Polygyny, Timing of Marriage and Economic Shocks in Sub-Saharan Africa

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Motivation

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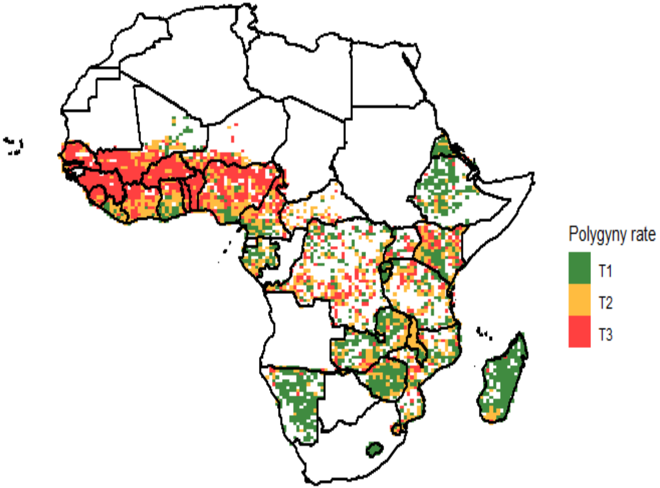
- Local norms and culture are crucial for economic development (Ashraf et al., 2020; Collier, 2017)
- Marriage market: important aspect of household welfare and economic development that relies heavily on such norms
  - Marriage related to: investment in human capital, risk-coping and risk-sharing opportunities, fertility, etc.
    - (Chiappori et al., 2018; Field and Ambrus, 2008; Tertilt, 2005)
- One of the most salient local norms of marriage markets in SSA: Extent to which polygyny is practiced

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

Polygyny rate: share of women aged 25-49 in union with a polygynous male in each 0.5 $\times$ 0.5 decimal degree 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%). ▸ Source Variation ▸ KDE Polygyny ▸ Country Trend



- **Timing of marriage:** Child marriage has big consequences
  - Bargaining power, pregnancy complications (Save the Children, 2004), low HK for children, high fertility, etc...
- **This paper:** Studies how local polygyny norms affect the equilibrium response of marriage markets to short term changes in aggregate economic conditions in SSA
  - Revisits the impact of droughts on marriage timing in SSA (Corno et al., 2020): Setting with substantial bride price
- Presence of polygyny changes market structure (demand side) + incentives (potentially both sides)
- How does this affect equilibrium reaction to aggregate shocks?

Main Findings

- **Presence of polygyny attenuates the impact of droughts on the timing of marriage**
- Polygyny provides an extra margin of adjustment to shocks:
  - Relative income and price elasticity demand for 1st/unique spouse (D_1) Vs demand for 2nd spouse (D_2)
- Same shock has no detectable effect on timing of marriage in high polygyny areas
  - $\uparrow$ seniority levels and $\downarrow$ in age of husband for women who marry during droughts
- Differences in marriage market reaction $\implies$ differences in fertility onset and levels

Related Literature

- **Marriage markets and economic conditions:** Corno and Voena (2021), Corno et al. (2020), Rexer (2020), Tertilt (2005), Greenwood et al. (2017)

- **Importance of culture/norms in shaping economic behavior:** *on economic development* (Tertilt, 2005; La Ferrara ,2007; Jayachandran and Pande, 2017) - *HH economic decisions* (Anderson and Bidner, 2015; Ashraf et al., 2020; Bhalotra et al., 2020)

- **Determinants and consequences of wife seniority ranking in polygyny:** (Reynoso, 2019; André and Dupraz, 2019; Munro et al., 2019; Mammen,2019; Rossi, 2018)
  - **Consequences of coping mechanisms used to deal with shocks**: Morten (2019), Shah and Steinberg (2017), Kazianga and Udry (2006), Rosenzweig and Stark (1989)

Plan

- Model
- Empirical Strategy and Results
  - Main results
  - Threats to Identification and Interpretation
  - Consequences on Fertility

Model Setup

Table: 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

$\mathcal{M}_y^f$: [12-17]; $\mathcal{M}_o^f$: [18-30]; $\mathcal{M}_y^m$:[15/18-25]; $\mathcal{M}_o^m$: [26-35]

- 1st participation to market:
  - Parents make marital decision at this stage
  - Net contribution of young men and women (child brides): $w_y^m > 0$ and $w_y^f > 0$
- 2nd participation to market
  - Sons married during their 1st participation $(t-1)$ may be looking for a 2nd spouse depending on local polygyny norm p
    - $p = 0 \implies \textit{monogamy}$
    - **Variation in p exogenous to model**

- 2nd participation to market (cntd): Sons' emancipate
  - Run autonomously their own production/consumption unit
  - They make their own marital decisions
  - **Patrilocality:** They still contribute to their parents HH
  - This contribution is higher if son is already married by that time: $w_o^{m,h} > w_o^{m,l}$
- No emancipation for daughters: Their parents make marital decisions for them
- Assume mass 1 of men, a balanced sex ratio by birth cohort and the population grows at a constant rate a
- Imperfect monetary market: no borrowing/saving
- Each marriage involves the payment of a unique bride price (τ_t) that clears supply and demand

