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

Augustin Tapsoba[†]

May 14, 2022

Abstract

This paper studies how short term changes in aggregate economic conditions influence family formation outcomes in presence of polygyny. It develops a simple marriage market framework with overlapping generations in which polygyny is modeled as a sequential one-to-one matching and bride price acts as an important source of consumption smoothing. During drought years, the demand for second spouses from old men is more sensitive to the income and price drop compared to the demand for first/unique spouses that comes from younger men. This leads to an increase in the market share of young men and a much smaller rise in the equilibrium quantity of female child marriage compared to the one observed in monogamous markets. This attenuation effect is such that there is no detectable impact of droughts on the timing of marriage and fertility onset in high polygyny areas. Evidence from global crop price shocks confirms these patterns and shows that higher food prices affect marital outcomes in opposite directions in crop-producing and crop-consuming areas.

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

---

[*] An earlier version of this paper circulated under the title "Polygyny, Timing of Marriage and Economic Shocks in Sub-Saharan Africa". I acknowledge funding from the French National Research Agency (ANR) under the Investments for the Future (Investissements d'Avenir) program, grant ANR-17-EURE-0010. I thank Ingela Alger, Pierre-André Chiappori, Horacio Larreguy, Pauline Rossi, François Salanié and Paul Seabright for their feedback and comments. I also thank participants of the following seminars/conferences: Stanford University, Pacific Development Conference (PACDEV, University of San Francisco) , GIGA-Hamburg, University of Freiburg, North East Universities Development Consortium (NEUDC, Boston), BREAD conference on the economics of Africa, Nordic conference in Development Economics and TSE internal workshops. All errors are mine.

[†] Toulouse School of Economics. Email: augustin.tapsoba@tse-fr.eu

1 Introduction

Local norms and culture are crucial for economic development and the efficacy of policy interventions may depend on the particular context in which they are enacted (Ashraf et al., 2020; Collier, 2017; World Bank, 2015). The marriage market is an important determinant of household welfare that relies heavily on such norms. The extent to which polygyny is practiced is one of the most salient norms of this market in Sub-Saharan Africa.[1] There is indeed a substantial spatial variation in its presence and intensity with some persistence over time (Fenske, 2015; Tertilt, 2005; Jacoby, 1995). Figure 1 shows the share of women in union with a polygamous husband for each 0.5 × 0.5 decimal degree grid cells (split in terciles). Monogamy is the norm in the green cells (lowest tercile) with more than 50% of these cells having a polygyny rate below 5%. On the other side of the spectrum, polygyny rate is higher than 40% in high polygyny areas (red cells for top tercile). This variation is relatively persistent over time with only a slow decline observed in high polygyny areas.[2] This creates strong local social norms that deeply affect the structure of marriage markets and the characteristics of unions that are formed in them.

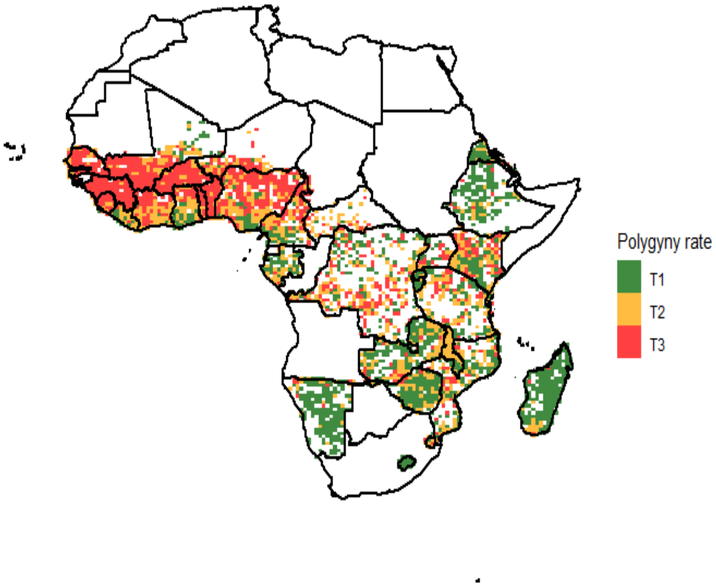
Family formation outcomes play an important role for welfare within the household after a union. In both monogamous and polygamous markets, the timing of marriage is an important marital outcome that affects female welfare. Child marriage is still a common practice across Sub-Saharan Africa (prevalence of 56% (UNICEF, 2019)) and differences in age of marriage are associated with different health, fertility and socio-economic outcomes for women and their offspring (Corno et al., 2020; Duflo et al., 2015; Save the Children, 2004). The presence of polygyny gives rise to additional types of union that also have important consequences for female welfare. First, there is spousal ranking. Marrying as a first or unique spouse (versus marrying as a second or higher order 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). Second, there is spousal age gap. 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). Understanding what drives these key family formation outcomes is therefore crucial for economic policy design and implementation in developing countries.

---

[1] Polygamy is a type of union that includes more than two partners. Polygyny is the most common form of polygamy in which men marry several wives.

[2] The spatial variation in polygyny rates comes from a combination of historic and slow moving cultural factors: precolonial ethnic customs, male income inequality (hierarchy in societies), slave trade, colonial missions and schools, religion, female productivity, etc... (Fenske, 2015; Boserup, 1970; Becker, 1974; Jacoby, 1995; Gould et al., 2008; De La Croix and Mariani, 2015). This explains its persistence over time.

Figure 1: Practice of Polygyny across Space in Sub-Saharan Africa



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 ($\sim$ 50×50 km) weather grid cell using 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%).

This paper studies how aggregate economic forces influence family formation outcomes in presence of polygyny. It aims at understanding how, in these markets, short term variations in aggregate economic conditions affect (i) the timing of unions for girls, (ii) their likelihood of marrying as first/unique spouses (spousal ranking), (iii) their likelihood of marrying husbands with low age gap. Aggregate economic shocks are common in agrarian economies such as those in Sub-Saharan Africa. They affect agents on both the supply and the demand side of the marriage market and this creates some ambiguity/complexity in how such shocks may impact family formation outcomes when polygyny is allowed.

I aim to overcome this ambiguity by modeling the relevant features that characterize marriage markets in Sub-Saharan Africa. I consider an overlapping generation matching model in which each birth cohort of boys and girls are active on the market for at most 2 periods. On the supply side, girls leave the market once they marry. Child marriage (for girls) corresponds to getting married during the first period of being active on the market (between age 12 and 17 for instance). On the demand side, men also leave the market once they get married when polygyny is not allowed. When it is allowed and depending on the strength of the local polygyny norm, a certain share of men remain active on the market after being matched during their first participation. Those among them who find it optimal to second-marry will have two spouses when they exit the marriage market.[3] Polygyny is therefore modeled as a sequential one-to-one matching.

---

[3] Bigamy is by far the most common form of polygyny in Sub-Saharan Africa as shown in Figure A9.

At any given time period, there are two generations of men and women on the market and this may lead to multiple equilibria in the matching pattern. The simplest equilibrium consistent with the data is such that there is an excess quantity of unmarried old men on the market (2nd participation) compared to unmarried old women, leading to a substantial number of cross cohort unions.[4] The market is cleared by the youngest generations 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: a demand for first/unique spouses from young adult men and a demand for second spouses from older men. In monogamous marriage markets only the former exists.

When aggregate income is low, many households prefer bringing forward their daughters' marriage in order to smooth consumption with the bride price (payment made by the groom's family in order to ratify the marriage). 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 as well. The relative sensitivity of the demand for first/unique spouse to the income and price drop compared to the demand for second spouse will determine which component will see an increase in their market share when aggregate income is low. I show that if the extra utility that men derive from marrying a second spouse is high enough, the demand for second spouses is more elastic to income and price changes. This means that negative shocks will lead to a decrease in their market shares at the benefit of younger men that are looking for a first/unique spouse.

The second prediction of the model is on how aggregate shocks affect the timing of marriage for girls. The equilibrium quantities of child marriage will vary depending on which side of the market is more elastic to the income and price decline. Child marriage increases in case of monogamy because the supply is more elastic than the demand for a unique spouse (Corno et al., 2020).[5] When polygyny is allowed, the fact that the demand for second spouses is more elastic to income and price changes compared to the demand for first/unique spouses implies that the overall demand will be more sensitive to income and price changes. This leads to a much smaller rise in the equilibrium quantity of child marriage compared to the one observed when the market does not allow for polygyny. The magnitude of this attenuation effect depends on the strength of the polygyny norm. Areas with the highest levels of polygyny norm will have a much smaller change (if any) in the equilibrium quantity of child marriage when there is a negative shock.

To test the implications of the model, I examine the effect of rainfall shocks and global food price shocks on the key family formation outcomes mentioned above. Rainfall shocks are a major and plausibly exogenous source of income variability in areas that rely on rain-fed agriculture. Low levels of rainfall

---

[4] Data shows that age of marriage for women that are unique, first and second spouses are very similar (see Appendix Figure A10) and there is a large age gap between husband and 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 A11).

[5] As in Corno et al. (2020), the difference in income and price-elasticity of supply and demand comes from the contribution of the son to his parents' consumption when he is adult due to patrilocality.

reduce annual crop yields by 10 % on average but there is no clear positive relationship between higher rainfall realization and crop yields in Sub-Saharan Africa (Corno et al., 2020). To test whether households and markets react in symmetric way to positive and negative shocks, I also use income variation induced by plausibly exogenous changes in world agricultural prices.[6] These can generate opposing effects for areas that produce crops and areas that are net-consumers. A rise in crop price such as the one observed during the last (agricultural) commodity super cycle that peaked with the food crisis of 2007-2008 and 2010-2011 increased real income in crop-producing areas and decreased it in net-consuming areas (Verpoorten et al., 2013). This has been shown to also 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 level of production) while the latter is a production shock.

I use Demographic and Health Surveys (DHS) survey data for more than 300,000 women spread across Sub-Saharan Africa and rainfall data from the University of Delaware Air Temperature and Precipitation project (UDel) to evaluate the impact of droughts on family formation outcomes in 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. Being exposed to a drought between ages 12 and 24 significantly decreases spousal age gap by a year on average (10 percent of average age gap) in high polygyny areas.[7] It also decreases the likelihood of marrying as second/ higher order spouse by 2.5 percentage points (14 percent of average share of second/higher order spouses). This evidence shows that the demand for second spouses is more sensitive to income and price drop that comes from droughts compared to the demand for first/unique spouses.

The empirical evidence also shows that droughts have a bigger impact on the hazard of child marriage (between ages 12 and 17) and early marriage (between 12 and 24) in areas with less polygamy. In monogamous markets, a drought raises the average annual hazard of child marriage by 5%.[8] This effect is decreasing 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 effect 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.

---

[6] Households may move forward the timing of marriage of their daughters when facing a negative shock but fail to delay it when the shock is a positive one. This type of behavior is for instance 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).

[7] Droughts have no effect on spousal age gap in low polygyny areas.

[8] This represents almost the double of the average effect documented in Corno et al. (2020)

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. A standard deviation rise in PPI increases the hazard of early marriage by 0.6 percentage points for women living in rural areas in low polygyny cell grids. This effect is halved in medium polygyny areas and vanishes in high polygyny areas. In these areas, the rise in PPI increases the market shares of old men looking for a second spouse at the expense of younger ones. The rise in CPI has opposite effects for women living in urban areas: A standard deviation increase in CPI rises the hazard of early marriage by 1.5 percentage points in low and medium polygyny areas, but has no significant effect in high polygyny areas.

These differences in equilibrium response of marriage outcomes to short term shocks translate into differences in fertility onset and levels by age 25.[9] Sensitivity and robustness checks show that the documented patterns are present only among women from ethnic groups that practice bride price payment (as predicted by the model). Importantly, they are not driven by other cultural factors that may be correlated with polygyny such as religion or matrilineal/patrilineal kinship systems. They are also not driven by differences in the reaction of the supply side of the market to the shocks, differential migration, differential sizes of the relevant marriage markets, or differential effects of the shocks on household income.

The findings in this paper have two main policy implications. First, they suggest that policies that generate windfall aggregate income during "normal years" (such as large-scale cash transfer programs) can reduce child marriage in monogamous areas, but they will have unintended negative consequences for marital outcomes in high polygyny areas.[10] In equilibrium, the extra income will basically fund more second-unions for older men with limited resources. Second, aggregate income stabilization policies are more efficient/needed in monogamous areas since they can help against an increase in child marriage that will otherwise occur in these areas. In polygamous areas however, negative shocks can create opportunities for young men because they are more likely to find a spouse and for women because they are more likely to marry younger men as first spouses (which improves their bargaining power within the household). Aggregate income stabilization policies will act as a push against this compositional change without improving the equilibrium quantity of child marriage. In presence of polygyny, it is therefore crucial to target interventions that aim at improving marital outcomes to only on one side of the market (often the supply side for ethical reasons). This paper gives therefore clear recommendations on the optimal targeting of different policy instruments that can affect marital outcomes.

---

[9] 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).

[10] The evidence on how markets react to positive shocks is what allows me to infer the potential effect of policy interventions that generate windfall aggregate income. The evidence provided by negative shocks such as droughts could not sustain by itself such policy conclusion given the possibility of asymmetric reactions.

Related Literature

This paper is related to three main strands of economic literature. First, it contributes to a recent and growing literature on the effect of income shocks on marital decisions in developing countries (Corno and Voena, 2021; Corno et al., 2020; Rexer, 2020; Hoogeveen et al., 2011; Chort et al., 2021). These papers assume that marriages are monogamous and therefore only focus on the impact of aggregate shocks on marriage timing. Corno et al. (2020) use a supply and demand model with a one-to-one marriage matching framework to show that the effect of droughts on marriage timing depends on the direction of marriage payment: It increases child marriage in presence of bride price (paid by groom's family) and decreases it in presence of dowry (paid by bride's family). The other papers also focus on rainfall shocks as source of variation in aggregate economic conditions and study their impact on timing of marriage for girls. Rexer (2020) studies how rainfall shocks can increase violence (using the case of Boko Haram insurgency in Nigeria) through their impact on marriage inequality which can be related to marriage timing for girls (but not necessarily). He treats rainfall variations as a supply side shocks and argues that exposure to high rainfall realization between age 12 and 16 leads to a bigger delay in marriage timing in polygamous markets compared to monogamous ones because of the possibility of marrying off daughters to already married rich men. This supply side mechanism is not consistent with the evidence presented here which shows that rainfall shocks on the contrary have a stronger effect on the annual hazard of child/early marriage in monogamous areas.[11]

My paper adds to this literature in several respects. First, it extends the one-to-one matching framework to analyze how aggregate economic conditions affect marital outcomes when polygyny is allowed. The presence of polygyny gives rise to two other key family formation outcomes besides the timing of marriage that are also affected by aggregate economic conditions: wife ranking and age gap with husband. These three marital outcomes interact with each other and with short term economic shocks in non-trivial ways that are explicitly modeled and empirically documented for the first time in this paper. Second, I also use an additional source of variation in aggregate income that has not been used before in this literature: changes in real income due to global commodity price fluctuations. As argued earlier, this generates both positive and negative shocks for food-producing and food-consuming areas and is used to confirm that households and markets react in a symmetric way to aggregate shocks.

Second, this paper contributes to the large literature that investigates the coping mechanisms used by poor households to deal with income shocks (Rosenzweig and Stark, 1989; Townsend, 1994; Fafchamps and Lund, 2003; Kazianga and Udry, 2006; Jayachandran, 2006; Morten, 2019). Receiving bride price

---

[11] This is the case also when I use the DHS sample from Nigeria (see Appendix Section A.6 for more details). Importantly, my analysis abstracts from the potentially complex interaction between violence and marital decisions by focusing on the cohorts of girls that are not exposed to any conflict when they are making marital decisions (no conflict before age 25). I also treat rainfall shocks as aggregate economic shocks that affect both the demand and supply side of the market in a given year.

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, negative 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. This can improve welfare for two reasons. First, women who marry in these hard times may benefit from marrying as first/unique spouses to younger men as argued earlier. Second, there is evidence suggesting 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.[12] By showing that even temporary shocks affect spousal ranking, this paper also contributes to a growing literature on the determinants and consequences of wife seniority in polygamous households (Reynoso, 2019; Matz, 2016; Rossi, 2019; André and Dupraz, 2019).

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 marriage market to aggregate income shocks. Taking marriage market structure into account when designing and implementing policy interventions is therefore crucial.

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 discusses the empirical strategy used to test the main predictions of the model. Section 5 shows the main empirical results and some robustness checks. Section 6 concludes.

2 Model

In this section, I propose a simple model to study how marital outcomes react to short term aggregate economic shocks in presence of polygyny. It is a supply and demand marriage market model that features 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.

---

[12] In polygynous societies and those with 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, 2020; Koos and Neupert-Wentz, 2020).

2.1 Set Up

Market Structure: Marriage market at each period t involves men and women of two consecutive birth cohorts as shown in Table 1. On the demand side of the market, teenage sons (cohort B_1) are too young to participate to the market. Only adult sons are active on the marriage market. Young adult sons ($\mathcal{U}_y^m$) are the youngest men on the market and old adult sons are the oldest. Each birth cohort is active on the market for only 2 periods and leaves the market for good afterwards. Sons can marry only once per period. When polygyny is allowed, they can remain active on the market for a second period after a union in their first period of participation. This happens with probability p. In case of monogamy ($p = 0$) they leave the market for good after a union.

On the supply side of the market, teenage daughters (cohort B_1) are already active and can potentially be married off by their parents.[13] They are the youngest cohort on the marriage market at period t. The oldest cohort are young adult daughters (B_2). Older daughters (B_3) are not active on the market anymore because their fertility prospects become 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.[14]

The last row of Table 1 shows whether a child is old enough to emancipate economically from his parents: run autonomously his/her own production and consumption unit. Until young adulthood, sons are part of their parents production and consumption unit with a positive net contribution $w_y^m > 0$. The parents decide to support the marriage of their son at this stage or not. The son then splits/emancipates and creates his own production/consumption unit when he becomes an old adult.[15]

After their economic emancipation, old adult sons still contribute to their parents household consumption because of patrilocality. I assume that this contribution is higher if they got married during young adulthood ($w_o^{m,h} > w_o^{m,l}$). Several factors support this assumption. First, being single can prevent the newly emancipated son from producing resources at his full potential.[16] 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 the consumption/production unit of their parents to that of their husband's

---

[13] In the data, 54% of girls are married by age 18 versus less than 1% for men.

[14] Divorce rates are relatively high in Sub-Saharan Africa 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 after 10 years after their first union. Divorces are mostly driven by factors other than polygyny such as urbanization, education, female employment, kinship systems, etc... Divorce rates are even higher in monogamous areas compared to polygamous ones.

[15] There is ample evidence that parents are very involved in the first union of their sons (especially 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. However, the decision to marry a second spouse and the expenses involved in it are mostly paid for by the groom himself, with little involvement of his parents (Goldschmidt, 1974; Mondain et al., 2004; Antoine et al., 2002).

[16] Having a spouse brings socio-emotional stability, extra labor force and motivation to a young man.

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)

family when they get married (patrilocality).[17] They are no longer active on the marriage market by the time they could emancipate from their parents so they would have to remain single forever in this case. The net contribution of a daughter to her parents (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, while for sons, it is taken by their parents during young adulthood and by themselves when they become old adults.

Men that marry young at period $t-1$ can be looking for a second spouse at period t. The extent to which this happens in a given market is determined by its local social norm. This norm is constant over time and varies from one market to another for reasons exogenous to the model, as argued in Section 3.4. Let $p \in [0,1]$ denote the share of men that are active on the market for second spouses. $p = 0$ means polygyny is not allowed 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 that is looking for a second spouse will be able to find/afford one. The equilibrium share of men that marry a second spouse is therefore determined endogenously within the model. I assume a balanced sex ratio by birth cohort and the population grows at a constant rate a from one cohort to the next one. For simplicity, I also assume that each family has only one child, male or female.

