The Mystery of Monogamy

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Abstract

This paper examines why developed countries are monogamous while rich men throughout history have tended to practice polygyny (multiple wives). Assuming that wives and children are normal goods, wealth inequality naturally produces multiple wives for rich men in a standard model of the marriage market. This paper argues that the sources of inequality, not the level of inequality, is what determines the equilibrium degree of monogamy or polygyny. In particular, we show that when inequality is determined more by differences in human capital versus non-labor income (such as land and/or capital), the outcome is more monogamous. This explains why developed countries, where human capital is the main source of inequality, are monogamous while less-developed economies tend to be polygynous. These results are driven not only by the switch towards quality versus quantity children in developed countries, but more importantly by the increasing “price” of educated women in the marriage market when the return to human capital is high. That is, rich men become more monogamous in developed economies because they cannot afford more than one wife, which is consistent with the equal division of resources in modern marriages. We also show that an enforced ban on polygyny in a less-developed country, as seen in Egypt and Turkey, can force richer men to invest in child quality over quantity, thus leading to higher rates of human capital growth to the point at where polygyny disappears in equilibrium due to the increasing value of women. Using data from Cote d’Ivoire, our empirical analysis provides evidence for all the main implications of the model. In particular, we show that higher levels of non-labor income increase polygyny while higher levels of education and wage income make men more monogamous.

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1 Introduction

Throughout history, wealthy men have tended to mate with multiple wives (see Becker (1974) for a summary of the evidence). This practice, known as polygyny, is prevalent in 850 of the 1170 societies recorded in Murdock’s Ethnographic Atlas (Hartung (1982)). Polygyny is the norm in most of Africa where the percentage of women living in polygynous households ranges from 25% to 55% in the Western, Central, and Eastern parts (Lesthaege (1986)). Economists have long recognized that the number of wives and children are normal goods, and therefore, polygyny is the natural equilibrium when there is an unequal distribution of wealth amongst men (Becker (1973, 1974)). If all men were equal, there would be no reason for a woman to become the second wife of a man when she can just as easily be the only wife of someone just as good. However, it is not well understood why polygyny is virtually non-existent in modern industrialized societies, or in other words, why polygyny is so strongly associated with primitive economies both today and throughout history. Given the large and often staggering disparities in wealth in many highly developed countries, it is somewhat of a mystery that monogamy has emerged almost universally as the observed outcome in the marriage market of advanced economies.

Therefore, the primary goal of this paper is to explain the emergence of monogamy as an equilibrium outcome even in the presence of persistently high levels of income inequality. Although polygyny is officially outlawed in most advanced countries, Becker (1991) argues that the ban on polygyny only seems to be effective because people do not want to be polygynous, or else the ban would be violated as seen in countries like Egypt and Tailand today. Following this line of thought, our goal is to create a simple but unified model which can explain the existence of both monogamy and polygyny without relying on changes in individual preferences, cultural values, or attitudes about the civil rights of women and men.

The model demonstrates that a key factor explaining the practice of monogamy versus polygyny is the distinction between the different components of income inequality, and not just the level of inequality. In particular, income is derived from labor income, which is a function of human capital, and non-labor income such as land or physical capital. The model shows that the marriage market equilibrium becomes more monogamous as the
level of inequality is determined more by disparities in human capital versus disparities in non-labor income. This result is consistent with the evidence which shows that inequality in advanced economies is determined more by differences in human capital, while inequality in more primitive societies is primarily due to a skewed distribution of land and capital (see Fogel (2002)). Consequently, the model shows that the equilibrium level of monogamy or polygyny in the marriage market is crucially dependent on the sources of inequality, and not just the level of inequality as emphasized in the current literature.

The importance of the different sources of inequality stems from the basic fertility decision each person makes concerning the trade-off in child quantity and quality. In primitive economies, the rich men are typically the men with high non-labor income (land and/or capital). In addition, the value of quality in children is low since the return to human capital is low. Therefore, rich men in primitive economies are not very interested in producing quality children, and thus the value of a woman in the marriage market is not dependent on the quality of children that she can produce. Rather, the value of women in less-developed economies is determined more by the quantity of children they can produce. Assuming that all women can produce the same expected number of children ex-ante, all women are equivalent in the marriage market in primitive economies. As a result, all women are close substitutes for each other, which keeps the price of wives low enough so that rich men can afford more than one wife. Consequently, rich men in primitive economies can afford to marry multiple wives and have many children in equilibrium.

In more advanced economies, the return to human capital is higher, and therefore, the wealthier men are typically the higher quality men, not just the ones with more non-labor income. We assume that higher quality parents have lower costs in producing higher quality children (i.e. higher quality men and women have a comparative advantage in producing higher quality children). As a consequence, higher quality men increase their preference for child quality versus quantity in the advanced economy where the return to quality is higher. The increased demand for quality children increases the demand for quality women in the marriage market, since quality women reduce the cost of producing quality children. As a result, high quality women become a scarce resource in the marriage market, and women are now valued according to both their potential output in child quality and quantity. This increase in the demand for high quality females by high quality men,
who are the rich men in advanced economies, increases the price of quality women in the marriage market high enough so that it becomes too expensive for rich men to acquire more than one wife. Monogamy emerges because of the increasing value of high quality women in the marriage market, which stems from the increasing value of their input in the production of child quality.¹

In other words, polygyny is just too expensive in modern economies, even for rich men who are the only ones who are ever polygynous in the first place. This notion is consistent with the perception that husbands and wives divide the family resources evenly in developed countries. It is impossible for a man to give fifty percent of his resources to more than one woman, thus implying that the price of one wife in modern economies is practically as high as it can possibly be, thus virtually eliminating polygyny. This result suggests that the value of women in the marriage market is strongly determined by the value of their productivity in producing quality children, since all women can produce quantity with a similar ex-ante distribution.

Beyond showing that monogamy emerges in advanced economies due to the changing sources of inequality, this paper also investigates how monogamy and polygyny affect growth. So far, our explanation points to a correlation between monogamy and economic development through the correlation between development and the increasing value of women in the marriage market. These correlations do not necessarily imply that polygyny stunts economic growth and that monogamy spurs growth, despite the fact that many developing countries such as Turkey and Egypt have banned polygyny with the specific goal to increase growth. Taking an extreme example, it is not easy to see why it would hurt growth for someone like Albert Einstein to mate with hundreds of women and have thousands of offspring. To take a less drastic case, it is not clear why it is not optimal for skilled men to marry a few less-skilled women and skilled women to marry less-skilled men. This negative assortative mating pattern could produce the most skilled cohort of offspring.

¹Our model focuses on the comparative advantage of high quality men and women in the production of quality children as the key factor in reducing polygyny rather than focussing on the increasing preference of quality over quantity. Theoretically, the switch towards quality versus quantity in advanced economies, as in Becker, Murphy and Tamura (1990), could increase the demand for polygyny if a rich man tries to increase quality by decreasing the number of children per wife, and therefore, may lead to an offsetting increase in the number of wives. This equilibrium does not occur in our model since the comparative advantage of quality women in producing quality children drives up the price of quality women to the point of making polygyny too expensive.
if children need only one skilled parent to become skilled themselves. Consequently, the effect of polygyny on growth depends on the complementarity of skilled men and women in the production of skilled children.

