The African Slave Trade and the Curious Case of General Polygyny

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Abstract

General polygyny – near universal marriage *and* polygyny – is common in Africa. But why would men marry n wives for $1/n$:th of the time instead of monogamously? Downsides include prolonged bachelorhood and a high degree of step-parenting. We point to the African slave trade which disproportionately removed young men, thus allowing old men to take young wives. Modeling endogenous social stigma, we argue that this temporary perturbation permanently changed the equilibrium to one where all men marry late and polygynously. Data are supportive: polygyny in Africa delays first marriage for men, raises under-five mortality, but does not predict life-long bachelorhood.

Key words: General polygyny; African slave trade; social norms; multiple equilibria; child mortality.

JEL Codes: J12, N37, O10

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1 Introduction

The disproportional allocation of young women to rich and powerful men has a clear cut logic to it, be it Darwinian [Trivers, 1972] or neo-classical [Becker, 1974]. However, that is only one form of polygyny. Another form has *all* men taking several wives. This "general" form of polygyny is common in Africa but rare elsewhere [White, 1988]. It is made possible by men's marrying late; and women's marrying young and often [Dorjahn, 1958, Goody, 1973, 1976, Pison, 1986, Borgerhoff Mulder, 1989, Garenne and Walle, 1989, Hayase and Liaw, 1997, Timaeus and Reynar, 1998, Gibson and Mace, 2007].

While mathematically possible, general polygyny poses as puzzle. All men marrying polygynously suggests male (relative to female) homogeneity, in which case theory predicts monogamy [Becker, 1974]. Although this allocation need not literally be in the form of one wife per man, transactions costs alone suggests that one wife would be preferable to n wives for $1/n$:th of the time. Moreover, the brief marriage duration necessitated by multiple wives is often achieved by marriage delay for men and thus extended bachelorhood. Other drawbacks of polygyny include early widowhood and remarriage for women, and thus fatherless children and a high degree of step-parenting.

In this paper, we propose that the prevalence of general polygyny in Africa traces its origins to the African slave trade which disproportionately removed young males [Fage, 1980, Manning, 1990]. While there was also a market for female slaves, the numerically most important slave trade was male dominated, demand being driven by plantations in the Americas.[1] As a result, young women outnumbered young men, facilitating polygyny *during* the slave trade [Fage, 1980, Manning, 1990, Thornton, 1997]. Wrote Manning [1990, pp. 22-23]:

> "Slave exports brought about substantial distortions in African sex ratios: along the West Coast most male slaves were exported and the re-

[1] Female-biased trades to the Orient were much smaller in scale than the male-biased Atlatnic slave trades. Moreover, in the case of female-biased trades, male captives retained in Africa were made domestic slaves. And slave males married only infrequently as their masters take the women [Manning, 1990]. Therefore, female-biased slave trades did not lead to polyandry. Moreover, the conditions for polyandry to arise are not symmetric to those for polygyny, see Korn [2000], Edlund and Korn [2002].

> maining population became predominantly female; in the Savanna and Horn most slaves exported to the Orient were female, so that the remaining population became dominantly male. The result of these imbalances was that the institution of slavery, of marriage, and the sexual division of labor were placed under great pressure to change."

But why would slave trade in the past explain current marriage patterns? Young women no longer outnumber young men. The mechanism, we argue, was a change in social norms: the slave trade reduced the stigma attached to marriage between a young woman and an old man.

To model general polygyny, we consider a population with men and women who have two adult periods, young and old. Women are fecund when young while men are fecund when young and old. The purpose of marriage is children. Thus, in each period, marriage can be between a young woman and a young man or a young woman and an old man. Men and women are homogenous within age and sex cells.

We assume that marriage between an old man and a young woman carries stigma, the degree of which depends on the prevalence of the practice. Young women deliberating marriage do not know the stigma they will face in the event they marry an old man since that will depend on their not yet realized actions. Our key assumption is that individuals act based on expectations of stigma and that they look to the past when forming their expectation – expectations that in equilibrium are confirmed. In this set up, there can be multiple equilibria. A temporary removal of young men can result in a permanent lowering of stigma and thus a shift towards women marrying older men. This process, we propose, captures the mechanism through which historic slave trade continues to cast a shadow on current African marriage patterns.

The shift towards older men, we argue, corresponds to more polygyny. In our model, this will literally be the case because men marry both as young and old, and there is no divorce. As a result, marriage when old amounts to bigamy. While this particular modeling may seem contrived, what amounts to more polygyny is a surprisingly thorny question. In the case of general polygyny, more polygyny is by necessity a question of the degree of bunching up of wives over a man's lifetime. More concurrent wives means briefer marriage duration which for practical purposes means later marriage. In inequality-driven polygyny, rich men deprive poor men of wives. By contrast, in general polygyny, the old deprive the young. Thus, a marriage market shift towards old men may be considered a shift towards more polygyny. While not the only way to characterize polygyny it may be a reasonable description of *general* polygyny.

Empirically, we examine whether polygyny in Africa can be explained by the past slave trades (see Dalton and Leung [2011] below); whether polygyny is characterized by general polygyny; and the possibility that polygyny is inefficient. To that end, we combine Nunn [2008]'s data on the historic slave trades with data on polygyny and marital outcomes (from the United Nations and World Bank). Analyzing country-level data for Africa, we find that the extent of polygyny (married women over married men) predicts larger spousal age gaps at *first* marriage, but not a greater incidence of never married men, consistent with general polygyny. Moreover, countries with more polygyny are shown to have lower marital output as measured by infant and child mortality, a finding more easily reconciled with general polygyny than with quality-based polygyny. These patterns are found both in OLS estimates and when, following Nunn [2008], polygyny is instrumented for using distances to the different slave markets, the Atlantic trade in particular.

Our paper adds to a small but growing literature in economics seeking to explain the robust negative relationship between polygyny and economic development evident in cross-country comparisons or secular trends [Tertilt, 2005, Gould et al., 2008, Lagerlöf, 2010, Edlund and Lagerlöf, 2010]. Our finding of a sizeable contribution of polygyny to under-five mortality chimes with Udry [1996]'s documentation of substantial intra-household inefficiency among rural households in Burkina Faso, the most polygynous country in our data set.[2] We are obviously also related to the literature that links the history of slave trade to the evolution of institutions detrimental to growth and development (in source or destination countries, for the former see e.g., Nunn [2008], Nunn and Wantchekon [2011], for the latter see e.g., Engerman and Sokoloff [1997, 2002]).

[2]Whether polygyny contributes to the inefficiency is not the focus of the paper, but it can be noted that it may be a factor in the lack of support for the unitary household model. Kazianga and Klonner [2009] also documents inefficiencies in intra-household allocation in a sample of polygynous households in rural Mali.

The work most closely related to ours is Dalton and Leung [2011] who (independently of us) linked polygyny in West Africa to past slave trades using DHS data. However, their paper does not address how a *past* demographic shock can affect *current* levels of polygyny, the focus of the paper at hand. The found link between past slave trade and current levels of polygyny was confirmed by Fenske [2012] who also examined a number of other correlates of present day polygyny in Africa. Interestingly, he found past but not current male inequality to predict polygyny.

The remainder of the paper is organized as follows. Section 2 gives a brief literature review. Section 3 presents our model. Sections 4 and 5 present the data and our empirical estimates. Section 6 concludes.

2 Background

Two-sided matching and absence of idiosyncratic preference orderings offer a compelling theoretical framework for analyzing the causes and consequences of polygyny. Polygyny, in this framework, results from high male relative to female heterogeneity [Trivers, 1972, Becker, 1974], abetted by low paternal input in offspring production. It is efficient (like any stable matching in this framework), but disadvantages low quality males. While general polygyny is recognized as a key feature of African marriage patterns, its poor fit with the above framework has left it understudied by economists. This background section organizes the literature into (somewhat arbitrary) subsections: "Causes and Consequences of Polygyny" and "Social norms."

2.1 Causes and Consequences of Polygyny

A universal feature of marriage is the so called paternity presumption: the father(s) of a child born to a married woman is her husband(s) [Posner, 1992]. Polygyny, one man several wives, occupies an interval on a continuum of marriage forms described by the number of husbands per wife: < 1, in the case of polygyny, > 1 in the case of polyandry. The number of men required to support the children of one woman is thus one factor behind the realized marriage form.

When this number is high, e.g., from poorness of the land [Korn, 2000], polyandry can result.[3] If, by contrast, this number is low, for instance from high degree of self sufficiency of women [Boserup, 1970, Trivers, 1972], polygyny is facilitated. In that spirit, Jacoby [1995] found that conditional on wealth men have more wives when the agricultural productivity of women is higher.

Subsistence, however, only dictates necessary conditions. Other factors noted in the literature include male (relative to female) inequality, skewed sex ratios and political pandering.

2.1.1 Causes of Polygyny

Male inequality

> "The question as it presents itself in practice to a woman, is whether it is better to have, say a whole share in a tenth-rate man or a tenth share in a first-rate man."
>
> George Bernard Shaw, Getting Married, 1907.

As pointed out by Becker [1974], polygyny can be the outcome of the efficient allocation of women when men are more heterogeneous than women. In that case, we would expect low quality men to remain life-long bachelors (and high quality men to have many wives). Moreover, we would expect children (and women) to do better in societies that allowed for polygyny, and within a society, polygynous families would do at least as well as monogamous ones (controlling for wife quality). Grossbard [1976] is an early empirical application.

Becker [1974] viewed marriage form as endogenous, religious and other social prescriptions regulating polygyny being reflections rather than drivers of the observed marriage patterns. Gould et al. [2008] is paper in that spirit. They argued that from economic development follows increasing emphasis on child quality. As a result, men become more interested in the quality of their children instead of their quantity. Fewer children necessitate fewer wives. Moreover, to the extent that quality depends on maternal quality, there will be a shift in emphasis from female ability to bear children to women's human capital. Assuming that the latter is less evenly distributed, women become more heterogeneous, which in turn promotes monogamy

[3] For polyandry, also see Edlund and Korn [2002].

(because it raises the price of high quality women, further limiting the number of wives bought by high quality men).

Female sex-ratios

It has long been recognized that a surplus of (young) females over men facilitates polygyny, cf. Spencer [1876]. This surplus can result from population growth (if men marry younger women), the elimination of men, and/or the addition of women.

Additionally, any society or social group that can maintain a permanent numerical surplus of (young) women over men can also practice polygyny. This surplus may be curtesy of high socio-economic status that attracts young women, or through constant warfare which reduces the number of young men (in battle) and increases that of women (through capture).

Political Economy

> Any marriage system which condemns a majority of the population to celibacy will be violently wrecked on the pretext that it outrages morality.
>
> George Bernard Shaw, Maxims for Revolutionists, 1903.

If polygyny is at the expense of low quality men (cf. Becker [1991]), then monogamy might be understood as a populist measure, made to appease low quality men who otherwise would face steep marriage odds [Lagerlöf, 2010].

By contrast, our paper point to the possibility of polygyny being inefficient, its occurrence owing more to accidents of history than efficiency arguments. If general polygyny is inefficient, norms encouraging monogamy might be efficient.

Other

Polygyny correlates with a number of other factors. The extent to which they have been proposed as explanations, consequences, or neither, vary. For a further review see, e.g., White and Burton [1988].

Nineteenth century evolutionary theorists such as Engels and Spencer noted that polygyny was a feature of primitive societies [Spencer, 1876, Engels, 1972, first published in 1884]. The bunching up of women facilitates a long post-partum sex taboo [Whiting, 1964], although the extent to which this feature can account for polygyny can been questioned [Ember, 1974]. It has also been noted that rules prescribing in-marriage restricts polygyny since the sex ratio within a kin group is likely to be balanced.

Goody [1976] observed that dowry giving (chiefly European or Hindu) societies gravitate towards monogamy because when daughters are endowed rather than sold off for a bride price, parents will take greater care to marry them positively assortatively, a notion that becomes impractical, if not in-operational, if the husband is free to add wives. Still, each wife could be associated with a clearly defined set of property, much like a man in Imperial China could take one wife for each ancestral branch he was heir to. Moreover, and importantly, as Hartung [1982] has pointed out, causality might be reverse: polygyny leading to male only inheritance.

2.1.2 Effects of Polygyny

While Becker [1991] argued that polygyny allowed for the efficient allocation of women when men are heterogeneous (relative to women), the robust negative relationship between polygyny and various measures of economic development and the status of women have prompted a search for theoretical reasons for why polygyny might hamper development. Tertilt [2005] proposed that the higher price daughters command under polygyny crowds out savings and investments. Thus, she pointed to a possible negative effect of polygyny. Edlund and Lagerlöf [2010] pointed to general polygyny reducing steady state human capital because men spend a lower fraction of their lives being fathers. Neither study addressed how (inefficient) polygyny might arise in the first place.