Marriage and bride price: Each marriage involves the payment of a unique bride price (τ_t) that clears supply and demand on a given market. Markets are assumed to be independent from one another. The equilibrium bride price that clears supply and demand can be higher in markets with stronger polygyny norms due to the higher demand for brides as argued in Grossbard (1978) and Goldschmidt (1974) but there is no heterogeneity on the supply side of the market in this model. 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

---

[17] Patrilocality is a key feature in the model. It is often practiced in patrilineal societies which is the most common kinship/inheritance system in Sub-Saharan Africa as shown in Figure A7. Lowes (2017) is one of the few studies that collects information on matrilocality in Congo and she reports that it happens to less than 10% of men in her sample even in matrilineal societies.

all the brides are assumed to be equivalent in the model. In practice, there is some variation in the amount of bride price payments but the existing evidence does not point towards a systematic difference between first/unique spouses and second spouses. Goldschmidt (1974) for instance studied bride price payments among some tribes in East Africa and found no difference in bride price of first/unique spouses and second/third spouses. He explains it by the fact that there are two type of men that marry a second spouse. The first type are men with limited resources who are persuaded by social/peer pressure to marry a second time. They can ill afford it and often seek arrangements that they can manage. They end up marrying less desirable women as second spouses in order to pay a lower bride price. The second type are rich old men that are seeking particularly attractive young women and are willing to pay more to get one. It is not clear whether there is an overall selection effect in one direction or the other. Allowing for heterogeneity on the supply side will therefore unnecessarily complicate the model and require even stronger assumptions in absence of data on actual bride price payments and other relevant bride characteristics at the time of marriage.

I assume that the monetary market is incomplete and there is no borrowing or savings across periods. Next period is discounted at a rate δ. Each family decides to have their child marry or not when they are young adults or younger (for girls). Parents are authoritarian not altruistic. Old adult sons make their own marital decision because they are emancipated from their parents' household at this age.

Future Utility: Families derive some utility in future periods from having their child marry by the time they are leaving the marriage market:

- For groom's family: It captures the future net contributions of their son's family to their own resources. When the parents are too old to work, this can be interpreted as a within family pension system in which married sons contribute to the consumption of their elderly parents. The presence of sons' offspring provides an extra motivation for them to make such contributions to set an example and reinforce the norm for their own benefit in future. 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.[18]
- For bride's family: This can capture contributions from the groom's family whether occasional (gifts, insurance against negative shocks, etc...) or regular. These contributions are smaller than the ones that the groom's parents receive in patrilocal societies.

Let $V_M^{m,f}$ denote the discounted sum of expected utility for a father (or household head) of a son who gets married. $V_M^{m,nf}$ is the discounted sum of expected utility for a son (nf for non-father) who gets

---

[18] 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) and signals a certain social status in areas where polygyny is endorsed. The alternative view that it is practiced mostly for economic and productive reasons has little support in the data (Goody, 1973; Fenske, 2013; Lee, 1979; Goldschmidt, 1974).

married. The decision maker in the supply side is always the father of the girl (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 he/she exits the market. Thinking about the benefit of having your child married in terms of increased future consumption utility allows us to depart from assumption made in Corno et al. (2020) that ties this benefit to preference factors such as acquiring offspring through a son or avoiding the social stigma of having an unmarried old daughter.

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 year (depending on aggregate shocks). The idiosyncratic shocks are iid with pdf f. Households have Constant Relative Risk Aversion Utility (CRRA) over consumption each period: $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$, $\gamma \geq 1$.

2.2 Equilibrium Matching Process

At each period t, there are 2 overlapping generations on the marriage market. It is therefore important to establish who matches with whom in equilibrium. Multiple equilibria in the matching pattern are possible in theory but the data seems to support 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 (even without any polygyny). 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 a unique spouse. They have a higher willingness to pay for a bride compared to men of the youngest generation.
- Men from the youngest generation can only marry women from youngest generation on the marriage market.
- All second spouses are from the youngest generation.[19]

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 the population growth. Men/women from the oldest generation on the market have the highest willingness to *pay a bride price/accept a bride price* in order to be matched. All the men from the youngest generation are willing to marry but their family may not have the resources for it and they have the outside option of waiting for next period. For a given bride price, many parents of young girls may want to keep them off the marriage market

---

[19] 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 for some old women to become second spouses. What matters is that a substantial share of second spouses marry as child brides as it is the case in the data (see footnote 4, Appendix Figure A10 and A11).

unless forced financially to do otherwise. The market is therefore cleared by the males and females of the youngest generation on the market. There will be a unique equilibrium bride price in each period for all the women. 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's 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 value 1 if the person is married at the beginning of period t. The payoffs for families of "old" children (2nd participation to the market) unmarried at the beginning t:[20]

$U^f_{o,t}(b_t|M_{t-1} = 0, y_t, \epsilon_{ti}, \tau_t) = u\big(y_t + \epsilon_{ti} + w^f_o + b_t(\tau_t - w^f_o)\big) + b_t V^f_M + (1 - b_t)V^f_U$

$U^m_{o,t}(b_t|M_{t-1} = 0, y_t, \epsilon_{tj}, \tau_t) = u\big(y_t + \epsilon_{tj} - w^{m,l}_o - b_t(\tau_t - w^f_g)\big) + b_t V^{m,nf}_M + (1 - b_t)V^m_U$,

where $g \in \{o, y\}$.

The payoffs for families of "old" children married at the beginning of t:

$U^f_{o,t}(b_t|M_{t-1} = 1, y_t, \epsilon_{ti}) = u\big(y_t + \epsilon_{ti}\big) + V^f_M$

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

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

Any bride price τ_t such that $U^s_{o,t}(b_t = 1|M_{t-1} = 0, y_t, \epsilon_t, \tau_t) \geq U^s_{o,t}(b_t = 0|M_{t-1} = 0, y_t, \epsilon_t)$ is acceptable for a union to happen between a pair of families. The main incentive for not remaining single is due to the future expected consumption utility that comes from being married for males (or their parents) in the demand side of the market or having a married daughter for the supply side of the market. Old sons that are already married at the beginning of period t can decide to look for a second spouse with probability p. They trade-off in this case the extra cost of marrying a second spouse with the extra expected future utility from 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 $\epsilon_{tj} > \epsilon^*_{m,2}$ 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

---

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

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 $(V^{m,nf}_{M2} - V^{m,nf}_{M})$.[21]

2.4 Phase 1: Adolescence/Young Adulthood

Parents are the decision makers at this stage for both boys and girls. For a given bride price τ_t, their payoffs are:

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

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

$\bar{V}^s_{o,t+1}$ represents the sum of future consumption utility for parents. The expectation terms are taken with respect to the future realizations of aggregate income and idiosyncratic shocks. A family with a potential young bride and a family with a potential young groom will want to marry them off at period t if $U^s_{y,t}(b_t = 1|M_{t-1} = 0, y_t, \epsilon_t, \tau_t) \geq U^s_{y,t}(b_t = 0|M_{t-1} = 0, y_t, \epsilon_t, \tau_t)$. 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 the daughter to her parents household: $\tau_t > w^f_y$. With these constraints, a threshold rule on ϵ_{ti} will determine the fraction of child marriages 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 first period of participation to the market. All families on the supply side with $\epsilon_{ti} < \epsilon^*_f(\tau_t, y_t)$ and all families on the demand side with $\epsilon_{tj} > \epsilon^*_m(\tau_t, y_t)$ will want to marry off their children.

Proof: See Appendix section A.1.2

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

2.4.1 Supply and Demand for Brides

Given the equilibrium matching pattern, the demand for child brides comes from 3 sources:

- Old single men who cannot find an adult spouse because a big share of women in their marriage market cohort are already married to older men at $t - 1$.
- Potential young grooms whose family received a high enough shock $\epsilon_{tj} > \epsilon^*_m$.
- Old and married men whose family received high enough shock $\epsilon_{tj} > \epsilon^*_{m,2}$ for them to marry a second spouse.

---

[21] This will play a crucial in how polygyny affects the equilibrium reaction of marriage markets to aggregate shocks.

Supply for child brides comes from households with a low enough shock ϵ_{ti} to marry their daughters as child brides. This demand and supply of child brides will determine an equilibrium bride price that clears the market. Under concavity, the poorest households with a daughter want to receive a bride price and the richest ones with a son looking for a spouse want to pay it.

Proposition 3: The income elasticities are such that 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 ($S_y = \frac{\partial S(\tau_t, y_t)}{\partial y_t} < 0$). The price elasticities are such that 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 ($V_{M2}^{m,nf} - V_{M}^{m,nf}$) 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 a second spouses.

Proof: See Appendix section A.1.4.

The threshold for marrying a second spouse ($\epsilon^*_{m,2}$) is a decreasing function of $V_{M2}^{m,nf} - V_{M}^{m,nf}$. When the latter is high enough, concavity implies that the demand for second spouses is more sensitive to income and price change 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 Sub-Saharan Africa where polygamy is not just practiced by a rich elite but is also almost equally common among less rich and poorer men (Heath et al., 2020; Boltz and Chort, 2019; Antoine et al., 2002).[22]

Proposition 5: Lower aggregate income increases child marriage in equilibrium when polygyny is not allowed $\left(Q^*_y = \frac{dQ^*(y_t)}{dy_t} < 0\right)$. In presence of polygyny, this increase in child marriage is weaker as p increases $\left(\frac{dQ^*_y}{dp} > 0\right)$ when $V_{M2}^{m,nf} - V_{M}^{m,nf}$ is high enough.

Proof: See Appendix section A.1.5.

When there is only monogamy on the market ($p = 0$), the overall effect of a negative aggregate economic shock depends on the differences in income-elasticity and price-elasticity of supply and demand for child brides. As shown in the proof, $sgn\left(Q^*_y = \frac{dQ^*(y_t)}{dy_t}\right) = sgn\left(\frac{S_y}{S_\tau} - \frac{D_y}{D_\tau}\right) < 0$. 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.

For the second part, I show that when $p > 0$:

$$sgn\left(\frac{dQ^*_y}{dp}\right) = sgn\left[\frac{dD_y}{dp}(S_\tau - D_\tau) - \frac{dD_\tau}{dp}(S_y - D_y)\right] > 0$$

---

[22] Marrying a second spouse still requires resources and some of the poorest men will not be able to afford it throughout their life.

The threshold for marrying a second spouse $\epsilon^*_{m,2}$ is a decreasing function of the extra utility that men derive from having 2 spouses ($V^{m,nf}_{M2} - V^{m,nf}_{M}$). When this difference is high enough, the income to price-elasticity ratio is higher (in absolute value) for the demand for a second spouse compared to the demand for a first/unique spouse which explains the positive sign.[23] 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.

Proposition 4 and 5 are testable predictions that I take to the data. A third (implicit) testable prediction of the model is that households and market should react in a symmetric way to positive and negative aggregate shocks. I exploit the persistent spatial variation in the extent to which polygyny is practiced in Sub-Saharan Africa to test these three predictions of the model. 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 ($V^{m,nf}_{M2} - V^{m,nf}_{M}$). One can think of it as having similar geographic areas in terms of economic activity and level of productivity for a given vector of inputs, with the only difference being that some of these areas have high p because of a combination of traditional norms, religion, exposure to slave trade and colonial institutions and other historic factors as argued below.[24]

3 Data and Descriptive Evidence

I provide here a general overview of the different datasets used to test the predictions of the model. I also discuss some key descriptive evidence.

3.1 Marriage, Ethnicity and Religion 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 around the world. The final dataset assembles all the publicly available DHS surveys in Sub-Saharan Africa 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.[25] 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

---

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

[24] The rural-urban divide is for instance one source of variation in p that may be linked to variation in $V^{m,nf}_{M2} - V^{m,nf}_{M}$ but this is not the kind of variation that the empirical exercise in this paper relies on.

[25] Validation studies show that women's recollection of marriage year is accurate enough so the estimated results that use this information are not likely to be substantially downward-biased (Pullum, 2006).

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 Sub-Saharan Africa. 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 exposure to droughts and crop price shocks over time for each survey respondent.

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, but not all 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 that are married to a husband who is polygynous. I also use information on religion, which is available for most, but not all DHS surveys. The codes for religion are country specific and I harmonize them into 3 main groups: Christians, Muslims, and Animist/other religion. There is clearly a link between religious beliefs and the practice of polygyny. Polygyny is formally forbidden in most Christian religions and is accepted/tolerated and sometimes even encouraged in Islam and most traditional religions in Sub-Saharan Africa. There is however a substantial variation in the religious mix and the extent of polygyny across space. This allows me to check whether the results are driven by religion or not. The information on ethnic groups in the DHS is also used to merge the data with precolonial ethnic characteristics such as the presence of bride price payment and the kinship system from the Atlas of Precolonial Societies (Müller et al., 2010; Murdock, 1967).

3.2 Rainfall Data and 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. 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).[26] I also explore robustness around that threshold and to the use of continuous rainfall measure. The GPS information in the DHS data is used to match each DHS cluster to a weather grid cell. The final sample matches over 3,000 unique 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 generates essentially a negative aggregate income shock. As shown in Appendix Figure A1, lowest vingtiles of rainfall realizations lead to a substantial drop in crop yield (10% on average) but there is no clear positive relationship between higher rainfall realizations and country level crop yields. Second, this measure of

---

[26] The long-run time series of rainfall observations are use to fit a gamma distribution of calendar year rainfall for each location.

rainfall shock is orthogonal to permanent local characteristics which are likely to influence the family formation outcomes considered here or the extent to which polygyny is practiced. If rainfall realizations are iid, 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.

3.3 Commodity Price Shocks

Following Burke et al. (2015), I construct local price series that combine plausibly exogenous temporal variation in global crop prices with local-level 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 20007 and 2010 were for instance driven by factors such as weather shocks in main supplier 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.

3.3.1 Producer Price Index (PPI)

The producer price index (PPI) is obtained by combining the temporal variation in world prices with rich, high-resolution spatial variation in crop-specific agricultural land cover circa 2000 from the M3-Cropland project (see Ramankutty et al. (2008) for more details). [27] 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 the crop j share of land in cell g and π_{jt} the global price index of crop j in year t. The index varies over time only because of plausibly exogenous international price changes. Following Burke et al. (2015), I also define PPI^{food}_{gct} an index of prices for

---

[27] Appendix Figure A3 presents crop specific maps for a selection of six major commodities (maize, rice, wheat, sorghum, cocoa, and coffee).

food crops (those that constitute more than 1% of calorie consumption in the entire sample) and PPI_{gct}^{cash} is an index of prices for cash crops (the rest).

3.3.2 Consumer Price Index (CPI)

The CPI is constructed in a similar spirit but the spatial variation comes instead from country-level data on food consumption contained in the FAO food balance sheets (see Burke et al. (2015) 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 that are consumed in Africa and for which world prices exist, making up 56% of calorie consumption in the sample.[28]

3.4 Variation in the Practice of Polygyny in Sub-Saharan Africa

3.4.1 Practice of Polygyny over Time

I first investigate the evolution of polygyny rates at country level over time. Figure A13 shows the share of women aged 25 and older that are in union with a polygynous husband for each DHS wave.[29] Most countries have more than one wave and the graph shows some stability in the practice of polygyny. Polygyny rates are constantly low in countries like Madagascar and to a lesser extent, in Namibia, Rwanda, Zambia and Zimbabwe (below 20%). Monogamy is by far the norm in these countries and polygyny is rather marginal or practiced in very few areas within each country. Polygyny rates are also fairly constant for countries with intermediate levels of polygyny (between 20 and 40 %) such as Côte D'Ivoire, Cameroun, Kenya, etc... There is at best a relatively slow decline in polygyny rates for countries with high levels of polygyny such as Benin, Burkina Faso, Mali, Guinea, etc.. The decline (when there is one) is such that these countries still have higher levels of polygyny around 2015 than those with medium level of polygyny around 1995.

---

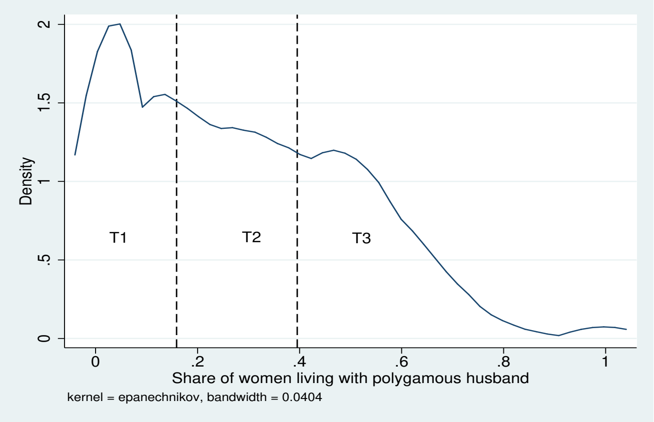
[28] The list includes important staples such as maize, wheat, rice, and sorghum, as well as sugar and palm oil, which are used to process other foods.

[29] Figure A14 shows the same graph when I restrict the sample to women that married at most 10 years before each DHS survey wave. This is a flow variable since DHS waves are at least 5 years apart from each other. The qualitative picture remains the same but the levels are lower since this is a flow variable and it mostly counts second spouses in the numerator.

3.4.2 Spatial Variation in the Practice of Polygyny

Here I investigate the spatial variation in the practice of polygyny. I aggregate the household survey data in the main sample into cell grid 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.[30] Figure 2 shows 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 3,201 grid cells (exactly 504 of them) have zero polygyny rate and the other 15% of the bottom tercile have a polygyny rate between 0 and 16%. Monogamy is the local norm on the marriage market in these cells. On the other side of the spectrum, around 18% of all cells have a polygyny rate higher than 50%. In the main analysis, I use the continuous polygyny rate as a measure of the extent to which polygyny is practiced in each area. To simplify the quantification of the effects and focus on major variations in the practice of polygyny, I also use the discretized measure (terciles).

Figure 2: 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%).

I then investigate the spatial variation in the practice of polygyny. Figure 1 shows the dispersion in space of grid cells with low, medium or high polygyny rates. 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 goes from Senegal and Guinea to Nigeria through countries like Mali, Burkina Faso, Benin and Togo. Polygyny is less prevalent on average in Central, Eastern and

---

[30] Information on presence of potential co-spouses is collected in DHS surveys that cover 3,201 grid cells out of the 3, 250 cells that are in the main sample.

Southern African countries. There is however important variations within each country.

In some West African countries, such as Burkina Faso and Guinea, we have a sea of red cells (high polygyny) with few islands of yellow cells (main urban centers for instance). In others, we have the 3 polygyny levels that appear in a compact and progressive way when we move from one side of the country to another. This is the case in Ghana for instance, where the North has high polygyny rates, the Center medium polygyny rates and the South low polygyny rates. Most countries in Central Africa also have a mix of cells with all 3 levels of polygyny, but with very little clustering in space. This is the case for countries like Democratic Republic of Congo and Tanzania. In countries like Madagascar and Eritrea, we have a sea of green grid cells (low polygyny) with few islands of yellow and red cells. Lesotho is the only country where all the cells are green. Polygyny rates are lower than 7% in all areas in this country.[31]

The practice of polygyny is therefore a very local norm with a spatial distribution pattern that varies substantially across countries/regions. I take these local norms as given in the analysis and try to understand how this might affect the equilibrium outcomes on the marriage market when there is a temporary aggregate economic shock.

3.4.3 Source of Heterogeneity in Polygyny Norms

The determinants of polygyny have been the focus of a large theoretical and empirical literature in economics. Among the factors considered in the literature we have income inequality, slave trade, religion, education, colonial missions and schools, pre-colonial ethnic customs, technological progress and female productivity (Boserup, 1970; Becker, 1974; Jacoby, 1995; Gould et al., 2008; Fenske, 2015; De La Croix and Mariani, 2015). In particular, Fenske (2015) has shown that historical factors explain more the spatial variation in the practice of polygyny compared to contemporaneous ones. It shows for instance that modern female education does not reduce polygamy but colonial schooling does. 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 variation in the practice of polygyny. Two of the most important factors that generate a substantial variation in polygyny norms are religion (Islam and traditional religions versus Christianity) and kinship systems (patrilineal versus matrilineal). I use the variation in the joint distribution of polygyny and each of these factors across space to check that the documented effects are not driven by them (see Appendix A.4.3 for more details).