As we show, the effect of monogamy and polygyny on growth is not unambiguous. At low levels of development where the return to skill is low, polygyny hurts growth because wealthier men squander all of their money on women rather than educating their children. A rigorously enforced ban on polygyny in the underdeveloped economy will, therefore, force wealthier men to invest in quality children since their quantity will be limited by having only one wife. This increased level of child quality will lead to economic growth which eventually leads naturally to a monogamous equilibrium in the developed state where there will be no need for the ban on polygyny (as we see in the United States today). This example may explain why the Church’s ban on polygyny in the early Middle Ages led to the eventual growth, development, and monogamous practices of Europe today. However, if the return to human capital is very high and the complementarity of men and women in the production of human capital is low enough, then polygyny is actually shown to help growth since skilled men will marry multiple unskilled women and still have skilled children, while skilled women also produce skilled children even if they marry unskilled men.

Using data from Cote d’Ivoire, our empirical analysis provides support for the main implications of our model. In particular, we show that higher levels of non-wage income increase polygyny while higher levels of education or wage income tend to make men more monogamous. Educated men not only tend to marry fewer wives, but they also marry more educated wives and have fewer and more educated children. This result is consistent with the model predictions that educated men prefer one expensive wife who is educated to multiple non-educated wives, and that this choice is related to the lower cost of producing educated children with an educated wife. In contrast, men with high non-labor income squander their money on multiple less-educated wives and produce many uneducated children. In this manner, the data from Cote d’Ivoire clearly show that the different sources of wealth have very different affects on the number of wives, and therefore, have very important implications on how the economy accumulates human capital in order to develop and grow out of a poverty trap.
Considering the prevalence of polygyny throughout history and even today in many less developed economies such as Africa and the Muslim world, there is surprisingly very little written about this issue. Most models about marriage behavior assume monogamous mating. Becker (1973, 1974) presents the classic model of the marriage market which allows for multiple partners, and shows that inequality in men naturally leads to polygyny. The results of our model coincide with Becker’s argument that the ban on polygyny is not the reason behind the lack of polygyny in modern society. Becker argues that monogamy prevails in the United States because there is little demand for polygyny.\footnote{It is somewhat debatable whether there is no polygny in modern societies like the United States. Even if we disregard certain Morman groups which are explicitly polygynous, many men are “serial monogamists” in the sense of marrying multiple wives in succession. This could be considered a form of polygyny, and points to the overall difficulty in categorizing various societies over time as either polygynous or monogamous. The very definition of marriage is not comparable in all places and over time. For example, concubines in China had certain privileges which were similar to wives, and the concept of marriage in Africa today is not the same as in Western societies. However, despite all this variation, our model seeks to explain the seemingly ubiquitous decline in polygyny in modern societies, using the working definition of a “wife” as a partner in raising children recognized by the man.} In contrast, we show that monogamy prevails in equilibrium when the price of quality wives is prohibitively high for polygyny to be affordable by the rich men in society. Our model also suggests why bans on polygyny, as seen in Egypt and Tailand, are so difficult to enforce: the price of wives is low enough for rich men in these societies to easily acquire multiple wives. But, as summarized above, we show that an enforced ban on polygyny could provide the shock needed to force wealthier men to reduce quantity in favor of quality, and thus lead to economic growth, an increasing value of women in the marriage market, and a monogamous equilibrium.

Becker’s classic analysis on polygyny has been extended by Bergstrom (1994a and 1994b), Guner (1999), Lagerlof (2002), and Edlund and Lagerlof (2002). The focus of these papers is to analyze the extent of polygyny within a less-developed economy, and investigate the interaction between the practice of polygyny with a host of other marriage market institutions in agrarian economies such as arranged marriages, dowries, bride prices, support of parents in old age, investments in sons versus daughters, and the division of bequests to children. In contrast, our focus is to explain why polygyny virtually disappears in advanced countries, and not on the interaction of polygyny and the myriad of mostly primitive marriage market customs. The existing models are limited in their ability to
explain the downfall of polygyny in advanced countries, since polygyny is very hard to rule out whenever there is inequality in men. Consequently, our model is the first model to explain monogamy in the presence of large and persistent inequality of men.³

Many of the existing models also have predictions which are clearly specific to the setting of an agrarian economy. For example, Becker’s analysis predicts that polygyny is positively associated with increasing transfers to the bride ("bride-prices") and with increasing productivity of women in the output market.⁴ Both of these predictions have strong empirical support in agrarian economies such as Africa (see Goode (1963), Grossbard (1976), and Jacoby (1995)). However, these predictions are problematic regarding advanced economies where the productivity of women and the implicit bride price (bargaining power) of women in marriage are the highest they have ever been. According to existing models, the high productivity and bargaining power of women should be a sign of higher rates of polygyny, not the virtual extinction of polygyny as we see today. In contrast, our model is consistent with the decline in polygyny accompanied by the increasing bargaining power of women in marriages, increasing productivity of women, and persistent inequality in men. We argue that while polygyny may increase bride prices within agrarian-based societies, the existence of polygyny in general is a sign that wives are inexpensive, or else wealthy men would not be able to afford more than one as is the case in modern societies.⁵

³Lagerlof (2002) looks at the interaction of many of the various marriage market customs and practices in a dynamic context, and consequently, does offer an explanation for the decline in polygyny in advanced countries. However, this is not the focus of his paper, and the explanation relies on the elimination of inequality to eliminate polygyny. The elimination of inequality results from the assumption that everyone has the same human capital so there is virtually no inequality in the advance economy where human capital is the dominant source of wealth. As stated, our model is the first to explain monogamy when inequality is still prevalent and sizeable.

⁴If female productivity in the market is associated with higher rates of polygyny in less developed economies, it is not clear why the equilibrium prices of wives and outside labor in competitive marriage and labor markets would not adjust to reduce the incidence of polygyny. Therefore, to explain the persistence of polygyny in less-developed economies and the near extinction of polygyny in highly developed economies, we focus on the primary function of a marriage - the production of child quantity and quality. The production of children has no substitute in the outside labor market. Therefore, we focus on the role of polygyny in determining the fundamental choice and trade-off between child quantity and quality that all men and women make in both high and less-developed economies.

⁵In contrast to what is commonly thought, Becker argues that allowing for polygyny is actually beneficial to women, since it raises the demand for women in the marriage market in comparison to a market where multiple wives is not allowed. Bergstrom (1994a) clarifies this idea by showing that monogamy benefits women who marry wealthy men and it hurts the leftover women who marry poorer men. Allowing for polygyny also increases the demand for women in our model relative to enforced monogamy, but
This paper is also related to the recent upsurge in research concerning marriage patterns, macro-economic conditions, and inequality (see Kremer (1997); Greenwood, Guner, and Knowles (2000); Aiyagari, Greenwood, and Guner (2000), Fernandez and Rogerson (2001); Fernandez, Guner, and Knowles (2001)). This literature mainly focuses on the effect of assortative monogamous mating on the inequality of household income. In contrast, this paper examines the reverse effect of inequality on assortative mating, and we consider assortative mating in terms of not only the quality of husbands and wives, but also on the quantity of wives (i.e. assortative polygynous mating). However, a main prediction of our model is that there will be higher rates of assortative mating on the skill levels of men and women in more advanced countries and in countries where there is a higher skill premium. Fernandez, Guner, and Knowles (2001) provide empirical evidence for both of these predictions, thus supporting our story behind the decline of polygyny in advanced economies.