Although polygyny raises demand for women, higher demand need not benefit women and on balance ethnographic studies find polygyny to be negatively viewed by women, co-wife rivalry being an important vector of stress [Meekers and Franklin, 1995, Agadjanian and Ezeh, 2000, Madhavan, 2002, Jankowiak et al., 2005, Bove and Valeggia, 2009]. A possible reason is that in most polygynous societies, women do not own themselves. Arranged marriage, with bride price going to the father of the bride, characterizes Sub-Saharan Africa.

Another reason is suggested by Trivers and Willard [1973] who pointed to fitness reasons why parents would bias resources towards sons (more resources, more daughters-in-law, more grandchildren), tamped under monogamy [Hartung, 1982]. Thus, evolutionary biology suggests a reason for why the correlation between marriage and inheritance pattern may be causal (but run in the opposite direction of that proposed by Goody [1976]). Evolutionary biology also sees direct negative effects to females of polygyny (and benefits to males), whenever male parental investments potentially extend beyond the siring of children [Verner, 1964, Verner and Wilson, 1966, Orians, 1969, Trivers, 1972, Davies, 1989, Maynard Smith, 1977].

With respect to child outcomes, on balance, polygyny has been associated with negative outcomes, including: mortality [Strassmann, 38, Omariba and Boyle, 2007, Gyimah, 2009], anthropometric measures [Sellen, 1999, Hadley, 2005, Gibson and Mace, 2007], low paternal involvement [Kitahara, 1974, Wilson, 2008], and co-wife rivalry (harms step-children) [Madhavan, 2002, Jankowiak et al., 2005].

However, empirical studies have been hamstrung by the lack of exogenous variation in polygyny and/or a narrow scope ignoring the relevant counter-factual. The slave trade history offers a solution to this problem assuming that it generated plausibly exogenous variation in present day polygyny.

2.2 Social Norms Regarding Polygyny

Social norms restricting polygyny come in many flavors. There are direct norms specifying the number of concurrent wives allowed. In addition, there are norms that indirectly curb the number of wives: regulation of divorce; periods of abstinence following marital dissolution; admissible spousal age gaps, to name a few. The extent to which such norms drive marriage patterns is debatable [Becker, 1991], still their presence is notable.

Notably, White [1988] proposed that a classification of societies with respect to polygyny based on cultural rules to be "more stable and intelligible" than one based on frequencies. He constructed the variable "Cultural rules constraining the frequency of polygyny" where on a scale of 1 to 5, 1 indicates "Monogamy prescribed" and 5 indicates general polygyny: "Polygyny prevalent and preferred by most men and practiced by most men of sufficient age or wealth." African societies are clearly

Table 1: Cultural Rules Constraining the Frequency of Polygyny

		Pre-Industrial Societies			
		African		Non-African	
Code	Description	n	%	n	%
.	Missing data	0	0	3	2
1	Monogamy prescribed	2	5	25	18
2	Monogamy preferred but exceptional cases of polygyny	3	7	29	20
3	Polygyny limited to individual men with leadership attributes(chiefs, medicine men, etc.)	9	20	36	25
4	Polygyny limited to men of higher social class (men of wealth, inherited rank, nobility, etc.)	3	7	30	21
5	Polygyny prevalent and preferred by most men and practiced by most men of sufficient age or wealth to obtain wives	27	61	19	13
	Total	44	100	142	100

Sample: Standard cross-cultural sample, see Murdock and White [1969].
Source: White [1988].

over-represented in the general polygyny category. Whereas 61% of African societies were thus classified, only 13% of non-African societies were given this classification, see Table 1. The African dominance in the general polygyny category is even more impressive if we consider the facts that the percentages do not represent individuals but the share of pre-industrial societies; Africa is over-represented in this category; and industrialized societies are overwhelmingly monogamous or moderately polygynous.

In addition, norms regarding the marriage of old men to young women may effectively limit polygyny. Polygyny tends to displace young men in favor of the old, and in many primitive societies this conflict is played out in the family pitching old fathers against grown sons. For example, among East African pastoralists, a daughter's marriage brings in cattle which the father then uses to purchase a bride – for himself or his son [Goody, 1973]. Among the Maasai a man is not allowed to take as a wife a woman whose father is the same generation as he is [Coast, 2006]. Still, the father-son conflict remains, wrote Hakansson [1989, page 125]:

> Each [house] wants to increase its own cattle wealth and to ensure the early marriages of its sons. The family head, however, wants to marry as many wives as he can buy this will sometimes conflict with the even

> distribution of cattle to houses and the early marriages of the sons. Thus, it often happens that when a father takes a new wife he delays the marriage of a son." [Furthermore] "between father and son there is considerable disagreement about incoming bridewealth cattle, since the family head will often use his authority over the herd for his own benefit instead of contributing to his sons' marriage cattle...

3 The Model

We now turn to a formal model. We will show how slave trade in the past may result in persisting, general, polygyny.

Consider a society in which the sex ratio is initially balanced and there is no heterogeneity in the quality of either men or women. Men and women live for two periods, young and old. Let $\eta \in [0, 2]$ denote the age of an individual, where $\eta \in [0, 1]$ corresponds to the young period and $\eta \in [1, 2]$ to the old period. Men are fecund in both periods, whereas women are fecund only when young. Marriage is for the purpose of procreation and thus adult men can marry at any age but women only when young.

For the narrative, we will assume that marriage decisions are made by the individuals themselves and we define the endogenous bride price to be a payment from husband to wife.

Population

In period t, there are M_t^y young men, M_t^o old men, and F_t young women. The index t is discrete and the young and old periods each last for one unit of time so that $M_t^y = M_{t+1}^o$. In this formulation, the fecund years of young women in period t can be mapped onto the interval $[t, t+1]$. Similarly, the fecund years of young men in period t can be mapped onto the interval $[t, t+1]$ when young and $[t+1, t+2]$ when old.

If a young woman is exposed to marriage for the duration of her young period, she bears n boys and n daughters. Thus, absent external shocks, sex ratios balance in each cohort $M_t^y = F_t, \forall t$. We assume that $n \geq 1$ to ensure a positive population (By construction, young women will be married for the entirety of their young period).

We restrict women to one husband at a time, while men can marry a young wife once when young and once when old. That is, we consider the case of bigamy, a modeling choice that is done for simplicity and without loss of generality. To fix ideas, monogamy in this setting might take the form of young men and women marrying each other at the beginning of their young period. An example of bigamy might have age 0 women marrying an old man of age 1.5, remain married to him for until widowhood at age 0.5, and then marry a same age young man. At age 1.5, he takes a second, age 0, wife.

Slave Trade

We model the slave trade as the removal of young men (the number of female slaves are normalized to zero) and let $\theta_t \in [0,1]$ be the proportion of young males removed in period t. That is, $M_t^y = (1-\theta_t)F_t$ and $M_t^o = M_{t-1}^y = (1-\theta_{t-1})F_t/n$. Furthermore, we assume that the degree of slave extraction is not "too large" so that the number of young and old men combined never falls short of the number of young women: $M_t^y + M_t^o \geq F_t$ or $(1-\theta_t) + (1-\theta_{t-1})\frac{1}{n} \geq 1$.[4]

3.1 Preferences

Young Women

The instantaneous utility of young women is

$$u_t^f = \begin{cases} b_t & \text{if} \quad \text{married, husband young,} \\ B_t - s_t & \text{if} \quad \text{married, husband old,} \\ -\infty & \text{if} \quad \text{unmarried,} \end{cases}$$

where $b_t \geq 0$ is the bride price paid by a young man and $B_t \geq 0$ is that paid by an old man. Marriage to an old man is associated with utility reducing stigma s_t. The basis for s_t could be a distaste for being a junior wife to an old (in equilibrium, polygynous) man. However, we will assume that stigma stems from peer pressure (see Section 3.2) in the spirit of Benabou and Tirole [2011]. That the regard of

[4]This assumption ensures that all old and all young men cannot marry young women, it is not critical for our argument.

others would enter the utility function seems plausible to us (outside of economics it might even be considered a truism).

Young Men

The instantaneous utility of young men is

$$u_t^y = \begin{cases} v + u(y - b_t), u'(\cdot) > 0, u''(\cdot) \leq 0 & \text{if} \quad \text{married, wife young,} \\ u(y) & \text{if} \quad \text{not,} \end{cases}$$

where v is the value of a young wife; y is the wealth of a young man; and b_t is the bride price.

For simplicity, let us assume that $u(x) = x$. This assumption is not necessary but allows us to solve for the bride price explicitly without using inverse functions.

Old Men

The instantaneous utility of old men is

$$u_t^o = \begin{cases} v + u(Y - B_t) & \text{if} \quad \text{married, wife young,} \\ u(Y) & \text{if} \quad \text{not,} \end{cases}$$

where v is the value of a young wife; Y is the wealth of an old man; and B_t is the bride price, we assume that old men are at least as wealthy as young men, $Y \geq y$.

3.2 Social Norms and Belief Formation

The social stigma a young woman married to an old man suffers depends on the prevalence of such marriages, we assume. Let π_t be the share of young women marrying an old man in period t. In an equilibrium where all young men marry eventually during their young period (to anticipate events, the case at hand), π_t serves as a measure of polygyny, since all old men married while young.

Denoting stigma by s_t we assume that

$$s_t = \begin{cases} > 0 & \text{if} \quad \pi_t \in [0, \widehat{\pi}), \\ 0 & \text{if} \quad \pi_t \in [\widehat{\pi}, 1], \end{cases}$$

where $\widehat{\pi} \equiv 1/(1+n)$. This means that non-zero stigma cost is associated with a marriage between young woman and old man if this practice is below a certain threshold $\widehat{\pi}$. However, once common enough, stigma is driven down to zero. This is a very simple way to model stigma.[5] The key assumption about the s_t function is that it is decreasing in the prevalence of polygyny, which we find quite plausible. It is also a common way to incorporate social stigma, see Besley and Coate [1992], Lindbeck et al. [1999] and Basu [2006].

Let $\widetilde{\pi}_t$ denote the *ex ante* belief at the start of period t about the degree of polygyny that will prevail in that period. This belief is positively correlated with the practice in the preceding period. For simplicity, assume that $\widetilde{\pi}_t$ can take one of two values, high ($\widehat{\pi}$) and low (0), and that this is determined probabilistically based on past behavior such that

$$\widetilde{\pi}_t = \begin{cases} \widehat{\pi} & \text{with probability} \quad \rho(\pi_{t-1}), \\ 0 & \text{with probability} \quad 1-\rho(\pi_{t-1}), \end{cases} \tag{1}$$

where $\rho'(\cdot) > 0$; $\rho(0) = 0$; and $\rho(1) = 1$. For simplicity, we assume that $\rho(x) \equiv x$.

3.3 Marriage Market Equilibrium

Young women always marry at the earliest possible age, $\eta = 0$, and stay married (not necessarily to the same man) throughout their young age (recall, being unmarried is prohibitively expensive). Thus, the supply of brides in any period t is F_t.

As for demand, men are willing to marry as long as as the bride price does not exceed the valuation of a bride. That is, the demand for brides by young men is

$$d_t^y = \begin{cases} M_t^y & \text{if} \quad b_t \leq v, \\ 0 & \text{if} \quad b_t > v. \end{cases}$$

Similarly, the demand for brides by old men is

$$d_t^o = \begin{cases} M_t^o & \text{if} \quad B_t \leq v, \\ 0 & \text{if} \quad B_t > v. \end{cases}$$

[5]An alternative formulation is to let the stigma function be continuous such that $s_t = s(\pi_t)$ with $s^{'}(\cdot) < 0$. To ensure that the equilibrium level of polygyny is non-degenerate, all we need is $u(\cdot)$ to be concave and for the old to be strictly wealthier than the young, $Y > y$.