---

[31] Given the regional differences in patterns of polygyny rates across space, I check in appendix Table A11 that the results hold within sub-regions.

4 Empirical Strategy

4.1 Prediction 1: Do droughts increase the likelihood of marrying a younger man as first/unique spouse in presence of polygyny?

The first prediction of the model is that in presence of polygyny, negative aggregate shocks should increase the market shares of young men that are looking for first/unique spouses at the expense of older men that are looking for second spouses. This means that women exposed to droughts should be more likely to marry younger men and to marry as first/unique spouses. I test this prediction in two ways. First, I check whether this is the case for women exposed to a drought between age 12 and 24 (peak marriageable age) using the following specifications:

$$Y_{i,g,k} = \alpha D_{i,g,k} + \theta D_{i,g,k} \times P_g + \omega_g + \gamma_k + \epsilon_{i,g,k}, \tag{3}$$

$$Y_{i,g,k} = \alpha^l D^l_{i,g,k} + \alpha^m D^m_{i,g,k} + \alpha^h D^h_{i,g,k} + \omega_g + \gamma_k + \epsilon_{i,g,k}. \tag{4}$$

$Y_{i,g,k}$ represents the union characteristics: age gap with husband or whether woman i gets married as a junior spouse (second spouse or higher order spouse). The variable $D_{i,g,k}$ is a dummy equal to 1 if woman i born in cell g in year k has been exposed to a drought between age 12 and 24. 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. 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. It captures in particular all the historical determinants of the spatial variation in long-term polygyny rates P_g. γ_k are year-of-birth fixed effects that account for cohort effects such as exposure to any common shock at a specific time. Sampling weights reweighted by each country's population in the year of the survey 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.

A drought is defined as a calendar year rainfall below the 15th percentile of that location's historical rainfall distribution. This implies that all the locations have the same probability of experiencing a drought in any given year but its timing is random. By construction, exposure to a drought within a fixed time window should therefore be orthogonal to unobserved local characteristics. The identifying variation comes from the random timing of the shocks. The extent to which polygyny is practiced in Sub-Saharan Africa is determined by a combination of historical factors as argued in Section 3. The time-invariant variation in polygyny rates P_g is absorbed by the location fixed effects and orthogonal to time varying shocks.

To simplify the interpretation of the coefficients and stress on the fact that identification relies only on the substantial spatial variations in polygyny rates, I also discretize the continuous variable P_g into 3 terciles and run the specification in Equation 4.[32] The variation over time in polygyny rates is such that almost all the cells remain in the same tercile over the 20 years of data that I have in the DHS surveys.[33] The model predicts that exposure to droughts decreases husband age gap only in polygamous areas and it decreases the likelihood of marrying into a polygamous household in these areas: $\alpha = 0$ and $\theta < 0$ in Equation 3 or at least $\alpha^h < 0$ and $\alpha^l = 0$ in Equation 4. Not all the women exposed to a drought marry in the year in which the drought occurred and this may lead to some attenuation bias in the previous specifications. An alternative specification is to compare the characteristics of unions for women that marry during droughts to those that marry in normal years as described in Appendix A.2.

4.2 Prediction 2: Do droughts have a weaker impact on early marriage in more polygamous areas?

The empirical strategy to test this prediction uses an approximation of a duration model adapted from Currie and Neidell (2005) following Corno et al. (2020). The duration of interest is the time between $t_0 = 12$, the age when a woman is first at risk of getting married, and t_m, the age when she enters her first marriage. The original data is converted into person-year panel format. A woman who is 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. Since I am interested in early marriage, I examine data on women until age 24 or 17 depending on the specification.[34] This data is then merged with the yearly rainfall data. Since marriages occur uniformly during a given year in Sub-Saharan Africa, the merge is done considering the calendar year in which a woman is of age t. This person-year sample allows us to estimate a hazard model to study how rainfall shocks can affect the timing of unions. To test the second prediction of my model, I use the following equation:

$$M_{i,g,k,a(t)} = \beta D_{g,k,a(t)} + \gamma D_{g,k,a(t)} \times P_g + Z_a + \omega_g + \gamma_k + \epsilon_{i,g,k,a(t)}. \tag{5}$$

$$M_{i,g,k,a(t)} \quad = \quad \beta^l D^l_{g,k,a(t)} + \beta^m D^m_{g,k,a(t)} + \beta^h D^h_{g,k,a(t)} + Z_a + \omega_g + \gamma_k + \epsilon_{i,g,k,a(t)}. \tag{6}$$

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 year in which the woman born in year k is of age a. P_g is the average (long-term) polygyny rate of the cell

---

[32] The superscript l stands for low polygyny area (bottom tercile), m for medium and h for high polygyny area (top tercile).

[33] Appendix Figures A13 and A14 show the evolution of poygyny rates over time. Even from this country level aggregation, we can see that the decline observed in some of the countries with high polygyny rates is very modest and keeps them above the polygyny rates in those with low and medium levels.

[34] The data is right-censored for females that marry after age 24 for early marriage specification and age 17 for child marriage specification.

g in which female i lives. 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 γ_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. The model predicts $\beta > 0$ and $\gamma < 0$ (or equivalently $\beta^l > \beta^m > \beta^h$ and at least $\beta^l > 0$). This is also a confirmation for the first prediction of the model since this attenuation effect happens because of the higher elasticity of the demand for second spouses to income and price changes. An alternative to the hazard model is to look at the impact of exposure to a any drought between age 12 and 17 (or age 24) on the likelihood of marrying before age 18 (age 25) using a specification similar to the on in Equation 5 and 6. Both models show consistent results as discussed below.

4.3 Prediction 3: Symmetric reaction to positive and negative shocks?

To test whether households and markets react in a symmetric way to positive and negative shocks, I evaluate the impact of crop price shocks on family formation outcomes. For the case of the hazard of early marriage the estimating equations are:

$$\begin{aligned} M_{i,g,k,a(t)} &= \beta^F PPI_{g,k,a(t)} + \gamma^F PPI_{g,k,a(t)} \times P_g + \beta^C CPI_{c,k,a(t)} + \gamma^C CPI_{c,k,a(t)} \times P_g \\ &+ Z_a + \omega_g + \gamma_k + \mu_t + \eta_c \times t + \epsilon_{i,g,k,a(t)}. \end{aligned} \tag{7}$$

$$M_{i,g,k,a(t)} = \beta^F PPI_{g,k,a(t)} + \gamma^F PPI_{g,k,a(t)} \times P_g + Z_a + \omega_g + \gamma_k + \eta_{ct} + \epsilon_{i,g,k,a(t)}. \tag{8}$$

PPI is the producer price index; CPI is the consumer price index; μ_t are calendar year fixed effects; $\eta_c \times t$ are country specific time trends and η_{ct} are country×year fixed effects. The model predicts $\beta^F < 0$ and $\gamma^F > 0$ for PPI and $\beta^C > 0$ and $\gamma^C < 0$ for CPI. In Equation 7, the identifying assumption is that, after accounting for time invariant factors at the cell level and common trending factors at the country level, variation in the CPI and PPI is not correlated with unobserved factors that also affect marital decisions. A more demanding specification is to replace year and country specific time trends by country×year fixed effects as shown in 8. The coefficients are estimated in this case from 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 country level. Accounting for common trending factors is important here because the price index displays some clear trends that can easily be correlated with other confounders.[35]

---

[35] This is not the case for droughts (their timing is iid) so there is no need to absorb time effects in this case. The fact that there are more droughts across Sub-Saharan Africa in some years than in others due to exogenous meteorologic factors is still a useful variation for identification. I nevertheless show robustness

5 Empirical Results

5.1 Prediction 1: Polygyny, Droughts and Types of Unions

Table 2 presents results from the specifications in Equation 3 and 4. Column (1) shows that exposure to a drought between ages 12 and 24 has no effect on husband age gap in monogamous areas (α close to zero and statistically insignificant) but significantly decreases it in areas where polygyny is more commonly practiced (interaction term θ is negative and significant at 1% level). Column (2) shows the average impact for low, medium and high polygyny areas (the terciles of the continuous polygyny rate). Droughts have no detectable effect in low and medium polygyny areas on average but decrease husband age gap by 1 year (10% of average gap, $p<0.01$) in high polygyny areas. Column (4) controls for age at first marriage and the estimates remain stable. Column (5) and (6) also show that droughts decrease the likelihood of marrying as a junior spouse (second spouse or higher as opposed to marrying as first/unique spouse) in high polygyny areas. Column (8) restricts the sample to women in a polygamous union in low or high polygyny area.[36] It shows that droughts decrease the likelihood of marrying as a junior spouse by 2.7 percentage points (pp) which represents 5% of the average probability of marrying as a junior spouse in that sample ($p<0.05$). Columns (3) and (7) split the window of exposure into exposure to drought in age range 12-17 and in age range 18-24. The pattern of results for the two outcomes hold within both age ranges.

These estimates are therefore consistent with the first prediction of the model: women exposed to a drought are more likely to marry younger men only in polygynous areas and as first/unique spouses. The results are qualitatively the same when I use the alternative specification in which I compare the characteristics of unions that occur during drought years and those that did not as discussed in Appendix Section A.2 (see Table A1). Women who got married during a drought year have a smaller spousal age gap only in high polygyny areas (age gap decreases by 0.34 years, $p<0.05$) and they are less likely to marry as junior spouse (decrease of 2 pp in likelihood of being a junior spouse, $p<0.05$).

5.2 Prediction 2: Polygyny, Droughts and Marriage Timing

I test the second prediction of the model by using the empirical strategy described in Section 4.2. Column (1) of Table 3 shows estimation results using the specification in Equation 5. The coefficient β on the main regressor is positive and significant (p-value<0.01), while the one on the interaction term γ is negative and significant (p-value<0.05). Girls who experience a drought in monogamous areas are 0.75 percentage points more likely to get married that same year, which corresponds to an increase of 6.2% in the average

---

to accounting for time effects when testing the impact of droughts with the same specifications used for PPI and CPI (see Appendix Table A19).

[36] Droughts have no effect on the probability of ending up in a polygamous union.

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

	Husband age gap				Junior wife (2nd wife or higher order)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Any drought ages 12-24 x low polygyny		0.1448		0.0389		0.0142		
		(0.3906)		(0.3701)		(0.0087)		
Any drought ages 12-24 x medium polygyny		0.0100		0.0076		-0.0071		
		(0.2521)		(0.2541)		(0.0088)		
Any drought ages 12-24 x high polygyny		-0.9997***		-1.0247***		-0.0248**		
		(0.2365)		(0.2366)		(0.0108)		
Any drought ages 12-24	0.4164				0.0089			-0.0267**
	(0.3151)				(0.0091)			(0.0121)
Any drought ages 12-24 x polygyny rate	-2.5309***				-0.0587**			
	(0.8232)				(0.0293)			
Any drought ages 12-17 x low polygamy			0.0094				0.0147*	
			(0.3890)				(0.0084)	
Any drought ages 12-17 x medium polygamy			0.0205				-0.0072	
			(0.2571)				(0.0092)	
Any drought ages 12-17 x high polygamy			-1.0882***				-0.0246**	
			(0.2422)				(0.0110)	
Any drought ages 18-24 x low polygamy			0.3451				0.0134	
			(0.3948)				(0.0096)	
Any drought ages 18-24 x medium polygamy			-0.0099				-0.0069	
			(0.2591)				(0.0099)	
Any drought ages 18-24 x high polygamy			-0.7582***				-0.0253**	
			(0.2691)				(0.0116)	
Age at first marriage				-0.2518***				
				(0.0137)				
Observations	225,522	225,522	225,522	225,522	226,702	226,702	226,702	73,459
Adjusted R-squared	0.1470	0.1470	0.1471	0.1515	0.0808	0.0809	0.0809	0.0562
Mean dependent variable	9.965	9.965	9.965	9.965	0.174	0.174	0.174	0.515

OLS regressions with observations at individual level. Sample of women aged 25 or older at the time of the survey that are married. The dependent variables are the husband's age gap (column 1-4) and whether woman married as a junior wife (columns 5-8). All regressions include birth year FE and grid-cell FE. Column (6) restricts the sample to women in polygynous union in medium and high polygyny areas. 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.

annual hazard of marriage for this age group. This is twice the average effect documented in Corno et al. (2020) (see Table A3).[37] This effect is fading out substantially as we move to areas with higher rates of polygyny. Assuming this decay is linear, results in column (1) suggest that the causal impact of droughts on the hazard of early marriage is halved for women living in areas with polygyny rates around 30% (medium level of polygyny) and vanishes completely for those living in areas with polygyny rates around 50% (high level of polygyny). This means that droughts have a much weaker impact on the hazard of early marriage in more polygynous areas, as predicted by the model.

This is confirmed by results in column (2) where I estimate the specification in Equation 6. The estimated impact of drought on the annual hazard of early marriage goes from 0.64 percentage points for low polygyny areas (bottom tercile) to 0.38 percentage points in areas with medium polygyny levels (middle tercile). Both estimates are significantly different from zero at 1% and 5% significance levels, respectively. For women living in high polygyny areas (top tercile), the estimated effect is close to zero and statistically insignificant. Columns (3) and (4) show the same attenuation pattern when I consider

---

[37] The impact reported in Corno et al. (2020) underestimate substantially the true effect of droughts on the annual hazard of early marriage in monogamous markets.

the hazard of marrying between ages 12 and 20, or between ages 12 and 17 (child marriage), respectively. I then split the sample of women according to whether bride price is practiced or not in their ethnic group in columns (5) and (6).[38] The results confirm the attenuation pattern only in ethnic groups that require some form of bride price payment to celebrate a union. 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.

Estimates from the duration model show therefore that women exposed to a drought in a given year between ages 12 and 24 (or 12 and 17) are more likely to get married the same year, but this effect is attenuated by the presence of polygyny. This weaker link between droughts and child marriage comes from the fact that the demand for second spouses from older men is more elastic to the income and price drop that occur when there is a drought as shown in the previous section. The income and price elasticity of the overall demand and supply of child brides are therefore closer to each other when polygyny norms are stronger. This attenuation is such that droughts have no detectable impact on child marriage in high polygyny areas.

An alternative specification to the hazard model is to estimate the impact of being exposed to any drought between age 12 and 17 (or 24 for early marriage) on the likelihood of marrying by that age. Each observation is an individual woman in this specification as opposed to the $person \times age$ level data used in the duration model. The results of this specification are presented in Table A2 and are consistent with those from the duration model in Table 3 (see Appendix Section A.3). The hazard model presents the advantage of linking droughts in a given year to likelihood of marrying that same year (not before or after). This creates a much sharper identifying variation that rules out other potential confounders as argued below. Further robustness checks are also discussed in the next sections.

5.3 Prediction 3: Polygyny, PPI/CPI and Marital Outcomes

In this section, I evaluate the impact of global crop price variation on marital outcomes. Table 4 shows the results of the specification in Equation 8 and includes $country \times year$ fixed effects (omits therefore the CPI).[39] Columns (1) and (2) use the whole sample and show that a rise in PPI significantly decreases the hazard of early marriage in monogamous areas and this effect is fading out as we move to areas where polygny is more commonly practiced. The impact of PPI shocks is concentrated in rural areas where most of the agricultural production is taking place (column 3-6). Estimates in column (4) 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

---

[38] This excludes all the observations with missing information on bride price practice.

[39] PPI shocks offer more cross sectional variation for how global crop prices affect local economies. This variation is preferred to the one provided by CPI for identification.

Table 3: Polygyny, Droughts and Timing of Marriage in Sub-Saharan Africa

	(1)	(2)	(3)	(4)	(5)	(6)
	Married by:				Married by age 25	
	Age 25	Age 25	Age 21	Age 18	Bride price	No bride price
Drought	0.0075***					
	(0.0021)					
Drought x polygyny rate	-0.0137**					
	(0.0065)					
Drought x low polygyny		0.0064***	0.0057***	0.0045**	0.0078***	-0.0028
		(0.0021)	(0.0020)	(0.0020)	(0.0024)	(0.0030)
Drought x medium polygyny		0.0038**	0.0035**	0.0024	0.0036*	0.0024
		(0.0016)	(0.0017)	(0.0017)	(0.0019)	(0.0031)
Drought x high polygyny		0.0004	0.0012	0.0015	-0.0008	0.0016
		(0.0024)	(0.0025)	(0.0025)	(0.0021)	(0.0058)
Observations	2,459,177	2,459,177	2,154,271	1,702,155	1,344,360	369,241
Adjusted R-squared	0.0616	0.0616	0.0683	0.0728	0.0636	0.0645
Mean dependent variable	0.112	0.112	0.105	0.0856	0.118	0.107

All regressions include age FE, birth 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. Observations are at the level of person x age. The dependent variable is a dummy equal to one if the woman gets married at the age corresponding to a given observation. Full sample includes women aged 25 or older at the time of interview and is used in all regressions. Column (3) restricts this sample to person x age observations from age 12 to 20 and column (4) uses observations from age 12 to 17 (child marriage). Observations with no information on the practice of bride price payment in their ethnic group are dropped in columns (5) and (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.

polygyny areas.[40] There is no detectable link between PPI and the hazard of early marriage in urban areas, irrespective of whether they are located in high or low polygyny areas (columns 8 and 9). Table A7 shows that the documented pattern is driven by food crops. There is no detectable effect of PPI for cash crops on timing of marriage, irrespective of the structure of the local markets (polygyny or not).

Table 5 includes CPI (no country × year fixed) and confirms that households and markets react in a symmetric way to aggregate shocks. The coefficients on PPI variables remain stable. CPI shocks do not affect the hazard of early marriage in rural areas (columns 1-4). For urban areas, a standard deviation rise in CPI increase the hazard of marriage the same year by 1.6 pp in low polygy areas, 1.4 pp in medium polygyny areas and has no detectable effect (magnitude of 0.3 pp) in high polygyny areas (column 6 and 8). The attenuation effect is less pronounced (and not statistically significant) between areas with low and medium levels of polygyny but the overall pattern is consistent with the model's prediction.

According to the model, the attenuation effect of PPI and CPI shocks on marriage timing is due to the fact that the demand for second spouses is more sensitive to income and price changes. Table 6 tests

---

[40] Column (5) also shows that this pattern is concentrated among ethnic groups that practice bride price payment at marriage.

Table 4: Polygyny, PPI and Timing of Marriage

	Whole Sample		Rural					Urban	
	Marriage before age 25		Marriage before age 25			Marriage before age 18		Marriage before age 25	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PPI	-0.0033***		-0.0071***			-0.0039**		0.0006	
	(0.0013)		(0.0023)			(0.0015)		(0.0014)	
PPI X polygyny rate	0.0076*		0.0157**			0.0080		-0.0030	
	(0.0045)		(0.0066)			(0.0080)		(0.0056)	
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 × bride price					-0.0065***				
					(0.0015)				
PPI × no bride price					-0.0032				
					(0.0039)				
PPI × polygyny rate × bride price					0.0096*				
					(0.0049)				
PPI × polygyny rate × no bride price					0.0010				
					(0.0109)				
Observations	1,630,520	1,630,520	974,426	974,426	678,801	635,162	635,162	647,716	647,716
Adjusted R-squared	0.0625	0.0625	0.0701	0.0701	0.0714	0.0835	0.0835	0.0472	0.0472
Mean dependent variable	0.116	0.116	0.134	0.134	0.143	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. Table shows OLS regressions for Sub-Saharan Africa (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.

directly the impact of PPI shocks on the market shares of young men to confirm this mechanism. It shows that women who marry during a high PPI year are 1.9 pp (p<0.05) more likely to marry as junior spouses as opposed to marrying as first spouses (column 3). They are also more likely to marry older men only in high polygyny areas. The results on age gap are not statistically significant but the differences in coefficient magnitude are substantial (+/-0.02 years in low/medium polygyny areas versus 0.14 years in high polygyny areas) and consistent with what the model predicts (see column 4-6).