- **Equilibrium Matching Process:** Possible multiple equilibria. Simplest one supported by data:
  - $\mathcal{U}_o^m > \mathcal{U}_o^f$: excess quantity of unmarried old men on market at t compared to unmarried old women ▸ Age gap ▸ Age marriage
  - Unmarried old men on the market can marry women from the youngest or the oldest 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*
- Market is cleared by the youngest generations
- **Preferences:** CRRA utility $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$, $\gamma \geq 1$
- **Income:** $I_t = y_t + \epsilon_t$
- y_t: aggregate income. Can be high (y^H) or low (y^L) with equal probability each year (depending on rainfall)
- ϵ_t: idiosyncratic income. iid following cdf f

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Solving the Model: Backward Induction

Phase 2

- Payoff for families of "old" children unmarried at beginning t:

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

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

- $\exists\ [\underline{\tau}_t,\bar{\tau}_t]$: **All singles at the beginning of stage 2 marry**

- Payoff for those married at the beginning of t:

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

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

- Men go back to market for 2nd spouse with probability p

- $\exists\ \epsilon^*_{m,2}$: $\epsilon_{tj}>\epsilon^*_{m,2} \implies$ **marry a 2nd spouse**

Phase 1

- Parents are decision makers. For a given, τ_t payoffs are:

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

- $\bar{V}^s_{o,t+1}(M_t)$: sum of future consumption utility for parents

- For any union to happen during stage 1 for a family with a daughter, $\tau_t > w^f_y$

- $\exists\ \epsilon^*_f(\tau_t, y_t)$ **and** $\epsilon^*_m(\tau_t, y_t)$**: daughter's family with** $\epsilon_{ti} < \epsilon^*_f(\tau_t, y_t)$ **and son's family with** $\epsilon_{tj} > \epsilon^*_m(\tau_t, y_t)$ **want to marry them off**

Supply and Demand for Child Brides

- Demand for child brides comes from 3 sources:
  - Old men who cannot find an adult spouse because $\mathcal{U}^m_{o,t} > \mathcal{U}^f_{o,t}$

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

  - Potential young grooms whose family draw $\epsilon_{tj} > \epsilon^*_m$:

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

  - Old married men on the market for a 2nd spouse (with probability p) that have a shock $\epsilon_{tj} > \epsilon^*_{m,2}$

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

- Supply of child brides: HH with a low enough shock ϵ_{ti}
  $S(\tau_t, y_t) = F(\epsilon^*_f(\tau_t, y_t))$

- This demand and supply of child brides will determine an equilibrium bride price that clears the market

- Equilibrium quantity of child marriage:
  $Q^*(y_t) \equiv D(y_t, \tau_t^*) = S(y_t, \tau_t^*)$
- **Proposition 4:**
  - $p = 0$: Polygyny not allowed (Corno et al., 2020)

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

If $w_o^{m,l}$ is high enough det

  - $p > 0$: polygyny allowed

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

If extra expected utility that men derive from having 2nd spouse ($V_{M2}^{m,nf} - V_M^{m,nf}$) is high enough det DS

Testable Predictions

- Additional margin of adjustment to aggregate shocks: relative income and price elasticity of $D^{(1)}$ compared to $D^{(2)}$

- **Predictions to take to data:**
    - Lower aggregate income increases child marriage in absence of polygyny. **This negative effect is fading out as p increases**
    - In polygamous areas: lower aggregate income should $\uparrow$ likelihood of marrying younger men as 1st Vs 2nd spouse

Data, Empirical Strategy and Results

- DHS survey data: 73 survey waves collected between 1994 and 2013 in 31 countries in SSA
    - Women provide info on month, year and age at 1st union
    - Whether married to a polygynous husband and rank in union
- GPS coordinates of each DHS HH cluster is used to match it with corresponding 0.5×0.5 DD weather cell grid
- These grid cells are then used to:
    - Measure exposure to droughts across space and over time
    - Measure local polygyny norms: share of women aged 25 or older married to a polygamous husband
- Rainfall data from University of Delaware ("UDel data")
- Ethnic characteristics from updated Ethnographic Atlas (Murdock, 1957)

Empirical Strategy

- Use approximation of a duration model adapted from Currie and Neidell (2005) as in Corno et al. (2020)
- Duration of interest: time between $t_0 = 12$ and t_m: age of 1st marriage (capped at 17/24)
- Original DHS data converted into person-year panel format
- Data is then merged with the yearly rainfall data

Hazard of early marriage

$$M_{i,g,k,t} = \beta X_{g,k,t} + \gamma X_{g,k,t} \times P_g + \alpha_t + \omega_g + \gamma_k + \epsilon_{i,g,k,t}. \quad (1)$$

- $M_{i,g,k,t}$: dummy $=$ 1 in the year the woman gets married
- $X_{g,k,t}$: time-varying measure of weather conditions (dummy for a drought) in location g during the year in which the woman i born in year k is age t
- Drought: calendar year rainfall below the 15th percentile of a location's historical rainfall distribution
- P_g: Average polygyny rate of the cell g in which female i lives
- α_t (age FE), ω_g (location FE), γ_k (year-of-birth FE)
- SE clustered at the grid-cell level

- Identification assumes that $X_{g,k,t} \perp$ potential confounders
- Model suggest $\beta > 0$ and $\gamma < 0$

Simplify interpretation $\&$ focus on major spatial variation in P

$$M_{i,g,k,t} = \beta^l X^l_{g,k,t} + \beta^m X^m_{g,k,t} + \beta^h X^h_{g,k,t} + \alpha_t + \omega_g + \gamma_k + \epsilon_{i,g,k,t} \quad (2)$$