2 The Model

Consider a discrete time over-lapping generations economy, in which men and women marry and give birth to children. The marriage market, which is not restricted to be monogamous, is organized by contracts that specify the allocation of resources within the household and, in particular, the investment in their children’s quality. Skilled men and women are assumed to have a comparative advantage in raising quality children.

The model of the marriage market consists of two types of men and women - high and low quality, which refers to the level of their human capital. Human capital in this sense consists of both formal and informal schooling and training. Each man may offer women of either type a marriage contract, and if she accepts, they marry and give birth to two children, a boy and a girl.\(^6\) When a man offers a marriage contract, the contract consists

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the existence of polygyny in equilibrium indicates that the demand for wives is quite low, thus making polygyny affordable. With the increasing value of high quality women in the production of quality children in advance economies, the equilibrium price of women makes polygyny prohibitively expensive.

\(^6\)Since the goal of this paper is to study the distribution of the number of wives across men, we normalize the number of children each woman bears to 2 - a boy and a girl. Thus, we abstract from issues concerning population growth and will not try to explain polygyny with an imbalanced sex-ratio. It would be trivial to develop a model with men marrying multiple women if there are a lot more women than men. We believe that sex-ratios may be an important factor, but they cannot explain the broad correlation between
of two components: (1) a “price” which specifies a money endowment that the husband must transfer to the wife for her consumption, and (2) a skill level of their offspring which requires a certain monetary investment level by the household. Men are allowed to marry as many wives as they wish subject to their budget constraint. Furthermore, we assume that men earn income in the labor market and women do not.7

Individuals’ preferences are defined over their own consumption, the number of their children, and their quality. In particular, men’s preferences are represented by the following utility function:

\[ u^m = \ln c + \ln (nx) \]

where \( c \) is consumption, \( n \) is the number of his wives (which equivalently is half the number of his children), and \( x \in \{1, h\} \) is the quality level of his children.8 If \( x = 1 \), his children will grow up to be unskilled, and if \( x = h > 1 \), his children will grow up to become skilled. Thus, we assume that all children within a household receive the same skill level.9

We assume that women have a similar utility function as men except for the restriction that women do not choose the number of their children, which is assumed to be two. Therefore, a woman’s utility function depends only on her consumption and the human capital level of her children. That is,

\[ u^f = \ln y + \ln x \]

where \( y \) is the monetary endowment (the “price”) she receives from her husband and \( x \in \{1, h\} \) is her children’s skill level.

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7 For reasons stated in the introduction, we do not believe that the productivity of women in the labor market can explain the decline in polygyny, and therefore, we abstract from the issue of female labor.

8 We follow the marriage market models of Becker (1991) and Bergstrom (1994) by making the number of wives a continuous variable. As noted by Bergstrom (1994) and Becker (1991), a fraction of a wife can be considered the expected number of years married to a wife and, if men have access to actuarially fair lotteries, then they can buy a fraction of an expected wife for the same fraction of the cost of a complete wife.

9 Again, this assumption implies that there are always an equal number of skilled men and women in the population, and an equal number of unskilled men and women. This serves to keep the sex-ratio within skill levels constant so that we can isolate other factors which affect the rate of polygyny and/or monogamy. In addition, this assumption implies that we are abstracting from issues concerning how marriage markets may interact with a gender bias in favor of sons or daughters. See Edlund and Lagerloff (2002) for an analysis of some of these issues.
To raise skilled children, parents have to invest resources in their skill. We assume that skilled parents are more efficient in the production of skilled children. In other words, skilled parents have a comparative advantage in producing skilled children. Hence, if both parents are skilled, the combined cost for educating both of the wife’s children is \( c \). If only one parent is skilled, the cost is \( \bar{c} \) where \( \bar{c} > c \). If both parents are unskilled, the cost is prohibitively high and their children will grow up to be unskilled.

Finally, we assume that each man marries women of only one type (skilled or unskilled), and offers them the same marriage contract (since the women will be of identical type). However, two men of the same type could marry two different types of women. For example, some skilled men might marry skilled women while other skilled men might marry unskilled women.

The budget constraint for each man is:

\[
c + n(y + \varepsilon e) = I
\]

where \( y \) is the price paid to each wife, \( \varepsilon = 0 \) if they raise low quality children \( \varepsilon = 1 \) if they raise high quality children and \( e \in \{c, \bar{c}\} \) is the cost per wife of raising quality children. In the basic setup, we assume that the man’s income is \( I \) where \( I = 1 \) if the man is unskilled or \( h \) if skilled. Later, we will consider adding to the analysis an additional source of income. For the sake of simplicity we assume that women do not have labor income. We denote by \( \theta \) the proportion of men and women who are skilled.

### 3 Analysis

Maximizing a skilled man’s utility function subject to his respective constraints yields a consumption level determined by:

\[
c = n(y + \varepsilon e) = h/2
\]

Maximizing a unskilled man’s utility function yields:

\[
c = n(y + \varepsilon e) = 1/2.
\]

An important implication of equations (1) and (2) is that a man’s consumption level is related only to his income and not to the number and type of his wives, and not to the skill of his children.
As stated above, the marriage offer that each man makes to a potential wife consists of a “price” (a consumption transfer) and a level of skill for both of her children. The offer will depend on the skill level of the man and the women – a man would offer different contracts (combinations of price and skill level for children) to women of different skill levels.

We denote the possible contracts that a skilled man can offer with the following pairs of prices and skill levels for children respectively:

- \( m^s, n^s \) if he marries skilled women and raises skilled children.
- \( m^u, n^u \) if he marries skilled women and raises unskilled children.
- \( M^s, N^s \) if he marries unskilled women and raises skilled children.
- \( M^u, N^u \) if he marries unskilled women and raises unskilled children.

As shown below, unskilled men can potentially marry only unskilled women in equilibrium, so we denote by \( \mu \) and \( \nu \) the price an unskilled man would offer each woman and skill level for his wives’ children, respectively.

An equilibrium is characterized by a set of marriage contracts which satisfy the following properties. First, men and women maximize their utility subject to their budget constrains. That is, there is no marriage contract that a man can offer to a woman that would make him better off without making the woman worse off. Second, the marriage market clears – i.e., all women get married.

We now establish several basic results of this model. We defer the technical proofs to the appendix.