Table 5: Polygyny, PPI/CPI and Timing of Marriage

	Rural				Urban			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PPI	-0.0063***		-0.0063***		-0.0007		-0.0007	
	(0.0023)		(0.0023)		(0.0014)		(0.0014)	
PPI × polygyny rate	0.0136**		0.0137**		0.0008		0.0008	
	(0.0068)		(0.0068)		(0.0062)		(0.0062)	
CPI	0.0065		0.0064		0.0172***		0.0171***	
	(0.0054)		(0.0053)		(0.0058)		(0.0058)	
CPI × polygyny rate	0.0121		0.0122		-0.0214		-0.0213	
	(0.0103)		(0.0103)		(0.0141)		(0.0142)	
PPI × low polygyny		-0.0055***		-0.0055***		-0.0010		-0.0010
		(0.0020)		(0.0020)		(0.0009)		(0.0009)
PPI × medium polygyny		-0.0015		-0.0015		0.0004		0.0004
		(0.0011)		(0.0011)		(0.0012)		(0.0012)
PPI × high polygyny		-0.0001		-0.0000		-0.0006		-0.0006
		(0.0021)		(0.0021)		(0.0024)		(0.0024)
CPI × low polygyny		0.0080		0.0078		0.0158***		0.0158***
		(0.0053)		(0.0053)		(0.0057)		(0.0057)
CPI × medium polygyny		0.0055		0.0054		0.0141**		0.0141**
		(0.0059)		(0.0059)		(0.0063)		(0.0063)
CPI × high polygyny		0.0127*		0.0125*		0.0036		0.0036
		(0.0069)		(0.0069)		(0.0079)		(0.0079)
Observations	965,595	965,595	965,595	965,595	642,518	642,518	642,518	642,518
Adjusted R-squared	0.0679	0.0679	0.0680	0.0680	0.0439	0.0439	0.0439	0.0439
Country × time trend	NO	NO	YES	YES	NO	NO	YES	YES
Mean dependent variable	0.133	0.133	0.133	0.133	0.0880	0.0880	0.0880	0.0880

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 *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Table shows OLS regressions for Sub-Saharan Africa (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.

5.4 Threats to Identification

This section discusses potential threats to identification that may affect the estimated effects. It shows that such threats are less likely to play an important role in my setting. Each potential threat could explain the evidence presented in support of a specific prediction of the model but none of them is consistent with all the 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 only in monogamous areas (and no effect in polygynous ones) and at the same time have a strong impact on husband age gap only in polygynous areas (and no effect in monogamous ones) exactly in the directions predicted by the model.

5.4.1 Potential Differential Effect of Aggregate Shocks?

The first threat to the identification is whether the aggregate shocks considered here are of different nature in polygamous and monogamous areas. In this analysis, a drought year in a given location is define as a calendar year with rainfall below the 15th percentile of that location's historical distribution. This means that all locations have the same probability of experiencing a drought in any given year. By construction, this measure of rainfall shocks will therefore be orthogonal to observable and unobserved permanent local

Table 6: PPI at Time of Union and Marriage Characteristics

	Junior wife (2nd wife or higher order)			Husband age gap		
	(1)	(2)	(3)	(4)	(5)	(6)
PPI x low polygamy		0.0003			0.0222	0.0217
		(0.0029)			(0.0672)	(0.0669)
PPI x medium polygamy		0.0008			-0.0214	-0.0209
		(0.0040)			(0.0710)	(0.0710)
PPI x high polygamy		0.0111*			0.1386	0.1396
		(0.0066)			(0.1005)	(0.1007)
PPI	-0.0021		0.0192**	-0.0158		
	(0.0040)		(0.0085)	(0.0802)		
PPI x polygyny rate	0.0178			0.1701		
	(0.0156)			(0.2574)		
Age first marriage						-0.1160
						(0.1002)
Observations	108,772	108,772	33,326	110,961	110,961	110,961
Adjusted R-squared	0.0933	0.0933	0.0642	0.1438	0.1438	0.1438
Mean dependent variable	0.182	0.182	0.555	9.758	9.758	9.758

OLS regressions with observations at individual level. Sample of women aged 25 or older at the time of the survey that are married. The dependent variables are whether woman married as a junior wife (column 1-3) and the husband's age gap (columns 4-6). All regressions include birth year FE, grid-cell FE, and marriage year FE. Column (3) restricts the sample to women in polygynous union in medium and high polygyny areas. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. The PPI is measured in terms of average temporal standard deviations. All Regressions are weighted using country population-adjusted survey sampling weights.

characteristics such as the extent to which polygyny is practiced. Similarly, PPI and CPI shocks are also defined in relative term. They are both measured in terms of temporal standard deviation from their historic mean in a given location.

The second concern is whether the same shock has same effect on household economic conditions in monogamous and polygynous areas. The global commodity price shocks affect real income for a given level of production. There is no obvious reason for the value of production to be different between monogamous and polygynous areas.[41] Rainfall shocks affect however agricultural production and droughts could in theory lead to a bigger drop in household resources in monogamous areas compared to polygamous ones. This could explain the fact that they have a stronger effect on the timing of marriage in monogamous areas. Appendix Table A17 shows the relationship between droughts and agricultural output/economic conditions 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.

---

[41] Especially given the nature and reasons behind the spatial variation in the practice of polygyny discussed in Section 3.4.

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.[42] None of these two pairs of coefficients are statistically different from each other and their magnitudes even suggest, if anything, a potentially bigger effect of droughts on household consumption and GDP per capita in high polygyny areas. Moreover, such alternative explanation wouldn't be able to explain why droughts increase the likelihood of marrying younger men only in polygynous areas.

5.4.2 Differential Marriage Market Size and Migration?

Differential Market Size

I focus first on the evidence regarding the impact of aggregate shocks on marriage timing. 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) conduct a large scale survey in rural Senegal and collect information on distance between spouse parents and her current place of residence. Senegal is a country with very high polygyny rates and the average distance is 20 km for girls so it still fits easily within the 50 × 50 km cell grids. Moreover, I do find a strong effect of of aggregate shocks on the likelihood of marrying younger men only in high polygyny areas and on the likelihood of being 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 of the 50 × 50 km cell grids that are considered here.

Differential Migration Behavior

Another concern for identifying this attenuation effect is whether marriage migration happens more (or less) often during droughts and whether this happens differentially in polygamous and monogamous areas. Table A13 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 is therefore not a threat to the identification strategy and it is also not able to explain the documented pattern of empirical evidence. Table A14 shows 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 year are slightly more likely to migrate after marriage but in both low and high polygyny areas (columns 1 and 2).[43] This means that there is no systematic

---

[42] Columns (1), (3) and (5) show the overall effect without any sample split following Corno et al. (2020). Their paper provides more details on the data used for this exercise.

[43] Three of the four coefficients are significant only at 10% level.

pattern that suggest that differential migration behavior during PPI shocks is a threat to the identification.

5.5 Threats to Interpretation

There is a potential concern about attributing the documented difference in the impact of aggregate shocks to polygyny per se and not another factor that could be correlated with it. Importantly, no single factor can explain the spatial variation in the extent to which polygyny is practiced as argued in Section 3.4.3. This variation is instead the result of a combination of many historic and slow moving cultural factors. This allows us to test whether any given alternative factor can be driving the results. Ethnic traditions and religion are the two main factors that strongly correlate with polygyny and I check whether they could be driving the documented results.

5.5.1 Polygyny and Religion

There is a strong correlation between polygyny and religion that may cast some doubt on the interpretation of the empirical evidence. Christian women are much less likely to be in polygynous unions compared to Muslims and Animists. It is indeed possible that households living in areas with different local norms in terms of polygyny also belong to different religious groups and what I am capturing is just the effect of differences in religious practices. Given the substantial variation across space in the joint distribution of religion and polygyny documented in Section A.4.3, I can check whether this is the case.

In Table 7, I run the specification in Equation 5 and 6, splitting the sample into two: Christians and non-Christians. The first 4 columns use the full sample and the other columns restrict the sample to observations that belong to an ethnic group that practices bride price payments. There are more Christians in the sample and they tend to marry later so there are significantly more $person \times age$ observations in this sub-sample and much fewer observations for the sub-sample of non-Christians. The pattern in the magnitude of the estimated coefficients is very similar across both groups: Droughts substantially affect the timing of marriage, but this effect is fading out in areas with more polygyny. There is no detectable effect of droughts on marriage timing in high polygyny areas across both groups. The results from Table 7 suggest therefore that the impact of droughts on the timing of marriage depends on the extent to which polygyny is practiced in a given area, and not on religion per se.[44] Appendix Table A5 conducts a similar exercise with PPI and also shows the same pattern within both Christian and non-Christian samples.

---

[44] I find a similar conclusion in Appendix Table A8 where I test whether religion matters for the impact of droughts on marriage timing, splitting the sample this time into people that live in low, medium and high polygyny areas.

Table 7: Polygyny, Droughts and Timing of Marriage: Robustness to Religion

	Full sample				Bride price only			
	Christians		Non-Christians		Christians		Non-Christians	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drought x low polygyny	0.0055***		0.0089		0.0062***		0.0256***	
	(0.0018)		(0.0080)		(0.0020)		(0.0081)	
Drought x medium polygyny	0.0033*		0.0032		0.0036		0.0043	
	(0.0020)		(0.0033)		(0.0024)		(0.0040)	
Drought x high polygyny	0.0011		-0.0003		-0.0043		0.0007	
	(0.0047)		(0.0033)		(0.0054)		(0.0025)	
Drought		0.0059***		0.0116**		0.0074***		0.0162***
		(0.0022)		(0.0056)		(0.0026)		(0.0063)
Drought x polygyny rate		-0.0085		-0.0232*		-0.0168		-0.0289**
		(0.0100)		(0.0128)		(0.0114)		(0.0127)
Observations	1,428,209	1,428,209	669,376	669,376	651,243	651,243	450,924	450,924
Adjusted R-squared	0.0537	0.0537	0.0707	0.0697	0.0525	0.0525	0.0778	0.0762
Mean dependent variable	0.124	0.124	0.163	0.163	0.126	0.126	0.165	0.165

All regressions include age FE, birth 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. Table shows OLS cross-sectional regressions for Sub-Saharan Africa. Full regression sample: 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. Observations with no information on religion are dropped.

5.5.2 Polygyny and Kinship System

Kinship system in most areas across Africa is patrilineal except in the matrilineal belt that stretches across central Africa (see Appendix Figure A7). In Matrilineal kinship systems, lineage and inheritance are traced through women. This means that women have more support from their family and are less subject to the authority of their husband. This correlates with the practice of monogamy (or less polygyny) but there is still substantial variation in the data to test whether the pattern documented in this paper is driven by kinship systems. Table 8 shows that the main results regarding the impact of droughts on the timing of unions hold in both kinship systems. The coefficients β and γ are both significant, have the expected signs and similar magnitudes when I run Equations 5 only using, on one hand observations from matrilineal ethnic groups (column (3) and (7)), and on the other hand those that are not from a matrilineal ethnic group (columns (1) and (5)).[45] The results are similar when I split the drought variable into 3 dummies for low, medium and high polygyny areas (other columns of Table 8). Appendix Table A6 shows that the documented pattern for PPI also holds for patrilineal ethnic groups but the impact of PPI is noisier within the matrilineal sample.

These results show that the documented heterogeneity in the impact of droughts on marriage timing and the other marital outcomes is not driven by kinship systems. These kinship systems are becoming less relevant for economic decision making within households. The increasing privatization of production and

---

[45] Columns (5) and (7) restrict the sample to respondents that are from an ethnic group that practices bride price payments.

consumption activities across Sub-Saharan Africa has led to more individualistic behavior within nuclear families (parents and children). This has weakened both matrilineal and patrilineal influence on people's wealth transfer behaviors and other family related decisions. Mtika and Doctor (2002) is one of the rare papers that studies financial transfers among family members across different kinship systems. Using data from rural Malawi, the authors show that most transfers happen between parents and children and transfers outside the nuclear family are not patterned differently under matrilineality and patrilineality. In particular, even respondents of the matrilineal group receive and give more to their parents compared to their maternal uncles. Moreover, women give and receive less transfers than men irrespective of the kinship system. This similarity in the role of parents may explain the fact that the documented heterogeneity in the impact of droughts on marriage timing is present in both kinship systems when there is bride price payment.

Table 8: Polygyny, Droughts and Timing of Marriage: Robustness to kinship System

	Full sample				Bride price only			
	Not Matrilineal		Matrilineal		Not Matrilineal		Matrilineal	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drought	0.0078***		0.0088**		0.0087***		0.0123**	
	(0.0022)		(0.0041)		(0.0023)		(0.0053)	
Drought x polygyny rate	-0.0119**		-0.0366**		-0.0143**		-0.0521**	
	(0.0059)		(0.0180)		(0.0061)		(0.0224)	
Drought x low polygyny		0.0073***		0.0043		0.0083***		0.0071*
		(0.0022)		(0.0033)		(0.0023)		(0.0041)
Drought x medium polygyny		0.0043**		0.0025		0.0043**		0.0000
		(0.0020)		(0.0027)		(0.0022)		(0.0037)
Drought x high polygyny		0.0011		-0.0155*		0.0007		-0.0189*
		(0.0019)		(0.0088)		(0.0020)		(0.0106)
Observations	1,316,604	1,316,604	396,997	396,997	1,151,269	1,151,269	193,091	193,091
Adjusted R-squared	0.0656	0.0656	0.0577	0.0577	0.0660	0.0660	0.0517	0.0518
Mean dependent variable	0.121	0.121	0.117	0.117	0.121	0.121	0.101	0.101

All regressions include age FE, birth 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. Table shows OLS cross-sectional regressions for Sub-Saharan Africa. Full regression sample: 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. Observations with no information on kinship system in their ethnic group are dropped.

5.6 Consequences on Female Fertility

This section investigates a direct and dramatic consequence of early marriage: female fertility. Early fertility is one of the most important risks facing teenage girls in developing countries (Duflo et al., 2015; Chari et al., 2017). Pregnancy in adolescence is associated with increased risks of maternal and fetal complications, including premature delivery, and with 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 and commodity price shocks 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 early fertility outcomes.

I study the effect of droughts on the onset of fertility, substituting marriage with birth as the outcome variable in equation 5 and 6. Column (1) and (2) of Table 9 show that a drought increases substantially the annual hazard of early fertility (for age range 12-24) in monogamous areas but only has a small impact in polygynous ones. This hazard increases by 0.4 pp in low and medium polygyny areas (columns 2, $p<0.05$) when there is a drought. This corresponds to a 4% increase in the average hazard. In high polygyny areas this effect is almost halved (2.6 pp) and becomes statistically insignificant. The attenuation effect is less pronounced in this specification but the magnitude of the estimated coefficients still suggests that it happens to some sizable extent. This attenuation pattern becomes less clear when I focus on fertility onset before age 18.

These results might be less sharp because a drought that occurs in a given year might affect fertility the following year as well given the time lag between marriage, conception and first birth. The estimated coefficients are more precisely estimated and consistent with the model's predictions when I look at the impact of exposure to droughts between age 15 and 17 on the hazard of having a child by age 18 using individual level data.[46] Column (3) of Appendix Table A9 shows that the coefficient on drought and the one on its interaction with polygyny rate are both sizable and statistically significant at 5% level. Column (4) confirms this substantial attenuation effect. A drought increases the likelihood of fertility onset in that age range by 2.1 pp ($p<0.001$) for low polygyny areas but only 0.49 pp for medium and 0.40 pp for high polygyny areas (and those two coefficients are not statistically different from zero). Early fertility onset often translates into high number of children in Sub-Saharan Africa due to the limited practice of family planning. Columns (5) and (6) of Appendix Table A9 show that a history of droughts between age 12 and 24 is positively related to fertility levels by age 25 in monogamous areas and this effect is fading out in areas where polygyny is more commonly practiced.

Columns 5-8 of Table 9 show that a rise in PPI in a given year decreases the hazard of fertility onset the same year in monogamous areas. This effect is substantially attenuated in areas where polygyny is more common to the extent that there is no detectable effect of PPI shocks on the timing of fertility onset in high polygyny areas.

---

[46] Very few women have their first child before age 15 in my sample (5% versus 27% between age 15 and 17) so droughts have no detectable effect on fertility onset in that age range (see columns (1) and (2) of Appendix Table A9).

Table 9: Polygyny, Drought/PPI and Fertility Onset

Fertility onset window:	Before age 25		Before age 18		Before age 25		Before age 18	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drought	0.0049***		0.0024					
	(0.0018)		(0.0015)					
Drought × polygyny rate	-0.0045		0.0005					
	(0.0051)		(0.0047)					
Drought × low polygyny		0.0040**		0.0029**				
		(0.0018)		(0.0014)				
Drought × medium polygyny		0.0041***		0.0017				
		(0.0015)		(0.0014)				
Drought × high polygyny		0.0026		0.0031*				
		(0.0018)		(0.0017)				
PPI					-0.0030***		-0.0019**	
					(0.0005)		(0.0009)	
PPI × polygyny rate					0.0105***		0.0061*	
					(0.0023)		(0.0032)	
PPI × low polygyny						-0.0021***		-0.0012*
						(0.0005)		(0.0007)
PPI × medium polygyny						-0.0003		-0.0009
						(0.0008)		(0.0009)
PPI × high polygyny						0.0015		0.0012
						(0.0011)		(0.0013)
Observations	2,752,317	2,752,317	1,827,869	1,827,869	1,809,171	1,809,171	1,072,799	1,072,799
Adjusted R-squared	0.0637	0.0637	0.0477	0.0477	0.0651	0.0651	0.0512	0.0512
Mean dependent variable	0.0992	0.0992	0.0544	0.0544	0.111	0.111	0.0576	0.0576

Hazard model with observations at $person \times age$ level. All regressions include age FE, birth year FE, and grid-cell FE. Columns 5-8 add $country \times year$ FE. Robust standard errors clustered at cell-grid level in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$. The dependent variable is a binary variable for fertility onset, coded to one if the woman had her first child at the age corresponding to the observation. The age range considered is between age 12 and 24 (columns 1, 2, 5 and 6) or between age 12 and 18 (the rest). Full sample includes 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. The PPI is measured in terms of average temporal standard deviations. All Regressions are weighted using country population-adjusted survey sampling weights.

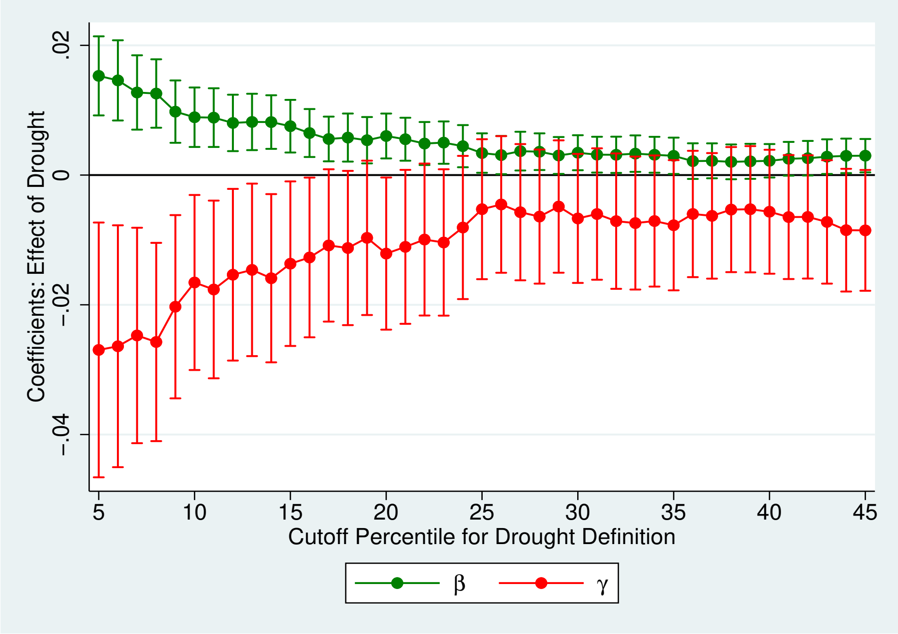
5.7 Further Robustness for Rainfall Shocks

5.7.1 Alternative Definition of Rainfall Shocks

I first check that the main results are robust to varying the cutoff used to define drought years. I re-estimate the main regression equation (Equation A4) varying cutoff levels to define a drought, ranging from the 5th percentile to the 45th percentile. Figure 3 shows the estimated coefficients β and γ, along with 95% confidence intervals. Point estimates are stable around the 15th percentile cutoff used in the main specification. The magnitude of both coefficients increase in absolute value as the definition of drought becomes more severe.

