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Gary Becker devotes a chapter of his *Treatise on the Family* to ‘‘Polygamy and Monogamy in marriage markets. The inclusion of polygamy in his analysis is more than an intriguing curiosum. Although overt polygamy is rare in our own society, it is a very common mode of family organization around the world. Of 1170 societies recorded in Murdock's *Ethnographic Atlas*, polygyny (some men having more than one wife) is prevalent in 850. (Hartung, 1982). Moreover, our own society is far from completely monogamous. About 1/4 of all children born in the United States in 1990 were born to unmarried mothers who were not cohabiting with the fathers.[1] Even though simultaneous marriages to multiple partners are not officially recognized, divorce and remarriage leads to a common pattern of ‘‘serial polygamy’’, in which males remarry more frequently than females and are more likely than females to have children by more than one spouse.[2]

This paper concerns the economics of polygynous societies with well-functioning markets for marriage partners. The institutions that we model appear to be particularly close to those found in the polygynous societies of Africa where polygyny is the norm. In the countries of the Sahel region of Africa, the percentage of women living in polygynous households ranges from 45% to 55%. In West Africa, Central Africa, and East Africa, these percentages are mostly in the range from 25% to 35%. In Southern Africa, polygyny is less common, with just under 10% of women living in polygynous households. (Lesthaege (1986)). Descriptions of these institutions can be found in Goody (1973) and in Kuper (1982). Most polygynous societies have positive prices for brides.[3] In the polygynous societies of Africa, these prices, which anthropologists call ‘‘bridewealth’’, are typically paid to the bride's male relatives rather than to the bride. According to Jack Goody (1973, p. 5), ‘‘Bridewealth is not to be consumed in the course of the celebration, nor is it handed to the wife, it is given to the bride's male kin (typically brothers) in order that they can themselves take a wife.’’ Dowry, in contrast to bridewealth, is a payment *from* the bride's relatives. But according to Goody, dowry is not the ‘‘reverse’’ of bride wealth. Dowry typically goes directly to the newly married couple rather than to the relatives of the groom, constituting as Goody suggests,

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I am grateful to Jack Hirshleifer, Bobbi Low, Alan Rogers, and for instruction and encouragement.

[1] See Da Vonza and Rahman (1993). In the U.S. in 1990, 23% of all children lived in single-parent, mother-only households. For Black Americans, the statistics are even more dramatic. Two-thirds of births in 1990 were out of wedlock and more than half of all children lived in single-parent households.

[2] See Gaullin and Boster (1990). In the U.S. in 1971, about 40% of all males and 30% of all females who married had previously been married at least once. (Chamie and Nsuly (1981))

[3] About 2/3 of all of the societies listed in Murdoch's *Ethnographic Atlas* (1967) have positive bride prices. Gaulin and Boster (1990).

‘‘a type of pre-mortem inheritance to the bride.’’ Goody distinguishes bridewealth from ‘‘indirect dowry.’’ , which is a payment from the groom’s family to the *newlywed couple* rather than to the bride’s male relatives. Goody reports that in polygynous African societies, payments at the time of marriage normally take the form of bridewealth rather than of indirect dowry.

In human societies, males who inherit economic wealth from parents or other relatives can increase their reproductive success substantially by acquiring additional wives, mistresses, or concubines. For females, on the other hand, an extra husband adds little to her lifetime fertility. Once a female has achieved moderate prosperity, additional wealth does little to relax the biological constraints on the number of offspring she can have. Therefore, we expect that in an an economy with well-functioning markets for marital partners, where parents distribute inheritance and the the bridewealth of their daughters in such a way as to maximize the number of their surviving grandchildren, we would expect there to be polygyny rather than polyandry and we would expect brides to command a positive price. We would further expect to see parents leave their inheritances (including the bridewealth received for their daughters predominantly to their sons rather than to their daughters. According to Goody (1973) and Kuper (1981), most of the polygynous societies of Africa fit this description.

In a polygynous society, one may want to distinguish the rights and obligations of full siblings from those of half-siblings who share the same father but have different mothers. In particular, it is useful to know whether males typically share the bridewealth of half-sisters or whether bridewealth is preferentially passed to full siblings. While the norm may differ across societies, Kuper’s book (p. 28) contains a beautifully explicit description of this pattern of property rights in traditional societies of southern Africa.

