + \epsilon_{it} + \tau_t)^{1-\gamma}}{1-\gamma} + V^f_M > \frac{(y_t + \epsilon_{it} + w^f_o)^{1-\gamma}}{1-\gamma} + V^f_U \\
\iff\quad & \tau_t > \left[(y_t + \epsilon_{it} + w^f_o)^{1-\gamma} - (1-\gamma)\big(V^f_M - V^f_U\big)\right]^{\frac{1}{1-\gamma}} - y_t - \epsilon_{it} = \underline{\tau}_t
\end{aligned}$$

Similarly, an unmarried old son in his household j wants to marry if:

$$\begin{aligned}
& \frac{(y_t + \epsilon_{jt} - w^{m,l}_o + w^f_g - \tau_t)^{1-\gamma}}{1-\gamma} + V^{m,o}_M > \frac{(y_t + \epsilon_{jt} - w^{m,l}_o)^{1-\gamma}}{1-\gamma} + V^{m,o}_U \\
\iff\quad & \tau_t < y_t + \epsilon_{jt} - w^{m,l}_o + w^f_g - \left[(y_t + \epsilon_{jt} - w^{m,l}_o)^{1-\gamma} - (1-\gamma)\big(V^{m,o}_M - V^{m,o}_U\big)\right]^{\frac{1}{1-\gamma}} = \bar{\tau}_t
\end{aligned}$$

For $V^{m,o}_M - V^{m,o}_U \geq 0$ and $V^f_M - V^f_U \geq 0$, I have $\bar{\tau}_t \geq \underline{\tau}_t$. Any bride price $\tau^*_t \in [\underline{\tau}_t, \bar{\tau}_t]$ is an equilibrium price that makes all the old agents want to marry at t (QED).

Part 2:

An old son who is looking for a second spouse will find it optimal to second-marry if:

$$H_2(y_t, \epsilon_{jt}, \tau_t) \equiv \Big[u\big(y_t + \epsilon_{jt} - w^{m,h}_o - \tau_t + (w^f_o + w^f_y)\big) + V^{m,o}_{M2}\Big] - \Big[u(y_t + \epsilon_{jt} - w^{m,h}_o + w^f_o) + V^{m,o}_M\Big] > 0$$

Convavity and monotonicity ensures that the difference in flow utility is strictly increasing in ϵ_{jt} ($\tau_t > w^f_g$). Therefore $\epsilon^*_{m,2}$ is defined such that $H_2(y_t, \epsilon^*_m, \tau_t) \equiv 0$ (QED).

Note: $\epsilon^*_{m,2}$ is a decreasing function of $V^{m,o}_{M2} - V^{m,o}_M$. This will play a crucial role in the proofs of Proposition 4 and 5.

A.1.2 Proposition 2

Define $\Omega^f = \delta\Big[E[\bar{V}^f_{o,t+1}(M_t = 0)] - E[\bar{V}^f_{o,t+1}(M_t = 1)]\Big]$: Option value of marriage for woman's family and $\Omega^m = \delta\Big[E[\bar{V}^m_{o,t+1}(M_t = 0)] - E[\bar{V}^m_{o,t+1}(M_t = 1)]\Big]$: Option value of marriage for man's family (household head). Everyone finds it optimal to marry by the end of the next period (before leaving the market), so future utility terms beyond phase 2 cancel out. The presence of a potential second spouse next period does not affect the future stream of utility expected by a man's parents at t. Their son will emancipate, and his decision to marry a second spouse does not affect his contribution to his parents' consumption in the future (as argued in Section 2).

$$\Omega^f = \delta \sum_{z\in\{H,L\}} \frac{1}{2} \int \left[u\big(y^z_{t+1} + \epsilon_{i,t+1} + \tau^*_{t+1}\big) - u\big(y^z_{t+1} + \epsilon_{i,t+1}\big)\right] dF(\epsilon_{i,t+1}) > 0$$

$$\Omega^m = \textstyle\sum_{z\in\{H,L\}} \frac{\delta}{2} \int \left[u\big(y^z_{t+1} + \epsilon_{j,t+1} + w^{m,l}_o\big) - u\big(y^z_{t+1} + \epsilon_{j,t+1} + w^{m,h}_o\big)\right] dF(\epsilon_{j,t+1}) < 0.$$

The future expected equilibrium bride price τ^*_{t+1} is independent of y_t and τ^*_t in the case of monogamy ($p = 0$), although we have overlapping generations in the model. Men leave the market after a union, so if a negative shock leads to more child marriages at period t, this will not change the excess quantity of old men looking for a child bride at $t+1$. The "supply of old bachelorettes" will go down by the same quantity as the "supply of old bachelors" at $t+1$, thanks to the 1:1 matching technology and the structure of the equilibrium matching pattern. When polygyny is allowed ($p > 0$), the expected market clearing bride price τ^*_{t+1} will depend on the steady-state quantity of men that are looking for a second spouse but it is assumed to be orthogonal to short term fluctuations in child marriages at period t that come from changes in y_t. These short-term variations play a negligible role in how households expect the market to clear in the future. The supply of child brides at $t+1$ will come from the new cohort that will enter the market at this point. The demand for child brides comes from: (i) the excess quantity of unmarried old men (which does not change with y_t given the equilibrium matching pattern), (ii) the young cohort of men that will enter the market at $t+1$, (iii) the steady state demand for second spouses, and (iv) the fluctuations in the demand for second spouses around this steady state due to aggregate shocks at t. The last component is relatively small compared to the others and is assumed to play no role in how households build their expectation about the market clearing price next period. The primary driver of the marital decision on the supply side of the market in this model is to smooth consumption with the bride price and not necessarily to maximize the bride price that they could receive in the future based on short-term fluctuations in aggregate income.

This modeling approach allows for simple and tractable comparative statics. It is also consistent with the way polygyny is practiced in SSA. In most of the empirical exercise, markets are assumed to clear on a yearly basis. However, most men go back to the market for a second spouse between 5 and 15 years after their first union so the demand for second spouses at period t comes in practice from several cohorts of men that entered the market at different points and this smooths out the effect of short-term shocks that may have happened in the relevant time window prior to period t. In particular, an income shock at year t will not systematically affect the demand for second spouses at $t+1$ even if it had an effect on the equilibrium quantity of child marriage at t. These men will wait for a few years before re-entering the market again, and even then, they will be competing with other married men from different cohorts for a second spouse.

A woman's family will want her to marry young at period t if and only if:

$$W(y_t, \epsilon_{it}, \tau_t) \equiv u(y_t + \epsilon_{it} + \tau_t) - u(y_t + \epsilon_{it} + w_y^f) - \Omega^f > 0 \tag{A1}$$

Concavity and monotonicity of the utility function ensure that the right-hand side (RHS) of this equation is decreasing in ϵ_{it}, while Ω^f does not depend on it. Therefore ϵ_f^* is defined such that $W(y_t, \epsilon_f^*, \tau_t) \equiv 0$.

Similarly, a son's family will want to marry him off if:

$$H(y_t, \epsilon_{jt}, \tau_t) \equiv u(y_t + \epsilon_{jt} + w_y^m - \tau_t + w_y^f) - u(y_t + \epsilon_{jt} + w_y^m) - \Omega^m > 0 \tag{A2}$$

Again, concavity and monotonicity ensure that the RHS is strictly increasing in ϵ_{jt}, while Ω^f does not depend on it. Therefore ϵ_m^* is defined such that $H(y_t, \epsilon_m^*, \tau_t) \equiv 0$.

A.1.3 Proposition 3

Given the threshold rules and the equilibrium matching pattern defined above, the demand for child brides comes from three separate components:

- The demand for child brides as unique spouses from old unmarried sons: $D^{(1,old)}(\tau_{t-1}, y_{t-1}) = \frac{1}{1+a}\left[F(\epsilon_m^*(\tau_{t-1}^*, y_{t-1})) - (1 - F(\epsilon_f^*(\tau_{t-1}^*, y_{t-1}))\right]$. This represents the difference between the number of old men that could not get married young at $t-1$ and the number of old women that did not have to be married off as child brides at $t-1$. It is independent of y_t and τ_t. All the old unmarried women will marry old unmarried men as unique spouses. The surplus of old unmarried men will have to marry young brides. Same for old men that already have a spouse and are looking for a second one.
- The demand for child brides as first/unique spouses from potential young grooms: $D^{(1,young)}(\tau_t, y_t) = 1 - F(\epsilon_m^*(\tau_t, y_t))$. This represents young sons whose families got idiosyncratic shocks $\epsilon_{jt} > \epsilon_m^*$.
- The demand for second spouses from old grooms: $D^{(2,old)}(\tau_t, y_t, \tau_{t-1}, y_{t-1}) = \frac{p}{(1+a)}\Big[\big(1 - F(\epsilon_m^*(\tau_{t-1}, y_{t-1})\big) \times \big(1 - F(\epsilon_{m,2}^*(\tau_t, y_t))\big)\Big]$. This is the joint likelihood of marrying at $t-1$ and t. Idiosyncratic income shocks are i.i.d across time. p is the share of men that remain on the market after their first marriage (when young): $p = 0$ in case of monogamy. p is an exogenously given local norm.

The supply for young brides at t is: $S(\tau_t, y_t) = F(\epsilon_f^*(\tau_t, y_t))$.

By the Implicit Function Theorem (IFT), the chain rule, the fact that F is strictly increasing, and the fact that $D^{(1,old)}$ is independent of y_t and ϵ_t, we have:

$$\frac{\partial S(\tau_t, y_t)}{\partial y_t} = S_y(\tau_t, y_t) = f(\epsilon_f^*(\tau_t, y_t))\frac{\partial \epsilon_f^*(\tau_t, y_t)}{\partial y_t} = -f(\epsilon_f^*(\tau_t, y_t))\frac{\partial W/\partial y_t}{\partial W/\partial \epsilon_f^*} = -f(\epsilon_f^*(\tau_t, y_t)) < 0$$

$$
\begin{aligned}
\frac{\partial D(\tau_t, y_t)}{\partial y_t} &= D_y(\tau_t, y_t) = D_y^{(1,young)}(\tau_t, y_t) + D_y^{(2,old)}(\tau_t, y_t, \tau_{t-1}, y_{t-1}) \\
= \quad & -f(\epsilon_m^*(\tau_t, y_t))\frac{\partial \epsilon_m^*(\tau_t, y_t)}{\partial y_t} - f(\epsilon_{m,2}^*(\tau_t, y_t))\frac{\partial \epsilon_{m,2}^*(\tau_t, y_t)}{\partial y_t} \times \frac{p}{(1+a)}\Big[1 - F(\epsilon_m^*(\tau_{t-1}, y_{t-1})\Big] \\
= \quad & f(\epsilon_m^*(\tau_t, y_t))\frac{\partial H/\partial y_t}{\partial H/\partial \epsilon_m^*} + f(\epsilon_{m,2}^*(\tau_t, y_t))\frac{\partial H_2/\partial y_t}{\partial H_2/\partial \epsilon_{m,2}^*} \times \frac{p}{(1+a)}\Big[1 - F(\epsilon_m^*(\tau_{t-1}, y_{t-1})\Big] \\
= \quad & f(\epsilon_m^*(\tau_t, y_t)) + f(\epsilon_{m,2}^*(\tau_t, y_t)) \times \frac{p}{(1+a)}\Big[1 - F(\epsilon_m^*(\tau_{t-1}, y_{t-1})\Big] > 0
\end{aligned}
$$

With similar arguments, we also have:

$$
\frac{\partial S(\tau_t, y_t)}{\partial \tau_t} = S_\tau(\tau_t, y_t) = f(\epsilon_f^*(\tau_t, y_t))\frac{\partial \epsilon_f^*(\tau_t, y_t)}{\partial \tau_t} = -f(\epsilon_f^*(\tau_t, y_t))\frac{\partial W/\partial \tau_t}{\partial W/\partial \epsilon_f^*} > 0
$$

The denominator is negative because of the concavity and monotonicity of u and the numerator is positive because u is increasing.

$$
\begin{aligned}
\frac{\partial D(\tau_t, y_t)}{\partial \tau_t} &= D_\tau(\tau_t, y_t) = D_\tau^{(1,young)}(\tau_t, y_t) + D_\tau^{(2,old)}(\tau_t, y_t, \tau_{t-1}, y_{t-1}) \\
= \quad & -f(\epsilon_m^*(\tau_t, y_t))\frac{\partial \epsilon_m^*(\tau_t, y_t)}{\partial \tau_t} - f(\epsilon_{m,2}^*(\tau_t, y_t))\frac{\partial \epsilon_{m,2}^*(\tau_t, y_t)}{\partial \tau_t} \times \frac{p}{(1+a)}\Big[1 - F(\epsilon_m^*(\tau_{t-1}, y_{t-1})\Big] \\
= \quad & f(\epsilon_m^*(\tau_t, y_t))\frac{\partial H/\partial \tau_t}{\partial H/\partial \epsilon_m^*} + f(\epsilon_{m,2}^*(\tau_t, y_t))\frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial \epsilon_{m,2}^*} \times \frac{p}{(1+a)}\Big[1 - F(\epsilon_m^*(\tau_{t-1}, y_{t-1})\Big] < 0
\end{aligned}
$$

A.1.4 Proposition 4

The equilibrium quantity of child marriage is given by $Q^*(y_t) \equiv D(y_t, \tau_t^*) = S(y_t, \tau_t^*)$.

We have: $\frac{dQ^*(y_t)}{dy_t} = S_y(y_t, \tau_t^*) + S_\tau(y_t, \tau_t^*)\frac{\partial \tau_t^*}{\partial y_t}$.