I also investigate the relationship between the annual rainfall and the hazard of early marriage. Appendix Table A18 shows that an increase in annual rainfall by 1 meter is associated with a decline in the hazard of early marriage by 1.2 percentage points in monogamous areas and has no detectable effect in high polygyny areas only in ethnic groups that practice bride price payments (columns 1-2, $p<0.05$ for α and γ). This effect disappears completely in absence of bride price payments (columns 3-4).

Figure 3: 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 drought in absence of polygyny. γ is the coefficient on the interaction term between drought and polygyny rates.

5.7.2 Placebo with Past and Future Droughts

Finally, I check that the documented heterogeneity is not driven by differences in the timing structure of the effect of droughts by examining lagged and future shocks. Appendix Table A20 shows that past and future shocks have no effect on the timing of marriage irrespective of whether we are in areas with low, medium or high polygyny areas. Only current shocks have an effect on marriage hazard in a given year in low polygyny areas (increase of 0.6 percentage points, $p<0.01$) and medium polygyny areas (increase of 0.38 percentage points, $p<0.05$). Appendix Table A19) also shows that the documented patterns in Table 3 are robust to accounting for calendar year fixed effects with same the specifications used for PPI and CPI.

5.7.3 Heterogeneity by Rural/Urban Residence and Education

Table A10 shows a heterogeneity analysis by place of residence (rural versus urban) and by education. Polygyny is more practiced in rural areas where the main economic activity is farming which is particularly labor intensive. Urban areas have however more diversified economic activities that are more capital intensive or require educated human capital. The value of marrying a second spouse is therefore potentially higher in rural areas compared to urban areas. School enrollment is also an important margin of heterogeneity to investigate. In my sample, only 50% of women have been enrolled in school. Girls that have not been enrolled to school potentially come from families that are more vulnerable to economic shocks, live in rural areas with no school around, etc... Despite these difference, the empirical results in Table A10 show that droughts increase the hazard of early marriage in monogamous areas in both rural and urban areas (columns 1, 2, 5 and 6) and for both girls that have attended school and those that have not (columns 3,4, 7 and 8). The attenuation effect (coefficient γ) due to the presence of polygyny is however stronger and statistically significant in rural areas (compared to urban) and for girls that have not been enrolled in school.

5.8 Other Robustness Checks

5.8.1 Independence of Shocks and long-term Polygyny Rates

The empirical strategy in Equation A4 relies on the assumption that the timing of aggregate shocks are orthogonal to long-term polygyny rates P_g, measured by the average share of women that are in union with a polygamous husband. As argued in Section 3.4, polygyny is a local norm that is at best slowly declining over time in high polygyny areas. Yearly rainfall realizations in each cell and variation in global crop prices are not likely to be correlated with the time invariant average polygyny rates.

In the main specification, I pull together all the DHS survey waves to compute the average polygyny rates. Some countries have several DHS waves with at least 5 years between two consecutive waves. As an additional confirmation that aggregate shocks are orthogonal to polygyny rates, I check whether the main results are robust to using data from the first or the last DHS wave (10 years gap on average) to define polygyny rates. Table A15 shows that this is the case for rainfall shocks. Column (1) uses only the first wave to define polygyny rates and shows that droughts increase the hazard of early marriage by 0.96 percentage points ($p<0.01$) in monogamous areas ($P_g = 0$) and this effect is decreasing significantly in areas with higher polygyny rates (coefficient of -0.018 for interaction term, $p<0.01$). This implies that there is no detectable effect of drought on the timing of marriage in high polygyny rates ($P_g \sim 0.5$). Column (2) shows a similar pattern when I use only the last DHS wave to compute polygyny rates.[47] Table A16 also shows that results for PPI shocks are robust to using the first or the last DHS survey wave to compute polygyny rates.

5.8.2 Sample Restrictions Across Space

Samples with Substantial within Country Variation in Polygyny Norms

Figure 1 shows substantial variation in the extent to which polygyny is practiced both within and across countries. I check in this section that the main findings of this paper are robust to relying only on the countries with substantial within variation. For that, I compute the interquartile range (IQR) of cell level

---

[47] Columns (3) and (4) split the continuous polygyny rates into terciles and shows same pattern.

polygyny rates and use it to split the sample in 3 groups.[48] Countries with $IQR > 0.3$ have the highest level of within variation in polygyny rates. This sample includes the Democratic Republic of Congo, Kenya, Mozambique and Uganda. Those with IQR between 0.2 and 0.3 have an intermediate level of variation (Cameroon, Côte d'Ivoire, Ghana, Mali, Nigeria, Sierra Leone and Tanzania.) while the others have little within variation. I run the main specification using the samples with substantial within country variation (first two samples) and the results are robust: the β coefficient is positive and significant while the γ coefficient is negative and significant (see Table A12).

Comparing West Africa to the Rest of the Continent

As shown in Figure 1, polygyny rates are very high in West Africa compared to the rest of the sample. In most countries in West Africa, polygyny is the rule even though there are several clusters of grid cells with low polygyny. This is the opposite outside West Africa. In Central, Southern and East African countries, the rule is either monogamy with several clusters with high polygyny, or grid cells with different polygyny levels seem to be evenly distributed across space. I check here that my main findings are robust in all these spatial configurations in Table A11. The results show that this is the case. A substantial part of the sub-sample of women living outside West Africa do not have bride price custom and coefficients in columns (5) and (6) are smaller and not significant. There is no difference between these two regions when I restrict the sample to women that have bride price custom in their ethnic group as predicted in the model. This means that equilibrium outcome on a marriage market that is affected by a temporary aggregate income shock depends on the extent to which polygyny is practiced on that market, irrespective of spatial pattern of local norms in neighboring areas.

---

[48] IQR is the difference between 75th and 25th percentiles.

6 Conclusion

This paper documents and explains important differences in how marriage markets across Sub-Saharan Africa adjust to short term changes in aggregate economic conditions such as droughts. The extent to which polygyny is practiced plays a key role. This local norm changes the structure of the marriage market. I show in an overlapping generation model with sequential one-to-one matching that the demand for second spouses provides an extra margin of adjustment when there is a negative aggregate income shock. It attenuates the increase in child marriage that comes from the fact that the supply of child brides is more elastic to the income and price drop compared to the demand for first/unique spouses. The empirical evidence shows that in areas with high polygyny rates, droughts have no detectable effect on child marriage. They increase instead the likelihood of marrying younger men as first/unique spouses as opposed to marrying as second spouses.

The evidence presented in this paper has two main policy implications. First, interventions that generate windfall aggregate income (such as cash transfers) can have unintended negative consequences for marital outcomes by increasing the market shares of old men that are looking for second spouses in polygynous areas. Second, aggregate income stabilization policies are more efficient in monogamous areas since they can help against an increase in child marriage that will otherwise occur in these areas. The presence of polygyny creates some sort of inertia to temporary shocks for the equilibrium quantity of child marriage making such intervention less efficient in this setting. Negative shocks can even create opportunities for young men because they are more likely to find a spouse and for women because they are more likely to marry younger men as first spouses. Aggregate income stabilization policies will act as a push against this compositional change without improving the equilibrium quantity of child marriage. It is therefore crucial to take marriage market structure into account when designing policy interventions that aim at affecting its outcomes.

References

Anderson, Siwan 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," 2019.

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.

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.

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.

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.

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.

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.

de Putte, Bart Van, 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.

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 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.

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

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, "Matrilineal kinship and spousal cooperation: Evidence from the matrilineal belt," *Unpublished manuscript. URL: https://scholar. harvard. edu/files/slowes/files/lowes_matrilineal. pdf*, 2017.

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.

Mtika, Mike Mathambo and Henry Victor Doctor, "Matriliny, patriliny, and wealth flow variations in rural Malawi," *African Sociological Review/Revue Africaine de Sociologie*, 2002, *6* (2), 71–97.

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.

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).

Rexer, Jonah, "The Brides of Boko Haram: Economic Shocks, Marriage Practices, and Insurgency in Nigeria," 2020.

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.

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

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

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.

UNICEF, "Updated data on the prevalence of child marriage," `https://data.unicef.org/topic/child-protection/child-marriage/` 2019.

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.

Appendix

A.1 Proofs

A.1.1 Proposition 1

Part 1:

There is an excess quantity of old men on the market at t: many women of oldest generation are already married off to older men at $t-1$. There is a rationing of old women for old men and some old men will have to have to find a spouse among the young women.

A household i wants to marry their old daughter by the end of period t if and only if:

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

Similarly, a son in his household j wants to marry if:

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

For $V^{m,nf}_M-V^m_U\geq 0$ 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 marry at t (QED).

Part 2:

An old son will want to have a second spouse if:

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

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).

Important remark: $\epsilon^*_{m,2}$ is a decreasing function of $V^{m,nf}_{M2}-V^{m,nf}_M$ (crucial in proof of proposition 4)

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 for marriage for man's family (HH head).

All children marry by the end of next period so future utility terms beyond phase 2 cancel out. For male's family, I assumed that the presence of a potential second spouse next period does not affect the future stream of utility expected by the household head at t. The rationale behind this assumption is that parents could be only expecting to receive fixed contribution from their son for their basic needs when they retire for instance. The son's decision to marry a second spouse does not affect his contribution to his parents consumption in future.[49]

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

$\Omega^m = \sum_{z \in \{H,L\}} \frac{\delta}{2} \int \left[u\big(y^z_{t+1} + \epsilon_{j,t+1} + w_o^{m,l}\big) - u\big(y^z_{t+1} + \epsilon_{j,t+1} + w_o^{m,h}\big) \right] dF(\epsilon_{j,t+1}) < 0$ [50]

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

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

Concavity and monotonicity of 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 for men, they want to marry if:

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

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 $H(y_t, \epsilon^*_m, \tau_t) \equiv 0$.

Important remark: With $w_o^{m,l}$ sufficiently large (compared to $\Delta w = w_o^{m,h} - w_o^{m,l}$) , concavity ensures that $|\Omega^m| < |\Omega^f|$ so I have $\epsilon^*_m > \epsilon^*_f$ (crucial in proof of proposition 4)

A.1.3 Proposition 3

Given the thresholds defined above, the supply for young brides at t is $S(\tau_t, y_t) = F(\epsilon^*_f(\tau_t, y_t))$.

The demand for child brides as 1st spouse from young grooms is $D^{(1,young)}(\tau_t, y_t) = 1 - F(\epsilon^*_m(\tau_t, y_t))$. The demand for child brides as unique spouses from old grooms is $D^{(1,old)}(\tau_{t-1}, y_{t-1}) = \frac{1}{1+a}\big[F(\epsilon^*_m(\tau_{t-1}, y_{t-1}))-$

---

[49] One could think of an extension where the son's decision to marry a second spouse affects the stream of future consumption of parents but this simplified version is more tractable and captures the main trade-offs in the decision making process. It is also in line with parents not being substantially involved in the decision of a son marrying a second spouse.

[50] $w_o^{m,h} = w_o^{m,l} + \tau^*_{t+1}$ if we want to assume that parents on the demand side always bear the cost of the first union of their son and nothing else affects his contribution to his parents consumption at this stage.

$(1-F(\epsilon_f^*(\tau_{t-1}, y_{t-1}))\big]$. This represents the difference between the number of old men that couldn't get married young at t-1 and the number of old women that didn't have to be married off as a 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 1 spouse and are looking for a second one.

The demand for second spouse child brides from old grooms is: $D^{(2,old)}(\tau_t, y_t, \tau_{t-1}, y_{t-1}) = \frac{p}{(1+a)}\Big[\big(1-F(\epsilon_m^*(\tau_{t-1}, y_{t-1})\big) \times \big(1-F(\epsilon_{m,2}^*(\tau_t, y_t)\big)\Big]$. This is the joint likelihood of marrying at t-1 and t. Idiosyncratic income shocks are iid 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.

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

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

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

With similar argument used above, I 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 concavity and monotonicity of u and 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

Need to compare $\frac{\partial H/\partial \tau_t}{\partial H/\partial y_t}$ and $\frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial y_t}$

$$A_{1,2} = \Big(\frac{\partial H/\partial \tau_t}{\partial H/\partial y_t} - \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial y_t}\Big)$$

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

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 and this is true when $V^{m,nf}_{M2} - V^{m,nf}_{M}$ is high enough since $\epsilon^*_{m,2}$ is a decreasing function of $V^{m,nf}_{M2} - V^{m,nf}_{M}$. This means that the demand for second spouses is more elastic to income and price changes.

A.1.5 Proposition 5

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 prices are defined implicitly as solution to $S(y_t, \tau^*_t) - D(y_t, \tau^*_t) = 0$

By IFT: $\frac{d\tau^*_t}{dy_t} = -\frac{S_y - D_y}{S_\tau - D_\tau}$

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

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

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

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

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

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

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

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

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

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

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

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

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

From Proposition 4, we have:

$$
A_{1,2} = \Big(\frac{\partial H/\partial\tau_t}{\partial H/\partial y_t}-\frac{\partial H_2/\partial\tau_t}{\partial H_2/\partial y_t}\Big)<0
$$

Moreover, since $A_{1,2}$ is an increasing function of $\epsilon_{m,2}^*$ and $A_{1,1}$ is independent of $\epsilon_{m,2}^*$, so we have $A_1<0$ for $\epsilon_{m,2}^*$ low enough. So $A<0 \implies \frac{dQ_y^*}{dp}>0$.

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.

A.2 Alternative Specification for Prediction 1

To test prediction 1, we can also compare the characteristics of unions for women that marry during droughts to those that marry in normal years with the following regressions:

$$Y_{i,g,k,\tau} = \alpha D_{i,g,k,\tau} + \theta D_{i,g,k,\tau} \times P_g + \delta_\tau + \omega_g + \gamma_k + \epsilon_{i,g,k,\tau}$$

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

where $D_{i,g,k,\tau}$ is a dummy equal to 1 if the year τ in which woman i got married was a drought year and δ_t is a set of marriage year fixed effects. These estimates are the result of both a potential negative selection effect (i.e. lower quality women are more likely to be married off during a drought year) and the causal effect (i.e. the fact women who marry during a drought may have different marital outcome because of changes in market composition on the demand side). The literature has however documented substantial evidence that shows that high ability women sort into marrying as first/unique spouses because it gives them better bargaining power (Reynoso, 2019; Matz, 2016; Munro et al., 2019). Such sorting pattern taken at face value would imply $\alpha^h > 0$ if the only force at play was the negative selection effect for getting married during a drought. Finding $\alpha^h < 0$ as predicted by the model means that the selection effect plays a minor role compared to the causal effect of droughts on the marital outcomes considered here. The estimated coefficients are therefore still informative about the causal effect despite the potential selection effect because they work in opposite direction. The results are shown in Table A1 and are consistent with those in Table 2.

A.3 Alternative Specification for Prediction 2

In this section, I study the impact of being exposed to any drought event between age 12 and 24 (or 12 and 17) on the likelihood of marrying early (before 25) or marrying as a child bride (before 18) using the individual level data as opposed to the *person* × *age* level data used in the duration model. Results are in Table A2 and are consistent with those from the duration model in Table 3. It shows that being exposed to any drought between ages 12 and 17 increases the likelihood of being married by age 18 only in low polygyny areas.

Table A1: Polygyny, Droughts at Time of Union and Marriage Characteristics

	Husband age gap			Junior wife (2nd wife or higher order)		
	(1)	(2)	(3)	(4)	(5)	(6)
Drought x low polygamy		-0.0287	-0.0297		0.0033	
		(0.1363)	(0.1362)		(0.0046)	
Drought x medium polygamy		0.1392	0.1389		-0.0071	
		(0.1537)	(0.1537)		(0.0060)	
Drought x high polygamy		-0.3408**	-0.3412**		-0.0047	
		(0.1687)	(0.1687)		(0.0072)	
Drought	0.0809			-0.0003		-0.0197**
	(0.1531)			(0.0055)		(0.0096)
Drought x polygyny rate	-0.5260			-0.0087		
	(0.4380)			(0.0178)		
Age first marriage			-0.0685			
			(0.0694)			
Observations	224,936	224,936	224,936	226,130	226,130	71,149
Adjusted R-squared	0.1514	0.1514	0.1514	0.0814	0.0814	0.0636
Mean dependent variable	9.975	9.975	9.975	0.175	0.175	0.516

OLS regressions with observations at individual level. Sample of women aged 25 or older at the time of the survey that are married. The dependent variables are the husband's age gap (column 1-3) and whether woman married as a junior wife (columns 4-6). All regressions include birth year FE, grid-cell FE and marriage year FE. Column (6) restricts the sample to women in polygynous union in medium and high polygyny areas. 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.

The likelihood of child-marriage increases by 2.7 percentage points in low polygyny areas (p<0.01) versus less than 0.5 percentage points for medium and 0.9 percentage points high polygyny areas (p>0.1 for both coefficients).[51]

Columns (3), (4) and (5) show the impact of droughts on the likelihood of marrying before age 25. They significantly increase this likelihood by 3.4 percentage points in absence of polygyny. This effect is significantly fading-out as polygyny rate increases (column (3)). Column (4) splits the effect between low, medium and high polygyny areas. It shows that droughts have a positive and significant impact on early marriage in low polygyny areas. They have no significant effect in medium polygyny areas and they decrease significantly this likelihood by 1.3 percentage points in high polygyny areas.[52] Column (5) splits drought

---

[51] The p-value of the difference between low and medium (high) polygyny is 0.067 (0.96).

[52] The p-values of the difference between these 3 coefficients is significant at 5% except the one between low and medium.

exposure between ages 12 and 24 into exposure between 12 and 17 and exposure between 18 and 24. The results confirm that we have the same pattern in both periods.