> ‘‘ A ‘house’ was constituted by a major wife and her children, and each such house was allocated its own estate during the lifetime of the homestead head. As a magistrate told a commision of inquiry at the turn of the century, ‘If a man had three wives, he would have three separate estates’. In addition to property allocated by the homestead head, a house had the right to the products of its gardens, to the calves and milk of its cows, to the earnings of the wife and her minor children, and crucially for my present purposes, to the bridewealth received for its daughters.
>
> If bridewealth for a daughter was used to acquire a wife for a man outside the ‘house’, then a debt was created. This was the case even if the cattle were used by the homestead head, either to acquire another wife for himself or to provide a wife for a son from a different house.’’

1. A Formal Model of Demand for Wives and Children by Polygynous Males

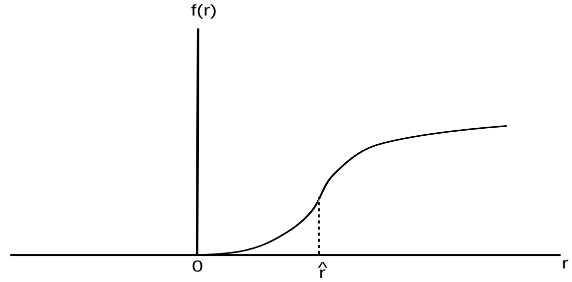
Suppose that production of surviving children requires two scarce inputs, wives and material resources. The expected number of surviving children that a woman produces depends on the amount of material resources that she is able to command. For simplicity of analysis and in order to get sharply drawn results, this model assumes that all women have the same fertility function. [4]

[4] It would be interesting, and relatively straightforward, to extend this theory to the case where characteristics observable in young women are associated with differences in their expected lifetime fertility functions. A good starting point is

Let $f(r)$ be the expected fertility (expected number of surviving children) of a woman who has r units of material resources. Let there be an upper bound on the total number of children a woman can produce and assume that with no material resources a woman could produce no children. Assume that beyond some threshold level of resources there is diminishing marginal product of resources in the number of children a single woman can produce, while for women who have less than this threshold amount, the marginal product of resources is increasing.

Figure 1 shows an example of a function with these properties, which are stated more formally as Assumption 1.

Figure 1



Assumption 1. *All women in the marriage market have the same fertility function, f, which has the following properties:*

(i) $f(0) = 0$ and f is bounded from above by a finite number.

(ii) For all $r \geq 0$, $f(r) \geq 0$ and $f'(r) \geq 0$.

(iii) There is some $\hat{r} \geq 0$ such that if $0 \leq r \leq \hat{r}$, then $f''(r) \geq 0$ and if $r \geq \hat{r}$, then $f''(r) \leq 0$.

A woman may earn some material resources with her own labor and she may also get some resources from her husband.[5] Although we have assumed that women have identical fertility

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Monique Borgerhoff Mulder's fascinating empirical study of the determinants of bride wealth among the Kipsigis tribe in Kenya (1988) . Borgerhoff Mulder finds that higher bridewealth is paid for brides who are plump and for brides who reach sexual maturity at a relatively early age. There is some evidence that, among the Kipsigis, early sexual maturity is also associated with greater lifetime fertility.

[5] The support contributed by a husband to his wives should not be confused with their bridewealth. The latter, as we have remarked, is paid to her family and typically used to buy wives for her male relatives.

functions, we will allow the possibility that different women have different earnings capabilities. Suppose woman j can earn w_j with her own labor and that her bride price is b_j. The total cost to a husband of purchasing her as a bride and ensuring that she has r units of material resources is $b_j - w_j + r$.[6] Let us define $p_j = b_j - w_j$ to be the difference between her bride price and her earnings. Then p_j is the ''net cost'' of purchasing woman j as a bride. Since we have assumed that all women have the same fertility functions, it must be that in competitive equilibrium there is a uniform net bride price p such $p = b_j - w_j$ for all women, j. Another way of saying this is to observe that in equilibrium, $b_j = w_j + p$. If two women in the same bride market have different earnings capabilities, this difference will be reflected by an equal difference in their bride prices.[7]

The cost of purchasing a bride and providing her with r units of resources is $p + r$. Since a bride provided with r units of resources will have $f(r)$ expected children, the cost per expected child is $f(r)/(p + r)$. In a polygynous society, a man must consider the tradeoff between expected number of wives and the amount of resources that he supplies to each wife.