- Model suggests: $\beta^l > \beta^m > \beta^h$ and at least $\beta^l > 0$

Prediction 1: Polygyny, drought and timing of marriage

	(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	0.127

Hazard model with observations at $person \times age$ level. Sample of women aged 25 or older at the time of the survey. All regressions include age FE, birth year FE, grid-cell FE and country FE

Prediction 2: Market shares on demand side

Dependent variable	Husband age gap	Low rank wife (2nd or higher order)			Polygyny
		All sample	Living with polygamous husband in:		
			Any area	Medium / high polygamy area	
	(1)	(2)	(3)	(4)	(5)
Drought x low polygamy	-0.0287	0.0029			0.0008
	(0.1363)	(0.0030)			(0.0054)
Drought x medium polygamy	0.1392	-0.0127***			0.0108
	(0.1537)	(0.0049)			(0.0079)
Drought x high polygamy	-0.3408**	-0.0102*			0.0105
	(0.1687)	(0.0062)			(0.0095)
Polygyny		0.5208***			
		(0.0049)			
Drought			-0.0160*	-0.0197**	
			(0.0092)	(0.0096)	
Observations	224,936	226,130	76,908	71,149	226,130
Adjusted R-squared	0.1514	0.4275	0.0693	0.0636	0.1864
Mean dependent variable	9.975	0.143	0.514	0.516	0.340

OLS regressions with observations at individual level. Sample of married women aged 25 or older at the time of the survey. All regressions include birth year FE, Marriage year FE, grid-cell FE and country FE

Threats to Identification

Threats to Identification

1. Potential differential effect of rainfall shocks
   - All locations have the same probability of experiencing a drought
   - Shock has same effect on HH resources in all locations

     Resources
2. Droughts $(X_{g,k,t}) \perp$ long term polygyny rates $(P_g\ )$
   - Yearly variation in rainfall not likely to affect local polygyny norms
   - Results robust to using first or last wave to compute P_g Waves

Threats to Identification

3. Differential Marriage Market Size and Migration

- Differential Market Size:
  - More than 75% of women do not move from their village/city at marriage, irrespective of polygyny rates
  - When they do, they migrate within 50 $\times$ 50 km grid
    - Average migration distance uppon mariage is 20 km in rural Senegal (Mbaye and Wagner, 2017)
  - No effect of droughts in neighboring cells, irrespective of polygyny rates P_g Spatial lag
- Differential Migration Behavior:
  - Migration likelihood is the same with a drought or not, irrespective of polygyny rates Migration

All these potential threats are not consistent with evidence on the 2nd prediction of model

Threats to Interpretation: Religion, Ethnicity and Kinship System

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%). 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%).

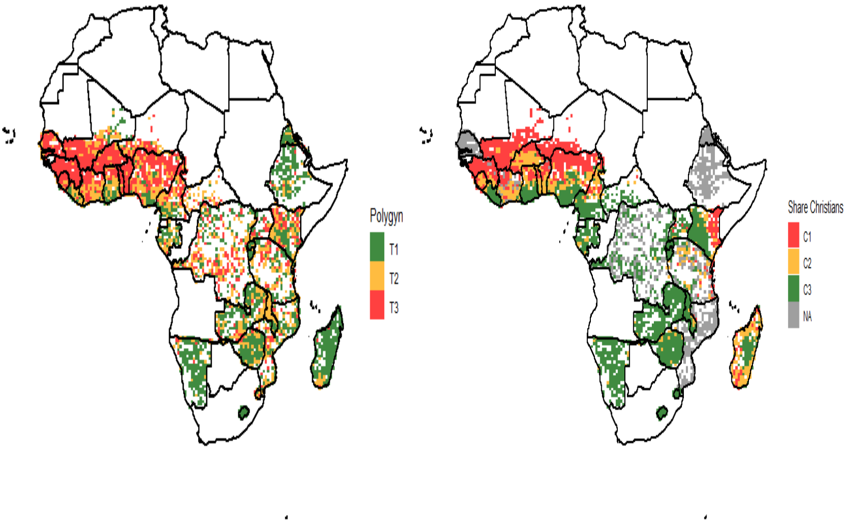

Table: Polygyny, drought and timing of marriage: Robustness to religion

	Full sample				Bride price only			
	Christians		Non-Christians		Christians		Non-Christians	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drought	0.0055***		0.0089		0.0062***		0.0256***	
	(0.0018)		(0.0080)		(0.0020)		(0.0081)	
Drought x polygyny rate	0.0033*		0.0032		0.0036		0.0043	
	(0.0020)		(0.0033)		(0.0024)		(0.0040)	
Drought x low polygyny	0.0011		-0.0003		-0.0043		0.0007	
	(0.0047)		(0.0033)		(0.0054)		(0.0025)	
Drought x medium polygyny		0.0059***		0.0116**		0.0074***		0.0162***
		(0.0022)		(0.0056)		(0.0026)		(0.0063)
Drought x high polygyny		-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

Hazard model with observations at $person \times age$ level. Sample of women aged 25 or older at the time of the survey. All regressions include age FE, birth year FE, grid-cell FE and country FE.

Split by polygyny levels

Figure: Practice of Polygyny across Space with Ethnic Homelands

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.