Table A2: Drought, Timing of Marriage and Polygyny in Sub-Saharan Africa

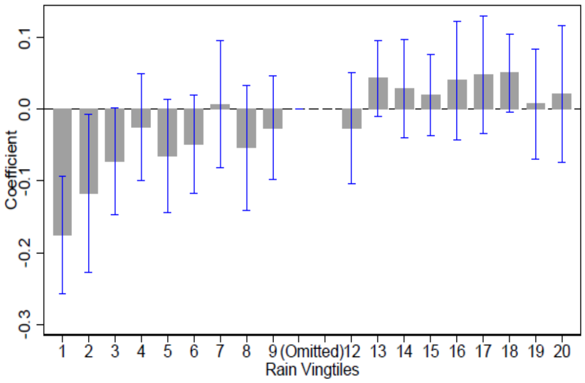
	Married by age 18		Married by age 25		
	(1)	(2)	(3)	(4)	(5)
Any drought ages 12-17	0.0216***				
	(0.0081)				
Any drought ages 12-17 × polygyny rate	-0.0304				
	(0.0207)				
Any drought ages 12-17 × low polygyny		0.0273***			0.0386***
		(0.0094)			(0.0129)
Any drought ages 12-17 × medium polygyny		0.0051			0.0205*
		(0.0073)			(0.0124)
Any drought ages 12-17 × high polygyny		0.0086			-0.0107*
		(0.0059)			(0.0055)
Any drought ages 12-24			0.0347***		
			(0.0116)		
Any drought ages 12-24 × polygyny rate			-0.0857***		
			(0.0261)		
Any drought ages 12-24 × low polygyny				0.0333**	
				(0.0131)	
Any drought ages 12-24 × medium polygyny				0.0145	
				(0.0113)	
Any drought ages 12-24 × high polygyny				-0.0132**	
				(0.0057)	
Any drought ages 18-24 × low polygyny					0.0257*
					(0.0151)
Any drought ages 18-24 × medium polygyny					0.0048
					(0.0109)
Any drought ages 18-24 × high polygyny					-0.0176**
					(0.0075)
Observations	326,400	326,400	326,400	326,400	326,400
Adjusted R-squared	0.1654	0.1654	0.1155	0.1155	0.1157
Mean dependent variable	0.542	0.542	0.845	0.845	0.845

OLS regression with observations at individual level. Sample of women aged 25 or older at the time of the survey. All regressions include age (at time of survey) FE, birth 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 dependent variable is a dummy equal to 1 if woman gets married before age 18 for columns 1-2 and a dummy equal to 1 if she gets married before age 25 for columns 3-5. 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.4 Descriptive Evidence

A.4.1 Rainfall Shocks and Crop Yield

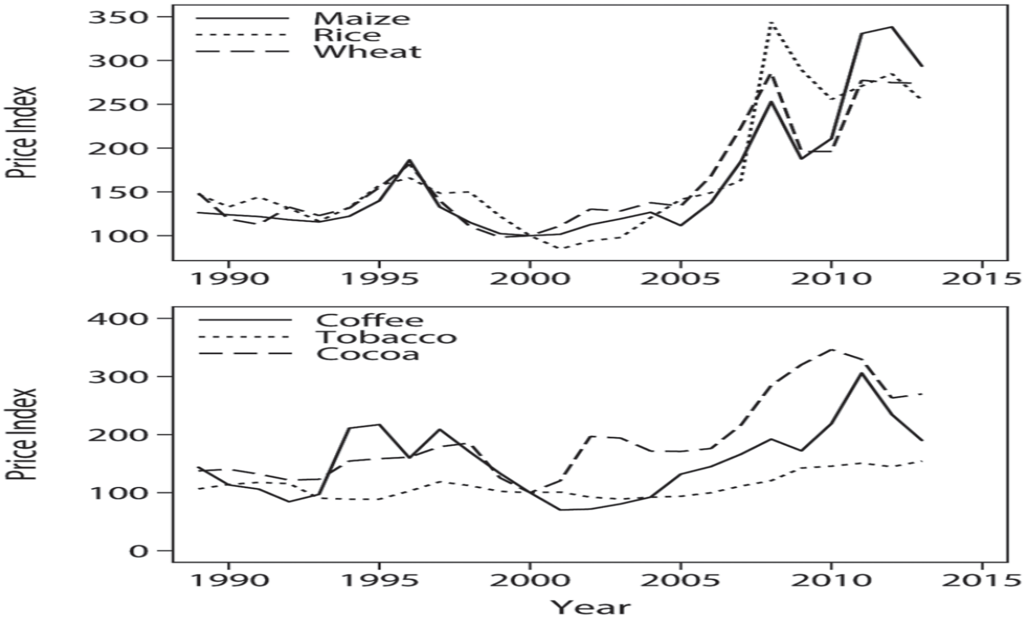
Figure A1: Crop Yield by Rainfall Vintiles



Note: Coefficients of regression of log of annual crop yield (tons per hectare) for 5 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).

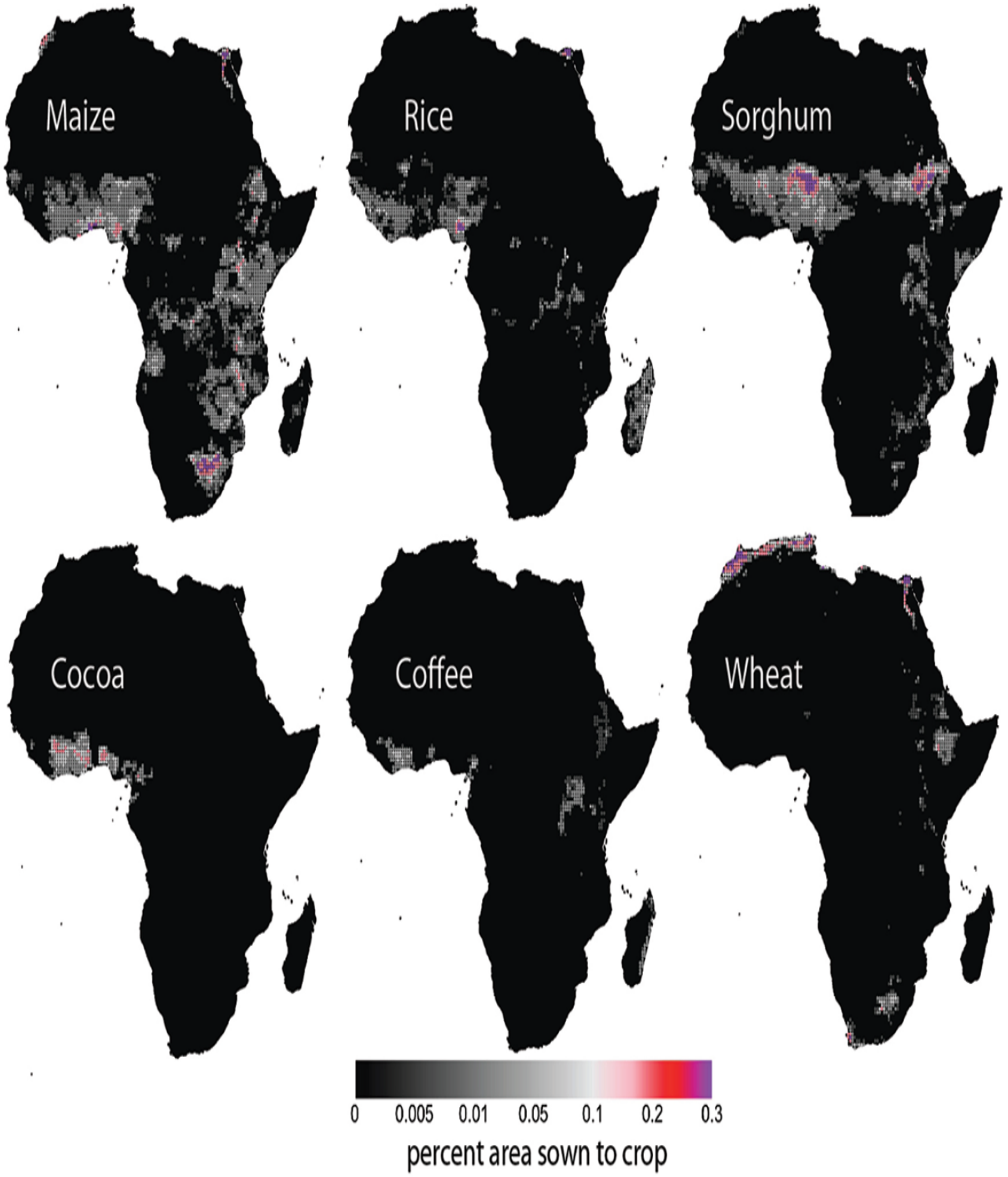
A.4.2 Global Food Price Shocks

Figure A2: Fluctuations in Global Crop Price



Note: Price data are taken from IMF and World Bank sources (year 2000 = 100).

Figure A3: Geographic distribution of crops in year 2000



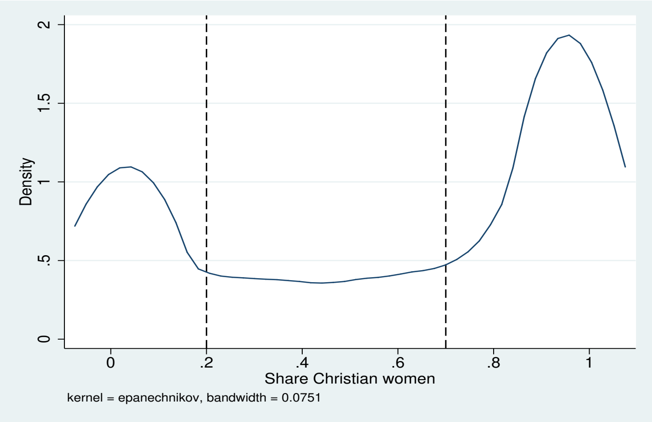
A.4.3 Polygyny and Religion across Space

An important determinant of local norms in terms of polygyny is religion. Religious beliefs often determine social norms and are often intertwined with ethnic/traditional values in Sub-Saharan Africa. The Catholic church prohibits polygyny for instance, while Islam tolerates or even encourages it. Some traditional African beliefs also promote polygyny while others don't. In order to separate any effects of differences in religious or ethno-religious beliefs from the effect of polygyny as a local norm, I need to check that there is enough variation in the joint distribution of these two factors in the data.

Figure A4 shows the distribution of geographical cell grids by proportion of christians among women aged 25 and older.[53] The distribution is bi-modal, with on one hand, cells with low share of Christians among which 367 cells out of the 3,201 have no Christians. On the other hand, there are more cells that have high shares of Christians. Over 490 cells have a proportion of Christians of 100%. For simplification purpose, I also split the continuous proportion of Christians into 3 groups and plot the spatial distribution of cell grids by religion.

Figure A5 shows that religion is distributed in a very clustered way across space. There is some variation within most countries, but in a very contiguous way across the 3 levels of Christianity. Compared to the distribution of polygyny across space, there are substantial variations despite the strong spatial correlation. Many regions are homogeneous with respect to religion but have grid cells with low, medium and high polygyny rates within. A country such as Eswatini (Swaziland) has very high share of Christians in each cell grid of its territory and yet medium to high polygyny rates in most of them.[54]

Figure A4: Share of Christians by Geographic Grid-Cell in Sub-Saharan Africa

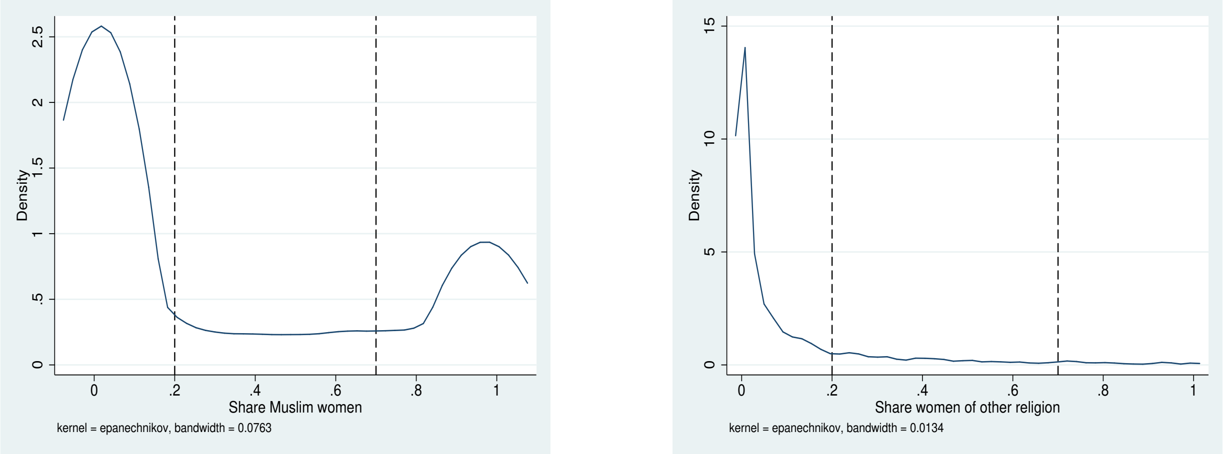


---

[53] Figure A6a and A6b show the kernel density estimation of the proportion of Muslims and traditional/other religious groups, respectively.

[54] Polygyny is strongly encouraged in traditional Swazi society. The current Christian king of Eswatini, Mswati III, has 15 wives.

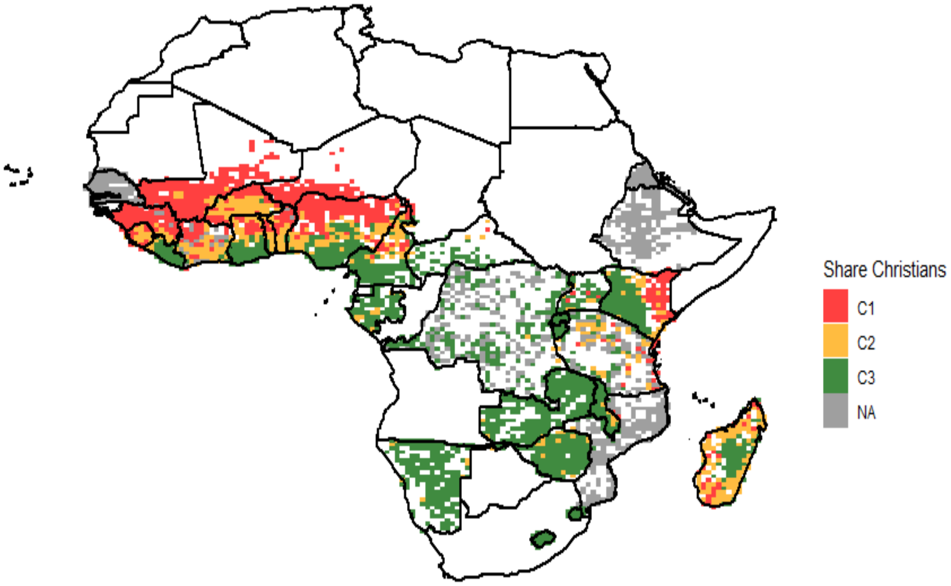
Figure A6: Distribution of the Share of non-Christian Population in Geographic Grid-Cells



(a) Islam

(b) Other Religions

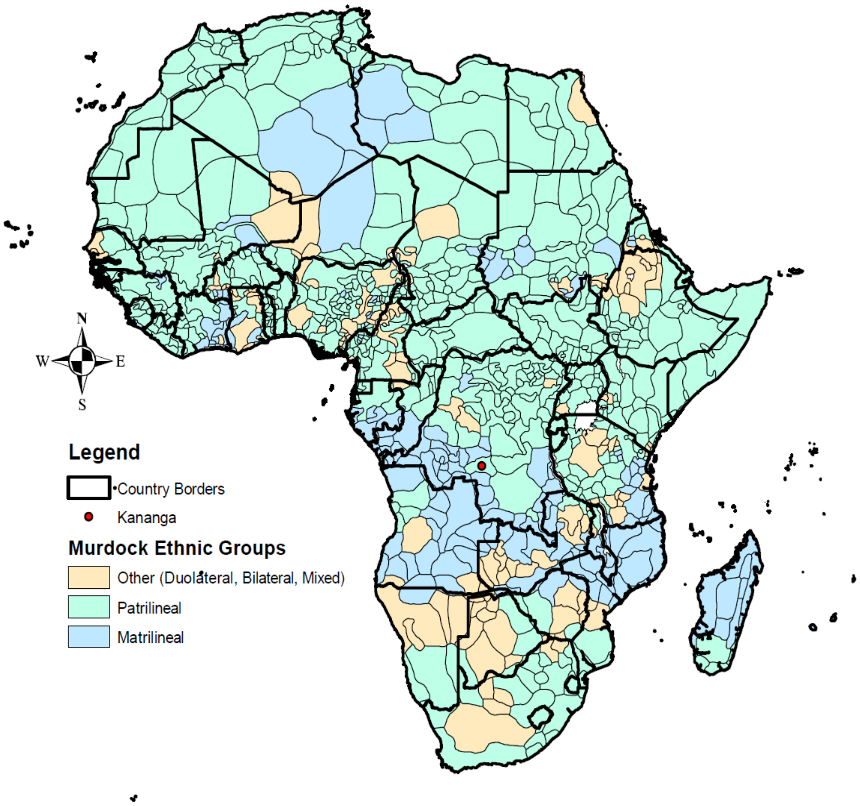
Figure A5: Proportion of Christians across Space in Sub-Saharan Africa



Note: This graph plots the proportion of women aged 25 and older that are Christians in each 0.5 × 0.5 decimal degree weather grid cell. C1 represents grid cells with low proportion of Christians (less than 20%), C2 is for areas with medium proportion (between 20 and 70%) and C3 is for areas with high proportion of Christians (more than 70%). Grid-cells in grey are cells that appear in DHS survey waves in which there is no information on religion.

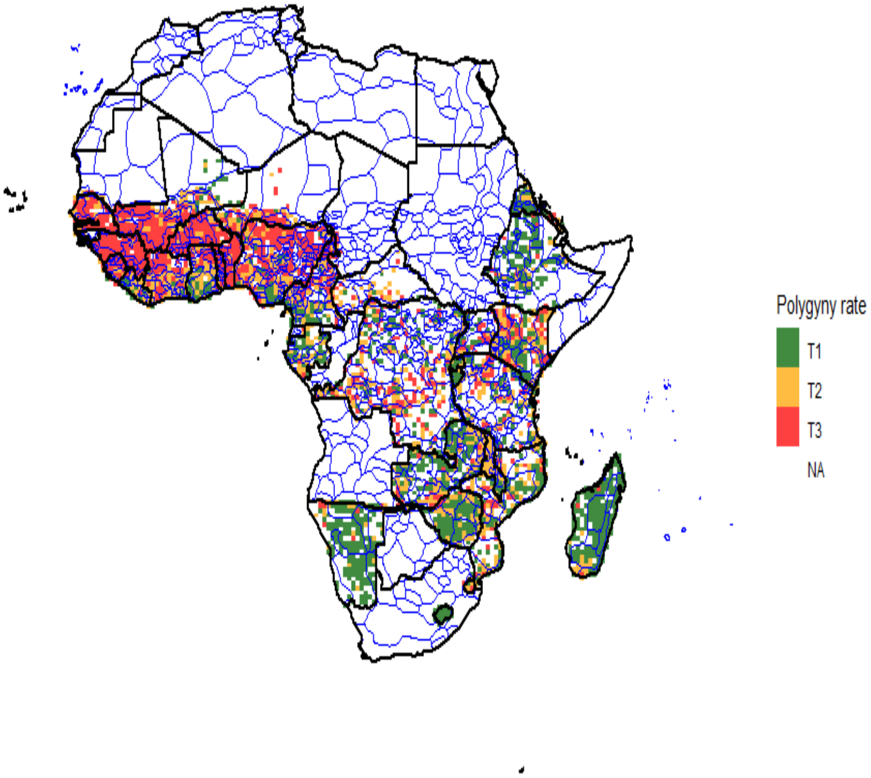
A.4.4 Patrilineality and Patrilocality

Figure A7: Ethnic Group Boundaries and Kinship System in Africa



Source: Lowes (2017)