The equilibrium price is defined implicitly as solution to $S(y_t, \tau_t^*) - D(y_t, \tau_t^*) = 0$

By the Implicit Function Theorem (IFT): $\frac{d\tau_t^*}{dy_t} = -\frac{S_y - D_y}{S_\tau - D_\tau}$

So $\frac{dQ^*(y_t)}{dy_t} = S_y - S_\tau \frac{S_y - D_y}{S_\tau - D_\tau} = \Big(\frac{S_y}{S_\tau} - \frac{D_y}{D_\tau}\Big)\frac{S_\tau D_\tau}{D_\tau - S_\tau}$

Part 1: For $p = 0$ (monogamy): $\frac{dQ^*(y_t)}{dy_t} < 0$

$$
sgn\Big(\frac{dQ^*(y_t)}{dy_t}\Big) = sgn\Big(\frac{S_y}{S_\tau} - \frac{D_y}{D_\tau}\Big) = sgn\Big(\frac{\partial W/\partial y_t}{\partial W/\partial \tau_t} - \frac{\partial H/\partial y_t}{\partial H/\partial \tau_t}\Big) < 0? \tag{A3}
$$

$$
\begin{aligned}
\frac{S_y}{S_\tau} - \frac{D_y}{D_\tau} \quad = \quad & \frac{u'(y_t + \epsilon_f^* + \tau_t) - u'(y_t + \epsilon_f^* + w_y^f)}{u'(y_t + \epsilon_f^* + w_y^f + (\tau_t - w_y^f))} \\
+ \quad & \frac{u'(y_t + \epsilon_m^* + w_y^m - \tau_t + w_y^f) - u'(y_t + \epsilon_m^* + w_y^m)}{u'(y_t + \epsilon_m^* + w_y^m - (\tau_t - w_y^f))} \\
= \quad & 2 - \Big(1 + \frac{\tau_t - w_y^f}{y_t + \epsilon_f^* + w_y^f}\Big)^\gamma - \Big(1 - \frac{\tau_t - w_y^f}{y_t + \epsilon_m^* + w_y^m}\Big)^\gamma
\end{aligned}
$$

Bernoulli inequality: $((1+x)^r \geq 1+rx \quad \forall r \geq 1, x \geq -1)$

$$\frac{S_y}{S_\tau} - \frac{D_y}{D_\tau} \leq \gamma(\tau_t - w_y^f)\Big(\frac{1}{y_t + \epsilon_m^* + w_y^m} - \frac{1}{y_t + \epsilon_f^* + w_y^f}\Big)$$

Since $\tau_t > w_y^f$, the upper bound < 0 if $\epsilon_m^* + w_y^m > \epsilon_f^* + w_y^f$.

As long as $w_o^{m,l}$ sufficiently large (compared to $\Delta w = w_o^{m,h} - w_o^{m,l}$) , concavity ensures that $|\Omega^m| < |\Omega^f|$ and that $\epsilon_m^* > \epsilon_f^*$ as noted before.

Part 2: The negative effect of income shock on child marriage is decreasing with p because the demand for second spouses is more sensitive to income and bride price changes compared to the demand for first spouses.

$$\frac{dQ_y^*}{dp} = -S_\tau \frac{-\frac{dD_y}{dp}(S_\tau - D_\tau) + \frac{dD_\tau}{dp}(S_y - D_y)}{(S_\tau - D_\tau)^2} > 0?$$

$$A = -\frac{dD_y}{dp}(S_\tau - D_\tau) + \frac{dD_\tau}{dp}(S_y - D_y) < 0?$$

$$\frac{dD_\tau}{dp} = f(\epsilon_{m,2}^*(\tau_t, y_t)) \times \frac{1}{(1+a)}[1 - F(\epsilon_m^*(\tau_{t-1}^*, y_{t-1})] \times \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial y_t} < 0$$

$$\frac{dD_y}{dp} = f(\epsilon_{m,2}^*(\tau_t, y_t)) \times \frac{1}{(1+a)}[1 - F(\epsilon_m^*(\tau_{t-1}^*, y_{t-1})] > 0$$

$$\frac{dD_\tau}{dp} = \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial y_t} \times \frac{dD_y}{dp}$$

$$\begin{aligned}
A = &-\frac{dD_y}{dp}\Big[-f(\epsilon_f^*(\tau_t, y_t))\frac{\partial W/\partial \tau_t}{\partial W/\partial y_t} - \Big(f(\epsilon_m^*(\tau_t, y_t))\frac{\partial H/\partial \tau_t}{\partial H/\partial y_t} + p \times \frac{dD_\tau}{dp}\Big)\Big] \\
&+\frac{dD_\tau}{dp}\Big[-f(\epsilon_f^*(\tau_t, y_t)) - \Big(f(\epsilon_m^*(\tau_t, y_t)) + p \times \frac{dD_y}{dp}\Big)\Big] \\
=&\frac{dD_y}{dp}\Big[f(\epsilon_f^*(\tau_t, y_t))\frac{\partial W/\partial \tau_t}{\partial W/\partial y_t} + \Big(f(\epsilon_m^*(\tau_t, y_t))\frac{\partial H/\partial \tau_t}{\partial H/\partial y_t} + p \times \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial y_t} \times \frac{dD_y}{dp}\Big)\Big] \\
&-\frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial y_t} \times \frac{dD_y}{dp}\Big[f(\epsilon_f^*(\tau_t, y_t)) + \Big(f(\epsilon_m^*(\tau_t, y_t)) + p \times \frac{dD_y}{dp}\Big)\Big] \\
=&\frac{dD_y}{dp}\Big[f(\epsilon_f^*(\tau_t, y_t))\Big(\frac{\partial W/\partial \tau_t}{\partial W/\partial y_t} - \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial y_t}\Big) + f(\epsilon_m^*(\tau_t, y_t))\Big(\frac{\partial H/\partial \tau_t}{\partial H/\partial y_t} - \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial y_t}\Big)\Big]
\end{aligned}$$

$$A_1 \quad = \quad \frac{\partial W/\partial \tau_t}{\partial W/\partial y_t} - \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial y_t} = \Big(\frac{\partial W/\partial \tau_t}{\partial W/\partial y_t} - \frac{\partial H/\partial \tau_t}{\partial H/\partial y_t}\Big) + \Big(\frac{\partial H/\partial \tau_t}{\partial H/\partial y_t} - \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial y_t}\Big)$$

$A_{1,1} = \frac{\partial W/\partial \tau_t}{\partial W/\partial y_t} - \frac{\partial H/\partial \tau_t}{\partial H/\partial y_t} > 0$ from Equation A3, and independent of $V_{M2}^{m,o} - V_M^{m,o}$

To get the sign of A_1, We need to compare the relative income and price elasticity of the demand for first spouses ($\frac{\partial H/\partial \tau_t}{\partial H/\partial y_t}$) with that of the demand for second spouses ($\frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial y_t}$). Let us consider $A_{1,2} = \frac{\partial H/\partial \tau_t}{\partial H/\partial y_t} - \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial y_t}$.

$$\begin{aligned} A_{1,2} &= \frac{\partial H/\partial \tau_t}{\partial H/\partial \epsilon^*_m} - \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial \epsilon^*_{m,2}} = \frac{-u'(y_t + \epsilon^*_m + w^m_y - \tau_t + w^f_y)}{u'(y_t + \epsilon^*_m + w^m_y - \tau_t + w^f_y) - u'(y_t + \epsilon^*_m + w^m_y)} \\ &- \frac{-u'(y_t + \epsilon^*_{m,2} - w^{m,h}_o - \tau_t + (w^f_o + w^f_y))}{u'(y_t + \epsilon^*_{m,2} - w^{m,h}_o - \tau_t + (w^f_o + w^f_y)) - u'(y_t + \epsilon^*_{m,2} - w^{m,h}_o + w^f_o)} \\ &= -\frac{1}{1 - B_1} + \frac{1}{1 - B_2} = \frac{B_2 - B_1}{(1 - B_1)(1 - B_2)}. \end{aligned}$$

We have $0 < B_1 = \frac{u'(y_t + \epsilon^*_m + w^m_y)}{u'(y_t + \epsilon^*_m + w^m_y - \tau_t + w^f_y)} < 1$ and $0 < B_2 = \frac{u'(y_t + \epsilon^*_{m,2} - w^{m,h}_o + w^f_o)}{u'(y_t + \epsilon^*_{m,2} - w^{m,h}_o - \tau_t + (w^f_o + w^f_y))} < 1$

$$B_1 = \Big(\frac{y_t + \epsilon^*_m + w^m_y - \tau_t + w^f_y}{y_t + \epsilon^*_m + w^m_y}\Big)^\gamma = \Big(1 - \frac{\tau_t - w^f_y}{y_t + \epsilon^*_m + w^m_y}\Big)^\gamma$$

$$B_2 = \Big(\frac{y_t + \epsilon^*_{m,2} - w^{m,h}_o - \tau_t + w^f_y + w^f_o}{y_t + \epsilon^*_{m,2} - w^{m,h}_o + w^f_o}\Big)^\gamma = \Big(1 - \frac{\tau_t - w^f_y}{y_t + \epsilon^*_{m,2} - w^{m,h}_o + w^f_o}\Big)^\gamma$$

$A_{1,2} < 0 \iff B2 < B1$: This is the case if $\epsilon^*_{m,2}$ is low enough. As noted earlier in Appendix A.1.1, $\epsilon^*_{m,2}$ is a decreasing function of $V^{m,o}_{M2} - V^{m,o}_M$ so this will happen if the extra utility that men derive from having a second spouse ($V^{m,o}_{M2} - V^{m,o}_M$) is high enough.

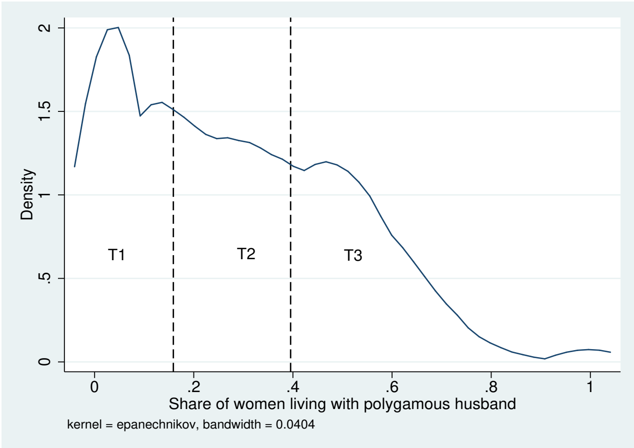
Moreover, since $A_{1,2}$ is an increasing function of $\epsilon^*_{m,2}$ and $A_{1,1}$ is independent of $\epsilon^*_{m,2}$, we have $A_1 < 0$ for $\epsilon^*_{m,2}$ low enough.[35] So $A < 0$ which implies that $\frac{dQ^*_y}{dp} > 0$.

This means that a negative aggregate income shock increases child marriage to a lesser extent in areas with high polygyny rates compared to areas with low polygyny rates.

[35] $A = \frac{dD_y}{dp}[f(\epsilon^*_f(\tau_t, y_t)(A_{1,1} + A_{1,2}) + f(\epsilon^*_m(\tau_t, y_t))A_{1,2}]$ is a function of the distribution of idiosyncratic shocks at the cutoffs $\epsilon^*_{m,2}(\tau_t, y_t)$, $\epsilon^*_m(\tau_{t-1}, y_{t-1})$, $\epsilon^*_m(\tau_t, y_t)$, and $\epsilon^*_f(\tau_t, y_t)$ but its sign depends on the sign and magnitude of $A_{1,2}$ with respect to $A_{1,1}$.

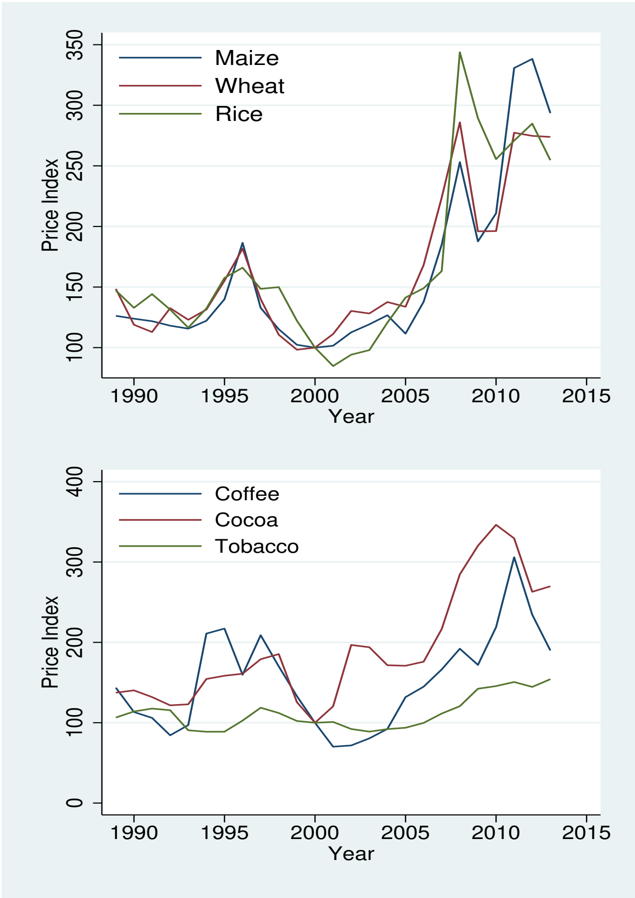
A.2 Descriptive Evidence

Figure A1: Kernel Density Estimation of the Distribution of Cell-Grids by Polygyny Rate