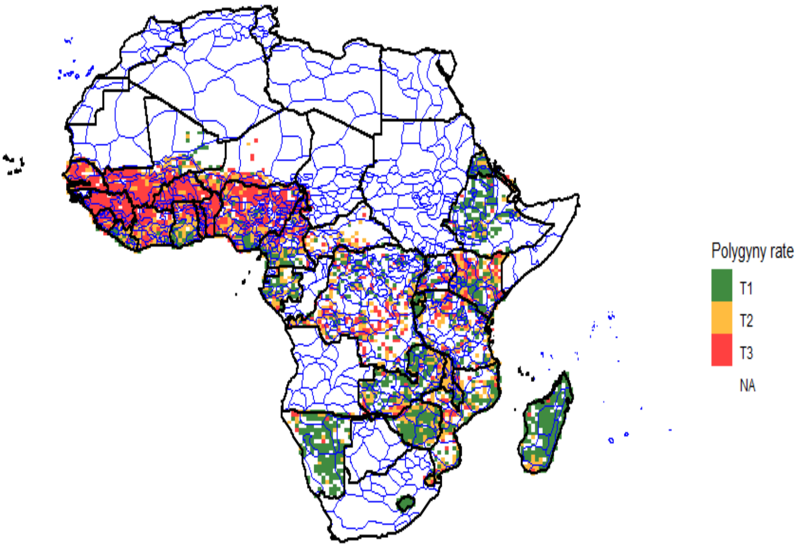

Table: Polygyny, drought and timing of marriage: Robustness to kinship system

	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

Hazard model with observations at $person \times age$ level. Sample of women aged 25 or older at the time of the survey. All regressions include age FE, birth year FE, grid-cell FE and country FE.

Consequences on Female Fertility

Consequences on Female Fertility: Onset and Levels

	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

OLS regressions with observations at individual level. Sample of women aged 25 or older at the time of the survey. All regressions include age FE, birth year FE, grid-cell FE and country FE.

Other Robustness

- Only within country variation: Within
- Different cutoffs for drought dummy cutoffs
- Continuous rainfall variable log(rainfall)
- Temporal lags and leads lags
- Residence (urban/rural) - education: Heterogeneity
- Across sub-regions: Sub-regions
- Supply side effect relevant? Nigeria
- etc...

Conclusion

- Polygyny norms create different marriage market structure across SSA
- This paper shows how they affect equilibrium reaction of marriage markets to aggregate shocks
- Reallocation of brides in presence of polygyny $\implies$ droughts may create opportunities for young men and women
- **Policy implication:** Income stabilization policies for fighting child marriage more needed/efficient in monogamous areas
- **Two Wrongs can make a Right!**

Thank You!!!

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- Practice of polygyny in given area as local norm: result of combination of historical & slow moving cultural/econ factors
  - (i)Traditional customs (ii) slave trade, religion, colonial institutions, etc. (iii) economic growth, inequality, etc...
    - (Boserup, 1970; Becker, 1974; Jacoby, 1995; Gould et al., 2008; Fenske, 2015; De La Croix and Mariani, 2015) Religion
      Back

Tables

Robustness: Spatial Lag

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

Hazard model with observations at $person \times age$ level. All columns include age, birth year, grid-cell and country fixed effects.

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Robustness: 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

Hazard model with observations at $person \times age$ level. All columns include age, birth year, grid-cell and country fixed effects.

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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

Hazard model with observations at $person \times age$ level. All columns include age, birth year, grid-cell and country fixed effects.

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Robustness: Whithin 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	$0.2<$IQR≤ 0.3	IQR>0.3	$0.2<$IQR≤ 0.3	IQR>0.3	$0.2<$IQR≤ 0.3	IQR>0.3	$0.2<$IQR≤ 0.3
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(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

Hazard model with observations at $person \times age$ level. Hazard model with observations at $person \times age$ level. All columns include age, birth year, grid-cell and country fixed effects. 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.

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Robustness to using log(rain)

	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

Hazard model with observations at $person \times age$ level. Hazard model with observations at $person \times age$ level. All columns include age, birth year, grid-cell and country fixed effects.

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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

Hazard model with observations at $person \times age$ level. Hazard model with observations at $person \times age$ level. All columns include age, birth year, grid-cell and country fixed effects.

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. 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$, while household final consumption expenditures are measured at the aggregate level in current US$. High polygyny countries are countries with average polygyny rates higher than 0.25.

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Robustness to definition of polygyny rates

	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

Hazard model with observations at $person \times age$ level. All columns include age, birth year, grid-cell and country fixed effects. Back

Migration

	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 country FE. Back

Table: Polygyny, religion, drought and timing of marriage

	(1)	(2)	(3)	(4)	(5)	(6)
		Polygamy			Christian	
	Full sample	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

Table: Polygyny, drought 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
Age FE	YES	YES	YES	YES	YES	YES	YES	YES
Birth year FE	YES	YES	YES	YES	YES	YES	YES	YES
Grid-cell FE	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Mean dependent variable	0.127	0.127	0.128	0.128	0.0988	0.0988	0.101	0.101

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.

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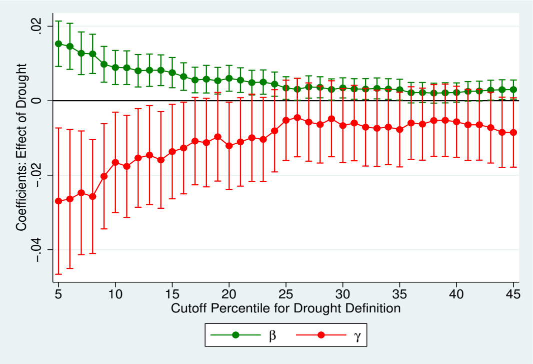
Figure: Robustness definition of drought based on cutoffs



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.