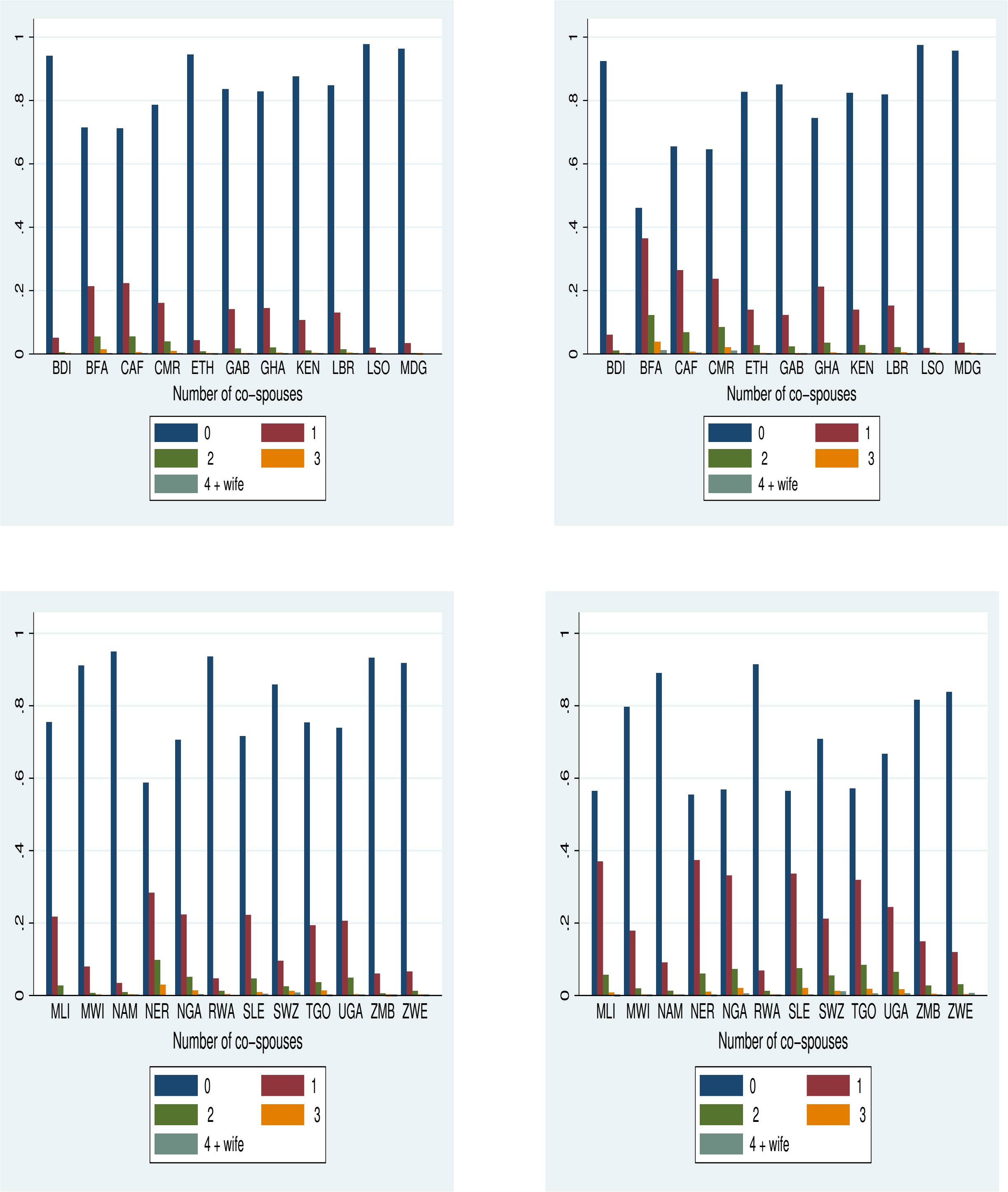
Figure A8: Practice of Polygyny across Space with Ethnic Homelands



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.4.5 Country Level Descriptive Evidence

Figure A9: Distribution of Women by Number of Co-spouses

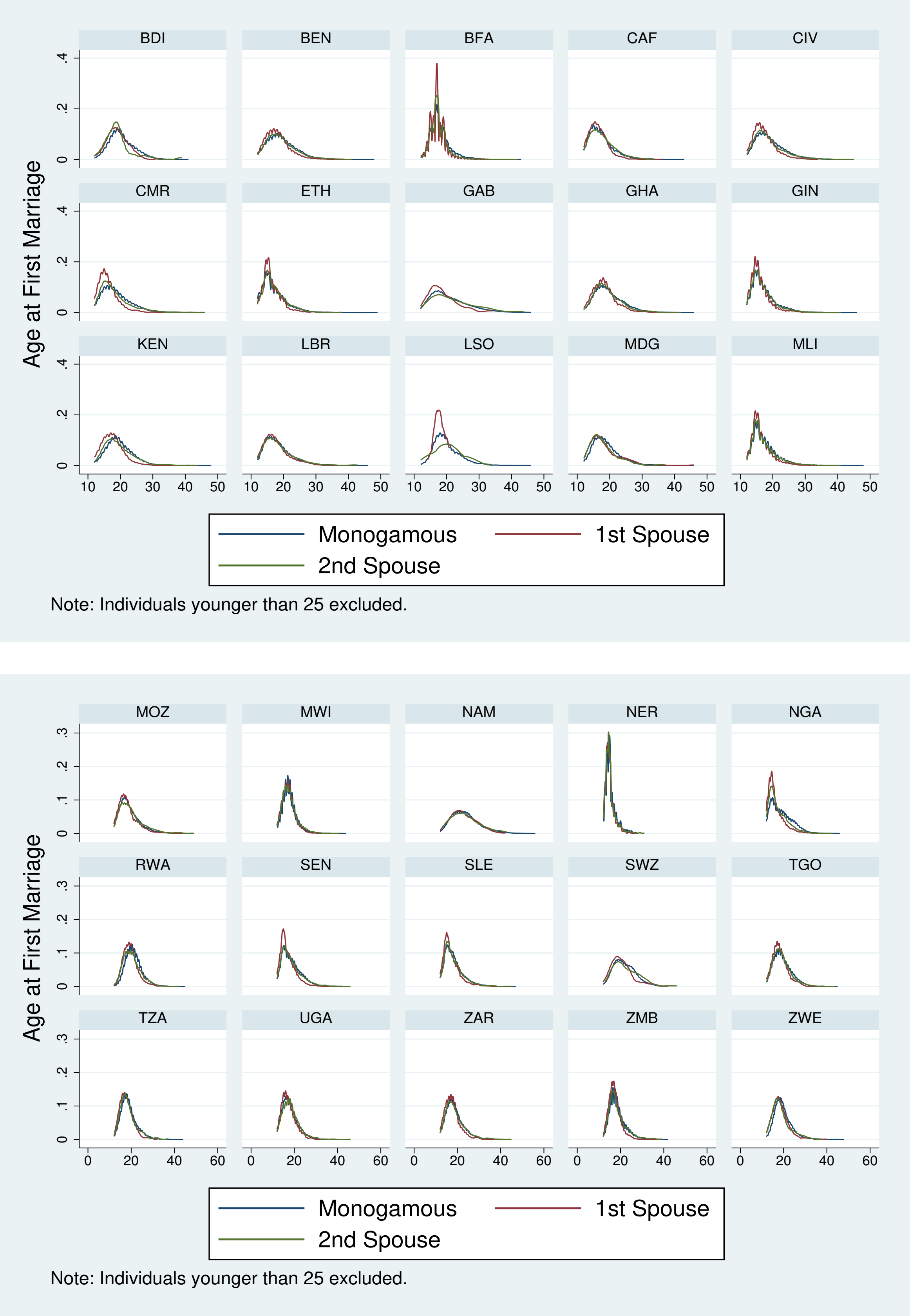


(a) Urban

(b) Rural

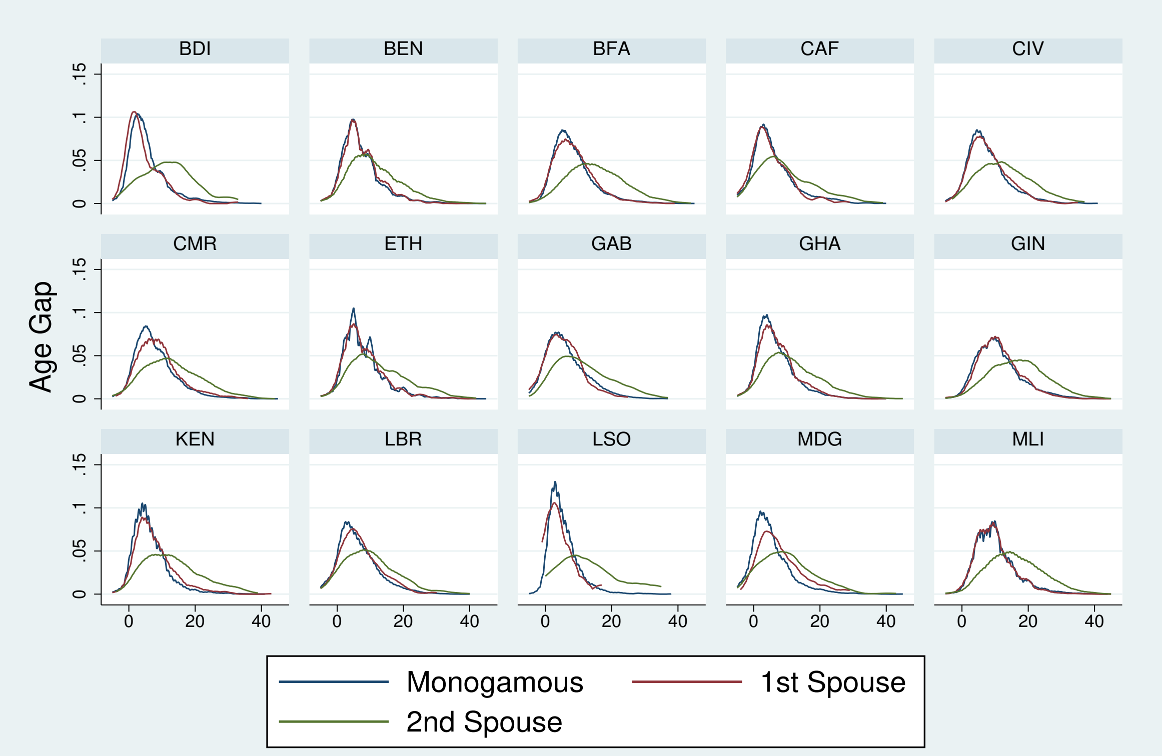
Note:

Figure A10: Age at first marriage by country

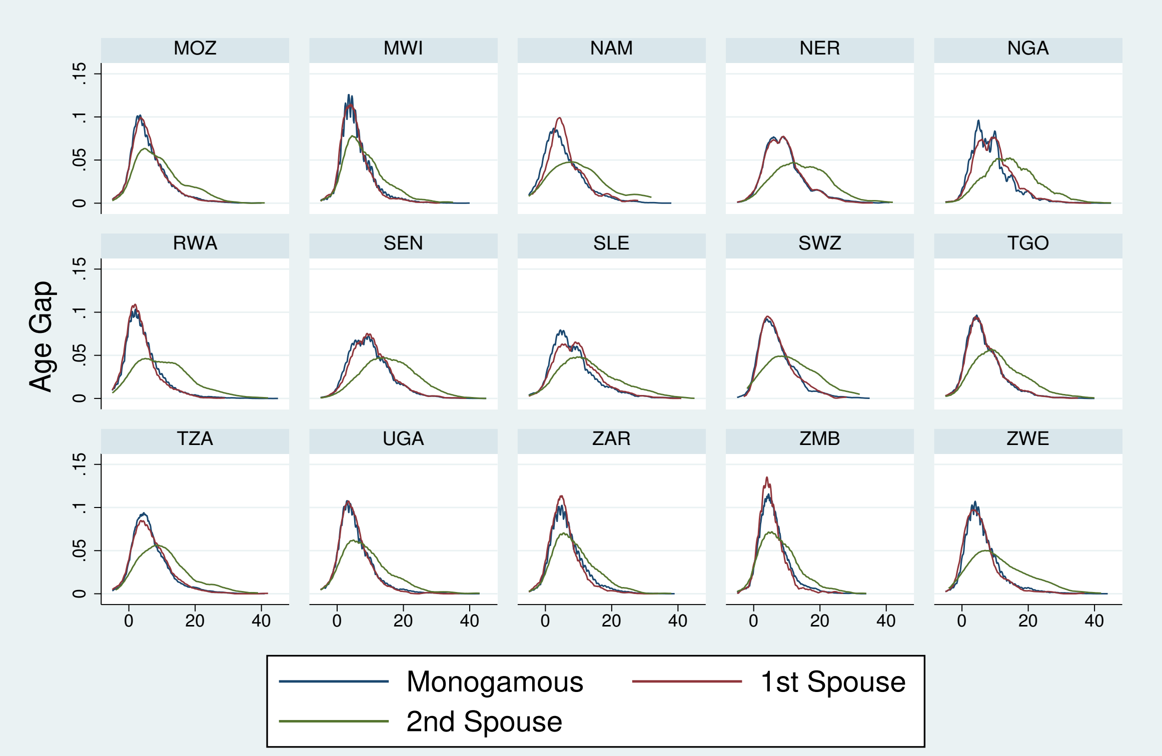


Note:

Figure A11: Age gap between husband and wife by country



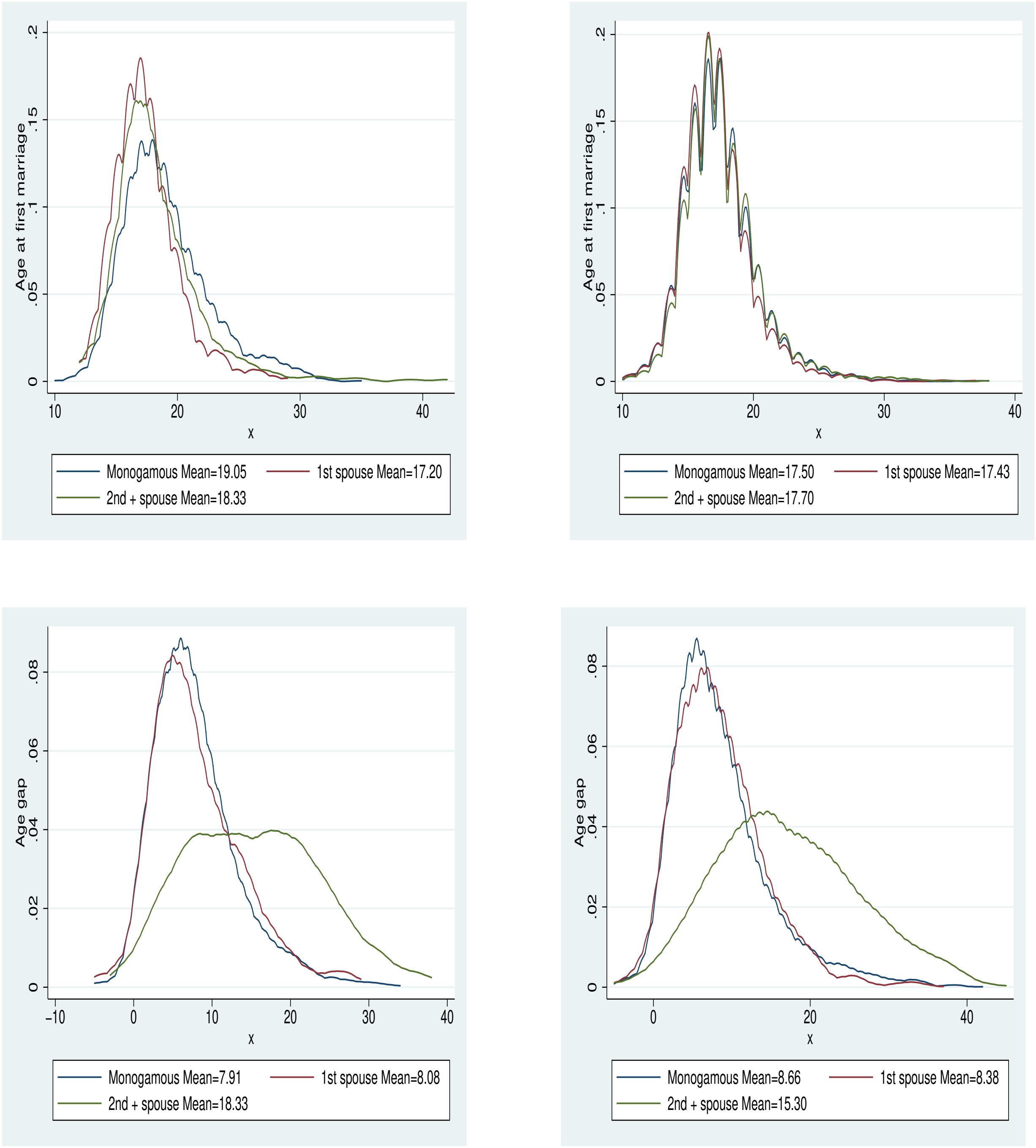
Note: Individuals younger than 25 and women older than husband by more than 6 years excluded.



Note: Individuals younger than 25 and women older than husband by more than 6 years excluded.

Note:

Figure A12: KDE of age at first marriage and age gap in Burkina Faso



(a) Urban (b) Rural

Figure A13: Evolution of Polygyny Rate over Time in SSA

Graphs by Country code from World Bank's WDI country population data set

Graphs by Country code from World Bank's WDI country population data set

Figure A14: Evolution of Polygyny Rate over Time in SSA for Unions within last 10 Years

A.5 Average Effect across Sub-Saharan Africa

This is a replication of the main results in Corno et al. (2020) for Sub-Saharan Africa. The results presented in Table A3 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 have no effect on the hazard of early marriage in absence of marriage payment since marrying-off a daughter does not provide extra resources to cope with the economic shock.

Table A3: Average Effect of droughts on early marriage in Sub-Saharan Africa

	(1)	(2)	(3)	(4)	(5)
		All Sample		Bride Price	
				YES	NO
Drought	0.0037*** (0.0012)	0.0037*** (0.0012)	0.0032*** (0.0011)	0.0037*** (0.0012)	-0.0000 (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 *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Table shows OLS regressions for the Sub-Saharan Africa (SSA) full regression samples: women aged 25 or older at the time of 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.

A.6 Supply Side Mechanism

The model proposed here is able to explain differences in how the equilibrium quantity of child marriage reacts to aggregate shocks in monogamous and polygynous marriage markets. It relies only on the difference in the structure of the demand side of the market and assumes no difference in the incentives on the supply side across these two types of markets. An alternative story could be that it is rather the differences in reaction of the supply side that lead to different equilibrium outcomes. Polygyny allows the most desired men to re-enter the marriage market even after a first union. This means that for women, the option value of waiting and marrying later is higher in polygamous markets. The supply side of the market can therefore be more elastic to income and price changes in polygamous markets compared to monogamous ones. A similar argument has been proposed in Rexer (2020). He studies the impact of female exposure to income shocks during pre-marital adolescence on the timing of marriage and how this fuels violence through an increase in marriage inequality that makes it easy to recruit young men for terrorist attacks. The paper treats rainfall shocks as idiosyncratic shocks that affect the supply side of the market and ignores their effect on the demand side.

I show that, if anything, the supply side mechanism only plays a minor role. This mechanism implies indeed that aggregate income shocks will have a stronger effect on the timing of marriage in polygamous markets. The empirical evidence documented in this paper supports the opposite: income shocks have stronger effects in monogamous markets compared to polygamous ones. Table A4 shows that my main results that use data from several countries are robust to using only the survey data from Nigeria, the country studied in Rexer (2020). As argued in the literature section, the results in Rexer (2020) could be driven by the fact that his identification relies on female specific,cohort-weighted average of past shocks. This problematic weighting of the rainfall shocks is unnecessary if one is only interested in studying their impact on the timing of marriage.[55] Note that the interaction

---

[55] The fact that rainfall shocks have weaker effects on marriage timing in polygamous areas does not prevent them from having stronger effect on marriage inequality. Therefore, my findings do not necessarily go against the first stage specification in Rexer (2020). They suggests however that the true mechanism behind it would be driven more by the fact that, a delay in marriage timing increases marriage inequality in polygamous markets but not so much in monogamous ones, and not because women in polygamous markets

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

Table A4: Polygyny, drought and timing of marriage in Nigeria

	Hazard model: person × age observations				Person level observations	
	Married by 25		Married by 18		Married by 18	
	(1)	(2)	(3)	(4)	(5)	(6)
Drought	0.0207***		0.0182**			
	(0.0067)		(0.0085)			
Drought × polygyny rate	-0.0487**		-0.0417*			
	(0.0195)		(0.0227)			
Drought × low polygyny		0.0192***		0.0175**		
		(0.0053)		(0.0077)		
Drought × medium polygyny		-0.0010		-0.0039		
		(0.0047)		(0.0057)		
Drought × high polygyny		-0.0018		0.0003		
		(0.0060)		(0.0065)		
Any drought ages 12-17					0.0723**	
					(0.0290)	
Any drought ages 12-17 × polygyny rate					-0.1568**	
					(0.0634)	
Any drought ages 12-14 × low polygyny						0.0982**
						(0.0396)
Any drought ages 12-17 × medium polygyny						0.0027
						(0.0199)
Any drought ages 12-17 × high polygyny						0.0000
						(0.0138)
Observations	165,868	165,868	112,030	112,030	23,284	23,284
Adjusted R-squared	0.0702	0.0702	0.0979	0.0979	0.2901	0.2905
Mean dependent variable	0.116	0.116	0.105	0.105	0.570	0.570

All columns include age, birth year, and grid-cell fixed effects. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. Table shows OLS regressions for Nigeria. Observations are at the level of person x age level from Column (1) to (4). The dependent variable is a binary variable for marriage, coded to one if the woman married at the age corresponding to the observation in these columns. The observations are at individual level in Column (5) and (6) and the dependent variable is a dummy equal to 1 if the woman got married before age 18. Full sample includes women aged 25 or older at the time of interview (excluding those exposed to a civil war). 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.7 Other Robustness Tables

---

delay more their unions when they have been exposed to good rainfall realizations during adolescence.