Since wives come in integer units, a man cannot literally buy a fraction of a wife.[8] But he can have an *expected number* of wives that is not an integer, if he makes a financial gamble and then decides how many wives to have after observing the outcome of these gambles. Suppose, for example, that a man has one wife, is spending r on her, and that he has access to actuarially fair gambles. One available option is to reduce his contribution to his wife by one dollar and to bet that dollar in a lottery that returns either zero or enough money to purchase and support an additional wife. He would win the lottery with probability $\frac{1}{p+r}$, in which case he would get a prize of $p + r$ which he would use to buy and support another wife. The dollar spent on the lottery reduces the support of his current wife by one dollar and on this account reduces his expected number of surviving children by $f'(r)$. But his chance of winning the lottery adds $\frac{f(r)}{p+r}$ to his expected number of surviving children. Therefore, if $f'(r) < \frac{f(r)}{p+r}$, he will increase his expected number of surviving children by reducing his contribution to the first wife and betting the money on the prospect of winning a second wife and her support. Similar reasoning shows that if $f'(r) > \frac{f(r)}{p+r}$, he can increase his expected number of surviving children without changing his total expenditures on wives and their support by increasing the amount of money that he gives each wife and reducing his expected number of wives.

It follows that in order to maximize his expected number of surviving children per dollar spent

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[6] In a model that takes more elaborate account of the timing of events, we would want to distinguish one-time payments like a bride price from flows of payments like wages or gifts from the husband to the wife. For the purposes of this simple model, think of all variables as present values of a lifetime flow.

[7] The assumption that differences in bride prices depend only on differences in labor productivity seems to accord well with empirical observations of Borgerhoff Mulder's 1988 study of the determinants of bridewealth. According to Borgerhoff Mulder: ''Wealth differences between intermarrying families have no effect on negotiated bridewealth settlements . Comparison with other ethnographic examples suggests that in labour-intensive egalitarian societies the reproductive and labour services are more valued than family connections.''

[8] Though, as we will discuss later, various time-sharing arrangements are possible.

on purchasing and supporting wives, a husband will choose to support each at a level r^* such that:

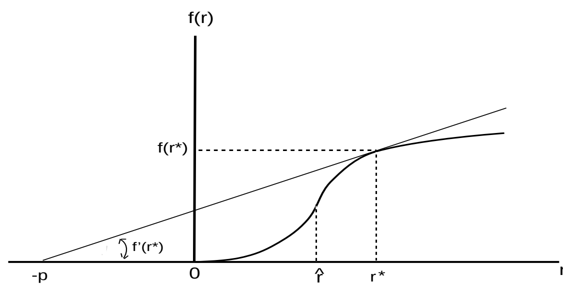
$$f'(r^*) = \frac{f(r^*)}{p + r^*}. \tag{1}$$

Equation 1 can be written equivalently as:

$$\frac{f(r^*)}{f'(r^*)} - r^* = p, \tag{2}$$

Figure 2 presents a geometrical interpretation of Equation 2.[9]

Figure 2



The above argument suggests that if men seek to maximize the expected number of offspring per dollar's expenditure on the purchase and support of wives, they will spend the same amount $r^* > \hat{r}$ on each wife, where r^* satisfies Equation 2. So far we have demonstrated only that Equation 2 is a ''first-order necessary condition'' for a local, interior maximum. As we show in the Appendix, it turns out that for $r^* > \hat{r}$, Equation 2 is also a sufficient condition for a global maximimum. Therefore we have the following proposition:

Proposition 1. *Consider a polygynous society where the net bride price is $p > 0$, and where fertility functions satisfy Assumption 1. For any given total expenditure on wives and their*

[9] Readers familiar with optimal foraging theory will recognize a formal isomorphism between this theory and the ''patch model'' as formulated by Charnov (1976). The condition in Equation 2 corresponds exactly to Charnov's ''marginal-value theorem''. Economists familiar with the Marshallian theory of the firm will notice the similarity between this theory and the theory of U-shaped cost curves, where the minimum cost method of producing children occurs at the point where with each wife the marginal cost of producing a child is equal to the average cost--as demanded by Equation 1.

support, a man will maximize his expected number of offspring if and only if he provides every wife that he acquires with r^* units of material resources, where r^* satisfies Equation 2 and where $r^* > \hat{r}$.