Aggregate Demand and Supply

Clearly, a bride price exceeding the valuation of brides implies zero demand and therefore in equilibrium the bride prices paid by the young and by the old cannot both exceed v. (Otherwise, aggregate demand would be zero – incompatible with the positive supply of brides.) Moreover, because of stigma, it must be that young men pay weakly less than old men, $b_t \leq B_t$ (recall that $s_t \geq 0$). Therefore, we are left with the following possible combinations of bride prices and *ex ante* beliefs about polygyny and the associated aggregate demand D_t:

$$D_t = d_t^y + d_t^o = \begin{cases} \text{(a1) } M_t^y + M_t^o & \text{if} \quad b_t \leq v; B_t \leq v; \quad \text{and } \widetilde{\pi}_t \in [0, \widehat{\pi}), \\ \text{(a2) } M_t^y + M_t^o & \text{if} \quad b_t \leq v; B_t \leq v; \quad \text{and } \widetilde{\pi}_t \in [\widehat{\pi}, 1], \\ \text{(a3) } M_t^y & \text{if} \quad b_t \leq v; B_t > v; \quad \text{and } \widetilde{\pi}_t \in [0, \widehat{\pi}), \\ \text{(a4) } M_t^y & \text{if} \quad b_t \leq v; B_t > v; \quad \text{and } \widetilde{\pi}_t \in [\widehat{\pi}, 1]. \end{cases} \tag{2}$$

Aggregate supply of brides $S_t = F_t$ by assumption (infinite disutility from singlehood). However, depending on the bride prices and stigma, women may give preference to either type of men as follows:

Table 2: Women's Preferences Conditional on Prices

	Prices	Women prefer to marry
(b1)	$B_t - s_t = b_t$	either young or old men
(b2)	$B_t - s_t < b_t$	young over old men
(b3)	$B_t - s_t > b_t$	old over young men

Market Clearing

Marriage market clearing requires that $D_t = S_t$. Given (2), we already know that there is no equilibrium in which only old men marry and therefore we can rule out (b3) in Table (2) from possible equilibrium conditions. Moreover, in conditions (a3) and (a4), $B_t > v \geq b_t$, which is neither compatible with (b1) nor (b2). Therefore, we can also rule out (a3) and (a4).

The combinations of aggregate demand and supply conditions that remain are: (a1) and (b2) (case (c1)); and (a2) and (b1) (case (c2)). Assume that if demand exceeds supply, then brides are randomly allocated among the highest bidders. Recall that π_t denotes the share of young women marrying old men.

There are two cases to consider. In case (c1), the *ex ante* belief of the contemporaries is such that few women will marry old men. Therefore, expected level of stigma is high. Young women will choose to marry an old man only if the bride price he pays is sufficiently high to compensate for the utility loss involved in such marriage. However, the bride prices offered by the old men net of stigma are below what young men are offering. Therefore, young women would rather marry young men than old men. With a high expected stigma and insufficient bride price offered by old men, none of the old men can marry. In case (c2), the contemporaries believe that the number of young women marrying old men will be above the threshold. Since the expected stigma is low (0), old men can in this case compete with young men even when offering the same bride price. Since the demand for brides exceeds supply and women are indifferent between marrying young or old men, women are randomly allocated, $\pi_t = M_t^o/(M_t^y + M_t^o)$ share of them marry old men, and $(1-\pi_t)$ share of them marry young men.[6]

The market clearing conditions corresponding to the classes (c1) and (c2) are detailed in Table 3.

Table 3: Market Clearing Conditions

				Quantity marrying:			
Case	b_t	B_t	$\widetilde{\pi}_t$	women	young men	old men	π_t
(c1)	v	$[0, v]$	$[0, \widehat{\pi})$	F_t	F_t	0	0
(c2)	v	v	$[\widehat{\pi}, 1]$	F_t	$(1-\pi_t)F_t$	$\pi_t F_t$	$\frac{M_t^o}{M_t^y+M_t^o}$

Rational Expectations

To close the model we require *ex ante* beliefs about prevalence of old men marrying young women to be confirmed in equilibrium:

$$\pi_t = \widetilde{\pi}_t, \tag{3}$$

which corresponds to finding fixed points in the $(\widetilde{\pi}_t, \pi_t)$ space.

[6]In case (c2),

$$\frac{M_t^o}{M_t^y + M_t^o} = \frac{(1-\theta_{t-1})F_t/n}{(1-\theta_t)F_t + (1-\theta_{t-1})F_t/n} = \frac{1}{1 + n(1-\theta_t)/(1-\theta_{t-1})}.$$

Table 4: Slave Trades and Marriage Marekt Equilibria

Type	π_t^*	b_t^*	B_t^*	S_t^*	$d_t^{y^*}$	$d_t^{o^*}$
	A. No slave trade, past or present, $\theta_{t-1} = \theta_t = 0$.					
M	0	v	[0,v]	F_t	F_t	0
P	$\frac{1}{1+n}$	v	v	F_t	$(1-\pi_t^*)F_t$	$\pi_t^* F_t$
	B. Onset of slave extraction, $\theta_{t-1} = 0$ and $\theta_t > 0$.					
P'	$\frac{1}{1+n(1-\theta_t)}$	v	v	F_t	$(1-\pi_t^*)F_t$	$\pi_t^* F_t$
	C. Cessation of slave extraction, $\theta_{t-1} > 0$ and $\theta_t = 0$.					
M	0	v	[0,v]	F_t	F_t	0
P"	$\frac{1}{1+n(1-\theta_{t-1})^{-1}}$	v	v	F_t	$(1-\pi_t^*)F_t$	$\pi_t^* F_t$

Marriage Market Equilibrium

The marriage market equilibrium is defined as the vector (π_t^*, b_t^*, B_t^*) that satisfies the market clearing conditions (Table 3), and the rational expectations condition (3), where *ex ante* beliefs are formed according to (1).

3.4 Slave Trade and Polygyny

In Table 4, we present the marriage market equilibria under various situations involving past or present slave trades. When $\theta_{t-1} = \theta_t = 0$, there are two classes of steady-state equilibria: **M**(onogamous) and **P**(olygynous), as stated in panel A and illustrated in Figure 1.

Panel B of Table 4 describes the marriage market equilibrium at the onset of slave extraction, $\theta_{t-1} = 0$ and $\theta_t > 0$. In this situation, case such as (c1) in Table 3 is not feasible because with $\theta_t > 0$, the quantity of young men is smaller than the quantity of young women. Ruling out case (c1), we are left with a **P'** type of equilibrium, also see Figure 2.

In panel C of Table 4, we present the equilibria in the aftermath of the slave trade shock, e.g., $\theta_{t-1} > 0$ and $\theta_t = 0$. In this situation, both (c1) and (c2) of Table 3 are feasible and there are two types of equilibria, **M** and **P"**, see Figure 3.

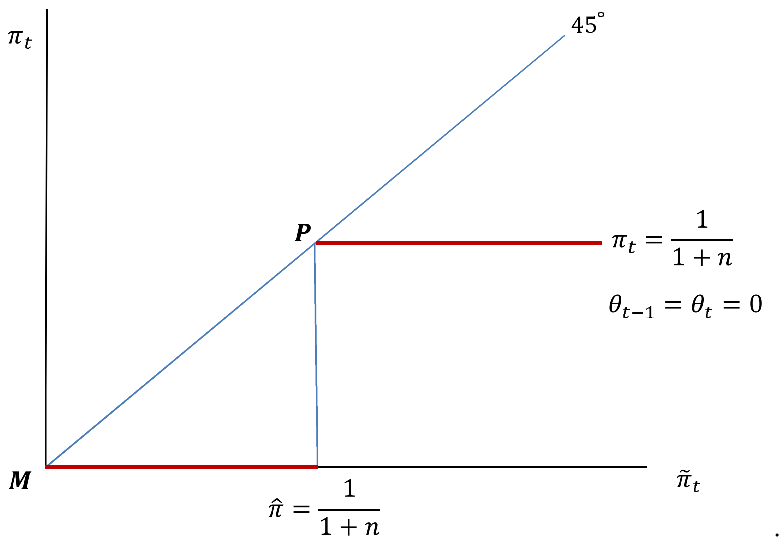

Figure 1: Steady-State Equilibria (The points **M** and **P** correspond to the equilibria detailed in Table 4, Panel A)

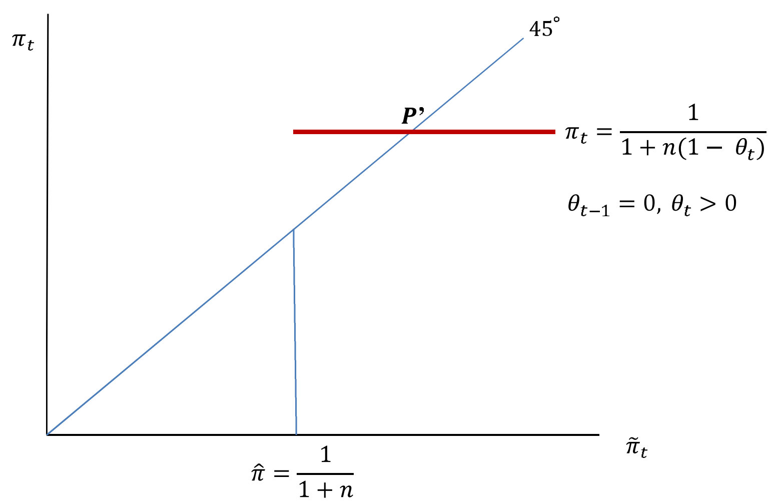

Figure 2: Transition from Steady-States: Onset of Slave Extraction (The point **P'** correspond to the equilibrium detailed in Table 4, Panel B.)

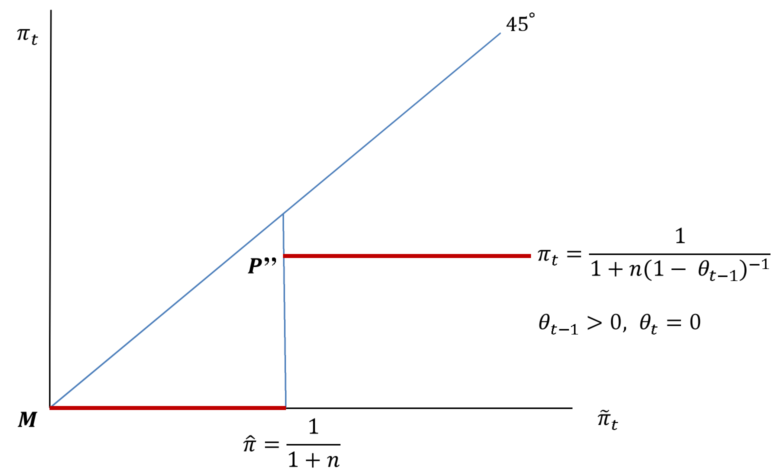

Figure 3: Transition from Steady-States: Cessation of Slave Extraction (The points **M** and **P"** correspond to the equilibrium detailed in Table 4, Panel C.)

Transition Dynamics

Consider a society in which all marriages are of type **M**. Absent an external shock, this society remains in **M** indefinitely.

Now ponder the effect of a one-period slave trade shock in period t, $\theta_t > 0$ and $\theta_{t-j} = \theta_{t+j} = 0, \forall j > 0$. In the next period, demographics are still perturbed since yesterday's young are today's old. Two periods on, however, the one-period shock has aged out and sex ratios balance for both the young and the old. The marriage market equilibrium might, however, be permanently changed from **M** to **P** as shown in Figure 4.

$\mathbf{P}_{t+2}$ and $\mathbf{M}_{t+2}$, are both steady-state equilibria, one of the polygynous type and the other of the monogamous type. In expectation, the degree of polygyny in the long run is

$$E(\pi^*) = E(\pi^*_{t+2}) = \rho(\frac{1}{1+n(1-\theta_t)})\rho(\frac{1}{1+n(1-\theta_t)^{-1}})\frac{1}{1+n}. \tag{4}$$

To see this, note that

$$E(\pi^*_{t+2}) = \Phi\{\Omega\widehat{\pi} + (1-\Omega)0\} + (1-\Phi)0,$$

where $\Phi \equiv \Pr(\mathbf{P"}_{t+1}|\mathbf{P'}_t)$ and $\Omega \equiv \Pr(\mathbf{P}_{t+2}|\mathbf{P'}_t,\mathbf{P"}_{t+1})$, and the transition probabilities are as detailed in Figure 4.

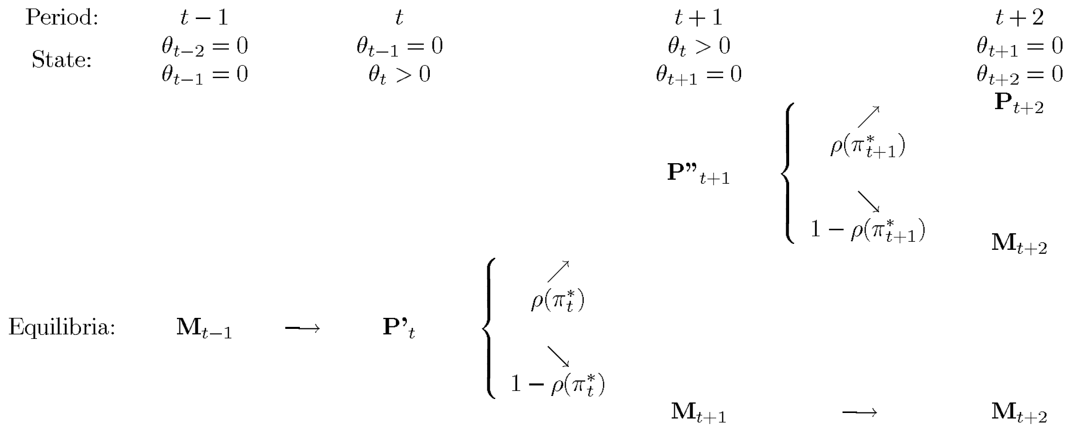

Figure 4: Slave Trade and Polygyny: Transition Dynamics

Intuitively, this expected value of polygyny in the long run depends on the magnitude of the slave trade shock, θ_t.