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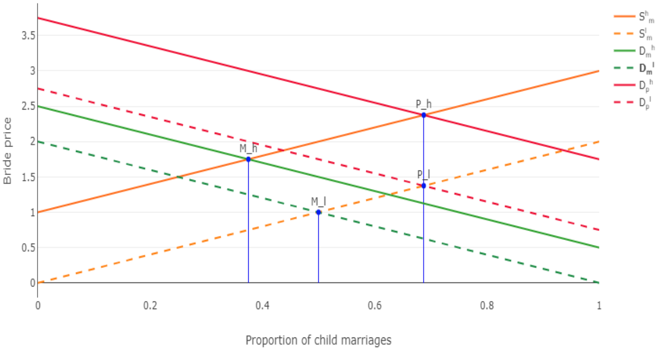
Figure: Equilibrium Outcomes



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Proofs

Proof proposition 1 - Part 1

- Household i wants to marry their daughter by the end of t if:

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

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

$$
\frac{(y_t + \epsilon_{tj} - w^{m,l}_o + w^f_g - \tau_t)^{1-\gamma}}{1-\gamma} + V^{m,nf}_M > \frac{(y_t + \epsilon_{tj} - w^{m,l}_o)^{1-\gamma}}{1-\gamma} + V^m_U
$$

$$
\iff \quad \tau_t < y_t + \epsilon_{tj} - w^{m,l}_o + w^f_g - \left[(y_t + \epsilon_{tj} - w^{m,l}_o)^{1-\gamma} - (1-\gamma)\left(V^{m,nf}_M\right.\right.
$$

- For $V^{m,nf}_M - V^m_U \geq 0$ and $V^f_M - V^f_U \geq 0$, we 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). Back

Proof proposition 1 - Part 2

- A married man will want to have a second spouse if

$$\begin{aligned} H_2(y_t, \epsilon_{jt}, \tau_t) &\equiv \Big[u\big(y_t + \epsilon_{jt} - w_o^{m,h} - \tau_t + (w_o^f + w_y^f)\big) + V_{M2}^{m,nf}\Big] \\ &- \Big[u(y_t + \epsilon_{jt} - w_o^{m,h} + w_o^f) + V_M^{m,nf}\Big] > 0 \end{aligned}$$

- Convavity and monotonicity ensure that difference in flow utility is strictly increasing in ϵ_{jt}
- Therefore $\epsilon^*_{m,2}$ is defined such that $H_2(y_t, \epsilon^*_m, \tau_t) \equiv 0$
- $\epsilon^*_{m,2}$ is a decreasing function of $V_{M2}^{m,nf} - V_M^{m,nf}$: crucial bellow

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- **Part 1:** For $p = 0$ (monogamy):

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

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

- $\frac{dQ^*(y_t)}{dy_t} < 0$ because $\epsilon_m^* > \epsilon_f^*$ when $w_o^{m,l}$ is high enough Back

Part 2: Variation in p

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

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

$$= \frac{dD_y}{dp}\left[f(\epsilon_f^*(\tau_t, y_t))\left(\frac{\partial W/\partial \tau_t}{\partial W/\partial \epsilon_f^*} - \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial \epsilon_{m,2}^*}\right) + f(\epsilon_m^*(\tau_t, y_t))\left(\frac{\partial H/\partial \tau_t}{\partial H/\partial \epsilon_m^*} - \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial \epsilon_{m,2}^*}\right)\right]$$

$$A_{1,1} = \left(\frac{\partial W/\partial \tau_t}{\partial W/\partial \epsilon_f^*} - \frac{\partial H/\partial \tau_t}{\partial H/\partial \epsilon_m^*}\right) > 0 \qquad A_{1,2} = \left(\frac{\partial H/\partial \tau_t}{\partial H/\partial \epsilon_m^*} - \frac{\partial H_2/\partial \tau_t}{\partial H_2/\partial \epsilon_{m,2}^*}\right) < 0?$$

- $A_{1,2} < 0$ if $\epsilon_{m,2}^*$ low enough $\iff$ $V_{M2}^{m,nf} - V_M^{m,nf}$ high enough
- Moreover, $|A_{1,2}|$ is decreasing function of $\epsilon_{m,2}^*$ and $A_{1,1}$ is independent of it: $A < 0$ for $V_{M2}^{m,nf} - V_M^{m,nf}$ high enough

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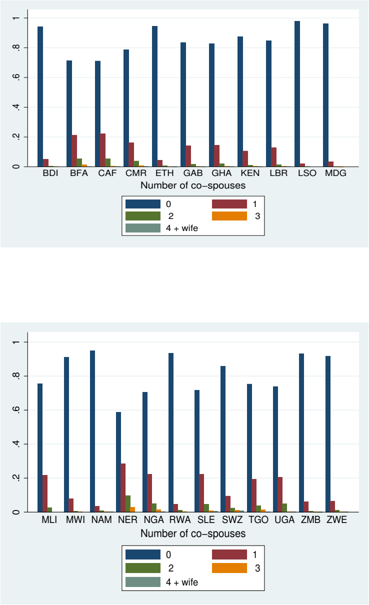
Data and Background