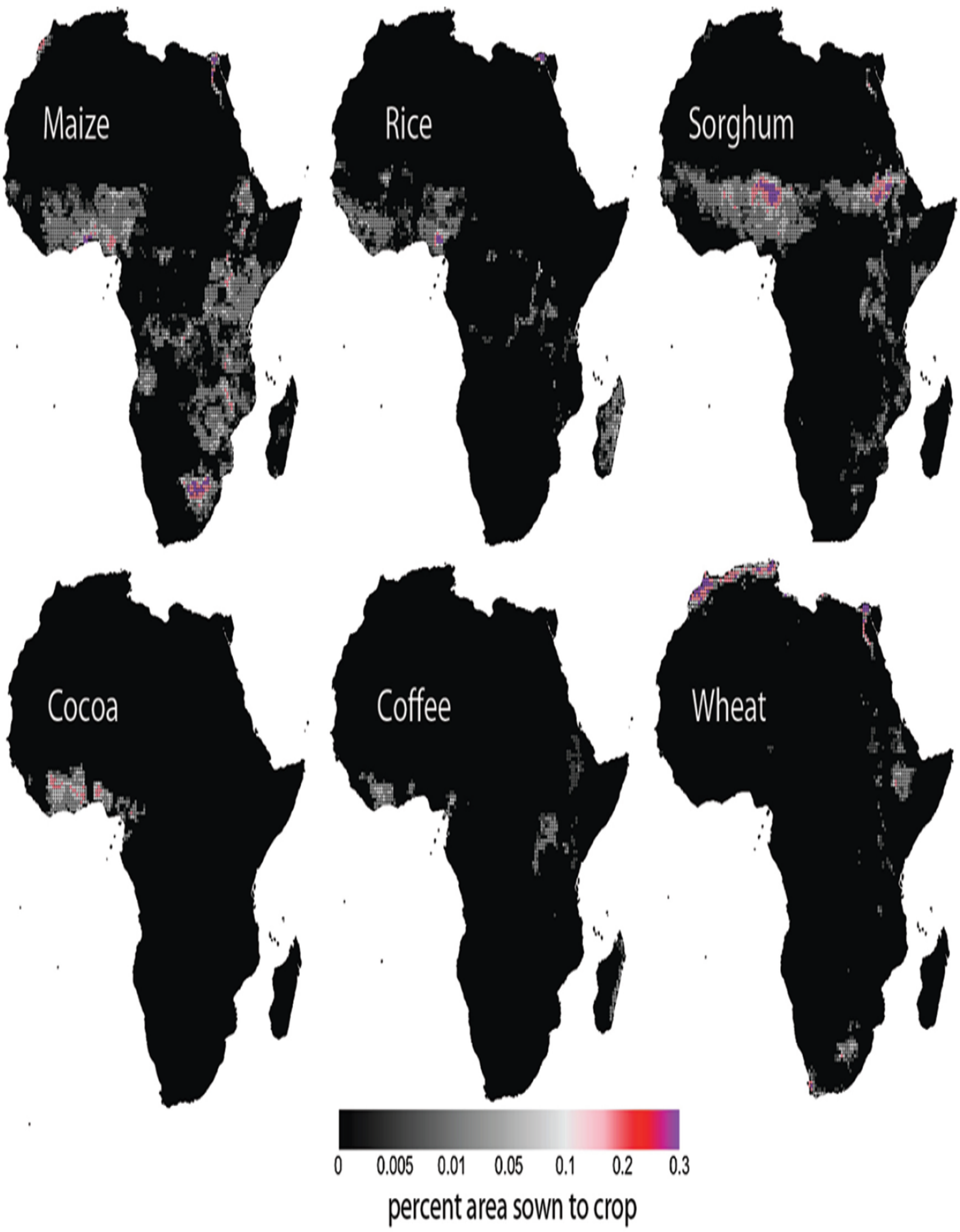
Note: Polygyny rate is the share of women aged 25 and older that are in a union with a polygynous male in each 0.5 × 0.5 decimal degree weather grid cell. T1 represents grid cells with low polygyny (less than 16%), T2 is for areas with medium polygyny (between 16 and 40%), and T3 is for areas with high polygyny (more than 40%).

Figure A2: Fluctuations in Global Crop Price



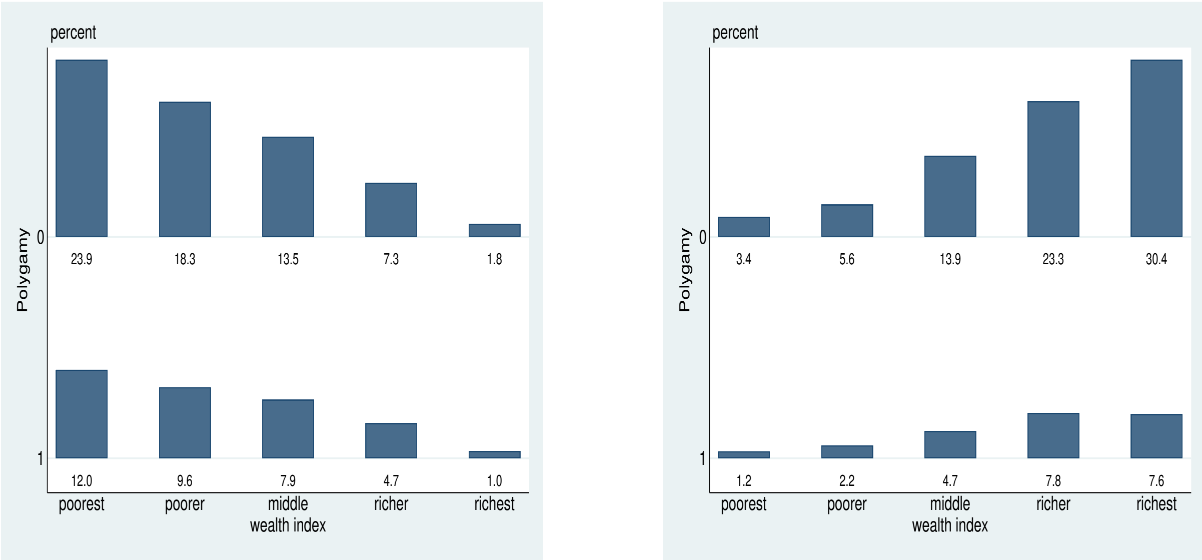
Note: Price data are taken from IMF and World Bank sources with 2000 as the base year (index=100) following McGuirk and Burke (2020).

Figure A3: Geographic Distribution of Crops in Year 2000



Source: McGuirk and Burke (2020)

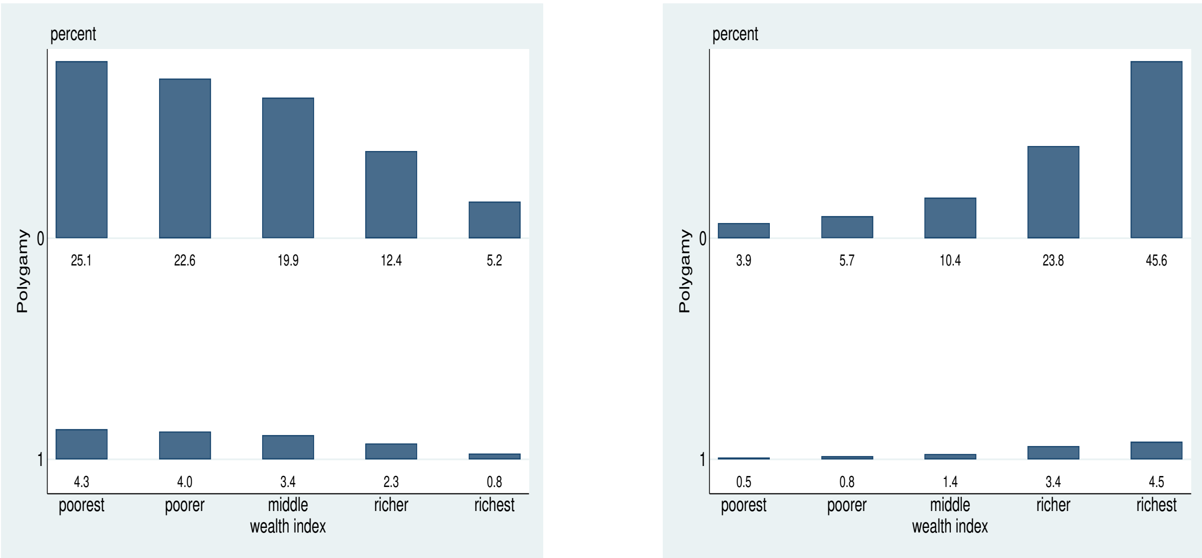
Figure A4: Polygamy by Household Wealth Quintiles in High Polygyny Areas



(a) Rural (b) Urban

Notes: Percentage of polygamous and monogamous households by wealth quintiles (joint distribution).

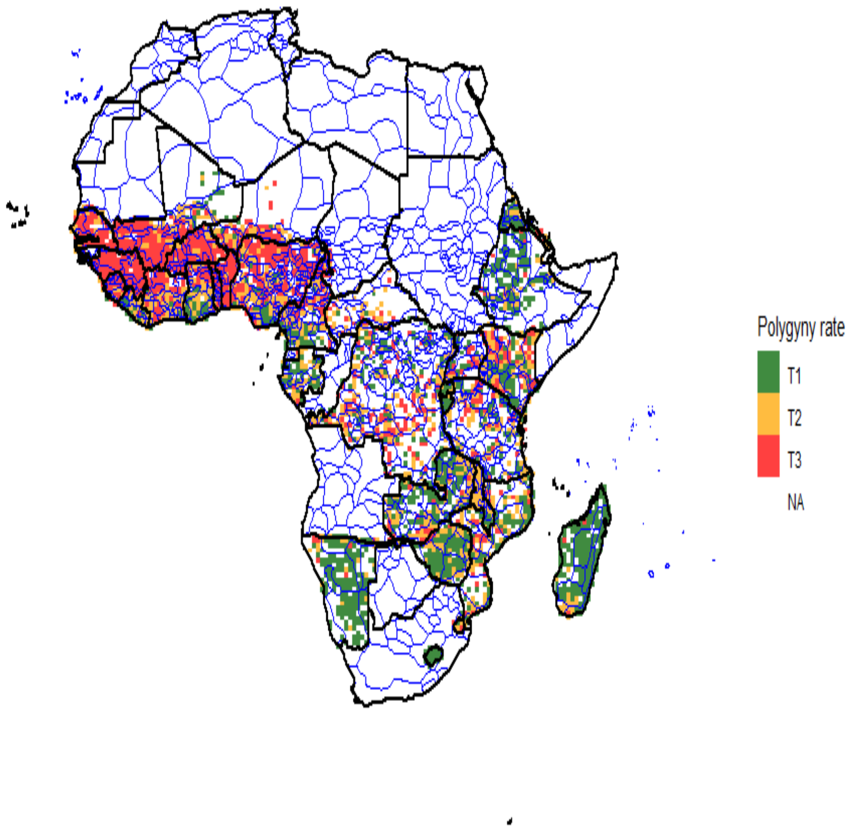
Figure A5: Polygamy by Household Wealth Quintiles in Midium Polygyny Areas



(a) Rural (b) Urban

Notes: Percentage of polygamous and monogamous households by wealth quintiles (joint distribution).

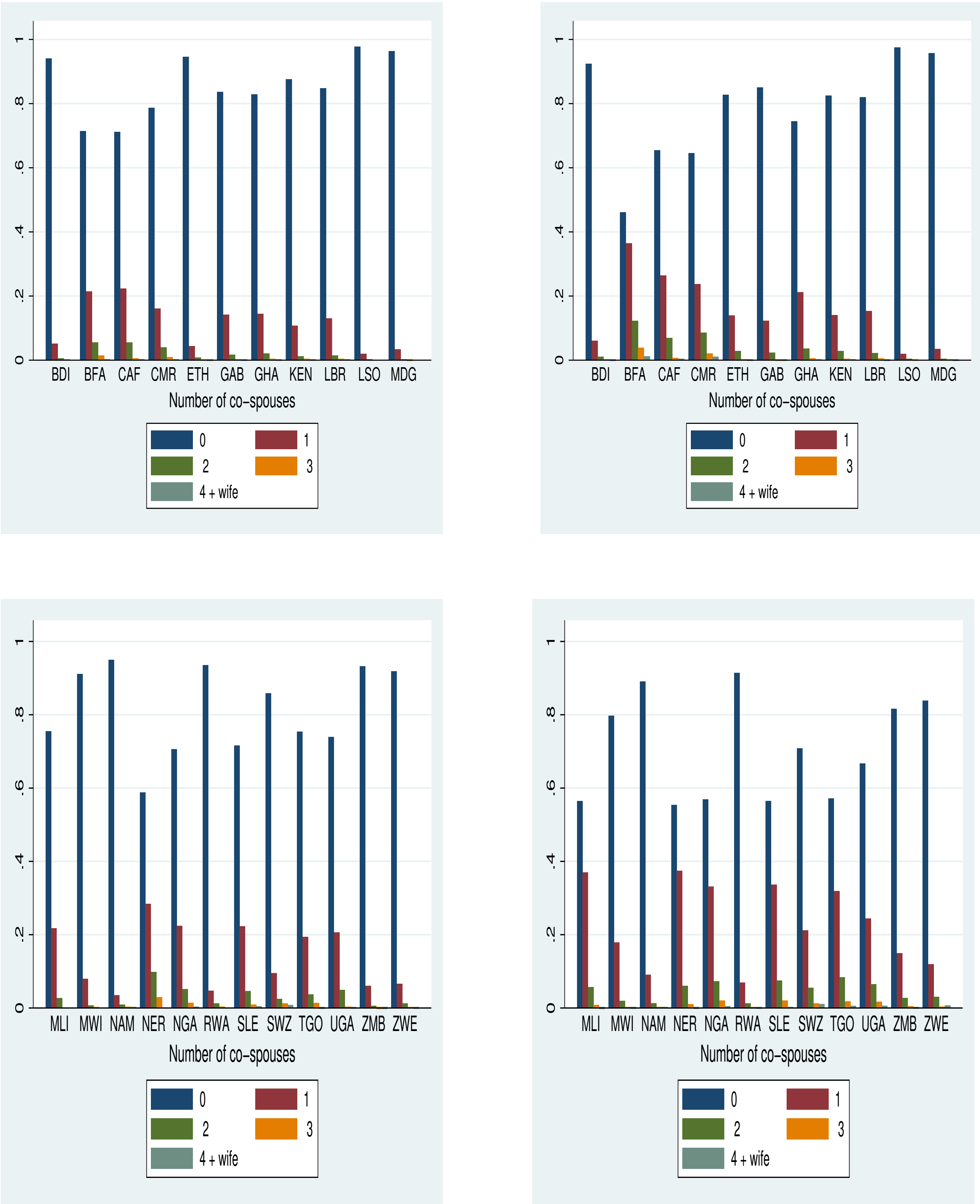
Figure A6: Practice of Polygyny across Space with Ethnic Homelands



Note: Polygyny rate is the share of women aged 25 and older that are in union with a polygynous male in each 0.5 × 0.5 decimal degree (∼ 50×50 km) weather grid cell using DHS data. T1 represents grid cells with low polygyny (less than 16%), T2 is for areas with medium polygyny (between 16 and 40%), and T3 is for areas with high polygyny (more than 40%). Blue lines are ethnic homeland boundaries.