**Lemma 1** If there is an unskilled woman that raises skilled children, then all skilled women raise skilled children.

The intuition for Lemma 1 is straightforward; skilled women have a comparative advantage in raising skilled children, so if couples where the woman is unskilled choose to invest in their children’s quality, then it is also profitable for couples with skilled women to do the same. This idea is also true for couples with skilled men, as the following lemma states.
Lemma 2 If there is an unskilled man that raises skilled children, then all skilled men raise skilled children.

Since raising high quality children is costly, men face a trade-off between marrying more wives and investing in their children’s quality. It turns out that although skilled men may invest resources in the human capital of their children while unskilled men do not, they always marry at least as many women as unskilled men.

Lemma 3 If polygyny exists, only skilled men are polygynous.

Proof: First, note that if a skilled man raises unskilled children then by 1 and 2 \( n^u = \nu h > \nu \). If a skilled man chooses to raise skilled children then the utility from having skilled children is at least as large as that of raising unskilled children. Thus, \( n^s h \geq n^u = \nu h \), implying \( n^s \geq \nu \). Hence, in both cases skilled men marry at least the same number of women as unskilled men who raise unskilled children.

Since unskilled men have the same utility whether they have skilled or unskilled children, it follows from 2 that they marry fewer wives if they raise skilled children, and therefore fewer wives than skilled men. Thus, unskilled men marry fewer wives than skilled men, completing the proof of the lemma.

At first glance, Lemma 3 is surprising because there are equilibria in which skilled men spend resources on raising quality children while unskilled men do not, and yet skilled men marry at least as many women as unskilled men regardless of \( \epsilon \). The reason for that is that the income ratio between skilled and unskilled men is the same as the yield on raising skilled children. Hence, if the yield, \( h \), is large enough to justify the investment of \( \epsilon \), then the income ratio, \( h \), is large enough to ensure that skilled men marry as many women as unskilled men. In other words, if the cost of raising quality children, \( \epsilon \), is high it would be invested only if its return, \( h \), is high. But at the same time, since \( h \) is also the income differential between skilled and unskilled men, the gap between their respective incomes is high enough to ensure that although the first type invests \( \epsilon \) they marry at least as many women.

Lemmas 1 2 and 3 imply that if parents invest in raising educated children than there is assortive mating in the marriage market in the sense that skilled men will tend
to marry skilled women. In particular, it can easily be shown from the lemmas that in a steady state all the skilled women are married to skilled men.

We now know that only skilled man are candidates to be polygynous. The following proposition studies when they are polygynous and when they are monogamous. It turns out that it depends on the value of human capital in the economy, $h$.

**Proposition 1** There exist $h_{\text{L}}$ and $h_{\text{R}}$, where $h_{\text{L}} > h_{\text{R}}$, such that if $h_{\text{L}} \leq h \leq h_{\text{R}}$, every man marries exactly one woman (i.e. monogamy is the equilibrium).

Proof: See Appendix.

It follows from the proof of Proposition 1 that polygyny exists in an economy with a low value of skill ($h < h_{\text{L}}$). If there are skilled people in this economy (i.e. $\theta > 0$), they will choose not to educate their children because the value of skill is too low relative to the cost. This is true even for skilled men who marry skilled women, and therefore, have the lowest cost of educating their children. Since no man wants to have skilled children, the skill level of a woman is not valued in the marriage market, thus the price of skilled and unskilled women are identical. As $h$ rises to $h_{\text{R}}$, the income of skilled men increases relative to unskilled men, which increases their demand for women. As a result, skilled men demand more wives and become more polygynous, while the single price of both types of women rises. However, as long as the value of skill is low enough ($h < h_{\text{L}}$) so that no one wants to educate their children, there will be no skilled people in the next generation. Consequently, there will be no skilled people ($\theta = 0$) in the steady-state equilibrium when the value of skill is low ($h < h_{\text{L}}$).

We now discuss the interval of $h$ ($h_{\text{L}} < h < h_{\text{R}}$) which produces a monogamous equilibrium according to Proposition 1. When the value of skill is within this range, the outcome of monogamy is unrelated to the proportion of skilled individuals in the economy, $\theta$. Thus, there exists a continuum of steady states with $\theta \in [0, 1]$.

An increase in $h$ within the interval of $[h_{\text{L}} h_{\text{R}}]$ has two opposing effects on the number of skilled women that a skilled man marries. On the one hand, a higher $h$ increases the utility from having skilled children, and therefore, increases the demand for skilled women who have a comparative advantage in raising skilled children. This results in an increase in the price of skilled women. On the other hand, a higher $h$ raises the income of skilled men.
relative to unskilled men which increases their resources available to buy multiple skilled women, thus leading towards more polygyny. It turns out that these two effects cancel each other out when $h$ lies within the interval $[h_l, h_r]$, thus producing monogamy within this range of $h$.

As $h$ increases with this range, the price of skilled women rises relative to unskilled women because skill is increasingly valued in children, and consequently, in women. But, at the point that $h$ reaches $h_r$, the price gap between skilled and unskilled women is sufficiently high enough so that a skilled man is indifferent between marrying an expensive skilled woman and paying a low cost of skill and marrying one unskilled woman and paying the higher cost of skill ($\bar{c}$) for his children. As $h$ rises beyond $h_r$, the prices of both types of women are rising, since both types of women are now in demand to produce skilled children. Since the income of the unskilled men is fixed at 1, they can afford less and less women which implies that the skilled men, whose income is increasing with $h$, marry more and more women. Therefore, the economy is polygynous at very high values of skill.

It is interesting to note that since skilled men are having skilled children with unskilled women when $h > h_r$, the proportion of skilled individuals in the economy is growing over time. Therefore, for $h > h_r$, the proportion of skilled individuals converges gradually to 1 ($\theta \to 1$). The rate of polygyny, which we define to be the proportion of men who marry more than one wife times the average number of wives in a polygynous marriage, is measured as $\theta(n^s - 1)$. This measure is an inverse U-shape function of $\theta$. This implies that over time, an economy which starts with a low $\theta$ would experience an increase in the rate of polygyny, followed by a decreasing rate which converges to a monogamous equilibrium where everyone is skilled.

This result shows how polygyny can actually be an engine of growth. In this scenario, polygyny acts as the “technology” which allows skilled men to “multiply” their type at a higher rate by marrying any type of woman. If polygyny was effectively banned in this economy, the size of the proportion of skilled people would remain constant over time ($\theta$ is constant), and economic growth would be stagnant. In contrast, if $h < h_r$, polygyny acts as an engine of decline – whereby all the rich men waste their money on multiple wives and produce low quality children, thus moving to a steady-state where there are no skilled people, and therefore, everyone is monogamous.
In this respect, for any given level of $h$, monogamy is the only steady-state equilibrium. However, this result is only true for the case where the only source of income is human capital. That is, when inequality stems only from human capital, the marriage market is monogamous in the steady-state. In the next section, we show that an additional source of income produces a polygynous equilibrium, even in the steady-state.