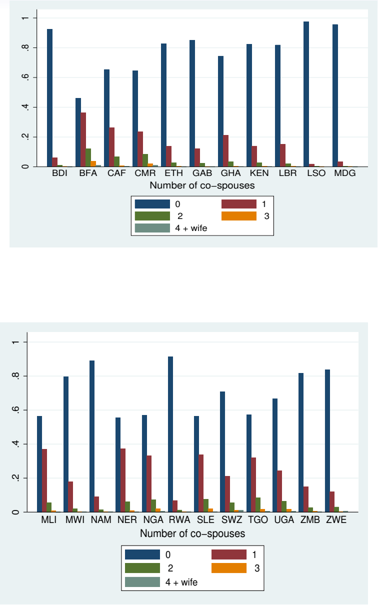
- DHS survey data: 73 survey waves collected between 1994 and 2013 in 31 countries in SSA
    - Women provide info on month, year and age at 1st union
    - Whether married to a polygynous husband and rank in union
- GPS coordinates of each DHS HH cluster is used to match it with corresponding 0.5×0.5 DD weather cell grid
- These grid cells are then used to:
    - Measure exposure to droughts across space and over time
    - Measure local polygyny norms: share of women aged 25 or older married to a polygamous husband
- Rainfall data from University of Delaware ("UDel data")

▸ KDE Polygyny ▸ KDE Christians ▸ Heatmap Polygyny and Religion

Distribution of Women by Number of Co-spouses



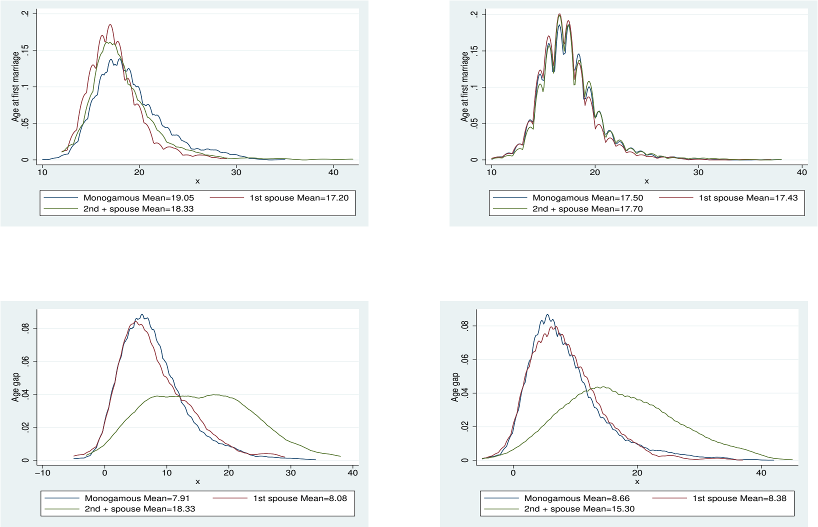
(a) Urban



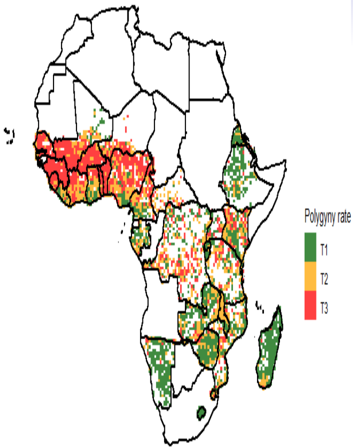
(b) Rural

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

▸ Age gap by country ▸ Age marriage by country



(a) Urban (b) Rural


Polygyny rate
T1
T2
T3

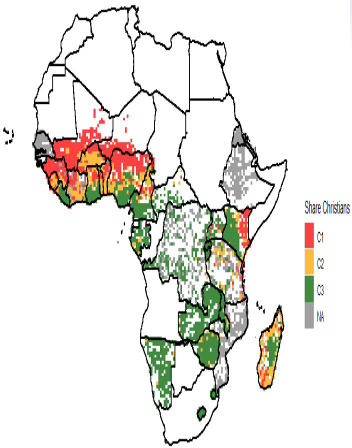
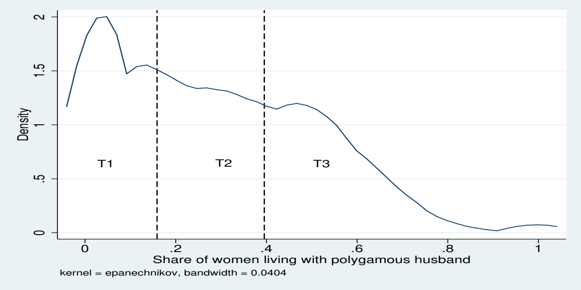

Share Christians
C1
C2
C3
NA

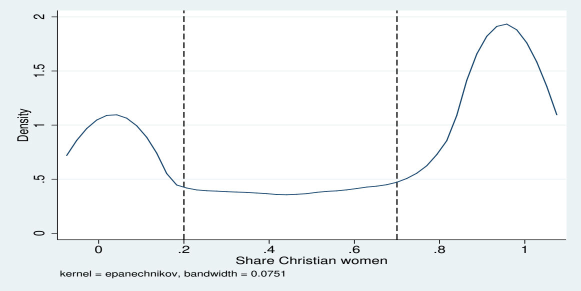
Figure: KDE of the Distribution of Cell-Grids by Polygyny Rate



Note: 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%).