A.2.1 Country Level Descriptive Evidence

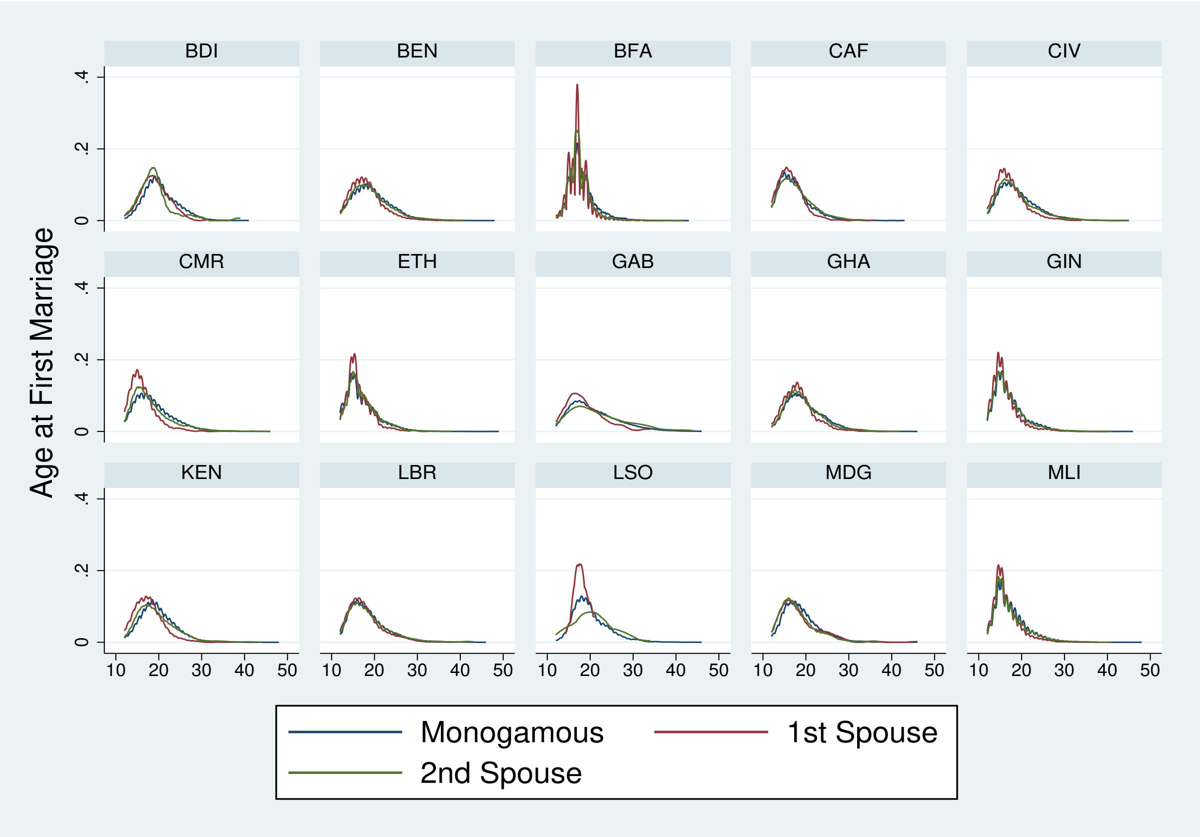
Figure A7: Distribution of Women by Number of Co-spouses



(a) Urban

(b) Rural

Figure A8: Age at First Marriage by Country



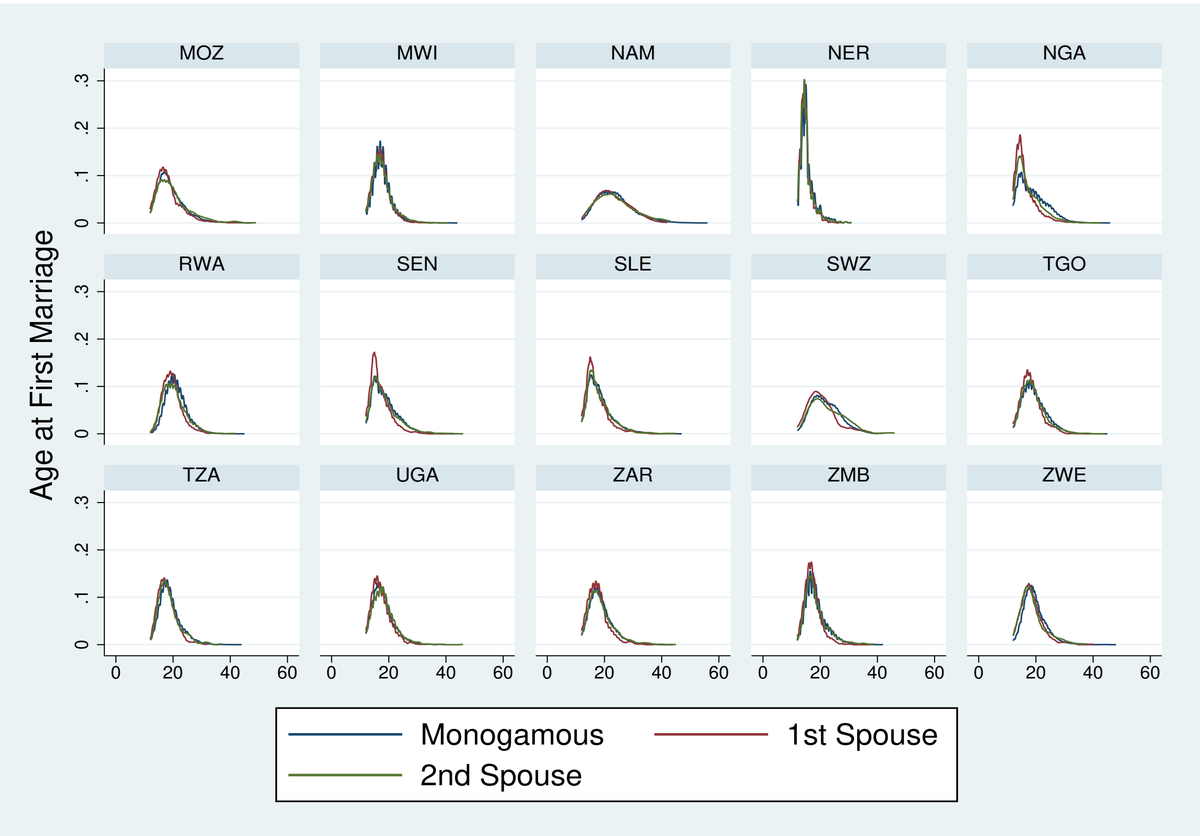
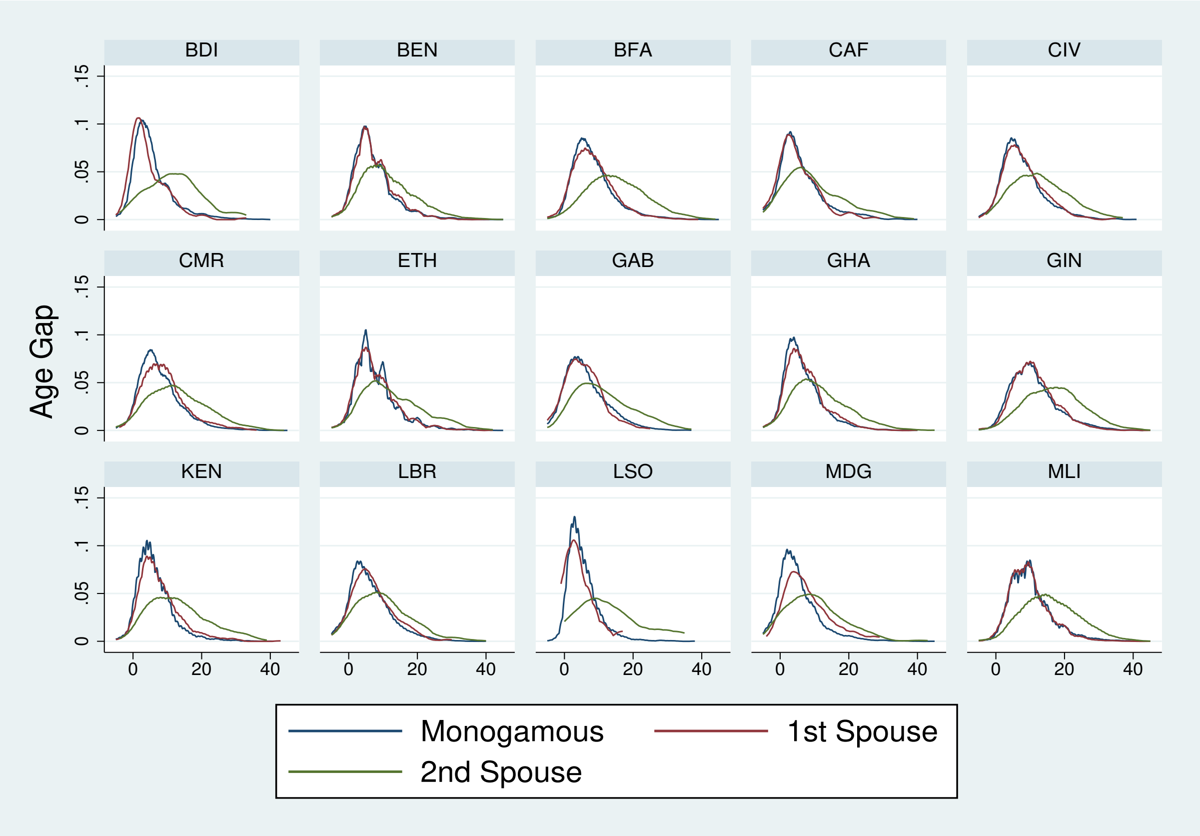


Figure A9: Age Gap between Husband and Wife by country



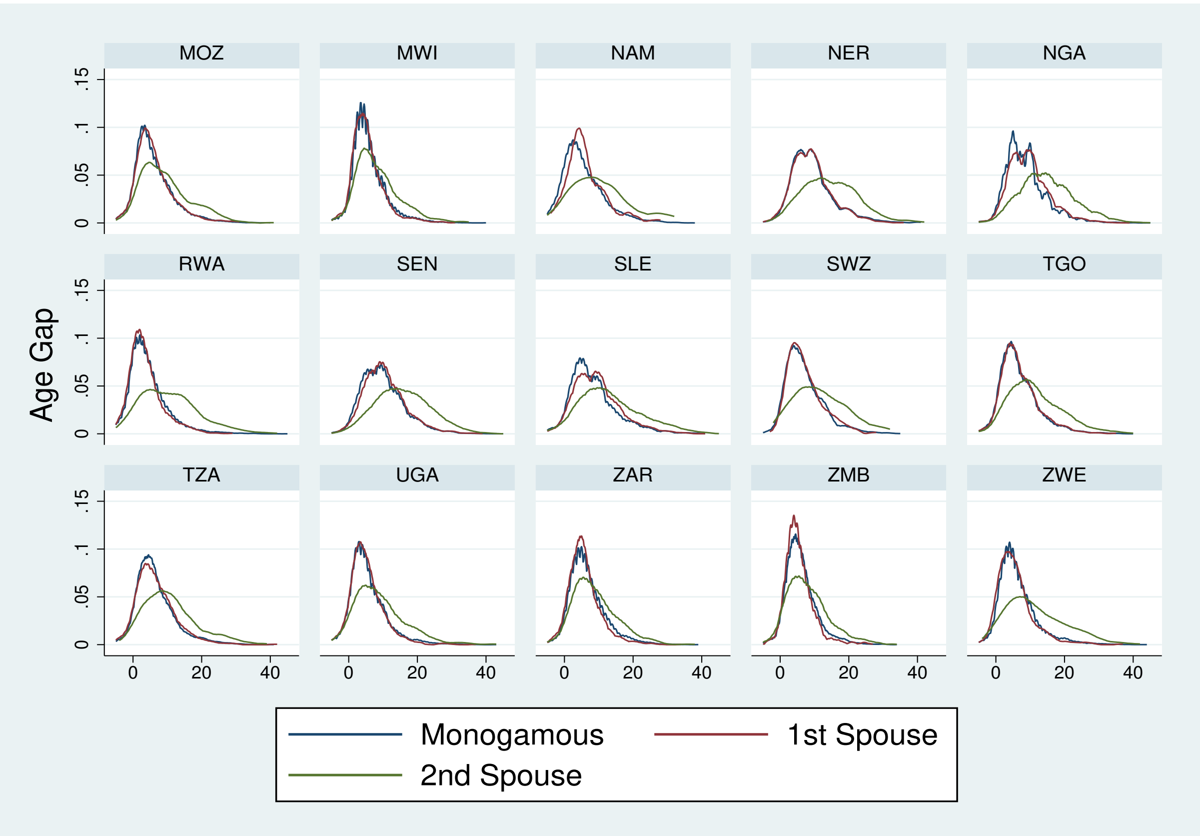
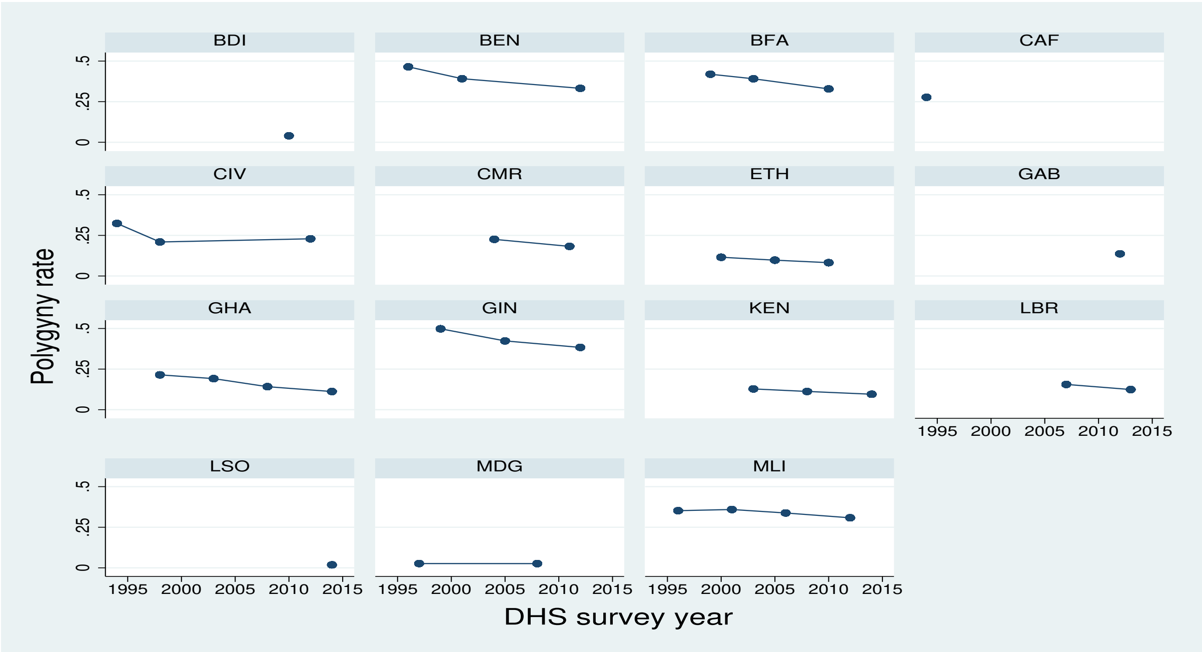
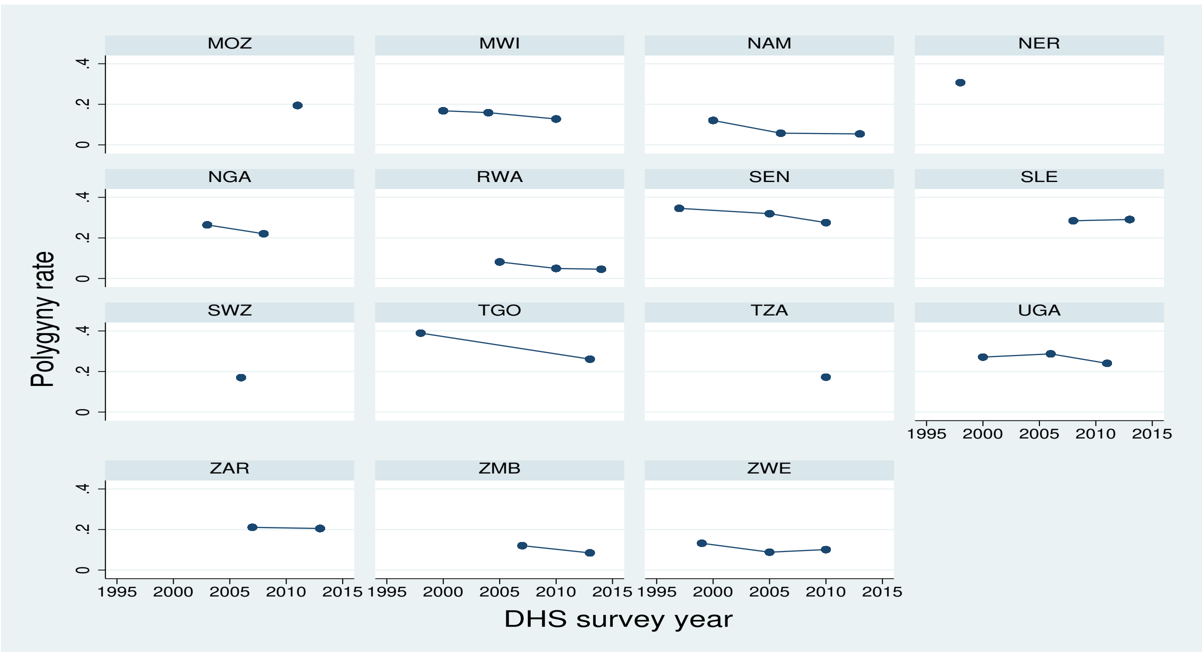