4 Adding an additional source of income.

We now examine what happens when men derive income from sources other than their human capital, such as land or physical capital. Suppose that there is an additional source of income which we call “land.” We now denote by $h + L$ and $1 + \lambda$ the income of a skilled man and unskilled man respectively. Therefore, the ratio of the income of the two types of men is represented by $r$:

$$r \equiv \frac{1 + \lambda}{h + L}.$$ 

Thus, there are two sources of inequality – inequality from differences in human capital, and inequality which is due to the disparity in the possession of land. We assume that land is distributed between skilled and unskilled men in a manner which does not reduce the level of inequality stemming only from human capital. Formally, the assumption is:

Assumption 1:

$$\frac{L}{\lambda} \geq h.$$ 

Under Assumption 1, the distribution of land does not increase the relative wealth of the unskilled men. Empirically, this assumption would suggest that men with higher labor income also have sufficiently higher non-labor income. Assumption 1 is sufficient (although not necessary) to rule out a situation in which the unskilled men are wealthier than the skilled men, which would lead to an equilibrium where the unskilled men are polygynous.

10 Although rare, equilibria in which poorer men marry more women than richer men do exist. One example is the Beduin in Israel, who are the poorest ethnic group in country, and yet are the only group practicing polygyny.
established a range of $h$ for which there is monogamy, is valid only for the case where the distribution of land does not alter at all the level of inequality stemming from human capital (i.e. $L/\lambda = h$). In other words, all the previous results hold as long as non-labor income does not alter inequality.

However, whenever the addition of land to the model increases inequality between skilled and unskilled men, the equilibrium will be polygynous and the level of polygyny will depend on the different sources of inequality.

**Proposition 2** *Holding the level of inequality constant (i.e. $r$ is constant), a higher $h$ (and therefore, lower $L/\lambda$), reduces polygyny. In addition, holding $h$ constant and increasing inequality (reducing $r$) increases polygyny.*

Proof: See Appendix.\textsuperscript{11}

This proposition states that the composition of inequality is crucial for determining the rate of polygyny in the marriage market. When inequality is determined more by disparities in human capital, higher $h$, the market is more monogamous. When inequality is determined more by a skewed distribution of non-labor income, higher $L/\lambda$, the market is more polygynous.

The intuition for this result is straightforward. When the rich people are rich because of the high value of their skill (high $h$), they will want to marry skilled wives in order to have skilled children. This increase in the demand for skilled women drives up the price of skilled wives so that skilled men can afford fewer wives, thus making the economy more monogamous. When inequality is determined more by the skewed distribution of land, the rich men in the economy are not wealthy because of their skill, and therefore, they do not care so much about marrying skilled women in order to produce skilled children. As a result, skilled women in the marriage market are not much more valuable than unskilled women, which keeps the price of all women in the marriage market low, thus making multiple wives more affordable for the rich men with lots of land.

Proposition 2 shows why polygyny declines in modern economies. In modern economies, inequality is determined more by disparities in human capital, while inequality

\textsuperscript{11}At this time, we have proved this for all steady-state levels of $\theta$ where $0 < \theta < 1$. That is, Proposition 2 is true for all steady-states except for the steady-states where no one is educated and where everyone is educated. This is similar to the “monogamy” bounds in Proposition 1, because outside of those bounds, the economy converges to either everyone being educated or no one being educated.
in primitive economies is determined more by a skewed distribution of non-labor income such a land. Consequently, the rich men in modern economies are the ones with high human capital, and they demand high quality women in order to produce high quality children more efficiently. This high demand for high quality women in modern economies increases the price of women to the point that even the rich men cannot afford multiple wives. In contrast, the rich men in primitive economies are not the ones with high human capital, and therefore, they are not very efficient, or interested, in producing high quality children. Consequently, high quality women are valued similarly to low quality women, which makes the price of all women in the marriage market low. As a result, the rich men with lots of land use their wealth to marry lots of women and raise lots of low quality children – thus preventing the accumulation of human capital necessary for growth and development.

5 Extension: Enforcing a Ban on Polygyny

This section considers what happens when men are forced to marry a single wife at most. As we show, a ban on polygyny has different effects according to the level of development. We examine the case of a typical poverty-trapped country, characterized by an unskilled population which has difficulty accumulating human capital because the cost of skill is very high. For simplicity, we assume that there are no skilled people. For any given value of skill, the cost of educating children is very high because the entire population is unskilled. In fact, the value of skill could be high enough so that if there were skilled people, they would want to have skilled children (i.e. $h > h$).

We now relax the assumption that it is prohibitively expensive for unskilled men and women to produce a skilled child together, although it is still more expensive than a mixed marriage of a skilled man and unskilled woman. We denote the cost of producing a skilled child by two unskilled parents as $e^H$. Also, we assume that there is still a distribution of land between two arbitrary groups of men who are both unskilled ($L$ and $\lambda$). In this case, the rich men are still the men with $L$ and the poor have $\lambda$.

In this scenario, a rich man will in general want to acquire multiple wives rather than waste his money on his children’s quality, since the return to skill is not very high and its
cost with a unskilled woman is still very high. If, however, the richer men are forbidden to acquire more than one wife, a rich man will have two options with his wealth: increase his personal consumption or invest in the skill of his children. Consequently, there exists a sufficiently high level of inequality \((L/\lambda)\) and sufficiently low cost of educating children when both parents are unskilled \((e^H)\) so that a wealthy man will invest in his child’s skill despite marrying an unskilled woman. The reason is that there are decreasing returns to consumption, so at some level of wealth and \(e^H\), a rich man would spend the extra money on educating his children rather than increasing his personal consumption as a result of restricting him to be monogamous.

As a consequence, there will be skilled men and women in the next generation, who will have lower costs of producing skilled children. As long as the ban on polygyny persists, all rich people, regardless of whether their wealth derives from skill or land, will tend to invest more in the skill of their children for the same reasons as the previous period plus the extra incentive for the newly skilled people to produce skilled children because it is cheaper for them. However, as this process continues and a greater share of the population becomes skilled, the wealth distribution will become more determined by the distribution of skill rather than land. As a result, the value of skilled women will increase in the marriage market, thus raising the price for a skilled wife to the point where polygyny becomes more expensive and eventually dies out naturally in equilibrium.

Thus, a “monogamous” shock to the system, such as effectively banning polygyny, creates a process where a low-developed economy uses monogamy to increase the skill of the population to the point where the ban will become less and less binding as polygyny becomes too expensive to exist voluntarily.

6 Empirical Evidence

The purpose of this section is to provide empirical support for the main assumptions and conclusions of the model. While this is not a formal test or estimation of the model parameters, this section demonstrates that the model is remarkably consistent with the empirical evidence.

The analysis uses the CILSS data from Cote d’Ivoire in 1986. The data consists
of a sample of households and has information on each member of the household. While polygyny is formally outlawed in Cote d’Ivoire, the practice of polygyny is rampant. Forty-one percent of all women between the ages of 18 and 40 are in a polygynous marriage. Moreover, this figure ranges from twenty-four percent for Catholic women to sixty-two percent for Muslim women. So, although Christianity may play a role in diminishing polygyny, polygyny is still prevalent even within the Christian community.