Back

Figure: KDE of the Distribution of Cell-Grids by Share of Christians

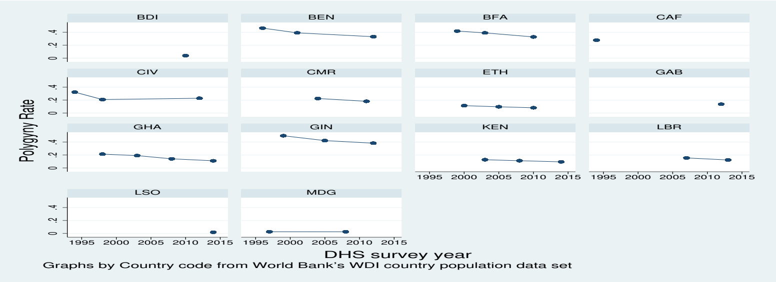


Note: C1 represents grid cells with low proportion of Christians (less than 20%), C2 is for areas with medium proportion (between 20 and 70%) and C3 is for areas with high proportion of Christians (more than 70%).

Back

Figure: Polygyny rate: unions within last 10 years

▸ Back ▸ Stock



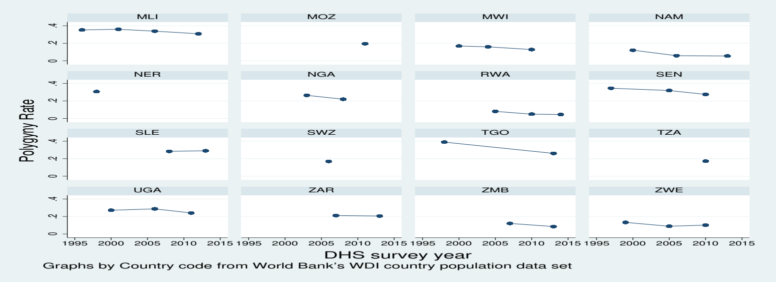
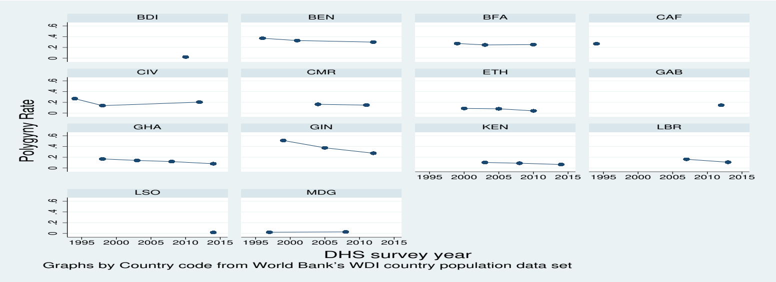


Figure: Polygyny rate: unions within last 5 years ▸ Back ▸ Stock



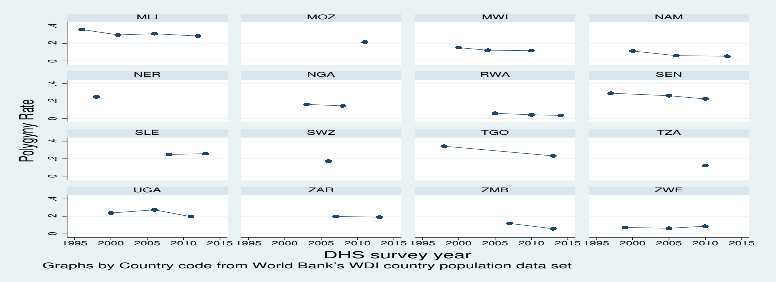


Figure: Stock of Polygynous unions over time in SSA

Flow

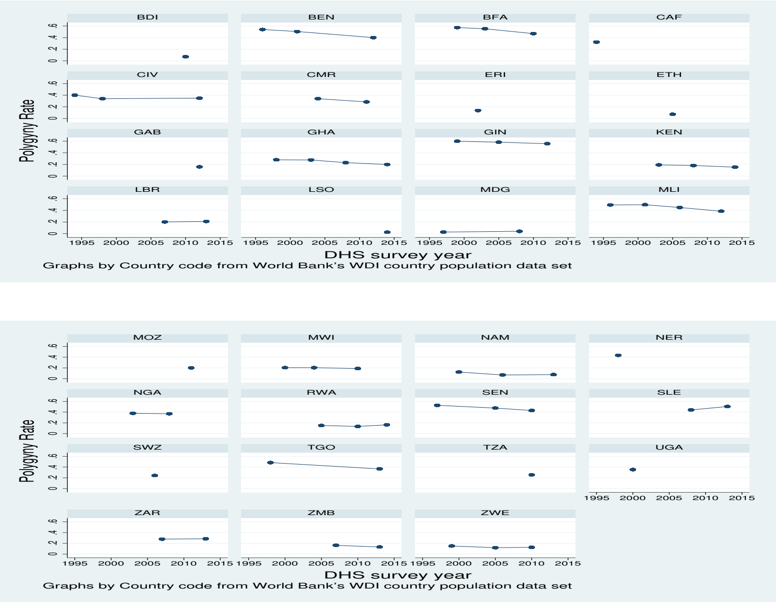
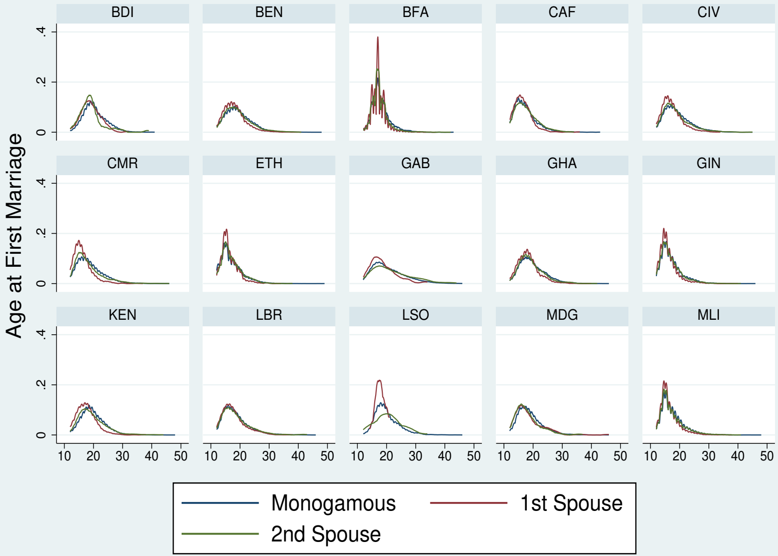