Proposition 1 *Holding constant the pre-slave trade equilibrium, the greater the slave trade shock, the higher the expected level of polygyny post-slave trade.*

A proof is provided in Appendix A.

Male Age at First Marriage

Our measure of polygyny is closely linked to male age at marriage and a one-off slave trade shock results not only in old men marrying more, but a delay in the age at *first* marriage for men. Recall that women marry at age 0 and that in monogamous equilibria so do young men. Similarly to Equation (4), the expected age at *first* marriage for men in the long run following a period t shock, $\theta_t > 0$ and $\theta_{t-j} = \theta_{t+j} = 0, \forall j > 0$, which we denote by $E(X)$, is

$$E(X) = E(X_{t+2}) = \rho(\frac{1}{1+n(1-\theta_t)})\rho(\frac{1}{1+n(1-\theta_t)^{-1}})E(X_{t+2}|\mathbf{P}_{t+2}), \qquad (5)$$

which comes from

$$E(X_{t+2}) = \Phi\{\Omega E(X_{t+2}|\mathbf{P}_{t+2}) + (1-\Omega)0\} + (1-\Phi)0.$$

Proposition 2 *Holding constant the pre-slave-trade equilibrium, the greater the slave trade shock, the larger the expected gender gap in age at first marriage post slave-trade.*

A proof is provided in Appendix A.

This result is quite intuitive. Proposition 1 shows that the higher the past slave extraction, the higher is the expected degree of polygyny in the long run. However, given the quantity of young women, to allow the re-marriage of old men, young men on average will have to wait longer for their *first* marriage. But this delay should be acceptable for the young men as in equilibrium they themselves will practice polygyny once they get old.

4 Data

Our main dataset is from Nunn [2008].[7] This dataset includes information on the intensity and direction of the slave trades for the period 1400–1900 and geographic information including distances to major locations where slaves were demanded (from the source country's centroid), for further description of these variables see Nunn [2008]. We complement Nunn's data set with country level information on polygyny, age at marriage, marital status, and infant and child mortality (descriptive statistics are in Table 6).

Polygyny

We use the number of married women over the number of married men 15 to 49 years old (see, e.g., Coast [2006] for a study using this definition). This information is available for 50 out of the 52 countries included in Nunn [2008]. Our polygyny measure ranges from 1.06 to 2.01, and has a mean of 1.4. To compute this measure, we use the number of males and females who are married or in a consensual union, obtained from the UN Demographic Yearbook: Special Census Topic 2000 Round.[8] For the countries this information is not available, we use the UN World Marriage Data 2008, which reports the percentage of population by age groups and sex who are married or in consensual union. By multiplying these marriage rates by age group- and sex-specific population sizes from the UN World Population Prospects,

[7] Available at `http://www.economics.harvard.edu/faculty/nunn/data_nunn`.

[8] `http://unstats.un.org/unsd/demographic/products/dyb/dyb2.htm`. We used the latest year available.

we obtain the number of married men and women.[9] No data were available for Guinea-Bissau or Somalia.

There are a number of other ways to measure polygyny – the fraction of men with more than one wife, the fraction of women with non-zero co-wives, etc., and there is no "ideal" way. Thankfully, there is a fair degree of correlation between the various measures [Low, 1988]. Appendix B discusses further the relationship between different measures of polygyny used in the literature.

Figure 5 shows high correlation between our polygyny measure (married women to married men) and the percent of married women with non-zero co-wives (from a different dataset).[10] We do not use the latter measure since it would reduce the sample from 50 to 32 countries.

There are two potential concerns regarding our measure of polygyny (the number of married women to number of married men, 15-49 years). First, one might be worried that differential mortality between men and women upwardly biases the measurement of polygyny. However, in our data, women who are widowed are recorded as "widowed" rather than as "married." Therefore, our measure of polygyny is unlikely to be driven by gender differential mortality.

Second, it is possible that sex differences in age at marriage drives our measure of polygyny. Suppose that all women marry at 15 and all men marry at 22. Then, even with monogamous marriage, our measure of polygyny will point to 1.25 wives per husband ((49-14)/(49-21)). To account for this age gap we adjust the age ranges and use ages 15-49 for women and 19-54 for men to compute polygyny in some of our specifications and our results do not change much.

Gender gap, age at first marriage (Age gap)

[9] The countries for whom we used the UN World Marriage Data (`http://www.un.org/esa/population/publications/WMD2008/Main.html`) and the UN World Population Prospects (`http://esa.un.org/unpd/wpp/unpp/panel_population.htm`) are: Angola, Benin, Cameroon, Chad, Congo, Democratic Republic of Congo, Djibouti, Equatorial Guinea, Guinea, Lesotho, Liberia, Libya, Mauritania, Namibia, Rwanda, Sierra leone, Swaziland, and Togo. We use data on marriage rates for the latest year available for each country. Since the population data are available for every five year, we use the 5th year nearest to the year for the marriage data.

[10] The percent of married women with non-zero cowives is based on data from the Demographic and Health Surveys (`http://www.measuredhs.com/`). We used all African countries for which the information is available, leaving us with 32 observations. If the info is available for multiple years for the same country, we used data for the latest year.

We use the singulate mean age of marriage by gender obtained from the UN World Marriage Data 2008. It is the average length of single life expressed in years among those who have ever married in the age group 15-49. It therefore measures the average age at first marriage over the historic period covered by the age group 15-49, rather than the average age of those currently marrying for the first time. If each cohort followed the same age pattern with respect to marriage, the singulate mean age of marriage would also be the mean age of first marriage (by gender) for every cohort in the population. On average, there is a 4.84 year difference in the male and the female singulate mean age of marriage, ranging from 1.9 to 8.8 years.

Bachelorhood

We measure bachelorhood by the percent of men in the age group 40-44 who have never married. On average, this was true of some six percent of men in this age group, ranging from 0 to 26.6 percent. These data are from the *UN World Marriage Data 2008*.

Infant mortality

Infant mortality is the number of deaths per 1,000 in the first year, and the data are obtained from the World Bank, World Development Indicators for the year 2000. Average infant mortality was 82 infants per 1000 live births, ranging from 12 to 150 deaths.

Child mortality

Child mortality is the probability per 1000 that a newborn baby will die before reaching age five and the data are from the World Bank, World Development Indicators for the year 2000. Average child mortality was 130 deaths per 1000 children, ranging from 14 to 550.

5 Empirical Analysis

We focus on two questions: does general polygyny characterize polygyny in Africa; and what are the effects of this type of polygyny. While our theory does not have direct predictions for marital output, marital output being lower in highly polygynous societies would serve as evidence in support of our theoretical argument that general polygyny owes its existence to an accident of history rather than efficiency arguments.

To make progress on the first question, we note that general polygyny predicts later age at *first* marriage for men (greater spousal age gaps) but not a higher fraction of never married men. This can be contrasted with inequality driven polygyny where low quality men never marry. While spousal age gaps increase with polygyny in both types, when polygyny originates from male inequality this gap is driven by higher order marriages – age at first marriage for men who marry need not be higher. Moreover, for general polygyny we expect current levels of polygyny to be linked to past slave extraction, especially the Atlantic trade which was heavily male biased. By contrast, for inequality driven polygyny we expect no such relationship.

For the second question – marital output – we focus on infant and child mortality on the premise that children are an important measure of marital output. Under-five mortality compromises marital productivity by raising the cost of producing a given number of children (alternatively, reducing the number of surviving children).

Below schema summarizes the proposed chain of events

$$\texttt{Distances} \Rightarrow \texttt{SlaveExports} \Rightarrow \texttt{Polygyny} \Rightarrow \texttt{Outcomes}. \tag{6}$$

We first present the bivariate correlations between polygyny and other variables of interest in a series of scatter plots. We then show, using OLS, that our measure of polygyny predicts larger spousal age gaps at *first* marriage, but not a greater incidence of never married men, consistent with general polygyny. Moreover, countries with more polygyny are shown to have lower marital output as measured by infant and child mortality, a finding more easily reconciled with general polygyny (over and above inequality driven polygyny) than inequality driven polygyny alone.

The main empirical challenge is that polygyny and marital output may be driven by omitted country characteristics. Therefore, we also present results from IV estimates where polygyny is instrumented by the minimum distances to the historic slave markets. Our IV results confirm the OLS results of economically and statistically significant effects of polygyny.

The IV estimates suggest that a reduction of the ratio of married women to married men from two to one (the equivalent of going from the most polygynous country in our sample, Burkina Faso, to an essentially monogamous country such as the Seychelles or Rwanda) would reduce the spousal age gap by 7 years, infant mortality by 81/1000, and child mortality by 132/1000.

The posited mechanism through which the distances to historic slave markets affect polygyny is that proximity to the points of slave demand in the New World resulted in greater slave extraction, which in turn skewed the sex ratios in favor of polygyny. We conclude by corroborating this linkage, Section 5.2.4.

5.1 Basic correlations: OLS estimates

We start by showing correlations in a series of scatter plots.

Figure 6 shows a clear positive relationship between slave exports (normalized by the average population from 1400 to 1900) and present day polygyny.

Figure 7 plots polygyny and the gender gap in the singulate mean age of marriage. Although their positive correlation is well known, the figure reveals a strikingly strong relationship, both in statistical and economic terms. In the most polygynous countries, this gap is about seven years, while in the least polygynous countries it is around two years.

Figure 8 plots polygyny against the percent never married men, 40-44. Under inequality driven polygyny, we would expect more polygynous societies to also have more never married men, whereas no relationship is expected under general polygyny since all men marry eventually. In fact what we observe is a negative relationship, somewhat attenuated for men in the next (and oldest available) age group, Figure 9.

Finally, Figures 10 and 11 reveal a strong positive relationship between polygyny and infant and child mortality, respectively. Polygyny being harmful is consistent with general polygyny but is harder to reconcile with quality polygyny.

Turning to multivariate analysis, we start by estimating by OLS a regression equation of the following form:

$$y_i = \gamma_0 + \gamma_1 \texttt{Polygyny}_i + X_i\beta + \varepsilon_i, \tag{7}$$

where y_i is the dependent variable of interest for country i: age gap, bachelorhood, infant and child mortality.

$\texttt{Polygyny}_i$ is the variable measuring polygyny and γ_1 is our coefficient of interest.

X_i is a vector of control variables. Following Nunn [2008], we include in X_i a vector of colonizer (immediately prior to independence) indicator variables to control for colonizer identity (colonizer identity may be an important determinant of the health and educational infrastructure of a country, both through its impact on human and physical capital in the country on independence, and through continued links, notably foreign aid [Alesina and Dollar, 1998]). North African culture is distinct from the rest of Africa, being on the Mediterranean and sharing the twin influences of Islam and French civil law. To capture the influence of these factors, we include the percent of population that is Islamic, a dummy variable indicating North Africa, and a variable indicating whether the legal system is based on French civil law.

In addition, we include (the log of) population density in 1400. The reason is two fold. First, if current polygyny captures past polygyny, and if past polygyny reflects past economic development (e.g., richer areas being better able to procure brides or offering agricultural conditions conducive to polygyny), then the coefficient γ_1 might capture the effect of high levels of development in a country's past rather than that of current polygyny. Therefore, we would like to control for the level of development prior to the slave trade, and population density in 1400 may be the best available measure (see, e.g., Acemoglu et al. [2002]). Second, high population density might have directly impacted past polygyny, e.g., from lower transportation cost leading to a larger catchment area for brides (facilitating the allocation of brides across localities).

The geography and climate variables are: distance from equator, lowest monthly rainfall, average maximum humidity, average minimum temperature, and the natural log of coastline to area. These are factors known to affect prevalence of infectious diseases and agricultural productivity [Sachs et al., 2001]. We also include an indicator variable for whether the country is a small island, and (the log of real) per capita GDP in 2000 (from Maddison [2003]).

Polygyny is more widespread in West Africa (consistent with the pattern of slave trades). To make sure that we do not just capture a "West-Africa" effect, some specifications include a West-Africa indicator variable.

The results are presented in Tables 7-10. In column 1 we only include `Polygyny` (and colonizer fixed effects). Column 2 adds the three variables percent Islamic, North Africa and French legal origins dummies. Column 3 adds (the natural log of) population density in 1400. Column 4 introduces the geography covariates. Column 5 includes log real GDP per capita. Column 6 includes West Africa dummy.