Figure A10: Evolution of Polygyny Rate over Time for Unions within last 10 Years





A.3 Correlates Polygyny

Table A1: Correlates of Polygyny

Panel A: Without additional controls

	Dependent Variable: Binary variable coded as 1 if woman is married to a polygynous man								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Historic ethnic correlates									
Matrilineal dummy	-0.1529***								-0.0628***
	(0.0249)								(0.0166)
Bride price dummy		0.0863***							0.0307*
		(0.0306)							(0.0183)
Female agriculture dummy			-0.1858***						-0.0345*
			(0.0310)						(0.0182)
Catholic missions per unit area				-0.0344***					-0.0031
				(0.0087)					(0.0047)
Protestant missions per unit area					-0.0185***				-0.0054**
					(0.0038)				(0.0024)
Contemporeanous individual correlates									
Is Christian						-0.2811***			-0.1672***
						(0.0158)			(0.0133)
Lives in rural area							0.1314***		0.0897***
							(0.0143)		(0.0124)
Has no education								0.2629***	0.1308***
								(0.0135)	(0.0132)
Observations	199804	199804	199804	201339	201339	219674	257660	260894	130844
Adjusted R-squared	0.018	0.004	0.034	0.012	0.029	0.091	0.017	0.080	0.140
Number of clusters	464	464	464	365	365	485	546	553	285
Mean dependent variable	0.369	0.369	0.369	0.337	0.337	0.323	0.340	0.337	0.356

Panel B: With additional controls

	Dependent Variable: Binary variable coded as 1 if woman is married to a polygynous man								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Matrilineal dummy	-0.0367**								-0.0183
	(0.0143)								(0.0119)
Bride price dummy		0.0479***							0.0343**
		(0.0145)							(0.0133)
Female agriculture dummy			-0.0729***						-0.0462***
			(0.0231)						(0.0171)
Catholic missions per unit area				-0.0070**					0.0054
				(0.0035)					(0.0043)
Protestant missions per unit area					-0.0064***				-0.0030*
					(0.0016)				(0.0016)
Is Christian						-0.1757***			-0.1439***
						(0.0136)			(0.0111)
Lives in rural area							0.1020***		0.0919***
							(0.0118)		(0.0124)
Has no education								0.1426***	0.0906***
								(0.0105)	(0.0098)
Observations	158585	158585	158585	201339	201339	168757	198480	201337	130844
Adjusted R-squared	0.141	0.141	0.142	0.129	0.130	0.153	0.137	0.142	0.177
Number of clusters	303	303	303	365	365	323	359	365	285
Mean dependent variable	0.369	0.369	0.369	0.337	0.337	0.323	0.340	0.337	0.356

OLS regressions with observations at the individual level. The full regression sample includes married women aged 25 or older at the time of the survey that have been married only once. The dependent variables is a dummy equal to one if the woman is married to a polygynous husband. The additional controls are: A dumy for malaria endemis, ruggedness and elevation, distance to the coast, absolute latitude, constraints on rainfed agriculture, dummies for a variety of geographic regions, country fixed effects, birth year fixed effects, and quadratic age. Robust standard errors clustered at ethnicity level in parentheses *** p<0.01, ** p<0.05, * p<0.1. All regressions are weighted using country population-adjusted survey sampling weights.

A.4 Robustness for Prediction 1

Table A2: Prediction 1: Robustness to Ethnic/Religious Correlates of Polygyny

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A. Dependent variable: Husband-wife age gap					
Any drought ages 12-24 × low polygyny rate	-0.3311		-0.3683		-0.6805	
	(0.4011)		(0.4757)		(0.5953)	
Any drought ages 12-24 × medium polygyny rate	-0.1164		-0.0164		-0.3613	
	(0.3343)		(0.3901)		(0.5735)	
Any drought ages 12-24 × high polygyny rate	-1.1921***		-1.1385***		-1.3033***	
	(0.2959)		(0.3082)		(0.3356)	
Any drought ages 12-24		0.1884		0.1758		-0.3972
		(0.4688)		(0.5714)		(0.7575)
Any drought ages 12-24 × polygyny rate		-2.2589**		-2.0855*		-1.4107
		(1.0169)		(1.1602)		(1.3387)
Ethnicity control interactions	YES	YES	YES	YES	YES	YES
Christian Missions control interactions	NO	NO	YES	YES	NO	NO
Christian religion control interactions	NO	NO	NO	NO	YES	YES
Observations	133353	133353	109566	109566	115075	115075
Adjusted R-squared	0.173	0.173	0.161	0.161	0.179	0.179
Number of clusters	2317	2317	1750	1750	2124	2124
P-value: low versus high	0.0583		0.129		0.278	
P-value: medium versus high	0.00800		0.0109		0.0911	
P-value: low versus medium	0.589		0.430		0.430	
Mean dependent variable	10.56	10.56	10.72	10.72	10.53	10.53
	Panel B. Dependent variable: Junior wife indicator					
Any drought ages 12-24 × low polygyny rate	0.0126		0.0156		0.0224	
	(0.0115)		(0.0137)		(0.0156)	
Any drought ages 12-24 × medium polygyny rate	0.0019		0.0034		0.0079	
	(0.0099)		(0.0114)		(0.0127)	
Any drought ages 12-24 × high polygyny rate	-0.0245**		-0.0210*		-0.0250**	
	(0.0100)		(0.0108)		(0.0109)	
Any drought ages 12-24		-0.0002		-0.0047		-0.0016
		(0.0137)		(0.0167)		(0.0193)
Any drought ages 12-24 × polygyny rate		-0.0305		-0.0168		-0.0312
		(0.0314)		(0.0359)		(0.0383)
Ethnicity control interactions	YES	YES	YES	YES	YES	YES
Christian Missions control interactions	NO	NO	YES	YES	NO	NO
Christian religion control interactions	NO	NO	NO	NO	YES	YES
Observations	132380	132380	108999	108999	114170	114170
Adjusted R-squared	0.085	0.084	0.085	0.085	0.092	0.091
Number of clusters	2317	2317	1749	1749	2123	2123
P-value: low versus high	0.00976		0.0221		0.00566	
P-value: medium versus high	0.0497		0.0938		0.0309	
P-value: low versus medium	0.350		0.357		0.233	
Mean dependent variable	0.157	0.157	0.161	0.161	0.150	0.150

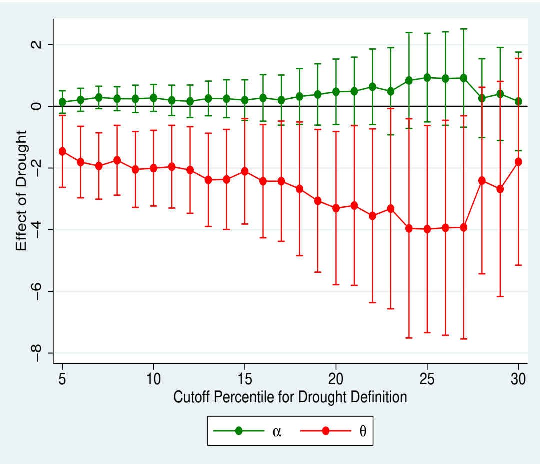
OLS regressions with observations at the individual level. The full regression sample includes married women aged 25 or older at the time of the survey that have been married only once. The dependent variables are the husband-wife age gap (Panel A) and whether a woman married as a junior wife (Panel B). All the regressions include birth year FE, marriage year FE, grid-cell FE, and country FE. "Ethnicity Control Interactions" consist of indicator variables for an individual belonging to an ethnic group that (i) is matrilineal, (ii) practices bride price, (iii) has female dominated agriculture, plus these indicator variables respectively interacted with the drought dummy. "Christian Missions Control Interactions" is the interaction of the number of catholic and christian missions (separately) with the drought dummy. "Christian religion control interactions" consist of a dummy for a woman being christian and this dummy interacted with the drought variable. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. All regressions are weighted using country population-adjusted survey sampling weights.

Table A3: Prediction 1: Robustness to other Correlates of Polygyny

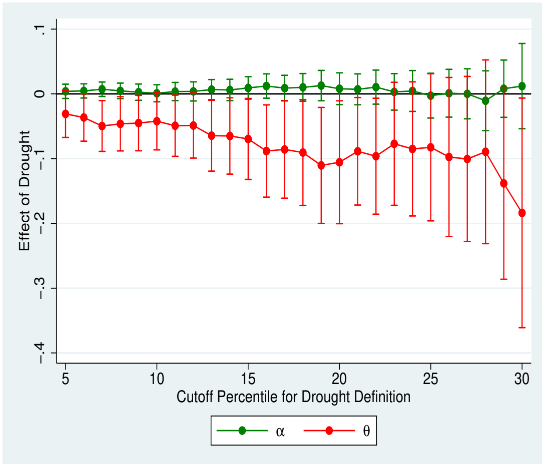
Dependent variable	Husband-wife age gap				Junior wife indicator			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Any drought ages 12-24 × low polygyny rate	-0.2222		-0.2168		0.0096		0.0096	
	(0.3740)		(0.3801)		(0.0093)		(0.0093)	
Any drought ages 12-24 × medium polygyny rate	-0.2257		-0.3645		-0.0030		-0.0089	
	(0.3975)		(0.3855)		(0.0119)		(0.0118)	
Any drought ages 12-24 × high polygyny rate	-1.3899***		-1.7574***		-0.0337**		-0.0489***	
	(0.3929)		(0.4352)		(0.0131)		(0.0167)	
Any drought ages 12-24		0.1142		0.1758		0.0120		0.0143
		(0.3790)		(0.3825)		(0.0113)		(0.0116)
Any drought ages 12-24 × polygyny rate		-2.2804***		-2.9360***		-0.0664**		-0.0912**
		(0.8789)		(0.9869)		(0.0308)		(0.0391)
Rural residence control interactions	YES	YES	YES	YES	YES	YES	YES	YES
No education control interactions	NO	NO	YES	YES	NO	NO	YES	YES
Observations	176209	176209	176206	176206	171846	171846	171843	171843
Adjusted R-squared	0.160	0.160	0.162	0.162	0.081	0.081	0.083	0.083
Number of clusters	2994	2994	2994	2994	2991	2991	2991	2991
P-value: low versus high	0.00958		0.00150		0.00225		0.00126	
P-value: medium versus high	0.00258		0.000852		0.0376		0.0163	
P-value: low versus medium	0.994		0.740		0.279		0.124	
Mean dependent variable	9.903	9.903	9.903	9.903	0.142	0.142	0.142	0.142

OLS regressions with observations at the individual level. The full regression sample includes married women aged 25 or older at the time of the survey that have been married only once. All the regressions include birth year FE, marriage year FE, grid-cell FE, and country FE. "Rural residence control interactions" consist of an indicator variable for an individual that lives in rural area plus this indicator variable interacted with the drought dummy. "No education control Interactions" is an indicator variable for having no education plus this indicator variable interacted with the drought dummy. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. All regressions are weighted using country population-adjusted survey sampling weights.