One of the main conclusions of the model is that richer men tend to have more wives, but higher levels of skill tend to reduce the number of wives. This result is examined in Table 1 where a probit is estimated for the probability that a man has more than one wife (i.e. practices polygyny). The analysis controls for the man’s region of residence (five regional for Abidjan, Other Cities, East Forest, West Forest, and Savannah), religion (dummies for being either Muslim, Catholic, Protestant, Other Christian, Animist, or Other Religion), and age (dummy variables for each ten-year interval). The sample consists of all male heads of households between the ages of 21 and 70.

The first column in Table 1 confirms the basic result of the model by showing that household income is positively associated with being in a polygynous marriage, while higher wage income is negatively associated with polygyny. Both variables are very significant and have the predicted signs according to the model. That is, richer men clearly have more wives, but controlling for wealth, men who earn their money through wages as opposed to non-wage income have fewer wives.

The second column in Table 1 uses the education level of the man rather than wage income, which is likely to be a better measure for the man’s skill level (since wage income is measured at the household level rather than the individual level). Again, the results strongly confirm the model predictions by showing that richer men take more wives, but more educated men tend to be more monogamous. The third column in Table 1 uses both wages and education levels together, and shows that both measures are still strongly significant when both are included. Finally, the fourth column includes additional control variables for whether the man is self-employed in agriculture, business, or is a wage earner. Up to now, the results could simply be picking up systematic differences between those that work for wages and those that do not. However, the fourth column clearly shows that these dummy variables do not affect the results at all.
Table 1 shows that educated men tend to be more monogamous. A second result of the model is that educated men will tend to marry an educated woman and have educated children. In other words, rather than using his wealth to buy multiple uneducated wives at a cheaper bride-price, an educated man will prefer the higher cost of an educated woman in order to reduce the cost of educating his (fewer) children. Table 2 supports this result by showing that men with higher education levels marry more educated women, even after controlling for the number of wives in the marriage, age, religion, and region of residence. In addition, Table 2 shows that women in polygynous marriages tend to be less-educated. Overall, Table 2 demonstrates that educated men tend to marry not only fewer wives, but more educated wives, and that polygynous men prefer lower educated wives.

Another major implication of the model is that educated men prefer educated women in order to produce more educated children. To examine this issue, Table 3 regresses the education level of children on the characteristics of their parents. However, although the data allows us to identify who the father of the child is, it is not possible to know who the mother of each child is if the household is polygynous. Consequently, we use the mean education of all wives in the household if the household is polygynous. (If the household is monogamous, then the education level of the mother is used.) Table 3 shows that the education levels of both the husband and wife (or wives) are significant determinants of the child’s education level - higher educated parents have higher educated children, even after controlling for household income. Table 3 also shows that children in polygynous households are less educated, even after controlling for parental education and household income. The results suggest that educated men use their money to acquire only one educated wife in order to produce more educated children.

Table 4 closes out the analysis by showing that polygynous households have more children after controlling for household income and parental education. Interestingly, parental education negatively affects the number of children, but the wife’s (or wives’) education level seems to be more statistically significant than the man’s.

Overall, the data from Cote d’Ivoire reveal many interesting phenomena which are consistent with the implications of the model. Although polygyny is banned, the ban is clearly not binding since a ban can never stop anyone from taking in more people into the household. The data clearly reveals underdeveloped country which is struggling
to accumulate human capital and escape poverty because polygyny is the equilibrium outcome in this economy for many men with relatively high levels of wealth but very low levels of human capital. Rich men in this economy are largely using their wealth to acquire multiple wives, although this tendency is reduced very significantly if the man’s wealth is derived from education or wage income rather than non-wage income. Consequently, a man with even a limited amount of education is more inclined to marry one expensive educated woman and raise fewer educated children, while men with abundant non-wage income spend their money on multiple women who raise many less-educated children. In this manner, wealth is squandered on multiple women and child quantity rather investing in the human capital of children, which would eventually lead to growth and a monogamous equilibrium in the marriage market.

7 Conclusion

See Abstract for now.
References


[9] Betzig, L.L.


8 Appendix

8.1 Proof of Lemma 1

Suppose the contrary is true: there is at least one unskilled woman that raises skilled children and a skilled woman that raises unskilled children.

It is easy to show that in equilibrium women of each type attain the same utility level. Between types, there are two alternatives: (1) unskilled women have greater or equal utility than skilled women; or, (2) unskilled women have strictly smaller utility than skilled women. Let us examine each alternative.

Alternative 1: Suppose that unskilled women have greater or equal utility than skilled women. Since it takes at least one skilled parent to raise skilled children, there must be at least one skilled man that raises skilled children with an unskilled woman. If so, a skilled man who offered $M^s$ could make instead the same offer, $m^s = M^s$ to a skilled woman that had unskilled children and raise skilled children. He saves $\bar{e} - \bar{e}$ on skill and she attains the utility level of the unskilled woman, which, in this alternative, is at least as high as her own. Thus, he strictly gains and she doesn’t lose, which could not exist in equilibrium.

Alternative 2: Suppose that skilled women have higher utility than unskilled women. Since all women of the same type have the same utility, this implies that $\ln y > \ln M^s + \ln h$, where $y$ is the payment that the skilled woman with unskilled children receives. Let $x$ satisfy $\ln x = \ln M^s + \ln h$. It follows that there exists $s$ such that $x < s < y$. Then, the skilled woman’s husband who offered $y$ could offer instead an unskilled woman $s$ and raise unskilled children. Her utility would increase since $\ln s > \ln x = \ln M^s + \ln h$, and his utility increases as he saves $y - s$, implying that this alternative cannot exist in equilibrium.

Thus, we have ruled out the two alternatives and may conclude that it cannot be that unskilled women have skilled children at the same time that some skilled women have unskilled children, which proves the lemma.

8.2 Proof of Proposition 1

We begin the proof by proving two claims.

Claim 1: If $h \geq h \equiv \bar{e} + \sqrt{1 + \bar{e}^2}$, then skilled men who marry skilled women would raise skilled children.

Proof of Claim 1: Suppose that there exists an equilibrium in which some skilled men who marry skilled women raise unskilled children and let $m^u$ be given. Consider the offer $\tilde{m}^s = m^u / h$. Since

$$\ln \tilde{m}^s + \ln h = \ln m^u$$

the woman is indifferent between $m^u$ (with unskilled children) and $\tilde{m}^s$ (with skilled children).
On the other hand, skilled men who marry skilled women prefer skilled children if and only if
\[ \ln c + \ln(n^s h) \geq \ln c + \ln n^u \]
which holds if and only if:
\[ n^s h \geq n^u. \]  (3)
By equation 1, \( n^s (\tilde{m}^s + e) = n^u m^u \) implying \( n^s = n^u m^u / (\tilde{m}^s + e) \). Thus, condition (3) is satisfied if and only if:
\[ \frac{n^u m^u h}{\tilde{m}^s + e} \geq n^u. \]
Substituting \( \tilde{m}^s = m^u / h \), the last inequality holds if and only if
\[ m^u h \geq \frac{m^u}{h} + e. \]
or,
\[ m^u \geq \frac{h e}{h^2 - 1}. \]  (4)
Thus, skilled men who marry skilled women prefer \( \tilde{m}^s \) (with skilled children) over \( m^u \) (with unskilled children) if and only if inequality (4) holds.