Consistent with our theory and the bivariate correlations, we find that polygyny is associated with a greater gender gap in age at first marriage, and higher infant and child mortality. As for bachelorhood, once the geographic covariates are introduced, the sign of the coefficient on polygyny flips from negative to positive, but in no specification is it significant, consistent with general polygyny.[11]

5.2 Instrumental Variables Strategy

The OLS estimates show a clear association between polygyny and negative marriage market outcomes (infant and juvenile mortality). However, there are many reasons why the relationship need not be causal. Factors linked to development may both improve child health and lead to a decline in polygyny. The adoption of Western ideals may prompt an embrace of monogamy and modern medicine. Moreover, higher levels of human capital shifts focus from child quantity to quality, resulting in both more monogamy and better child health outcomes [Gould et al., 2008]. Additionally, increased urbanization makes large households less practical, and may have an independent effect on child mortality. Thus, more urbanized countries may both have lower levels of polygyny and under-five mortality.

Furthermore, polygyny may be more common in more stratified society [Becker,

[11] Table 8 presents the results for ages 40-44. The results for never married men 45-49 are similar, available from the authors on request.

1974], and heterogenous societies may be less able to provide public goods such as sanitation or public health measures [Alesina et al., 1999, Alesina and La Ferrara, 2000, Easterly and Levine, 1997, Miguel and Gugerty, 2005], factors likely to have a strong impact on the under-five mortality rate, e.g., Miller [2008]. The pattern of foreign aid may also create an association between polygyny and child health, for instance because aid may target maternal and child health directly, and be directed to countries with cultural values congruous with those of the (Western) donor's. Alternatively, aid may be disproportionately steered to countries with historical ties, such ties often being in the form of Christian missions (outfits which combined the promotion of, inter alia, monogamy with that of health and primary education). Although colonizer indicator variables capture some of this effect, many of the main donors, notably the United States, Canada, the Nordic countries, and Japan, did not have colonies in Africa [Alesina and Dollar, 1998].[12]

To address the issue of causality we instrument for polygyny using distances to the different slave trades. Before motivating our estimation strategy, we give a brief description of the different trades.

5.2.1 The African Slave Trades

Africa has a long tradition of slave trades and four main slave trades can be distinguished: the Atlantic, the Indian Ocean, the trans-Saharan, and the Red Sea trade. Of these four, the Atlantic is the most recent and it stands out by its sheer volume and male bias, both dictated by plantation demand in the Americas following the continent's discovery and settlement by Europeans. The other trades were smaller in scale, and the trans-Saharan and Red Sea trades tended to be female biased due to Oriental demand for domestics.

The Atlantic slave trade

For the Atlantic slave trade, sex ratio among slaves (male ratio) was roughly 65% and this ratio was similar across ports of embarkment, see Table 5.

Wrote Manning [1990, pp. 41-42]:

[12]Save the U.S. colony Liberia.

Table 5: Sex Ratio among Slaves by Region of Embarkation for the Atlantic Trade

Region of embarkation	Male ratio (Stdev)	Shipment sample
Senegambia	0.70 (0.14)	92
Sierra Leone	0.68 (0.09)	67
Gold Coast	0.65 (0.11)	154
Bight of Benin	0.67 (0.12)	109
Bight of Biafra	0.58 (0.11)	122
West-central Africa	0.68 (0.09)	198
Windward Coast	0.62 (0.11)	105
South-east Africa	0.84 (0.06)	4

Source: Constructed by authors based on Eltis et al. [1999].

> In the Western Coast] The Captors retain half of the female Captives as Domestic slaves, and sell the rest to European slave merchants who export them; the Captors sell almost all of the male Captives to be exported across the Atlantic. [...] The reason for the difference in the destinations of female and male Captives is the difference in prices by sex. For male Captives, the price paid by European slave merchants were higher than those paid by African purchasers of slaves. For female Captives, the prices paid by African purchasers were nearly as high as those paid by European purchasers. [...] In keeping half the women [Captives] as Domestics, the Captors create around themselves a larger Slave Society population. Most of the women of marriageable age among the Domestics are brought into polygynous relationships (marriage or concubinage), and many of them may end up in harems of the political and military elite.[...] The Exports from the West Coast, who comprise an initial Occidental slave population, are in the ratio of two males for every female, and dominantly in the age group from fifteen to thirty.

A Portuguese colonial census of Angola taken in the late 1770s reveals a demographic structure consistent with Manning's study. According to the census, among the "Free blacks",[13] the ratio of adult men (15-60) to adult women (14-40) in 1777-1778 was 0.47 to 0.93 (see Miller [1988, p. 160] and studies cited therein). Wrote Miller [1988, p. 163]:

[13] Those not directly owned by a European subject of the Portuguese colony. This category accounted for 89.3% of the total population.

> In areas west of the slaving frontier, like the Portuguese territories surveyed for the census, visitors would have gotten the impression of villages filled with women and children, with the pre-pubertal girls outnumbering the boys. Men would have been striking only by their absence. The numbers of young wives surrounding older males in fact astonished visitors to the interior of Angola, unaccustomed to such demographic imbalances.

The Non-Atlantic slave trades

By contrast, the non-Atlantic slave trades did not create a surplus of young women in the source countries. Wrote Manning [1990, pp. 45-46]:

> [In the Savanna and Horn] Captives sold to slave merchants from the Middle East and North Africa are dominantly female, in a ratio of two females for each male. The reason for this sexual disparity, as for the Western Coast, is differences in prices and demand. In this case, however, the demand for female slaves exceeds that for male slaves both in the African Savanna and in the Orient. Further, the relative preference for female slaves in the Orient is even greater than in Africa. [...] The Captors of the Savanna sell two-thirds of the female Captives and one-third of the males to North African and Middle Eastern merchants. Thus the Captors, in making Domestic slaves of the retained Captives (with nearly twice as many males as females), create a larger Slave Society population. The Domestic slave women become wives and concubines of their masters, and notably of leading figures in the society. Slave males marry only infrequently, since their masters take the women. [...] However, the historical magnitude of this Savanna and Horn surplus of male slaves was not usually large.

Referring to the Indian Ocean trade, Manning [1990, p. 52] wrote:

> In the Eastern Coast] The Eastern Coast contributed to both Occidental and Oriental trade, though the Oriental trade dominated. [...] Overall the proportions of men and women among Eastern Coast exports were relatively even.

5.2.2 Distances as Instruments for Polygyny

From our model, we expect the removal of young adult males to result in higher levels of general polygyny. While the argument could be made for using the slave trades themselves as instruments, such an approach is problematic because it is possible that already polygynous societies participated more actively in the supply of slaves, e.g., old men raiding young men and selling them to slave traders [Miller, 1988].

Therefore, we turn to geography to instrument for polygyny. We use Nunn [2008]'s distances to the locations of demand as instrument for polygyny. The exogeneity of a country's location relative to the location of slave demand seems reasonable to us, see Nunn [2008]. Our preferred instrument is the minimum distance to the market for slaves in the Americas, `AtlanticD`, because of the historical evidence that, through its male bias and sheer volume, the Atlantic trade had a sizeable impact on local marriage markets.

In our IV strategy, the second stage outcomes of interest are: age gap, bachelorhood, infant and child mortality. The exclusion restriction for the IV is that conditional on all the control variables included, Atlantic distance affects the marital outcomes only through polygyny (see (6)). An important concern regarding this approach is that distances affect the extent of Atlantic slave trade and the Atlantic slave trade may affect other factors besides polygyny, factors which bear on the outcomes of interest. For instance, if the slave trades reduce trust [Nunn and Wantchekon, 2011], quality of domestic institutions, economic opportunities, etc., these may impact infant and child mortality. Therefore, we first present the correlations between distances and polygyny (first stage) and distances and the second stage outcomes (reduced form). These correlations should provide some evidence of the mechanism we hypothesize, and do not require the strong assumptions of the IV. We then present the IV results, which should be interpreted with caution.

5.2.3 Distances, Polygyny, and Marital Outcomes

The goal of this subsection is to establish the link:

$$\texttt{Distances} \Rightarrow \texttt{Polygyny} \Rightarrow \texttt{Outcomes}.$$

Table 11 presents the results from estimating Equation (7) when polygyny is instrumented for using `AtlanticD`. All regressions include the full set of control variables as listed in Table (6). The first stage for the regression with age gap as the dependent variable is in Column 1. Column 2 presents the first stage for the three other outcomes. In both cases, distance to the Atlantic slave market negatively predicts polygyny, significant at the 5 and 1 percent levels respectively. Columns 3 through 6 present the reduced form estimates of the effects of distance to Atlantic slave market on marital outcomes. The signs of the estimates are consistent with what we found using OLS: The further the country was from the slave market, the less polygyny exists in that country today, and the lower is the male-female age gap at first marriage as well as infant and child mortality, with no effect on permanent bachelorhood. In columns 7 through 10, we present the IV estimates of the impact of polygyny on marital outcomes when polygyny is instrumented for by distances. With the exception of fraction of never married men, the outcome for which we do not expect general polygyny to have an effect on, the results are in the same direction as the OLS results, and are larger and more significant. The estimated effect sizes are large enough to account for the difference between the most (Burkina Faso) and the least (Seychelles) polygynous countries in our sample.

While our instrument, `AtlanticD`, has sufficient power predicting polygyny, one may argue that the shown negative correlation between `AtlanticD` and `Polygyny` might be spurious. `AtlanticD` tends to be inversely related to the distances to the Orient, proximity to which may influence polygyny. For instance, Arab traders may have taken African wives, thus reducing polygyny among African men. Moreover, `AtlanticD` might be proxying for the general facility in trade with the outside world and if there are reasons to believe that (any) contact with the outside world should have a systematic influence on polygyny, not only the distances to the Atlantic slave markets but the distances to other markets should matter as well. To address these concerns and check whether the source of polygyny is indeed the proximity to the Atlantic slave markets, we repeat our analysis in Table 11 with an additional instrument. Specifically, we use the minimum distance to other (non-Atlantic) slave markets, `ISRmin` (ISR for Indian Ocean, trans-Saharan or Red Sea).[14] If `AtlanticD` were

[14]Specifically, ISRmin is the minimum of the three distances.

to proxy for the proximity to the Orient, we would expect it to lose its significance once we control for `ISRmin` (a more direct measure of proximity to the Orient than `AtlanticD`). However, as shown in Columns 1 and 2 in Table 12, polygyny seems better explained by `AtlanticD` than by `ISRmin`. In addition, the results go against the story of general facility with foreign trade since the coefficients on `AtlanticD` and `ISRmin` have opposite signs. The two distance measures are jointly significant in explaining polygyny and the coefficients are of the hypothesized sign: negative for the Atlantic distance and positive for the non-Atlantic distance (`ISRmin`). The reduced form estimates (columns 3 through 6) and the IV estimates (columns 7 through 10) are similar to those obtained when only the Atlantic distance was used as an instrument, albeit 3/4th of the size.[15]

An additional concern is that the above results are driven by regional idiosyncracies. As a robustness check, we repeat our main analysis on two (more homogenous) subsets of the data, one where we exclude countries with zero slave trade and one where we exclude North African and Island countries. The results for these subsets are qualitatively similar, (instrumented) polygyny has a positive and significant effect on age gaps, infant and child mortality, although the point estimates are larger and estimated with less precision, Table 13.

Furthermore, we repeat our main analysis based on an alternative measure of polygyny, the ratio of married women (15-49) to married men (19-54), to make sure that our baseline polygyny measure is not driven by gender differences in marriage age as discussed earlier. The results are quite similar using this alternative measure of polygyny, Table 14 (and Table 11), despite losing sample size.[16]

[15] An additional argument for considering both `AtlanticD` and `ISRmin` as instruments is that although `AtlanticD` should be the primary factor affecting Atlantic slave trades, proximity to the other markets might also matter in determining the volume of Atlantic exports. Imagine two countries with same AtlanticD but with different `ISRmin` and there was demand for slaves from all directions. In this situation, if one country sends more slaves to the Atlantic trade than the other country, exploiting the other distances as well might give more precision although more instruments will make it more subject to potential weak instrument issues.

[16] In the UN World Marriage Data, marital status is not reported for ages above 49 for three countries (Liberia, Namibia, and Swaziland), hence the reduction in sample size.

5.2.4 Evidence of A Mechanism

The rationale behind our instrumenting strategy is that the distance to the Atlantic slave trade impacted current polygyny via past (male-biased) slave extraction. Indeed, there is a strong positive association between Atlantic slave exports and current polygyny, as presented in columns 1 through 3 in Table 15. We present results suggesting a causal link: the positive relationship remains when the slave trades are instrumented for using the distances. Specifically, we examine the link:

$$\texttt{Distances} \Rightarrow \texttt{SlaveExports} \Rightarrow \texttt{Polygyny}.$$

Table 15 presents the results. Column 7 shows the second stage estimate of the effect of the Atlantic slave trade on polygyny, when `AtlanticD` is used as an instrument for the slave trade (first stage results are in Column 4). The effect is positive and economically and statistically highly significant. An increase in Atlantic slave exports by ten percent raises polygyny by 0.7 percentage points or by about one third of the standard deviation. This finding replicates that of Dalton and Leung [2011].