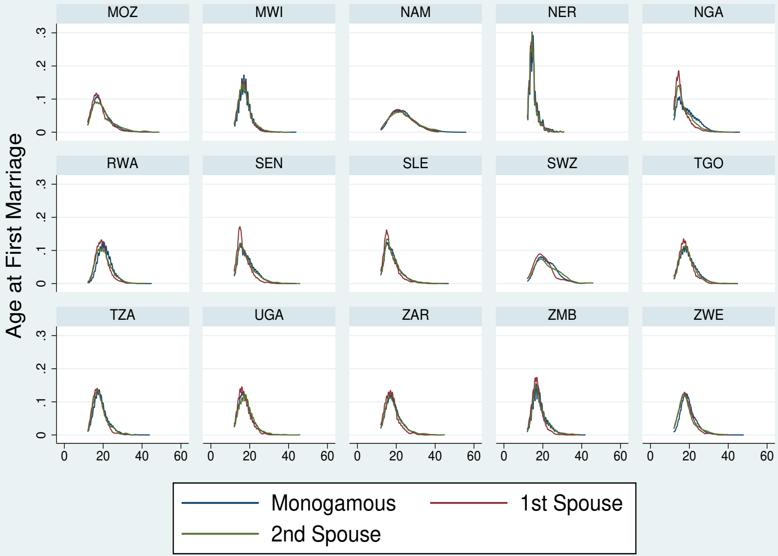
Figure: Age at first marriage by country (1/2) ▸ BFA ▸ Back



Note: Individuals younger than 25 excluded.

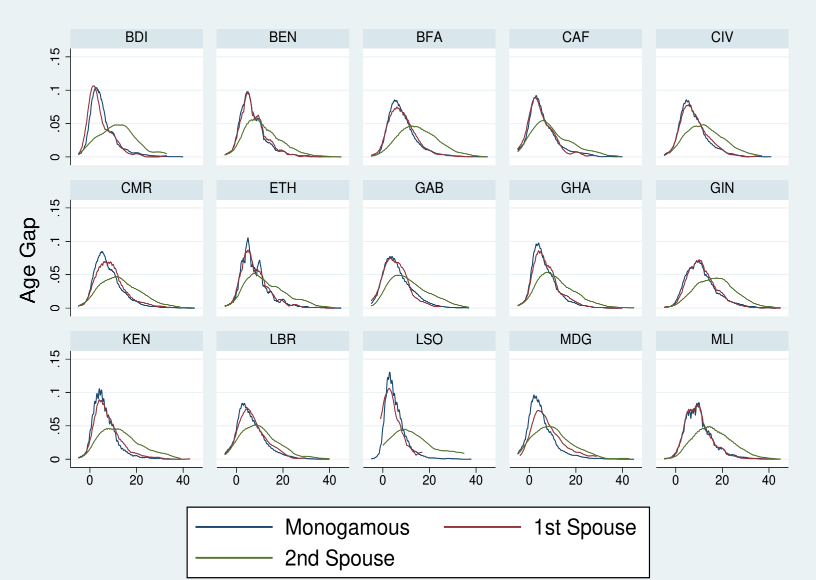
Figure: Age at first marriage (2/2)

BFA Back



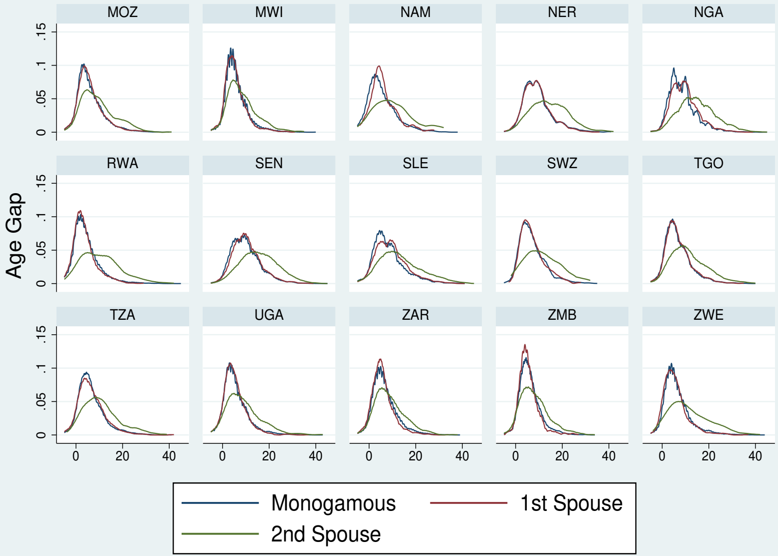
Note: Individuals younger than 25 excluded.

Figure: Age gap by country (1/2) ▸ BFA ▸ Back



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

Figure: Age gap by country (2/2) ▸ BFA ▸ Back



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