Figure A11: P1: Robustness definition of drought based on cutoffs



(a) Impact on husband-wife age gap



(b) Impact on junior wife indicator

Notes: The connected points show the estimated coefficients and the capped spikes show 95% confidence intervals calculated using standard errors clustered at the grid cell level. α is the effect of drought in absence of polygyny. θ is the coefficient on the interaction term between drought and polygyny rates.

Table A4: Prediction 1: Sensitivity to Time Window and Husband's age at Marriage

Dependent Variable	Husband-wife age gap		Husband's age at marriage		Junior wife indicator	
	(1)	(2)	(3)	(4)	(5)	(6)
Any drought ages 12-17 x low polygamy	-0.1985				0.0117	
	(0.3413)				(0.0073)	
Any drought ages 12-17 x medium polygamy	-0.0896				-0.0061	
	(0.2933)				(0.0090)	
Any drought ages 12-17 x high polygamy	-1.2579***				-0.0363***	
	(0.2798)				(0.0130)	
Any drought ages 18-24 x low polygamy	0.1669				0.0040	
	(0.3503)				(0.0078)	
Any drought ages 18-24 x medium polygamy	0.0316				-0.0014	
	(0.3020)				(0.0094)	
Any drought ages 18-24 x high polygamy	-0.8672***				-0.0350***	
	(0.3141)				(0.0133)	
Any drought ages 12-17		0.1286				0.0127
		(0.3368)				(0.0090)
Any drought ages 12-17 × polygyny rate		-2.1491**				-0.0784**
		(0.8668)				(0.0323)
Any drought ages 18-24		0.3703				0.0049
		(0.3480)				(0.0094)
Any drought ages 18-24 × polygyny rate		-1.9807**				-0.0535
		(0.9324)				(0.0337)
Any drought ages 12-24 × low polygyny rate			-0.1076			
			(0.3451)			
Any drought ages 12-24 × medium polygyny rate			-0.0247			
			(0.2925)			
Any drought ages 12-24 × high polygyny rate			-1.1140***			
			(0.2705)			
Any drought ages 12-24				0.1905		
				(0.3371)		
Any drought ages 12-24 × polygyny rate				-2.0149**		
				(0.8563)		
Observations	176209	176209	176209	176209	171846	171846
Adjusted R-squared	0.160	0.160	0.164	0.164	0.080	0.080
P-value Ages 12-17: low versus high	0.0150				0.00112	
P-value Ages 12-17: medium versus high	0.00346				0.0517	
P-value Ages 12-17: low versus medium	0.806				0.124	
P-value Ages 18-24: low versus high	0.0266				0.0125	
P-value Ages 18-24: medium versus high	0.0380				0.0404	
P-value Ages 18-24: low versus medium	0.768				0.662	
P-value: low versus high			0.0203			
P-value: medium versus high			0.00566			
P-value: low versus medium			0.853			
Mean dependent variable	9.903	9.903	27.58	27.58	0.142	0.142

OLS regressions with observations at the individual level. The full regression sample includes married women aged 25 or older at the time of the survey that have been married only once. All the regressions include birth year FE, marriage year FE, grid-cell FE, and country FE. "Rural residence control interactions" consist of an indicator variable for an individual that lives in rural area plus this indicator variable interacted with the drought dummy. "No education control Interactions" is an indicator variable for having no education plus this indicator variable interacted with the drought dummy. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. All regressions are weighted using country population-adjusted survey sampling weights.

Table A5: Prediction 1: Including Country-Specific Cohort Effects and using the most Recent Survey Wave

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Include birth year FE × country FE				**Use most recent survey wave by country**			
Dependent Variable	Husband-wife age gap		Junior wife indicator		Husband-wife age gap		Junior wife indicator	
Any drought ages 12-24 × low polygyny rate	0.0761		0.0134		-0.3537		0.0039	
	(0.3771)		(0.0083)		(0.3650)		(0.0097)	
Any drought ages 12-24 × medium polygyny rate	0.1519		-0.0023		0.1099		0.0046	
	(0.3051)		(0.0091)		(0.3899)		(0.0099)	
Any drought ages 12-24 × high polygyny rate	-0.6725**		-0.0391***		-0.7308**		-0.0409***	
	(0.2634)		(0.0135)		(0.3044)		(0.0118)	
Any drought ages 12-24		0.2299		0.0156		0.0314		0.0125
		(0.3613)		(0.0100)		(0.4070)		(0.0105)
Any drought ages 12-24 × polygyny rate		-1.2787		-0.0852**		-1.1162		-0.0785**
		(0.8885)		(0.0353)		(1.0078)		(0.0320)
Birth year FE × country FE	YES	YES	YES	YES				
Observations	176209	176209	171846	171846	91154	91154	89775	89775
Adjusted R-squared	0.173	0.173	0.081	0.080	0.111	0.111	0.069	0.069
Number of clusters	2994	2994	2991	2991	1964	1964	1964	1964
P-value: low versus high	0.102		0.00118		0.424		0.00327	
P-value: medium versus high	0.0370		0.0221		0.0807		0.00261	
P-value: low versus medium	0.872		0.189		0.377		0.957	
Mean dependent variable	9.903	9.903	0.142	0.142	9.903	9.903	0.142	0.142

OLS regressions with observations at the individual level. The full regression sample includes married women aged 25 or older at the time of the survey that have been married only once. All the regressions include birth year FE, marriage year FE, grid-cell FE, and country FE. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. All the regressions are weighted using country population-adjusted survey sampling weights.

Table A6: Prediction 1: Clustering and Survey Weights

	Panel A. Dependent variable: Husband-wife age gap					
	(1)	(2)	(3)	(4)	(5)	(6)
	Clustering at region level		**Clustering at country level**		**No survey weights**	
Any drought ages 12-24 × low polygyny rate	-0.0571		-0.0531		-0.1677	
	(0.2030)		(0.1727)		(0.1498)	
Any drought ages 12-24 × medium polygyny rate	-0.0417		-0.0428		-0.0003	
	(0.2484)		(0.2578)		(0.1709)	
Any drought ages 12-24 × high polygyny rate	-1.1463***		-1.1499***		-0.6752***	
	(0.2740)		(0.3256)		(0.2497)	
Any drought ages 12-24		0.2327		0.2353		-0.0063
		(0.2398)		(0.1892)		(0.1796)
Any drought ages 12-24 × polygyny rate		-2.1564***		-2.1668***		-0.9596
		(0.7583)		(0.7323)		(0.6432)
Number of clusters	427	427	30	30	176209	176209
Observations	175880	175880	176209	176209	0.156	0.156
Adjusted R-squared	0.160	0.160	0.160	0.159	2994	2994
P-value: low versus high	0.00178		0.000631		0.0805	
P-value: medium versus high	0.00155		0.000114		0.0242	
P-value: low versus medium	0.961		0.967		0.461	
Mean dependent variable	9.903	9.903	9.903	9.903	9.903	9.903

	Panel B. Dependent variable: Junior wife indicator					
	(1)	(2)	(3)	(4)	(5)	(6)
	Clustering at region level		**Clustering at country level**		**No survey weights**	
Any drought ages 12-24 × low polygyny rate	0.0089*		0.0087*		0.0031	
	(0.0049)		(0.0046)		(0.0038)	
Any drought ages 12-24 × medium polygyny rate	-0.0044		-0.0044		0.0028	
	(0.0094)		(0.0056)		(0.0053)	
Any drought ages 12-24 × high polygyny rate	-0.0360***		-0.0360**		-0.0086	
	(0.0126)		(0.0159)		(0.0064)	
Any drought ages 12-24		0.0103		0.0100		-0.0014
		(0.0080)		(0.0101)		(0.0051)
Any drought ages 12-24 × polygyny rate		-0.0714**		-0.0709		-0.0029
		(0.0316)		(0.0477)		(0.0171)
Number of clusters	423	423	30	30	171846	171846
Observations	171561	171561	171846	171846	0.078	0.078
Adjusted R-squared	0.080	0.080	0.080	0.080	2991	2991
P-value: low versus high	0.000664		0.0301		0.117	
P-value: medium versus high	0.0538		0.0188		0.168	
P-value: low versus medium	0.213		0.155		0.968	
Mean dependent variable	0.142	0.142	0.142	0.142	0.142	0.142

OLS regressions with observations at the individual level. The full regression sample includes married women aged 25 or older at the time of the survey that have been married only once. All the regressions include birth year FE, marriage year FE, grid-cell FE, and country FE. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. All the regressions are weighted using country population-adjusted survey sampling weights except in column (5) and (6).

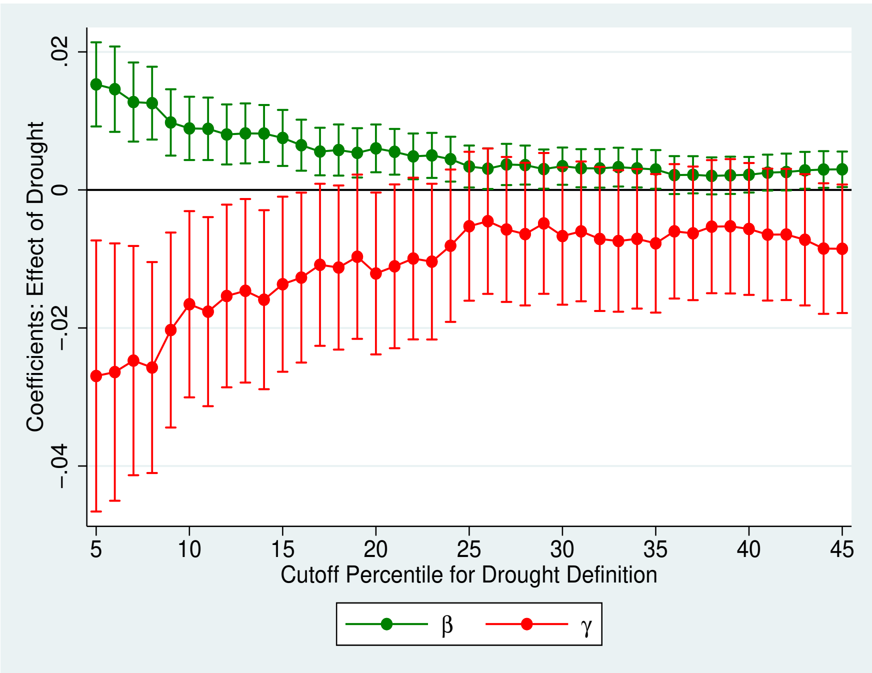
A.5 Robustness for Prediction 2

Table A7: Prediction 2: Robustness to Ethnic/Religious Correlates of Polygyny

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent variable:	**Binary variable coded as 1 in the year the woman gets married**											
Sample	Unions between age 12 and 24						Unions between age 12 and 17					
Drought x low polygyny	0.0105***		0.0139***		0.0107**		0.0082**		0.0120***		0.0070	
	(0.0040)		(0.0043)		(0.0046)		(0.0039)		(0.0044)		(0.0048)	
Drought x medium polygyny	0.0065*		0.0073*		0.0065		0.0044		0.0052		0.0031	
	(0.0034)		(0.0038)		(0.0040)		(0.0033)		(0.0036)		(0.0037)	
Drought x high polygyny	0.0003		0.0015		-0.0004		0.0010		0.0029		0.0002	
	(0.0032)		(0.0036)		(0.0034)		(0.0031)		(0.0034)		(0.0034)	
Drought		0.0124***		0.0160***		0.0247***		0.0096**		0.0123***		0.0198***
		(0.0043)		(0.0046)		(0.0052)		(0.0042)		(0.0047)		(0.0052)
Drought x polygamy rate		-0.0223***		-0.0285***		-0.0397***		-0.0167**		-0.0196**		-0.0314***
		(0.0076)		(0.0085)		(0.0087)		(0.0073)		(0.0084)		(0.0086)
Ethnicity control interactions	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Christian Missions control interactions	NO	NO	YES	YES	NO	NO	NO	NO	YES	YES	NO	NO
Christian religion control interactions	NO	NO	NO	NO	YES	YES	NO	NO	NO	NO	YES	YES
Observations	1713601	1713601	1417585	1417585	1442241	1442241	1215652	1215652	1003562	1003562	1027887	1027887
Adjusted R-squared	0.063	0.063	0.063	0.063	0.066	0.065	0.075	0.075	0.075	0.075	0.078	0.078
Number of clusters	2411	2411	1831	1831	2155	2155	2411	2411	1831	1831	2155	2155
P-value: low versus high	0.00380		0.00130		0.00622		0.0302		0.0145		0.0918	
P-value: medium versus high	0.0241		0.0621		0.0361		0.199		0.432		0.353	
P-value: low versus medium	0.162		0.0288		0.154		0.175		0.0232		0.205	
Mean dependent variable	0.120	0.120	0.120	0.120	0.121	0.121	0.0937	0.0937	0.0938	0.0938	0.0943	0.0943

OLS regressions with observations are at the person x age level. All regressions include age FE, birth year FE, grid-cell FE, and country FE. The dependent variable is a dummy equal to one if the woman gets married at the age corresponding to a given observation. The full sample includes women aged 25 or older at the time of the interview. "Ethnicity Control Interactions" consist of indicator variables for an individual belonging to an ethnic group that (i) is matrilineal, (ii) practices bride price, (iii) has female dominated agriculture, plus these indicator variables respectively interacted with the drought dummy. "Christian Missions Control Interactions" is the interaction of the number of catholic and christian missions (separately) with the drought dummy. "Christian religion control interactions" consist of a dummy for a woman being christian and this dummy interacted with the drought variable. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. All regressions are weighted using country population-adjusted survey sampling weights.

Figure A12: P2:Robustness in the Definition of Droughts Based on Cutoffs in Rainfall Distribution



Note: The connected points show the estimated coefficients, and the capped spikes show 95% confidence intervals calculated using standard errors clustered at the grid cell level. β is the effect of droughts in the absence of polygyny. γ is the coefficient on the interaction term between droughts and polygyny rates.