Lastly, we present in Table 16 evidence for the link

$$\texttt{Distances} \Rightarrow \texttt{SlaveExports} \Rightarrow \texttt{Outcomes}.$$

Columns 1 through 4 show the OLS estimates and columns 6 through 9 the IV estimates. The IV estimates show that overall impact of the Atlantic slave trades on the marital outcomes. Consistent with our hypothesis, the Atlantic slave exports increase male-female age gap at first marriage, but not the rate of permanent bachelorhood. To the extent that the most plausible determinants of today's marital outcomes (age gap, and infant and child mortality) are accounted for by the included controls, especially current GDP per capita [Nunn, 2008], it seems unlikely that the estimated effects of slave exports on outcomes are driven entirely by channels other than polygyny, in particular our result for the age gap.

6 Conclusion

Polygyny in sub-Saharan Africa is characterized by late but universal marriage for men, thus the qualifier "general." Unlike inequality-driven polygyny, where high quality men obtain more wives while leaving lower quality men unmarried, it is unclear how general polygyny might be efficient, rendering its presence all the more puzzling. Our paper proposes that general polygyny traces its roots to the African slave trade – the disproportionate extraction of young males – and provides a theoretical framework for understanding how general polygyny might arise from a temporary surplus of young women.

We argue that due to stickiness in beliefs, conventions and social norms, countries that were more heavily exposed to slave extraction in the past might have settled in a highly polygynous equilibrium despite its being, in the present day, inferior to monogamy. If general polygyny and monogamy are both feasible equilibria (where under balanced sex ratios, each obtains the sum total of one wife) and general polygyny's prevalence relies on the history of slave trade as opposed to its efficiency, then interventions to curb polygyny may be justified. In the presence of multiple equilibria, a one-time intervention can suffice to achieve a regime change. And unlike in a unique equilibrium case, such interventions do not have perverse effects.

Even a "one-spouse-at-a-time" rule limits polygyny (for practical purposes, marriage has a minimum-efficiency duration). Such a rule could, if applied to a society dominated by general polygyny, lower the spousal age gap and thus be beneficial.

General polygyny does not call into question male heterogeneity as a driver of polygyny. Modern day marriage in the West might be characterized by serial polygyny [Bergstrom, 1994], and a high divorce-remarriage equilibrium may very well be efficient [Chiappori and Weiss, 2006].[17] Our paper proposes an additional explanation for polygyny, with a particular application to African marriage patterns.

Our analysis emphasizing the possibility of multiple equilibria and the role of social norms suggests that cultural prescription of monogamy, or against intergenerational marriage, may be socially efficient, a departure from the literature

[17] In a recent paper, De la Croix and Mariani [2012] analyze the evolution of marriage institutions inside a political economy framework and provide conditions under which monogamy, polygamy or serial monogamy can arise as an equilibrium voting outcome.

which so far has focused on monogamy rules as being populist measures [Lagerlöf, 2010], and possibly ineffective [Becker, 1974].

Our paper adds to the rather few voices in Economics calling for restrictions on polygyny (notably Tertilt [2005]). One obvious policy instrument is the legislative route. Although the effectiveness of that approach can be debated, monogamy was effectively promoted through legal reforms in the East Asia. First in Japan (Meiji restoration) [MacFarlane, 2002, Fuess, 2004] and subsequently in China (Republican family code) [Bernhardt, 1999] by the removal of the legal recognition of concubines. These reforms were part and parcel of a deliberate effort to modernize society through emulation of Western institution, including western family law [Goode, 1970, MacFarlane, 2002].

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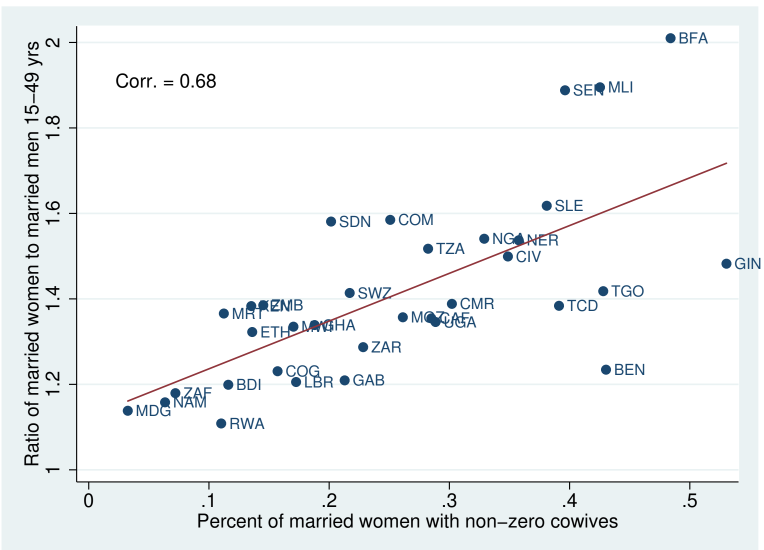

Figure 5: Correlation between different measures of polygyny

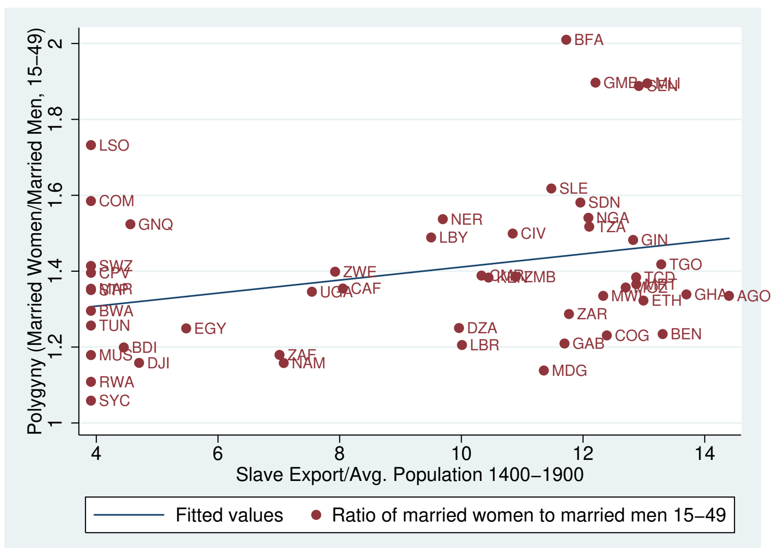

Figure 6: Slave exports and polygyny

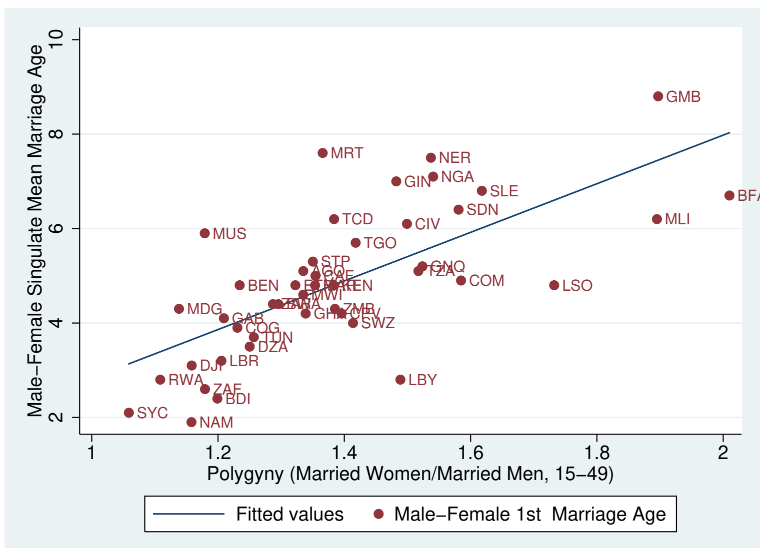

Figure 7: Polygyny and male-female age gap at first marriage

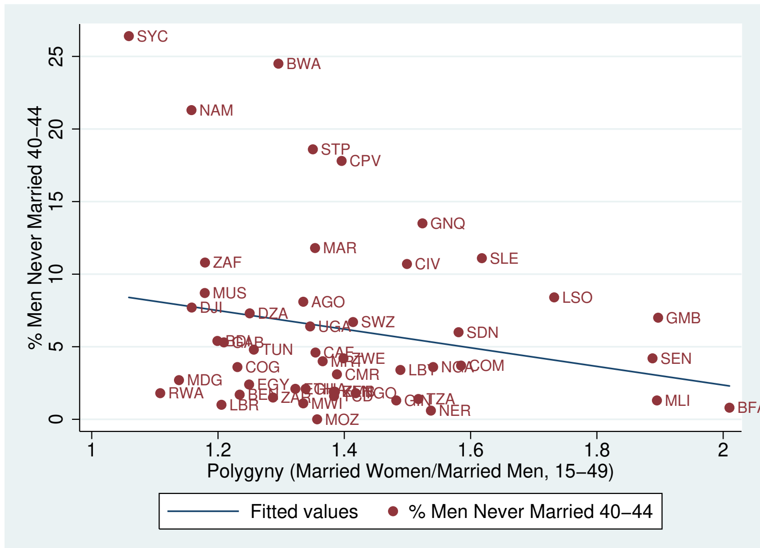

Figure 8: Polygyny and bachelorhood (men 40-44)

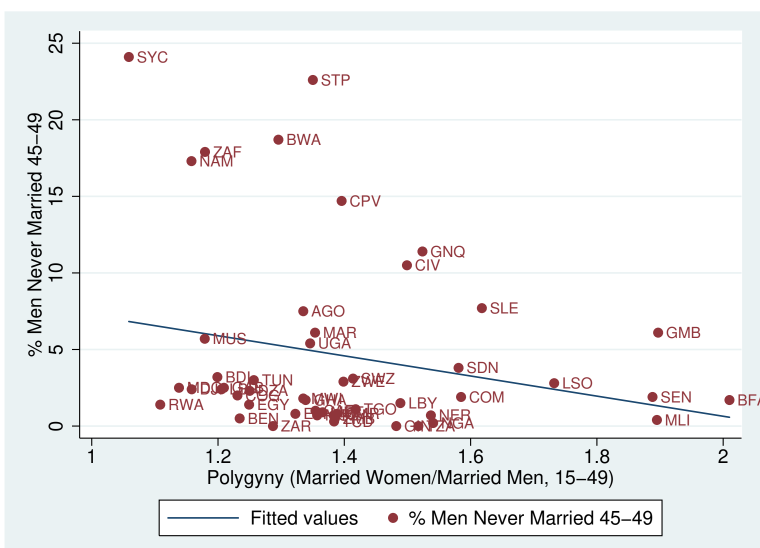

Figure 9: Polygyny and bachelorhood (men 45-49)