To complete the proof of the claim we show next that \( m^u \geq 1/2 \) while if \( h \geq \bar{h} \equiv e + \sqrt{1 + e^2} \) then the right hand side of (4) is strictly smaller than 1/2.

To show that \( m^u \geq 1/2 \) note that by 2, \( \nu \mu = 1/2 \) and by Lemma 3, \( \nu \leq 1 \). Hence, \( \mu \geq 1/2 \), and since in equilibrium \( m^u = \mu \), it follows that:
\[ m^u \geq 1/2. \]  (5)

On the other hand, \( \frac{he}{n^u - 1} \) is declining with \( h \) and is smaller or equal than 1/2 if and only if \( h \geq e + \sqrt{1 + e^2} \). This together with (4) and (5) imply that if \( h > \bar{h} \), skilled men strictly prefer \( \tilde{m}^s \) over \( m^u \) and since women are indifferent between the two offers, \( m^u \) can not exist in equilibrium. This proves Claim 1.

**Claim 2:** If \( h < \bar{h} \equiv \bar{e} + \sqrt{1 + \bar{e}^2} \), then skilled men who marry unskilled women prefer unskilled children over skilled children.

**Proof of Claim 2:** Given \( M^s \), an unskilled women would accept \( M^u \) if and only if:
\[ \ln M^u \geq \ln M^s + \ln h \]
Or,
\[ M^u \geq M^u / h. \]
Suppose, that given \( M^s \), a skilled man offers an unskilled woman the lowest offer she would accept: \( M^u = M^s h \). Since by equation 1, his total spending on \( c \) is unchanged, it
must be that \( N^u \tilde{M}^u = N^s(M^s + \bar{e}) \) implying \( N^u = N^s(\tilde{M}^s + \bar{e})/\tilde{M}^u \). Hence, his utility would be:

\[
\ln c + \ln N^u = \ln c + \ln N^s \left( \frac{M^s + \bar{e}}{M^u} \right) = \ln c + \ln N^s + \ln \left( \frac{M^s + \bar{e}}{M^s h} \right).
\]

Thus, the offer \( \tilde{M}^u \) increases his utility if:

\[
\frac{(M^s + \bar{e})}{M^s h} > 1
\]

(6)

Or,

\[
M^s < \frac{\bar{e}}{h^2 - 1}.
\]

(7)

It follows from Lemma 3 that \( N^s \geq 1 \), and it follows that \( M^s + \bar{e} \leq h/2 \). Since \( h < \bar{e} + \sqrt{1 + \bar{e}^2} \) this implies that:

\[
M^s \leq \frac{h}{2} - \bar{e} < \frac{\sqrt{1 + \bar{e}^2} - \bar{e}}{2}.
\]

On the other hand,

\[
\frac{\bar{e}}{h^2 - 1} > \frac{\bar{e}}{(\bar{e} + \sqrt{1 + \bar{e}^2})^2 - 1} = \frac{1}{2\bar{e} + 2\sqrt{1 + \bar{e}^2}} = \frac{\sqrt{1 + \bar{e}^2} - \bar{e}}{2}
\]

where the last term is due to multiplying the numerator and the denominator by \( \sqrt{1 + \bar{e}^2} - \bar{e} \).

Thus, if \( h \leq \bar{h} \), then \( M^s < \frac{\bar{e}}{h^2 - 1} \) and therefore skilled men who marry unskilled women raise unskilled children, proving Claim 2.

Since \( e < \bar{e} \) and \( h < \bar{h} \), Claims 1 and 2 establish the existence of an interval, \([h, \bar{h}]\), such that for \( h \in [h, \bar{h}] \), skilled men who marry skilled women raise skilled children and skilled men who marry unskilled women raise unskilled children.

Assume by contradiction, that there is polygyny for \( h \in [h, \bar{h}] \). Then, since by Lemma 3, all the skilled women marry skilled men, it must be that some skilled men marry skilled women and the rest marry unskilled women. Skilled men who marry skilled women and raise skilled children, and skilled men who marry unskilled women, must have the same utility level:

\[
\ln c + \ln (n^s h) = \ln c + \ln N^u.
\]

Since \( c \) is the same in both cases, it follows that:

\[
n^s h = N^u.
\]

(8)
On the other hand, it follows from 1 that:

\[ n^s(m^s + e) = h/2. \] \hspace{1cm} (9)

and,

\[ N^u M^u = h/2. \] \hspace{1cm} (10)

By 2:

\[ \nu \mu = 1/2. \] \hspace{1cm} (11)

Let \( p \) denote the proportion of skilled men that marry unskilled women. Thus, since all the women get married,

\[ \theta p N^u + (1 - \theta) \nu = 1 - \theta \] \hspace{1cm} (12)

and,

\[ \theta (1 - p) n^s = \theta. \] \hspace{1cm} (13)

Finally, since unskilled women are indifferent between skilled and unskilled men (in both cases they raise unskilled children), it must be that:

\[ \mu = M^u. \] \hspace{1cm} (14)

Equations (8) - (14) comprise 7 equations with 7 variables; \( n^s, N^u, \nu, m^s, M^u, \mu \) and \( p \). Solving the above system of equations yields,

\[ p = 0 \] \hspace{1cm} (15)

That completes the proof of Proposition 1.

### 8.3 Proof of Proposition 2

First, note that when we introduce land, equations 2 and 1 are replaced by:

\[ c = n(y + \varepsilon e) = (h + L)/2 \] \hspace{1cm} (16)

for skilled men, and the following for an unskilled man:

\[ c = n(y + \varepsilon e) = (1 + \lambda)/2. \] \hspace{1cm} (17)

We continue by proving two claims.

**Claim 1:** If \( h \geq h(\lambda) \equiv \varepsilon + \sqrt{(1 + \lambda)^2 + \varepsilon^2} \), then skilled men who marry skilled women would raise skilled children.
Proof of Claim 1: Using exactly the same arguments as in the proof of Claim 1 in Proposition 1, it follows that equation (4) still holds and that:

\[ m^u \geq \frac{(1 + \lambda)}{2}. \]  

(18)

Note again that the right hand side of (4) is declining with \( h \) and is smaller or equal than \( \frac{(1 + \lambda)}{2} \) if and only if \( h \geq h(\lambda) \). Hence, it follows from equations (4) and (18) that if \( h > h(\lambda) \), skilled men prefer \( \tilde{m}^s \) over \( m^u \) proving Claim 1.

Claim 2: If \( h < \bar{h}(L) \equiv \bar{\epsilon} + \sqrt{(1 + L)^2 + \bar{\epsilon}^2} \), then skilled men who marry unskilled women prefer unskilled children over skilled children.