Table A8: Prediction 2: Robustness to other Correlates of Polygyny and Timing Placebo

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	**Binary variable coded as 1 in the year the woman gets married**						
Sample	**All**				**Low polygyny**	**Medium polygyny**	**High polygyny**
Drought x low polygyny	0.0075***		0.0076***				
	(0.0025)		(0.0026)				
Drought x medium polygyny	0.0052**		0.0050**				
	(0.0020)		(0.0021)				
Drought x high polygyny	0.0023		0.0014				
	(0.0030)		(0.0034)				
Drought		0.0086***		0.0090***	0.0060***	0.0038**	0.0007
		(0.0025)		(0.0025)	(0.0019)	(0.0016)	(0.0024)
Drought x polygamy rate		-0.0122*		-0.0154**			
		(0.0065)		(0.0075)			
Drought Lag 1					0.0006	-0.0020	-0.0017
					(0.0017)	(0.0019)	(0.0022)
Drought Lead 1					0.0005	0.0017	0.0003
					(0.0016)	(0.0019)	(0.0024)
Rural residence control interactions	YES	YES	YES	YES			
No education control interactions	NO	NO	YES	YES			
Observations	2433773	2433773	2433719	2433719	938991	810915	704377
Adjusted R-squared	0.063	0.063	0.065	0.065	0.050	0.053	0.067
Number of clusters	3064	3064	3064	3064	1133	963	1005
P-value: low versus high	0.103	0.103	0.0795	0.0795			
P-value: medium versus high	0.329	0.329	0.242	0.242			
P-value: low versus medium	0.362	0.362	0.327	0.327			
Mean dependent variable	0.112	0.112	0.112	0.112	0.0858	0.113	0.146

OLS regressions with observations are at the person x age level (from 12 to 24 or age of first marriage). All regressions include age FE, birth year FE, grid-cell FE, and country FE. The dependent variable is a dummy equal to one if the woman gets married at the age corresponding to a given observation. The full sample includes women aged 25 or older at the time of the interview. "Rural residence control interactions" consist of an indicator variable for an individual that lives in rural area plus this indicator variable interacted with the drought dummy. "No education control Interactions" is an indicator variable for having no education plus this indicator variable interacted with the drought dummy. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. All regressions are weighted using country population-adjusted survey sampling weights.

A.6 Robustness Prediction 3

A.7 Average Effect across SSA

This section replicates the main results in Corno et al. (2020) for SSA. The results presented in Table A18 show that women who experience a drought between ages 12 and 24 are 0.37 percentage points more likely to get married in the same year, which represents an increase of 3% in the annual hazard of early marriage. Columns (4) and (5) show that this effect is present only among women from an ethnic group that practice the bride price custom. Droughts do not affect the hazard of early marriage in the absence of marriage payment since marrying off a daughter does not provide extra resources to cope with the economic shock.

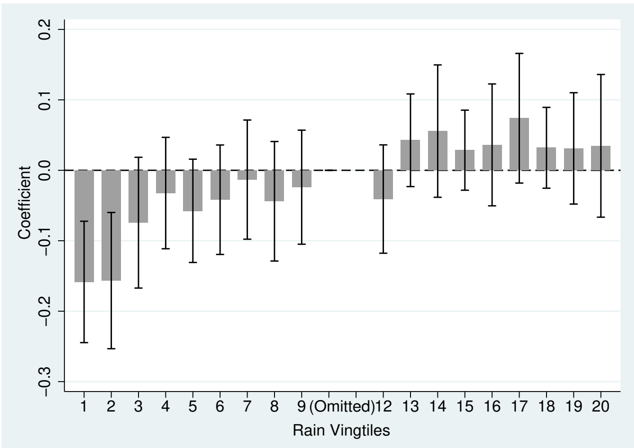
Table A9: Prediction 2: Robustness to Clustering at region and Country Level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	**Binary variable coded as 1 in the year the woman gets married**							
Sample	**All**				**Bripe price ethnic groups**			
Drought x low polygyny	0.0063***		0.0064**		0.0078***		0.0078***	
	(0.0023)		(0.0031)		(0.0024)		(0.0013)	
Drought x medium polygyny	0.0038**		0.0038**		0.0036*		0.0036*	
	(0.0016)		(0.0018)		(0.0019)		(0.0018)	
Drought x high polygyny	0.0004		0.0004		-0.0008		-0.0008	
	(0.0025)		(0.0018)		(0.0020)		(0.0024)	
Drought		0.0074***		0.0075**		0.0086***		0.0086***
		(0.0022)		(0.0030)		(0.0023)		(0.0016)
Drought x polygamy rate		-0.0134*		-0.0137		-0.0167***		-0.0168**
		(0.0071)		(0.0092)		(0.0063)		(0.0069)
Observations	2452919	2452919	2459177	2459177	1341530	1341530	1344360	1344360
Adjusted R-squared	0.062	0.062	0.062	0.062	0.064	0.064	0.064	0.064
Number of clusters	439	439	31	31	324	324	23	23
P-value: low versus high	0.0824		0.144		0.00553		0.00543	
P-value: medium versus high	0.243		0.0834		0.0951		0.105	
P-value: low versus medium	0.369		0.553		0.182		0.0884	
Mean dependent variable	0.112	0.112	0.112	0.112	0.118	0.118	0.118	0.118

OLS regressions with observations are at the person x age level (from 12 to 24 or age of first marriage). All regressions include age FE, birth year FE, grid-cell FE, and country FE. The dependent variable is a dummy equal to one if the woman gets married at the age corresponding to a given observation. The full sample includes women aged 25 or older at the time of the interview. Robust standard errors clustered at region level (columns 1-2 and 5-6) and country level (other columns) in parentheses *** p<0.01, ** p<0.05, * p<0.1. A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. All regressions are weighted using country population-adjusted survey sampling weights.

A.8 Other Tables and Graphs

Figure A13: Crop Yield by Rainfall Vintiles



Note: Coefficients of regression of the log of annual crop yield (tons per hectare) for five main staple crops (maize, sorghum, millet, rice, and wheat) on rainfall vingtiles. It uses country-level crop data over the period 1960–2010 from the FAOStat. The regression includes year and country fixed effects. Replication from Corno et al. (2020).

Table A10: Prediction 2: Robustness to Continuous Rainfall

	(1)	(2)	(3)	(4)
Dependent variable	**Binary variable coded as 1 in the year the woman gets married**			
Sample	**Bride price ethnic groups**		**No bride price**	
Log(rainfall) × low polygyny	-0.0104**		-0.0028	
	(0.0046)		(0.0049)	
Log(rainfall) × medium polygyny	-0.0027		-0.0000	
	(0.0035)		(0.0049)	
Log(rainfall) × high polygyny	0.0050		-0.0092	
	(0.0047)		(0.0115)	
Log(rainfall)		-0.0120**		-0.0011
		(0.0048)		(0.0060)
Log(rainfall) × polygyny rate		0.0309**		-0.0067
		(0.0141)		(0.0264)
Observations	1344360	1344360	369241	369241
Adjusted R-squared	0.064	0.064	0.064	0.064
Number of clusters	2135	2135	1062	1062
P-value: low versus high	0.0198		0.610	
P-value: medium versus high	0.197		0.462	
P-value: low versus medium	0.182		0.680	
Mean dependent variable	0.118	0.118	0.127	0.127

OLS regressions with observations are at the person x age level (from 12 to 24 or age of first marriage). All regressions include age FE, birth year FE, grid-cell FE, and country FE. The dependent variable is a dummy equal to one if the woman gets married at the age corresponding to a given observation. The full sample includes women aged 25 or older at the time of the interview. Robust standard errors clustered at grid cell level in parentheses *** p<0.01, ** p<0.05, * p<0.1. All regressions are weighted using country population-adjusted survey sampling weights.

Table A11: Prediction 2: Robustness to Survey Waves and Time Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable	**Binary variable coded as 1 in the year the woman gets married**									
Sample	**Most recent survey wave**		**All**						**All**	
Drought x low polygyny	0.0072***		0.0050**		0.0046**		0.0017		0.0060***	
	(0.0021)		(0.0021)		(0.0019)		(0.0021)		(0.0019)	
Drought x medium polygyny	0.0041**		0.0028*		0.0014		-0.0017		0.0031*	
	(0.0020)		(0.0016)		(0.0016)		(0.0019)		(0.0016)	
Drought x high polygyny	0.0004		-0.0010		-0.0026		-0.0056**		0.0002	
	(0.0025)		(0.0024)		(0.0024)		(0.0026)		(0.0024)	
Drought		0.0084***		0.0063***		0.0059***		0.0034		0.0071***
		(0.0022)		(0.0021)		(0.0020)		(0.0023)		(0.0020)
Drought x polygamy rate		-0.0152**		-0.0136**		-0.0163**		-0.0179**		-0.0137**
		(0.0068)		(0.0066)		(0.0065)		(0.0073)		(0.0064)
Observations	1370822	1370822	2459177	2459177	2459177	2459177	2459177	2459177	2459177	2459177
Calendar year FE			YES	YES	YES	YES	NO	NO		
Country x time trend			NO	NO	YES	YES	NO	NO		
Country x calendar year FE			NO	NO	NO	NO	YES	YES		
Birth year FE × Country FE									YES	YES
Adjusted R-squared	0.060	0.060	0.063	0.063	0.064	0.064	0.065	0.065	0.062	0.062
Number of clusters	2778	2778	3101	3101	3101	3101	3101	3101	3101	3101
P-value: low versus high	0.0408		0.0626		0.0198		0.0291		0.0589	
P-value: medium versus high	0.248		0.174		0.155		0.191		0.320	
P-value: low versus medium	0.283		0.414		0.202		0.193		0.233	
Mean dependent variable	0.107	0.107	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112

OLS regressions with observations are at the person x age level (from 12 to 24 or age of first marriage). All regressions include age FE, birth year FE, grid-cell FE, and country FE. The dependent variable is a dummy equal to one if the woman gets married at the age corresponding to a given observation. The full sample includes women aged 25 or older at the time of the interview. Robust standard errors clustered at grid cell level in parentheses *** p<0.01, ** p<0.05, * p<0.1. All regressions are weighted using country population-adjusted survey sampling weights.

Table A12: Prediction 2: Effect on Probability of Child Marriage

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent variable	**Marriage before age 15**		**Marriage at age 15 - 16 - 17**						
Sample	All		All		Bride price	No bride price	low polygyny	medium polygyny	high polygyny
Any drought ages 12-14 x low polygamy	-0.0023								
	(0.0030)								
Any drought ages 12-14 x medium polygamy	-0.0055								
	(0.0037)								
Any drought ages 12-14 x high polygamy	-0.0030								
	(0.0062)								
Any drought ages 12-14		-0.0019							
		(0.0036)							
Any drought ages 12-14 x polygamy rate		-0.0060							
		(0.0142)							
Any drought ages 15-17 x low polygamy			0.0173***		0.0125**	-0.0069			
			(0.0054)		(0.0062)	(0.0098)			
Any drought ages 15-17 x medium polygamy			-0.0041		-0.0044	-0.0039			
			(0.0058)		(0.0069)	(0.0112)			
Any drought ages 15-17 x high polygamy			0.0073		-0.0022	-0.0170			
			(0.0070)		(0.0056)	(0.0169)			
Any drought ages 15-17				0.0138**			0.0171***	-0.0060	0.0104
				(0.0060)			(0.0055)	(0.0059)	(0.0064)
Any drought ages 15-17 x polygamy rate				-0.0257					
				(0.0180)					
Observations	326361	326361	283653	283653	157273	45260	100293	94261	89099
Adjusted R-squared	0.169	0.169	0.126	0.126	0.148	0.088	0.088	0.074	0.108
Number of clusters	3101	3101	3077	3077	2120	1030	1112	962	1003
P-value: low versus high	0.922		0.265		0.0773	0.602			
P-value: medium versus high	0.722		0.204		0.798	0.515			
P-value: low versus medium	0.498		0.00620		0.0582	0.832			
Mean dependent variable	0.131	0.131	0.363	0.363	0.386	0.420	0.256	0.360	0.487

OLS regressions with observations are at individual level. All regressions include age FE, birth year FE, grid-cell FE, and country FE. The full sample includes women aged 25 or older at the time of the interview. Columns 3-8 only includes women who are are not married by age 15. The dependent variable is a dummy equal to one if the woman gets married between age 12 and 14 in column 1-2 abd between age 15 and 17 in column 3-8. Robust standard errors clustered at grid cell level in parentheses *** p<0.01, ** p<0.05, * p<0.1. All regressions are weighted using country population-adjusted survey sampling weights.

Table A13: Prediction 2: The case of Nigeria

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable is a dummy coded as 1:	**In the year the woman gets married**				**If married before 18**	
	Married before 25		Married before 18			
Drought x low polygyny	0.0192***		0.0175**			
	(0.0053)		(0.0077)			
Drought x medium polygyny	-0.0010		-0.0039			
	(0.0047)		(0.0057)			
Drought x high polygyny	-0.0018		0.0003			
	(0.0060)		(0.0065)			
Drought		0.0207***		0.0182**		
		(0.0067)		(0.0085)		
Drought x polygyny rate		-0.0487**		-0.0417*		
		(0.0195)		(0.0227)		
Any drought ages 12-17 x low polygyny					0.0557**	
					(0.0259)	
Any drought ages 12-17 x medium polygyny					-0.0044	
					(0.0199)	
Any drought ages 12-17 x high polygyny					0.0021	
					(0.0163)	
Any drought ages 12-17						0.0499*
						(0.0259)
Any drought ages 12-17 x polygyny rate						-0.1057*
						(0.0619)
Observations	165868	165868	112030	112030	23284	23284
Adjusted R-squared	0.070	0.070	0.098	0.098	0.309	0.309
Number of clusters	268	268	268	268	268	268
P-value: low versus high	0.0101		0.0853		0.0679	
P-value: medium versus high	0.912		0.620		0.785	
P-value: low versus medium	0.00491		0.0249		0.0559	
Mean dependent variable	0.116	0.116	0.105	0.105	0.506	0.506

OLS regressions with observations are at person x age level in columns 1-4 and at individual level in columns 5-6. All regressions include age FE, birth year FE, grid-cell FE, and country FE. The full sample includes women aged 25 or older at the time of the interview. Robust standard errors clustered at grid cell level in parentheses *** p<0.01, ** p<0.05, * p<0.1. All regressions are weighted using country population-adjusted survey sampling weights.