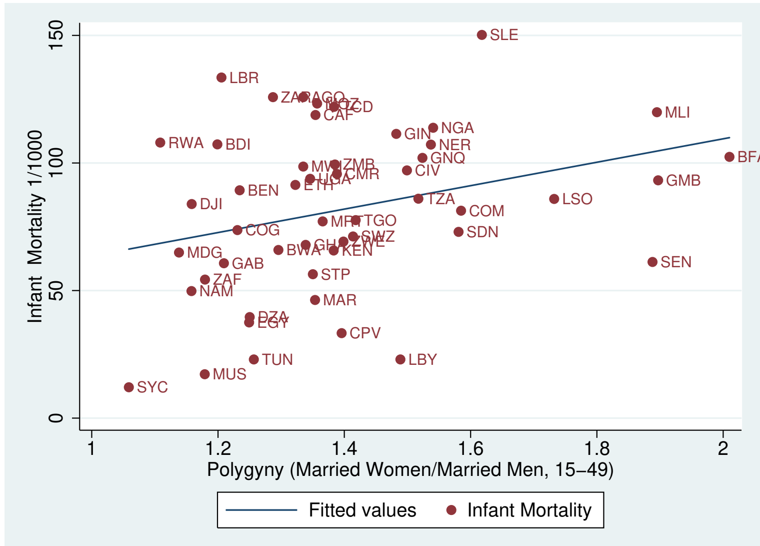

Figure 10: Polygyny and infant mortality

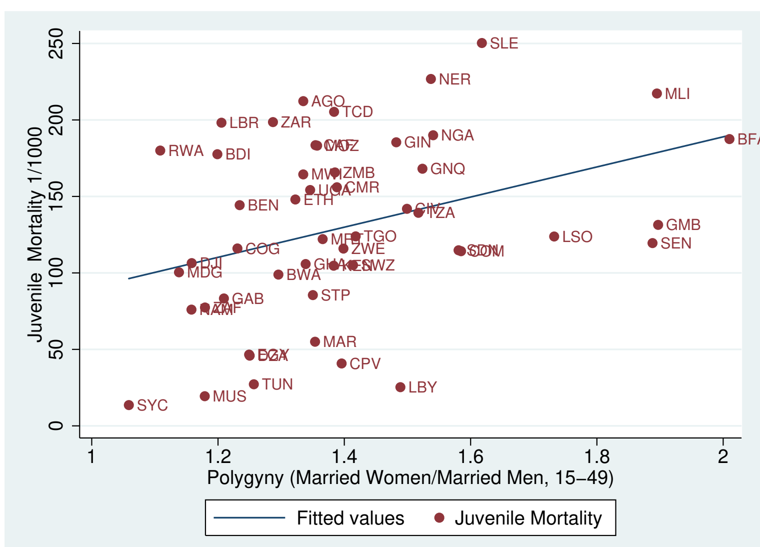

Figure 11: Polygyny and child mortality

Table 6: Descriptive Statistics

	N	Mean	SD	Min	Max
Polygyny (Wives/husbands)	50	1.40	0.21	1.06	2.01
Male-Female Gap in Age at First Marriage	44	4.84	1.57	1.90	8.80
% Men never married, 40-44	50	6.23	6.24	0.00	26.40
Infant mortality, deaths in first year/1,000 live births	50	81.75	32.46	12.10	150.20
Child mortality, deaths in years 1 through 4/1,000 live births	50	129.54	58.86	13.60	250.30
ln(Slaves/avg pop. 1400-1900, all)	50	9.15	3.70	3.91	14.40
ln(Slaves/avg pop. 1400-1900, Atlantic)	50	7.80	3.82	1.01	14.40
ln(Slaves/avg pop. 1400-1900, non-Atlantic)	50	6.60	3.64	2.30	12.99
Instruments:					
Minimum Atlantic trade distance	50	7.36	3.24	3.65	16.39
Minimum non-Atlantic trade distance	50	2.36	1.13	0.03	4.69
Controls:					
Colonizer indicator: Britain	50	0.34	0.48	0.00	1.00
Colonizer indicator: France	50	0.42	0.50	0.00	1.00
Colonizer indicator: Portugal	50	0.08	0.27	0.00	1.00
Colonizer indicator: Belgium	50	0.06	0.24	0.00	1.00
Colonizer indicator: Spain	50	0.02	0.14	0.00	1.00
Colonizer indicator: UN	50	0.02	0.14	0.00	1.00
Colonizer indicator: Italy	50	0.02	0.14	0.00	1.00
Percent Islam	50	34.05	38.77	0.00	99.00
North Africa	50	0.10	0.30	0.00	1.00
West Africa	50	0.30	0.46	0.00	1.00
French legal origin	50	0.66	0.48	0.00	1.00
Distance from the equator	50	13.75	9.98	0.20	36.00
Lowest monthly rainfall	50	9.22	16.28	0.00	69.00
Avg. max humidity	50	71.46	12.12	35.00	95.00
Avg. min temperature	50	8.54	7.56	-9.00	19.00
ln(Coast/area)	50	-0.32	3.27	-4.61	6.98
Small island	50	0.10	0.30	0.00	1.00
West Africa	50	0.30	0.46	0.00	1.00
ln(real GDP/capita, 2000)	50	7.15	0.84	5.38	9.27
ln(Pop./area, 1400)	50	0.09	1.36	-2.30	3.04

Table 7: Relationship between Age Gap and Polygyny: OLS

	Dependent var: Male-Female Gap in Age at First Marriage					
	(1)	(2)	(3)	(4)	(5)	(6)
Polygyny	4.778***	3.650***	3.199***	3.631***	3.429***	2.129*
	(0.855)	(0.910)	(0.921)	(1.104)	(1.104)	(1.065)
Percent Islam		0.015**	0.016**	0.017**	0.014*	0.013**
		(0.006)	(0.006)	(0.007)	(0.007)	(0.006)
North Africa		-1.722**	-2.080***	-0.812	-0.421	0.590
		(0.730)	(0.738)	(1.079)	(1.113)	(1.034)
French legal origin		1.582*	1.931**	2.361**	2.548**	3.261***
		(0.822)	(0.823)	(1.081)	(1.080)	(0.976)
ln(Pop./area, 1400)			0.246*	-0.039	-0.071	-0.243
			(0.142)	(0.225)	(0.224)	(0.205)
Distance from the equator				-0.049	-0.044	-0.071**
				(0.033)	(0.033)	(0.031)
Lowest monthly rainfall				-0.009	-0.009	-0.001
				(0.015)	(0.015)	(0.013)
Avg. max humidity				0.032	0.036	0.019
				(0.021)	(0.021)	(0.019)
Avg. min temperature				-0.024	-0.028	-0.068
				(0.046)	(0.046)	(0.043)
ln(Coast/area)				-0.001	0.017	0.011
				(0.090)	(0.090)	(0.079)
Small island				-0.961	-0.832	-1.060
				(1.176)	(1.168)	(1.024)
ln(real GDP/capita, 2000)					-0.352	-0.473*
					(0.284)	(0.252)
West Africa						1.299***
						(0.449)
N	44	44	44	44	44	44
R^2	0.604	0.716	0.741	0.795	0.808	0.859

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All regressions include colonizer fixed effects.

Table 8: Relationship between Bachelorhood and Polygyny: OLS

	Dependent var: Percent Men Never Married 40-44					
	(1)	(2)	(3)	(4)	(5)	(6)
Polygyny	-6.936*	-5.308	-0.843	3.443	4.325	3.919
	(4.107)	(5.293)	(4.901)	(5.365)	(5.142)	(5.697)
Percent Islam		-0.022	-0.028	-0.045	-0.023	-0.023
		(0.035)	(0.032)	(0.034)	(0.034)	(0.034)
North Africa		2.039	6.142	8.178	5.929	6.075
		(4.113)	(3.866)	(5.036)	(4.939)	(5.086)
French legal origin		-1.598	-3.798	-5.111	-6.480	-6.393
		(4.170)	(3.771)	(4.219)	(4.087)	(4.182)
ln(Pop./area, 1400)			-2.411***	-1.966*	-1.747	-1.786
			(0.728)	(1.157)	(1.110)	(1.149)
Distance from the equator				-0.041	-0.105	-0.112
				(0.162)	(0.158)	(0.166)
Lowest monthly rainfall				0.008	0.006	0.009
				(0.060)	(0.057)	(0.060)
Avg. max humidity				0.130	0.096	0.092
				(0.103)	(0.100)	(0.104)
Avg. min temperature				-0.134	-0.098	-0.113
				(0.238)	(0.228)	(0.248)
ln(Coast/area)				0.650	0.449	0.450
				(0.407)	(0.402)	(0.409)
Small island				2.553	2.014	1.967
				(5.581)	(5.337)	(5.431)
ln(real GDP/capita, 2000)					2.791*	2.771*
					(1.397)	(1.425)
West Africa						0.432
						(2.410)
N	50	50	50	50	50	50
R^2	0.302	0.313	0.470	0.601	0.648	0.649

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All regressions include colonizer fixed effects.

Table 9: Relationship between Infant Mortality and Polygyny: OLS

	Dependent var: Infant Mortality					
	(1)	(2)	(3)	(4)	(5)	(6)
Polygyny	65.677***	42.062*	24.838	22.576	16.890	27.383*
	(20.516)	(23.281)	(22.284)	(18.851)	(14.960)	(15.842)
Percent Islam		0.088	0.110	0.173	0.034	0.043
		(0.155)	(0.143)	(0.118)	(0.098)	(0.096)
North Africa		-37.911**	-53.734***	-29.980	-15.494	-19.246
		(18.092)	(17.575)	(17.696)	(14.369)	(14.142)
French legal origin		-35.316*	-26.831	3.009	11.828	9.594
		(18.341)	(17.145)	(14.824)	(11.889)	(11.630)
ln(Pop./area, 1400)			9.297***	-1.457	-2.869	-1.857
			(3.312)	(4.065)	(3.230)	(3.196)
Distance from the equator				0.259	0.672	0.865*
				(0.568)	(0.459)	(0.461)
Lowest monthly rainfall				0.237	0.249	0.186
				(0.211)	(0.167)	(0.166)
Avg. max humidity				0.282	0.496*	0.610**
				(0.362)	(0.290)	(0.290)
Avg. min temperature				2.040**	1.807**	2.213***
				(0.836)	(0.663)	(0.689)
ln(Coast/area)				-4.631***	-3.335***	-3.377***
				(1.432)	(1.169)	(1.136)
Small island				-50.240**	-46.769***	-45.571***
				(19.611)	(15.525)	(15.103)
ln(real GDP/capita, 2000)					-17.985***	-17.452***
					(4.064)	(3.961)
West Africa						-11.163
						(6.700)
N	50	50	50	50	50	50
R^2	0.357	0.509	0.595	0.818	0.832	0.832

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
All regressions include colonizer fixed effects.

Table 10: Relationship between Child Mortality and Polygyny: OLS

	Dependent var: Child Mortality					
	(1)	(2)	(3)	(4)	(5)	(6)
Polygyny	133.783***	93.752**	62.413	41.365	31.726	40.694
	(36.713)	(41.778)	(39.868)	(32.283)	(25.785)	(28.273)
Percent Islam		0.132	0.173	0.360*	0.125	0.132
		(0.279)	(0.256)	(0.202)	(0.169)	(0.171)
North Africa		-74.250**	-103.041***	-65.971**	-41.410	-44.618*
		(32.466)	(31.445)	(30.304)	(24.766)	(25.240)
French legal origin		-50.127	-34.687	14.826	29.777	27.868
		(32.913)	(30.674)	(25.386)	(20.492)	(20.755)
ln(Pop./area, 1400)			16.917***	1.533	-0.861	0.004
			(5.925)	(6.961)	(5.566)	(5.704)
Distance from the equator				0.202	0.902	1.067
				(0.973)	(0.791)	(0.822)
Lowest monthly rainfall				0.221	0.242	0.188
				(0.361)	(0.287)	(0.297)
Avg. max humidity				0.502	0.864*	0.962*
				(0.620)	(0.500)	(0.518)
Avg. min temperature				3.206**	2.810**	3.157**
				(1.432)	(1.143)	(1.229)
ln(Coast/area)				-10.414***	-8.218***	-8.253***
				(2.452)	(2.015)	(2.028)
Small island				-61.253*	-55.368**	-54.344*
				(33.583)	(26.759)	(26.953)
ln(real GDP/capita, 2000)					-30.491***	-30.036***
					(7.004)	(7.070)
West Africa						-9.541
						(11.958)
N	50	50	50	50	50	50
R^2	0.374	0.519	0.606	0.838	0.842	0.842

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
All regressions include colonizer fixed effects.

Table 11: Distance, Polygyny and Marital Outcomes

	Dependent var:									
	First stage:		Reduced form:				2SLS:			
	Polygyny		Age gap	Bachelor	Infant	Child	Age gap	Bachelor	Infant	Child
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Atlantic trade distance	-0.039**	-0.042***	-0.248***	0.076	-2.995**	-4.793**				
	(0.015)	(0.013)	(0.079)	(0.457)	(1.201)	(2.151)				
Polygyny							6.362***	-1.814	71.525***	114.481**
							(2.104)	(8.387)	(25.814)	(45.468)
Observations	44	50	44	50	50	50	44	50	50	50
R-squared	0.770	0.766	0.884	0.643	0.909	0.911	0.762	0.636	0.873	0.880

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All regressions include the full set of controls, see Table 6.

Table 12: Distance, Polygyny and Marital Outcomes: With Atlantic and Non-Atlantic Distances

	Dependent var:									
	First stage:		Reduced form:				2SLS:			
	Polygyny		Age gap	Bachelor	Infant	Child	Age gap	Bachelor	Infant	Child
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Atlantic trade distance	-0.012	-0.027	-0.251*	0.689	-3.033*	-5.209*				
	(0.022)	(0.016)	(0.124)	(0.574)	(1.583)	(2.833)				
Non-Atlantic trade distance	0.095	0.061	-0.010	2.536	-0.159	-1.721				
	(0.060)	(0.042)	(0.333)	(1.509)	(4.164)	(7.451)				
F-stat	4.85	6.82								
Prob>F	0.018	0.004								
Polygyny							4.671***	4.898	60.052***	92.397**
							(1.555)	(7.583)	(22.570)	(39.726)
Observations	44	50	44	50	50	50	44	50	50	50
R-squared	0.794	0.782	0.884	0.676	0.909	0.911	0.824	0.648	0.885	0.892

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All regressions include the full set of controls, see Table 6.