Proof of Claim 2: Using exactly the same arguments as in the proof of Claim 1 in Proposition 1, it follows that equation (7) still holds and that

\[ M^s + \bar{\epsilon} \leq \frac{h + L}{2}. \]

Thus, whenever \( h < \bar{\epsilon} + \sqrt{(1 + L)^2 + \bar{\epsilon}^2} \) it follows that

\[ M^s \leq \frac{h + L}{2} - \bar{\epsilon} < \frac{\sqrt{(1 + L)^2 + \bar{\epsilon}^2} - \bar{\epsilon}}{2}. \]

On the other hand,

\[
\frac{\bar{\epsilon}}{h^2 - 1} > \frac{\bar{\epsilon}}{(\bar{\epsilon} + \sqrt{(1 + L)^2 + \bar{\epsilon}^2})^2 - 1} = \frac{1}{2\bar{\epsilon} + 2\sqrt{(1 + L)^2 + \bar{\epsilon}^2}} = \frac{\sqrt{(1 + L)^2 + \bar{\epsilon}^2} - \bar{\epsilon}}{2}
\]

where the last term is due to multiplying the numerator and the denominator by

\[ \sqrt{(1 + L)^2 + \bar{\epsilon}^2} - \bar{\epsilon}. \]

Thus, if \( h \leq \bar{h}(L) \), then \( M^e < \frac{\bar{e}^u}{h^2 - 1} \) and therefore skilled men who marry unskilled women raise unskilled children, proving Claim 2.

Since \( e < \bar{\epsilon} \), and \( L > \lambda \), then \( h(\lambda) < \bar{h}(L) \). Thus, Claims 1 and 2 establish the existence of an interval, \([h(\lambda), \bar{h}(L)]\), such that if \( h \) is within it, skilled men who marry skilled women raise skilled children and skilled men who marry unskilled women raise unskilled children.

Next, we continue the proof assuming that \( h \in [h(\lambda), \bar{h}(L)] \). Hence, it follows from lemmas 1, 2 and 3, that whenever \( h \geq h(\lambda) \) some skilled men marry skilled women and raise skilled children. On the other hand, if there is polygyny, then by Lemma 3 some skilled men marry unskilled women, and since \( h \leq \bar{h}(L) \) they raise unskilled children. Hence, skilled men must be indifferent between the two options, implying:

\[ \ln c + \ln(n^s h) = \ln c + \ln N^u \]

and since \( c \) is the same in both cases, it follows that:

\[ n^s h = N^u. \]  

(19)
On the other hand, it follows from equation (16) that:

\[ n^e(m^e + e) = (h + L)/2 \]  

(20)

and,

\[ N^u M^u = (h + L)/2. \]  

(21)

By equation (17),

\[ \mu \nu = (1 + \lambda)/2. \]  

(22)

Let \( p \) denote the proportion of skilled men that marry unskilled women. Thus, since all the women marry:

\[ \theta p N^u + (1 - \theta) \nu = 1 - \theta \]  

(23)

and,

\[ \theta (1 - p) n^e = \theta. \]  

(24)

Finally, since unskilled women are indifferent between skilled and unskilled men (in both cases they raise unskilled children), it must be that:

\[ \mu = M^u. \]  

(25)

Equations (19) - (25) comprise 7 equations with 7 variables; \( n^s, N^u, \nu, m^s, M^u, \mu \) and \( p \). Solving them yields,

\[ p = \frac{(1 - \theta)(1 - rh)}{1 - \theta + \theta h}. \]  

(26)

Proposition 2 follows immediately from equation (26).
<table>
<thead>
<tr>
<th></th>
<th>Probit: Dependent Variable =1 if man has more than one wife</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Total Income</td>
<td>1.10 (0.11) 0.73 (0.09) 1.12 (0.12) 1.19 (0.12)</td>
</tr>
<tr>
<td>Household Wage Income</td>
<td>-1.30 (0.19) -1.12 (0.20) -1.39 (0.25)</td>
</tr>
<tr>
<td>Man’s Education Level</td>
<td>-0.02 (0.003) -0.01 (0.004) -0.01 (0.004)</td>
</tr>
<tr>
<td>Age Dummies</td>
<td>Yes Yes Yes Yes</td>
</tr>
<tr>
<td>Regional Dummies</td>
<td>Yes Yes Yes Yes</td>
</tr>
<tr>
<td>Religion Dummies</td>
<td>Yes Yes Yes Yes</td>
</tr>
<tr>
<td>Dummies for Self-Employed in Agriculture, Business, and being a Wage Earner</td>
<td>No No No Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>1351 1351 1351 1351</td>
</tr>
</tbody>
</table>

Coefficient estimates are the marginal effects from the probit results. Standard errors are in parentheses. Sample includes all male heads of household between the ages of 20 and 60.
Table 2: Explaining the Education Level of Wives

| Dummy for being in a Polygynous Marriage | -0.31  
|                                         | (0.11) |
| Education level of the Husband          | 0.42   
|                                         | (0.02) |
| Age Dummies                             | Yes    |
| Region Dummies                          | Yes    |
| Religion Dummies                        | Yes    |
| Number of observations                  | 1709   |

Standard errors in parentheses.
Table 3: Explaining the Education Level of Children

<table>
<thead>
<tr>
<th>OLS Regressions</th>
<th>Education Level of the Child</th>
<th>Dummy =1 if the Child has any education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education Level of the Father</td>
<td>0.06 (0.01)</td>
<td>0.01 (0.003)</td>
</tr>
<tr>
<td>Mean Education Level of the Wives in the Household**</td>
<td>0.05 (0.01)</td>
<td>0.01 (0.003)</td>
</tr>
<tr>
<td>Number of Wives in the Household</td>
<td>-0.08 (0.04)</td>
<td>-0.02 (0.01)</td>
</tr>
<tr>
<td>Household Income</td>
<td>0.47 (0.22)</td>
<td>0.14 (0.05)</td>
</tr>
<tr>
<td>Male Dummy</td>
<td>0.36 (0.07)</td>
<td>0.07 (0.02)</td>
</tr>
<tr>
<td>Age Dummies</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Region Dummies</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Religion Dummies</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>2177</td>
<td>2177</td>
</tr>
</tbody>
</table>

Standard Errors in parentheses.

** If there was only one wife in the household, then this is the education level of the only wife. If there were multiple wives, it is not possible to know who is the child’s mother, so we use the mean education level of all wives in the household.
Table 4: Explaining the Number of Children in Households

<table>
<thead>
<tr>
<th></th>
<th>OLS Regressions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dependent Variable:</td>
</tr>
<tr>
<td></td>
<td>Number of Children in the Household</td>
</tr>
<tr>
<td>Education Level of the Father</td>
<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
</tr>
<tr>
<td>Mean Education Level of the Wives in the Household**</td>
<td>-0.11</td>
</tr>
<tr>
<td>Number of Wives in the Household</td>
<td>1.90</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
</tr>
<tr>
<td>Household Income</td>
<td>2.65</td>
</tr>
<tr>
<td></td>
<td>(0.52)</td>
</tr>
<tr>
<td>Age Dummies</td>
<td>Yes</td>
</tr>
<tr>
<td>Region Dummies</td>
<td>Yes</td>
</tr>
<tr>
<td>Religion Dummies</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>2177</td>
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