Table A5: Polygyny, PPI and Timing of Marriage: Robustness to Religion

	Christians			Non-Christians		
	All	Rural	Urban	All	Rural	Urban
	(1)	(2)	(3)	(4)	(5)	(6)
PPI	-0.0024*	-0.0050**	0.0000	-0.0056*	-0.0082*	0.0011
	(0.0014)	(0.0024)	(0.0017)	(0.0030)	(0.0048)	(0.0034)
PPI × polygyny rate	0.0087*	0.0155**	0.0001	0.0127	0.0200	-0.0063
	(0.0052)	(0.0070)	(0.0080)	(0.0102)	(0.0148)	(0.0107)
Observations	1,010,451	583,406	427,045	394,101	260,375	133,726
Adjusted R-squared	0.0571	0.0653	0.0453	0.0698	0.0774	0.0564
Mean dependent variable	0.0995	0.116	0.0768	0.154	0.171	0.121

Hazard model with observations at *person* × *age* level. 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. Table shows OLS cross-sectional regressions for Sub-Saharan Africa. Full regression sample: women aged 25 or older at the time of interview. The PPI is measured in terms of average temporal standard deviations.

Table A6: Polygyny, PPI and timing of Marriage: Robustness to Kinship System

	Not Matrilineal				Matrilineal			
	All	Rural		Urban	All	Rural		Urban
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PPI	-0.0033***	-0.0066***		0.0005	0.0035	0.0034		-0.0025
	(0.0010)	(0.0015)		(0.0009)	(0.0040)	(0.0054)		(0.0040)
PPI × polygyny rate	0.0045	0.0107**		-0.0037	-0.0305**	-0.0329*		-0.0056
	(0.0035)	(0.0051)		(0.0056)	(0.0150)	(0.0186)		(0.0139)
PPI × low polygyny			-0.0057***				-0.0012	
			(0.0013)				(0.0047)	
PPI × medium polygyny			-0.0045***				-0.0057	
			(0.0013)				(0.0048)	
PPI × high polygyny			-0.0001				-0.0043	
			(0.0019)				(0.0065)	
Observations	858,708	508,770	508,770	341,888	274,078	170,031	170,031	103,793
Adjusted R-squared	0.0648	0.0728	0.0728	0.0473	0.0619	0.0721	0.0721	0.0469
Mean dependent variable	0.125	0.144	0.144	0.0955	0.122	0.140	0.140	0.0929

Hazard model with observations at *person* × *age* level. 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. Table shows OLS cross-sectional regressions for Sub-Saharan Africa. Full regression sample: women aged 25 or older at the time of interview. The PPI is measured in terms of average temporal standard deviations.

Table A7: Polygyny, PPI and Timing of Marriage by Crop Type

	Rural		Urban	
	(1)	(2)	(3)	(4)
PPI food crops	-0.0072***		0.0009	
	(0.0023)		(0.0014)	
PPI food crops × polygyny rate	0.0148**		-0.0078	
	(0.0069)		(0.0060)	
PPI cash crops	0.0004		-0.0004	
	(0.0009)		(0.0006)	
PPI cash crops × polygyny rate	0.0000		0.0031*	
	(0.0023)		(0.0018)	
PPI food crops × low polygyny		-0.0062***		0.0000
		(0.0020)		(0.0012)
PPI food crops × medium polygyny		-0.0027*		0.0002
		(0.0015)		(0.0014)
PPI food crops × high polygyny		-0.0001		-0.0038
		(0.0027)		(0.0027)
PPI cash crops × low polygyny		0.0007		-0.0001
		(0.0009)		(0.0005)
PPI cash crops × medium polygyny		-0.0000		0.0006
		(0.0007)		(0.0005)
PPI cash crops × high polygyny		0.0008		0.0007
		(0.0006)		(0.0008)
Observations	974,426	974,426	647,716	647,716
Adjusted R-squared	0.0702	0.0702	0.0472	0.0472
Mean dependent variable	0.134	0.134	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. Table shows OLS regressions for Sub-Saharan Africa (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. All Regressions are weighted using country population-adjusted survey sampling weights.

Table A8: Polygyny, Religion, Droughts and Timing of Marriage

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Polygamy			Christian	
		Low	Medium	High	YES	NO
Drought x Christian	0.0041***	0.0055***	0.0032	0.0002		
	(0.0013)	(0.0017)	(0.0020)	(0.0046)		
Drought x Muslim	0.0019	0.0137	0.0016	0.0001		
	(0.0028)	(0.0100)	(0.0037)	(0.0038)		
Drought x other	0.0025	-0.0002	0.0069	0.0004		
	(0.0039)	(0.0063)	(0.0069)	(0.0063)		
Drought x low polygyny					0.0055***	0.0089
					(0.0018)	(0.0080)
Drought x medium polygyny					0.0033*	0.0032
					(0.0020)	(0.0033)
Drought x high polygyny					0.0011	-0.0003
					(0.0047)	(0.0033)
Observations	2,097,585	872,719	710,744	514,122	1,428,209	669,376
Adjusted R-squared	0.0664	0.0511	0.0558	0.0742	0.0537	0.0707
Interacted age FE	YES	YES	YES	YES	YES	YES
Interacted birth year FE	YES	YES	YES	YES	YES	YES
Grid-cell FE	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES
Mean dependent variable	0.111	0.0841	0.115	0.153	0.124	0.163

All columns include age, birth year, and grid-cell fixed effects. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. Table shows OLS regressions for Sub-Saharan Africa (SSA). Observations are at the level of person x age (from 12 to 24 or age of first marriage). The dependent variable is a dummy equal to one if the woman gets married at the age corresponding to a given observation. Full sample includes women aged 25 or older at the time of interview and is used in column (1). Columns (2), (3) and (4) split the sample by level of polygyny in each cell-grid. Column (5) and (6) split the full sample by religion. Interacted age FE and birth year FE are interactions of age and birth year FE with religion dummies. 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 A9: Droughts, Fertility and Polygyny in Sub-Saharan Africa

	Any child before 15	Any child [15-17]		Number of children by 25	
	(1)	(3)	(4)	(5)	(6)
Any drought ages 12-14	-0.0011				
	(0.0028)				
Any drought ages 12-14 x polygamy rate	0.0015				
	(0.0099)				
Any drought ages 15-17		0.0201***			
		(0.0064)			
Any drought ages 15-17 x polygyny rate		-0.0377**			
		(0.0185)			
Any drought ages 15-17 x low polygyny			0.0212***		
			(0.0072)		
Any drought ages 15-17 x medium polygyny			0.0049		
			(0.0052)		
Any drought ages 15-17 x high polygyny			0.0040		
			(0.0059)		
Any drought ages 12-24				0.2056***	
				(0.0626)	
Any drought ages 12-24 x polygyny rate				-0.4419***	
				(0.1619)	
Any drought ages 12-24 x low polygyny					0.2012***
					(0.0768)
Any drought ages 12-24 x medium polygyny					0.0714*
					(0.0391)
Any drought ages 12-24 x high polygyny					-0.0144
					(0.0401)
Observations	326,400	308,584	308,584	326,400	326,400
Adjusted R-squared	0.0425	0.0584	0.0584	0.1522	0.1522
Mean dependent variable	0.0545	0.266	0.266	2.413	2.413

All regressions include age FE, birth 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. Table shows OLS cross-sectional regressions for Sub-Saharan Africa. Full regression sample: 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 A10: Polygyny, Droughts and Timing of Marriage: Place of Residence and Education

	Full Sample				Bride price only			
	Residence		Any Schooling		Residence		Any Schooling	
	Rural (1)	Urban (2)	NO (3)	YES (4)	Rural (5)	Urban (6)	NO (7)	YES (8)
Drought	0.0074***	0.0069**	0.0119**	0.0057**	0.0088***	0.0086***	0.0141**	0.0067***
	(0.0026)	(0.0028)	(0.0046)	(0.0024)	(0.0029)	(0.0028)	(0.0057)	(0.0025)
Drought x polygyny rate	-0.0166**	-0.0050	-0.0243**	-0.0072	-0.0201***	-0.0085	-0.0275**	-0.0126
	(0.0077)	(0.0106)	(0.0110)	(0.0099)	(0.0074)	(0.0100)	(0.0119)	(0.0096)
Observations	1,526,943	906,830	934,051	1,525,072	809,170	521,968	618,738	725,622
Adjusted R-squared	0.0689	0.0472	0.0711	0.0534	0.0724	0.0460	0.0766	0.0495
Mean dependent variable	0.126	0.0877	0.146	0.0909	0.134	0.0937	0.150	0.0906

All regressions include age FE, birth 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. Table shows OLS regressions for Sub-Saharan Africa (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. Full sample includes women aged 25 or older at the time of interview. The other columns restrict this sample to only women from an ethnic group where the bride price custom is practiced. 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 A11: Polygyny, Droughts and Timing of Marriage in Sub-Saharan Africa by sub-regions

	West Africa				Outside West Africa			
	Full Sample		Bride price only		Full Sample		Bride price only	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drought	0.0153***		0.0118***		0.0030		0.0091***	
	(0.0042)		(0.0040)		(0.0024)		(0.0032)	
Drought x polygyny rate	-0.0313***		-0.0208**		-0.0065		-0.0425**	
	(0.0103)		(0.0090)		(0.0138)		(0.0182)	
Drought x low polygyny		0.0140***		0.0102**		0.0019		0.0055**
		(0.0046)		(0.0042)		(0.0018)		(0.0023)
Drought x medium polygyny		0.0035*		0.0061***		0.0027		-0.0006
		(0.0020)		(0.0022)		(0.0026)		(0.0035)
Drought x high polygyny		-0.0002		0.0001		-0.0011		-0.0153
		(0.0025)		(0.0019)		(0.0084)		(0.0123)
Observations	1,145,604	1,145,604	866,974	866,974	1,313,573	1,313,573	477,386	477,386
Adjusted R-squared	0.0633	0.0633	0.0680	0.0681	0.0619	0.0619	0.0568	0.0568
Mean dependent variable	0.127	0.127	0.128	0.128	0.0988	0.0988	0.101	0.101

All columns include age, birth year, grid-cell fixed effects. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. Table shows OLS regressions for Sub-Saharan Africa (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. Full sample includes women aged 25 or older at the time of interview. The other columns restrict this sample to only women from an ethnic group where the bride price custom is practiced. 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 A12: Polygyny, Droughts and Timing of marriage: Samples with substantial within country variation

	Full Sample				Bride Price Only			
	Married by age 25		Married by age 18		Married by age 25		Married by age 18	
IQR polygyny rates	IQR> 0.3 (1)	0.2<IQR≤0.3 (2)	IQR> 0.3 (3)	0.2<IQR≤0.3 (4)	IQR> 0.3 (5)	0.2<IQR≤0.3 (6)	IQR> 0.3 (7)	0.2<IQR≤0.3 (8)
Drought	0.0103***	0.0132***	0.0105***	0.0096**	0.0115***	0.0132***	0.0120***	0.0084**
	(0.0037)	(0.0040)	(0.0034)	(0.0042)	(0.0040)	(0.0038)	(0.0036)	(0.0037)
Drought x polygyny rate	-0.0535**	-0.0285**	-0.0518***	-0.0212	-0.0550**	-0.0316***	-0.0579***	-0.0224**
	(0.0238)	(0.0121)	(0.0198)	(0.0129)	(0.0263)	(0.0106)	(0.0211)	(0.0103)
Observations	283,538	713,618	187,934	499,950	261,872	470,469	173,134	329,482
Adjusted R-squared	0.0549	0.0604	0.0501	0.0773	0.0547	0.0642	0.0491	0.0858
Mean dependent variable	0.0991	0.120	0.0626	0.0985	0.0981	0.120	0.0607	0.101

All columns include age, birth year, and grid-cell fixed effects. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. IQR is the interquartile range of grid-cell level polygyny rates within each country. The sample with $IQR > 0.3$ includes the Democratic Republic of Congo, Kenya, Mozambique and Uganda. The sample with $0.2 < IQR <\leq 0.3$ includes Cameroon, Côte d'Ivoire, Ghana, Mali, Nigeria, Sierra Leone and Tanzania. 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. Full sample includes women aged 25 or older at the time of interview. The other columns restrict this sample to only women from an ethnic group where the bride price custom is practiced. 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 A13: 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. Table shows OLS cross-sectional regressions for Sub-Saharan Africa. 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 A14: 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. Table shows OLS cross-sectional regressions for Sub-Saharan Africa. 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 A15: Robustness to the Definition of Polygyny rate: Droughts

	Married by age 25			
	(1)	(2)	(3)	(4)
Drought	0.0096***	0.0074***		
	(0.0021)	(0.0020)		
Drought x Polygyny rate (1st wave)	-0.0184***			
	(0.0060)			
Drought x Polygyny rate (last wave)		-0.0132*		
		(0.0068)		
Drought x Low polygyny (1st wave)			0.0081***	
			(0.0021)	
Drought x Medium polygyny rate (1st wave)			0.0037**	
			(0.0018)	
Drought x High polygyny rate (1st wave)			-0.0015	
			(0.0025)	
Drought x Low polygyny (last wave)				0.0059***
				(0.0018)
Drought x Medium polygyny rate (last wave)				0.0041**
				(0.0020)
Drought x High polygyny rate (last wave)				0.0018
				(0.0024)
Observations	1,985,343	2,246,344	1,985,343	2,246,344
Adjusted R-squared	0.0598	0.0607	0.0598	0.0607
Mean dependent variable	0.111	0.111	0.111	0.111

All columns include age, birth year and grid-cell fixed effects. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. Table shows OLS regressions for countries with at last two DHS survey waves. 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. 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 A16: Robustness to the Definition of Polygyny rate: PPI shocks

	ALL		Rural		Urban	
	(1)	(2)	(3)	(4)	(5)	(6)
PPI	-0.0027**	-0.0031**	-0.0064***	-0.0066***	0.0009	0.0006
	(0.0013)	(0.0012)	(0.0023)	(0.0022)	(0.0015)	(0.0013)
PPI × polygyny rate (1st wave)	0.0043		0.0115**		-0.0045	
	(0.0043)		(0.0058)		(0.0053)	
PPI × polygyny rate (last wave)		0.0082*		0.0158**		-0.0018
		(0.0042)		(0.0064)		(0.0052)
Observations	1,400,684	1,606,094	802,502	954,825	589,804	642,891
Adjusted R-squared	0.0612	0.0621	0.0690	0.0701	0.0469	0.0464
Mean dependent variable	0.115	0.115	0.134	0.133	0.0882	0.0880

Hazard model with observations at $person \times age$ level. All regressions include age FE, birth year FE, grid-cell FE and country × calendar year FE. 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.

Table A17: 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), log of household consumption (columns 3–4) or log of GDP per capita 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 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, 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. include year and country fixed effects.

Table A18: Robustness to Continuous Rainfall Measure

	Bride price		No bride price	
	(1)	(2)	(3)	(4)
Log (Rainfall)	-0.0120**		-0.0011	
	(0.0048)		(0.0060)	
Log (Rainfall) x Polygyny rate	0.0309**		-0.0067	
	(0.0141)		(0.0264)	
Log (Rainfall) x Low polygyny		-0.0104**		-0.0028
		(0.0046)		(0.0049)
Log (Rainfall) x Medium polygyny		-0.0027		-0.0000
		(0.0035)		(0.0049)
Log (Rainfall) x High polygyny		0.0050		-0.0092
		(0.0047)		(0.0115)
Observations	1,344,360	1,344,360	369,241	369,241
Adjusted R-squared	0.0636	0.0636	0.0645	0.0645
Mean dependent variable	0.118	0.118	0.127	0.127

All columns include age, birth year, and grid-cell fixed effects. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. 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. Results are weighted using population-adjusted survey sampling weights. Sample is split between girls from ethnic groups that traditional practice bride price payment or not based on the Murdock Ethnographic Atlas.

Table A19: Polygyny, Droughts and Timing of Marriage: Robustness to Time Fixed Effects

	(1)	(2)	(3)	(4)	(5)	(6)
Drought	0.0063***		0.0059***		0.0034	
	(0.0021)		(0.0020)		(0.0023)	
Drought × polygyny rate	-0.0136**		-0.0163**		-0.0179**	
	(0.0066)		(0.0065)		(0.0073)	
Drought × low polygyny		0.0050**		0.0046**		0.0017
		(0.0021)		(0.0019)		(0.0021)
Drought × medium polygyny		0.0028*		0.0014		-0.0017
		(0.0016)		(0.0016)		(0.0019)
Drought × high polygyny		-0.0010		-0.0026		-0.0056**
		(0.0024)		(0.0024)		(0.0026)
Observations	2,459,177	2,459,177	2,459,177	2,459,177	2,459,177	2,459,177
Adjusted R-squared	0.0625	0.0625	0.0636	0.0636	0.0651	0.0651
Calendar year FE	YES	YES	YES	YES	NO	NO
Country × time trend	NO	NO	YES	YES	NO	NO
Country × calendar year FE	NO	NO	NO	NO	YES	YES
Mean dependent variable	0.112	0.112	0.112	0.112	0.112	0.112

All columns include age, birth year, and grid-cell fixed effects. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. 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. Results are weighted using population-adjusted survey sampling weights.

Table A20: Current, Lagged, Future droughts and Timing of Marriage by Polygyny Levels

Polygyny level:	Low	Medium	High
	(1)	(2)	(3)
Drought	0.0060***	0.0038**	0.0007
	(0.0019)	(0.0016)	(0.0024)
Drought Lead 1	0.0005	0.0017	0.0003
	(0.0016)	(0.0019)	(0.0024)
Drought Lag 1	0.0006	-0.0020	-0.0017
	(0.0017)	(0.0019)	(0.0022)
Observations	938,991	810,915	704,377
Adjusted R-squared	0.0504	0.0533	0.0671
Mean dependent variable	0.0858	0.113	0.146

All columns include age, birth year, and grid-cell fixed effects. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. 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. Results are weighted using population-adjusted survey sampling weights.

Table A21: Droughts in Current/Neighboring Cells and Timing of Marriage by Polygyny Levels

Polygyny level:	Low	Medium	High
	(1)	(2)	(3)
Drought in cell of residence	0.0061**	0.0040*	0.0005
	(0.0026)	(0.0020)	(0.0025)
Drought in neighboring cell	-0.0002	-0.0003	0.0002
	(0.0016)	(0.0018)	(0.0021)
Observations	941,771	812,391	705,015
Adjusted R-squared	0.0503	0.0532	0.0671
Mean dependent variable	0.0858	0.113	0.146

All columns include age, birth year, and grid-cell fixed effects. Robust standard errors clustered at cell-grid level in parentheses *** p<0.01, ** p<0.05, * p<0.1. 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. Results are weighted using population-adjusted survey sampling weights. Drought in neighboring cell is a dummy equal one if there is a drought in at least one of the adjacent cells (first degree neighbors) to the current one.