Table 13: Distance, Polygyny and Marital Outcomes: Sample Restrictions

	Dependent var:									
	First stage:		Reduced form:				2SLS:			
	Polygyny		Age gap	Bachelor	Infant	Child	Age gap	Bachelor	Infant	Child
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Excluding countries with zero slave exports										
Atlantic trade distance	-0.031	-0.040**	-0.332**	-0.294	-2.964*	-5.795*				
	(0.027)	(0.019)	(0.134)	(0.402)	(1.688)	(2.873)				
Polygyny							10.699*	7.325	73.778**	144.244**
							(5.899)	(6.794)	(34.499)	(63.605)
Observations	33	39	33	39	39	39	33	39	39	39
R-squared	0.754	0.762	0.901	0.724	0.891	0.906	0.530	0.738	0.849	0.848
Panel B: Excluding North African and Island countries										
Atlantic trade distance	-0.036*	-0.040**	-0.257**	-0.292	-3.036**	-4.784*				
	(0.019)	(0.015)	(0.096)	(0.447)	(1.407)	(2.376)				
Polygyny							7.070**	7.333	76.277**	120.189**
							(2.809)	(8.288)	(31.824)	(54.359)
Observations	35	40	35	40	40	40	35	40	40	40
R-squared	0.753	0.756	0.884	0.633	0.824	0.851	0.733	0.637	0.741	0.776

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All regressions include the full set of controls, see Table 6.

Table 14: Distance, Polygyny and Marital Outcomes: Alternative Measure of Polygyny

	Dependent var:									
	First stage:		Reduced form:				2SLS:			
	Polygyny1		Age gap	Bachelor	Infant	Child	Age gap	Bachelor	Infant	Child
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Atlantic trade distance	-0.038***	-0.031**	-0.250***	0.236	-2.975**	-4.519*				
	(0.013)	(0.012)	(0.083)	(0.448)	(1.235)	(2.258)				
Polygyny1							6.500***	-7.654	96.303**	146.310**
							(1.882)	(11.494)	(37.797)	(65.411)
Observations	41	47	41	47	47	47	41	47	47	47
R-squared	0.806	0.738	0.876	0.653	0.909	0.910	0.816	0.620	0.858	0.874

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All regressions include the full set of controls, see Table 6.

Polygyny1 is the ratio of married women (15-49) to married men (19-54).

Table 15: Atlantic Slave Trades and Polygyny

	Dependent var:								
	OLS:			First stage:			2SLS:		
	Polygyny			SlaveAtl	SlaveAtl	SlaveNAtl	Polygyny		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln(All slave exports/pop.)	0.008								
	(0.011)								
ln(Atlantic slave exports/pop.):		0.018*	0.019*				0.071***	0.072***	0.064***
SlaveAtl		(0.009)	(0.010)				(0.026)	(0.026)	(0.025)
ln(Non-Atlantic slave exports/pop):			-0.008						-0.021
SlaveNAtl			(0.008)						(0.018)
Atlantic trade distance				-0.589**	-0.570*	-0.458			
				(0.252)	(0.332)	(0.365)			
Non-Atlantic trade distance					0.079	-2.670***			
					(0.874)	(0.961)			
Observations	50	50	50	50	50	50	50	50	50
R-squared	0.681	0.711	0.720	0.711	0.711	0.615	0.393	0.380	0.494

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All regressions include the full set of controls, see Table 6.

Table 16: Atlantic Slave Trades and Marital Outcomes

	Dependent var:								
	OLS:				First stage:	2SLS:			
	Age gap	Bachelor	Infant	Child	SlaveAtl	Age gap	Bachelor	Infant	Child
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln(Atlantic slave exports/pop.): SlaveAtl	0.028	-0.710**	1.143	1.922		0.408**	-0.129	5.081**	8.132**
	(0.060)	(0.279)	(0.869)	(1.532)		(0.186)	(0.572)	(2.172)	(3.667)
Atlantic trade distance					-0.589**				
					(0.252)				
Observations	44	50	50	50	50	44	50	50	50
R-squared	0.836	0.708	0.896	0.901	0.711	0.546	0.664	0.822	0.845

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All regressions include the full set of controls, see Table 6.

Appendix A: Proofs

6.1 Proof of Proposition 1

Let $\frac{1}{1+n(1-\theta_t)} \equiv \pi_t^*$ and $\frac{1}{1+n(1-\theta_t)^{-1}} \equiv \pi_{t+1}^*$. Know that $\pi_{t+1}^* < \pi_t^*$ when $\theta_t > 0$. Also know that

$$\begin{aligned}\frac{\partial \pi_t^*}{\partial \theta_t} &= \frac{1}{\{n(1-\theta_t)+1\}^2} > 0,\\ \frac{\partial \pi_{t+1}^*}{\partial \theta_t} &= \frac{-n}{\{n+(1-\theta_t)\}^2} < 0.\end{aligned}$$

Taking the derivative of $E(\pi_{t+2}^*)$ with respect to θ_t, we obtain

$$\begin{aligned}\frac{\partial E(\pi_{t+2}^*)}{\partial \theta_t} &= \frac{1}{1+n}\{\rho^{'}(\pi_t^*)\frac{\partial \pi_t^*}{\partial \theta_t}\rho(\pi_{t+1}^*) + \rho(\pi_t^*)\rho^{'}(\pi_{t+1}^*)\frac{\partial \pi_{t+1}^*}{\partial \theta_t}\}\\ &= \frac{1}{1+n}\{\rho^{'}(\pi_t^*)\frac{\partial \pi_t^*}{\partial \theta_t}\rho(\pi_{t+1}^*)\}\{1+\frac{\rho(\pi_t^*)\rho^{'}(\pi_{t+1}^*)\frac{\partial \pi_{t+1}^*}{\partial \theta_t}}{\rho^{'}(\pi_t^*)\frac{\partial \pi_t^*}{\partial \theta_t}\rho(\pi_{t+1}^*)}\}\\ &= \frac{1}{1+n}\{\rho^{'}(\pi_t^*)\frac{\partial \pi_t^*}{\partial \theta_t}\rho(\pi_{t+1}^*)\}[1+\frac{\pi_t^*\{\frac{\partial \rho(\pi_{t+1}^*)}{\partial \pi_{t+1}^*}\frac{\pi_{t+1}^*}{\rho(\pi_{t+1}^*)}\}\frac{\partial \pi_{t+1}^*}{\partial \theta_t}}{\pi_{t+1}^*\{\frac{\partial \rho(\pi_t^*)}{\partial \pi_t^*}\frac{\pi_t^*}{\rho(\pi_t^*)}\}\frac{\partial \pi_t^*}{\partial \theta_t}}]\\ &= \frac{1}{1+n}\{\rho^{'}(\pi_t^*)\frac{\partial \pi_t^*}{\partial \theta_t}\rho(\pi_{t+1}^*)\}(1+\frac{\pi_t^*\frac{\partial \pi_{t+1}^*}{\partial \theta_t}}{\pi_{t+1}^*\frac{\partial \pi_t^*}{\partial \theta_t}})\end{aligned}$$

since $\frac{\partial \rho(\pi_{t+1}^*)}{\partial \pi_{t+1}^*}\frac{\pi_{t+1}^*}{\rho(\pi_{t+1}^*)} = \frac{\partial \rho(\pi_t^*)}{\partial \pi_t^*}\frac{\pi_t^*}{\rho(\pi_t^*)}$ is the elasticity of $\rho(\pi)$ with respect to π, a constant.

Because $\rho^{'}(\pi_t^*) > 0$ and $\rho(\pi_{t+1}^*) > 0$, know that $\rho^{'}(\pi_t^*)\frac{\partial \pi_t^*}{\partial \theta_t}\rho(\pi_{t+1}^*) > 0$. Therefore, for $\frac{\partial E(\pi_{t+2}^*)}{\partial \theta_t} \geq 0$ to be true, we require $\frac{\pi_t^*\frac{\partial \pi_{t+1}^*}{\partial \theta_t}}{\pi_{t+1}^*\frac{\partial \pi_t^*}{\partial \theta_t}} \geq -1$. Plugging the values for π_t^*, π_{t+1}^*, $\frac{\partial \pi_t^*}{\partial \theta_t}$, and $\frac{\partial \pi_{t+1}^*}{\partial \theta_t}$ into $\frac{\pi_t^*\frac{\partial \pi_{t+1}^*}{\partial \theta_t}}{\pi_{t+1}^*\frac{\partial \pi_t^*}{\partial \theta_t}}$, we require

$$\frac{\pi_t^*\frac{\partial \pi_{t+1}^*}{\partial \theta_t}}{\pi_{t+1}^*\frac{\partial \pi_t^*}{\partial \theta_t}} = \frac{-n}{1-\theta_t}\frac{\frac{1}{n}+1-\theta_t}{1+\frac{1-\theta_t}{n}} \geq -1,$$

or

$$1 \times (1+\frac{1}{n}) \geq \frac{1}{n}(1+\frac{1-\theta_t}{n}),$$

which is necessarily true because with $n \geq 1$ and $\theta_t \in [0,1]$, $1 \geq \frac{1}{n}$ and $1+\frac{1}{n} \geq 1+\frac{1-\theta_t}{n}$. Therefore, $\frac{\partial E(\pi_{t+2}^*)}{\partial \theta_t} \geq 0$.■

6.2 Proof of Proposition 2

Recall that the fecund years of men who are young in period τ were mapped onto the interval $[\tau, \tau+1]$. Denote the equilibrium polygyny in that period by π_τ. Denote the probability that a man marries for the *first* time at age $x \in [0, 1]$ or at point $\tau + x \in [\tau, \tau + 1]$ by $f(x|\pi_\tau)$, which can be expressed as

$$f(x|\pi_\tau) = (1 - \pi_\tau)\pi_\tau^x \{\frac{-\ln(\pi_\tau)}{(1 - \pi_\tau)^2}\},$$

where the constant $\frac{-\ln(\pi_\tau)}{(1-\pi_\tau)^2}$ is multipled to $(1 - \pi_\tau)\pi_\tau^x$ to ensure that

$$\int_0^1 f(x|\pi_\tau)dx = 1.$$

With this density, the probability that a man ever marries during his young period $[\tau, \tau + 1]$ is unity. That is, all young men, who are *ex ante* identical, can marry in expectation. The question is whether one will *ex post* end up marrying early or late during the young period. In period τ, a young man's expected age at *first* marriage is

$$\begin{aligned} E(X_\tau|\mathbf{P}_\tau) &= \int_0^1 xf(x|\pi_\tau)dx \\ &= -\frac{\pi_\tau}{1 - \pi_\tau} - \frac{1}{\ln \pi_\tau}, \end{aligned}$$

which, when evaluated in the polygynous equilibrium in $\tau = t+2$ (i.e., $\pi_{t+2} = \frac{1}{1+n}$), is equal to $-\frac{1}{n} + \frac{1}{\ln(1+n)}$. Plugging this into $E(X_{t+2})$ in (5), we obtain

$$E(X_{t+2}) = \rho(\frac{1}{1 + n(1 - \theta_t)})\rho(\frac{1}{1 + n(1 - \theta_t)^{-1}})\{-\frac{1}{n} + \frac{1}{\ln(1 + n)}\}.$$

Then,

$$\frac{\partial E(X_{t+2})}{\partial \theta_t} = \{-\frac{1}{n} + \frac{1}{\ln(1 + n)}\}(1 + n)\frac{\partial E(\pi_{t+2}^*)}{\partial \theta_t} \geq 0$$

because with $n \geq 1$, $-\frac{1}{n} + \frac{1}{\ln(1+n)} > 0$ and $1 + n > 0$, and $\frac{\partial E(\pi_{t+2}^*)}{\partial \theta_t} \geq 0$ from Proposition 1.■

Appendix B: Measurement of Polygyny

There are a number of ways to measure polygyny and we discuss here the interlinkage between four different measures that have been used in the literature.

Consider an economy with m men in total. $1-p$ fraction of them are married monogamously and p are polygynously. Suppose the average number of wives among the polygynous men is q.

1. Percentage of men who are polygynously married: p

2. Average number of wives among all married men:

$$(1-p)\times 1+(p)\times q$$

3. Percentage of women who are polygynously married:

$$\frac{pq}{1-p+pq}\equiv\theta$$

4. Number of married women to number of married men:

$$\frac{(1-p)m\times 1+pm\times q}{m}\equiv\kappa$$

We use measure 4 in the paper. However, 2 and 4 are essentially the same measures.

We can also examine more closely the properties of κ and θ.

$$\begin{aligned}\frac{\partial\kappa}{\partial p} &= q-1>0,\\ \frac{\partial\kappa}{\partial q} &= p>0.\end{aligned}$$

Compare this with the properties of θ.

$$\begin{aligned}\frac{\partial\theta}{\partial p} &= \frac{q}{(1-p+pq)^2}>0,\\ \frac{\partial\theta}{\partial q} &= \frac{p(1-p)}{(1-p+pq)^2}>0.\end{aligned}$$

Clearly, both κ and θ have the "correct" properties and the two measures are highly correlated, see Figure 5.