Table A14: P3: Polygyny, PPI/CPI, and Timing of Marriage

	(1)	(2)	(3)	(4)
Dependent variable	**Binary variable coded as 1 in the year the woman gets married**			
Sample	**Rural**		**Urban**	
PPI × low polygyny	-0.0055***		-0.0010	
	(0.0020)		(0.0009)	
PPI × medium polygyny	-0.0015		0.0004	
	(0.0011)		(0.0012)	
PPI × high polygyny	-0.0000		-0.0006	
	(0.0021)		(0.0024)	
CPI × low polygyny	0.0078		0.0158***	
	(0.0053)		(0.0057)	
CPI × medium polygyny	0.0054		0.0141**	
	(0.0059)		(0.0063)	
CPI × high polygyny	0.0125*		0.0036	
	(0.0069)		(0.0079)	
PPI		-0.0063***		-0.0007
		(0.0023)		(0.0014)
PPI × polygyny rate		0.0137**		0.0008
		(0.0068)		(0.0062)
CPI		0.0064		0.0171***
		(0.0053)		(0.0058)
CPI × polygyny rate		0.0122		-0.0213
		(0.0103)		(0.0142)
Observations	965595	965595	642518	642518
Adjusted R-squared	0.068	0.068	0.044	0.044
Number of clusters	2597	2597	1207	1207
P-value for PPI: low versus high	0.0581			
P-value for PPI: medium versus high	0.538			
P-value for PPI: low versus medium	0.0749			
P-value for CPI: low versus high			0.0681	
P-value for CPI: medium versus high			0.114	
P-value for CPI: low versus medium			0.705	
Mean dependent variable	0.134	0.134	0.0884	0.0884

All regressions include age FE, birth year FE, grid-cell FE, and calendar year FE. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. The table shows OLS regressions for SSA. Observations are at the level of person x age (from 12 to 24 or age of first marriage). The dependent variable is a binary variable for marriage, coded to one if the woman married at the age corresponding to the observation. The PPI and CPI are measured in terms of average temporal standard deviations. All Regressions are weighted using country population-adjusted survey sampling weights.

Table A15: P3: Robustness to Polygyny Correlates and Heterogeneity

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	**Binary variable coded as 1 in the year the woman gets married**					
	Accounting for historical controls		**Accounting for education**		**Food Vs cash crops**	
PPI × low polygyny	-0.0070**		-0.0061***			
	(0.0028)		(0.0020)			
PPI × medium polygyny	-0.0059**		-0.0026*			
	(0.0026)		(0.0014)			
PPI × high polygyny	-0.0004		0.0002			
	(0.0028)		(0.0024)			
PPI		-0.0073**		-0.0071***		
		(0.0032)		(0.0023)		
PPI × polygyny rate		0.0100*		0.0150**		
		(0.0059)		(0.0067)		
PPI food crops × low polygyny					-0.0062***	
					(0.0020)	
PPI food crops × medium polygyny					-0.0027*	
					(0.0015)	
PPI food crops × high polygyny					-0.0001	
					(0.0027)	
PPI cash crops × low polygyny					0.0007	
					(0.0009)	
PPI cash crops × medium polygyny					-0.0000	
					(0.0007)	
PPI cash crops × high polygyny					0.0008	
					(0.0006)	
PPI food crops						-0.0072***
						(0.0023)
PPI food crops × polygyny rate						0.0148**
						(0.0069)
PPI cash crops						0.0004
						(0.0009)
PPI cash crops × polygyny rate						0.0000
						(0.0023)
Observations	559425	559425	974389	974389	974426	974426
Ethnicity control interactions	YES	YES	NO	NO	NO	NO
Christian Missions control interactions	YES	YES	NO	NO	NO	NO
No education control interactions	NO	NO	YES	YES	NO	NO
Adjusted R-squared	0.070	0.070	0.071	0.071	0.070	0.070
Number of clusters	1683	1683	2896	2896	2896	2896
P-value: low versus high	0.00692		0.0285		0.0463	
P-value: medium versus high	0.0184		0.233		0.338	
P-value: low versus medium	0.461		0.0961		0.0984	
Mean dependent variable	0.142	0.142	0.134	0.134	0.134	0.134

All regressions include age FE, birth year FE, grid-cell FE, and country × calendar FE. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. The table shows OLS regressions for the rural areas of SSA. Observations are at the level of person x age (from 12 to 24 or age of first marriage). The dependent variable is a binary variable for marriage, coded to one if the woman married at the age corresponding to the observation. The PPI and CPI are measured in terms of average temporal standard deviations. The Wald test p-values in column (5) correspond to the "PPI food crops" variable. All Regressions are weighted using country population-adjusted survey sampling weights.

Table A16: P3: Robustness to Survey Waves and Clustering

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	**Binary variable coded as 1 in the year the woman gets married**							
	Latest survey by country		**Clustering at region level**		**Clustering at country level**		**Trade Weights on PPI**	
PPI × low polygyny	-0.0042***		-0.0060***		-0.0060***		-0.0066**	
	(0.0011)		(0.0019)		(0.0002)		(0.0028)	
PPI × medium polygyny	-0.0037***		-0.0025**		-0.0026***		-0.0020	
	(0.0011)		(0.0013)		(0.0004)		(0.0013)	
PPI × high polygyny	0.0005		0.0006		0.0006		0.0012	
	(0.0018)		(0.0023)		(0.0008)		(0.0014)	
PPI		-0.0051***		-0.0071***		-0.0071***		-0.0078***
		(0.0013)		(0.0020)		(0.0004)		(0.0029)
PPI × polygyny rate		0.0084*		0.0158***		0.0157***		0.0190***
		(0.0047)		(0.0061)		(0.0018)		(0.0070)
Observations	652085	652085	972789	972789	974426	974426	965595	965595
Adjusted R-squared	0.071	0.071	0.070	0.070	0.070	0.070	0.070	0.070
Number of clusters	2580	2580	386	386	29	29	2597	2597
P-value: low versus high	0.0132		0.0109		1.26e-08		0.00547	
P-value: medium versus high	0.0188		0.145		0.00114		0.0268	
P-value: low versus medium	0.717		0.0588		5.16e-09		0.0791	
Mean dependent variable	0.127	0.127	0.134	0.134	0.134	0.134	0.134	0.134

All regressions include age FE, birth year FE, grid-cell FE, and country × calendar FE. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. The table shows OLS regressions for the rural areas of SSA. Observations are at the level of person x age (from 12 to 24 or age of first marriage). The dependent variable is a binary variable for marriage, coded to one if the woman married at the age corresponding to the observation. The PPI is measured in terms of average temporal standard deviations. Columns (7) and (8) show robustness to weighting the PPI crop components by the extent to which they are traded by a each country. Trade weights are defined as the sum of imports and exports divided by total domestic production for a given crop. These weights are averaged over the entire sample period and Winsorized to form a time-invariant weight varying from 0 to 1. Trade and production statistics come from the FAO Statistics Division. All Regressions are weighted using country population-adjusted survey sampling weights.

Table A17: P3: Consequence on Fertility Onset

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable	**Binary variable coded as 1 in the year the woman gets her first child**									
	Fertility onset between age 12-24						**Fertility onset between age 12-17**			
Sample	**All**		**Rural**		**Urban**		**All**		**Rural**	
PPI × low polygyny	-0.0021***		-0.0038***		-0.0004		-0.0012*		-0.0016	
	(0.0005)		(0.0010)		(0.0007)		(0.0007)		(0.0010)	
PPI × medium polygyny	-0.0003		-0.0010		0.0006		-0.0009		-0.0009	
	(0.0008)		(0.0011)		(0.0011)		(0.0009)		(0.0013)	
PPI × high polygyny	0.0015		0.0005		0.0019		0.0012		0.0005	
	(0.0011)		(0.0015)		(0.0016)		(0.0013)		(0.0015)	
PPI		-0.0030***		-0.0047***		-0.0011		-0.0019**		-0.0021*
		(0.0005)		(0.0012)		(0.0008)		(0.0009)		(0.0012)
PPI × polygyny rate		0.0105***		0.0121***		0.0076*		0.0061*		0.0052
		(0.0023)		(0.0038)		(0.0040)		(0.0032)		(0.0038)
Observations	1809171	1809171	1122989	1122989	673650	673650	1072799	1072799	692298	692298
Adjusted R-squared	0.065	0.065	0.073	0.073	0.053	0.053	0.051	0.051	0.055	0.055
Number of clusters	3060	3060	2910	2910	1309	1309	3011	3011	2857	2857
P-value: low versus high	0.000817		0.00824		0.164		0.0665		0.186	
P-value: medium versus high	0.109		0.328		0.424		0.121		0.380	
P-value: low versus medium	0.00862		0.0284		0.297		0.676		0.618	
Mean dependent variable	0.111	0.111	0.123	0.123	0.0918	0.0918	0.0576	0.0576	0.0651	0.0651

All regressions include age FE, birth year FE, grid-cell FE, and country × calendar year FE. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. The table shows OLS regressions for SSA. Observations are at the level of person x age. The dependent variable is a binary variable for first birth, coded to one if the woman gives birth at the age corresponding to the observation. The PPI and CPI are measured in terms of average temporal standard deviations. All Regressions are weighted using country population-adjusted survey sampling weights.

Table A18: Average Effect of Droughts on Early Marriage in SSA

	(1)	(2)	(3)	(4)	(5)
				Bride Price	
		All Sample		YES	NO
Drought	0.0037***	0.0037***	0.0032***	0.0037***	-0.0000
	(0.0012)	(0.0012)	(0.0011)	(0.0012)	(0.0021)
Observations	2,461,176	2,461,176	2,461,176	1,344,485	369,360
Adjusted R-squared	0.0616	0.0616	0.0621	0.0636	0.0646
Age FE	YES	YES	YES	YES	YES
Birth year FE	YES	YES	YES	YES	YES
Grid-cell FE	YES	YES	YES	YES	YES
Country FE	NO	YES	YES	YES	YES
Country FE x Cohort FE	NO	NO	YES	NO	NO
Mean dependent variable	0.112	0.112	0.112	0.118	0.127

Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. The table shows OLS regressions for SSA. The full regression sample includes women aged 25 or older at the time of the interview. Observations are at the level of person x age (from 12 to 24 or age of first marriage). The dependent variable is a binary variable for marriage, coded to one if the woman married at the age corresponding to the observation. Standard errors (in parentheses) are clustered at the grid cell level. A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. All Regressions are weighted using country population-adjusted survey sampling weights.

Table A19: Marriage Migration Patterns by Rainfall Realization at the Time of Marriage

	Born Here		Marriage Migration	
	(1)	(2)	(3)	(4)
Drought x low polygyny	-0.0003		-0.0020	
	(0.0082)		(0.0079)	
Drought x medium polygyny	-0.0096		0.0001	
	(0.0077)		(0.0056)	
Drought x high polygyny	0.0101		-0.0034	
	(0.0115)		(0.0097)	
Drought		-0.0049		0.0019
		(0.0088)		(0.0082)
Drought x polygyny rate		0.0167		-0.0118
		(0.0262)		(0.0243)
Observations	179,293	179,293	176,256	176,256
Adjusted R-squared	0.1565	0.1565	0.1012	0.1012
Mean dependent variable	0.408	0.408	0.172	0.172

All columns include Birth year FE, marriage year FE, and grid cell FE. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. The table shows OLS regressions for SSA. Full regression sample: married women aged 25 or older at the time of interview. A drought is defined as an annual rainfall realization below the 15th percentile of the local rainfall distribution. Results are weighted using population-adjusted survey sampling weights.

Table A20: Marriage Migration Patterns by PPI at the Time of Marriage

	Rural		Urban	
	Born Here	Marriage Migration	Born Here	Marriage Migration
	(1)	(2)	(3)	(4)
PPI × low polygyny	-0.0115***	0.0125*	0.0048	0.0005
	(0.0037)	(0.0064)	(0.0036)	(0.0046)
PPI × medium polygyny	0.0006	0.0031	-0.0072	0.0168*
	(0.0058)	(0.0042)	(0.0083)	(0.0087)
PPI × high polygyny	-0.0141*	0.0112*	0.0421*	0.0104
	(0.0076)	(0.0065)	(0.0215)	(0.0103)
Observations	75,097	73,867	29,943	29,294
Adjusted R-squared	0.1829	0.1154	0.1594	0.0980
Mean dependent variable	0.429	0.214	0.308	0.169

All columns include Birth year FE, marriage year FE, and grid-cell FE. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. The table shows OLS regressions for SSA. Full regression sample: married women aged 25 or older at the time of interview. The PPI is measured in terms of average temporal standard deviations. Results are weighted using population-adjusted survey sampling weights.

Table A21: Polygyny, Weather Shocks, Crop Yield, and Income

	Crop yield		HH consumption		GDP per capita	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Drought	-0.125***		-0.0652**		-0.0482*	
	(0.0271)		(0.0284)		(0.0274)	
Drought x Low Polygyny		-0.142***		-0.0433		-0.00398
		(0.0391)		(0.0394)		(0.0261)
Drought x High Polygyny		-0.109***		-0.0835		-0.0912*
		(0.0374)		(0.0505)		(0.0451)
Observations	1,670	1,670	1,335	1,335	1,455	1,455
Adjusted R-squared	0.736	0.736	0.950	0.950	0.917	0.917
Mean dependent variable	-0.109	-0.109	21.19	21.19	6.756	6.756

All regressions include year and country fixed effects. The dependent variable is the log of annual crop yield (tons per hectare, columns 1–2), household consumption (columns 3–4), and GDP per capita (columns 5-6) for each included country from 1961 to 2010. Crop yield data are from FAOStat; income data are from the World Development Indicators from the World Bank for 1960–2013. Regressions include all SSA countries in the FAOStat and WDI databases. In columns 1 and 2, the dependent variable is the log of the sum of the total production of main crops reported divided by the total area harvested for those crops. GDP per capita is measured in constant 2010 US $, while household final consumption expenditures are measured at the aggregate level in current US $. A drought is defined as an annual rainfall realization below the 15th percentile of the national rainfall distribution. High polygyny countries are countries with average polygyny rates higher than 0.25. It includes Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Cote d'Ivoire, the Democratic Republic of the Congo, Ghana, Guinea, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Swaziland, Togo. Standard errors (in parentheses) are clustered at the country level.