For $n > 0$, let us define $F(n, z)$ to be the expected number of surviving children fathered by a man who has n wives and divides z equally among them; that is, $F(n, z) = nf(z/n)$. Also, define $F(0, z) = 0$.[10] From Proposition 1, it follows that a man who has n wives and allocates a total of z units of material resources among them in such a way as to maximize his expected number of surviving offspring will have $F(n, z)$ surviving children. [11]

A striking conclusion of Proposition 1 is that in a competitive polygynous marriage market where all men seek to maximize the expected number of their offspring, not only will each man allocate equal material resources to each of his wives, but every woman in the society will have the same level of support. Perhaps, even more remarkably, this result holds if men care about their own consumption as well as about their fertility. Specifically, let us assume the following:

Assumption 2. *Each male has a utility function $U(x, k)$ where x is his own consumption and k is the expected number of surviving children that he fathers. The utility function U is strictly quasi-concave*[12] *and is an increasing function of k and a non-decreasing function of x. A male with income I chooses his own consumption x, number of wives n, and the total amount of resources z available to his wives so as to maximize $U(x, F(n, z))$ subject to the budget constraint $x + pn + z \leq I$.*

Since the variables n and z enter a man's utility functions only as ''factors'' in the production of children, it follows whatever the expected number of children that he chooses to have, he will want to produce them using the inputs wives and material resources in the proportions that maximize the number of children given the amount of money spend on wives and their support.[13] According to Proposition 1, he will therefore z and n so that $\frac{z}{n} = r^*$ where r^* solves Equation 2. It follows that his expenditure per wife is determined by the fertility function f and the net price of a bride, p, and does not depend on his income I or on the detailed specification of his utility function U.

Proposition 2. *In a competitive, polygynous marriage market satisfying Assumptions 1 and 2, every woman will receive the same amount of resources, regardless of the wealth of her*

[10] Since f is assumed to be bounded from above, the function F so defined is continuous on the non-negative orthant.

[11] Notice that the function F is necessarily homogeneous of degree one and is a concave function if and only if f is a concave function.

[12] The assumption of strict quasi-concavity means that if one increases k and decreases x, while holding U constant, the marginal utility of k falls relative to the marginal utility of x.

[13] Richard Muth (1967) reaches similar conclusions in a model of demand for inputs into a household production process that displays constant returns to scale.

husband, the number of wives he has, his tastes for consumption versus reproduction, the amount of money she is able to earn, or the wealth of her parents.

Some comparative statics

Recall that a man who seeks to maximize the expected number of surviving children for a given expenditure on wives and their support must choose a value of $r > \hat{r}$ such that Equation 2 is satisfied. Differentiating the left side of Equation 2 with respect to r, we have

$$\frac{d}{dr}\left(\frac{f(r)}{f'(r)} - r\right) = -\frac{f(r)f''(r)}{f'(r)^2}. \quad (3)$$

From Assumption 1 and the fact that the desired solution has $r > \hat{r}$, it follows that $f(r) > 0$, $f'(r) > 0$, and $f''(r) < 0$. Therefore the expression in Equation 3 must be positive. It follows that if for given $p > 0$, a solution r^* to Equation 2 exists, then that solution is unique. To emphasize the fact that the optimal r^* is determined by the price p, let us write this solution for r^* as $r^*(p)$.

Differentiating both sides of Equation 2 with respect to p, we find that

$$\frac{dr^*(p)}{dp} = -\frac{f'(r^*(p))^2}{f(r^*(p))f''(r^*(p))} > 0. \quad (4)$$

Alan Rogers, of the University of Utah's anthropology department pointed out to me that the result of Equation 4 can be stated more evocatively as:

Proposition 3 (Rogers' Law of Polygyny). *The more you have to pay for a wife, the better you will treat her.*

An *ordinary good* is defined to be a good such that if its price increases while income and other prices stay constant, an individual's demand for the good will decrease. The cost of producing a child can be shown to be an increasing function of the bride price.[14] Suppose that children are an ordinary good. According to Rogers' Law, $r^*(p)$ is an increasing function of p. Therefore an increase in p increases the cost of children, reduces the total number of children demanded and increases the number of children produced per wife. It follows that an increase in p reduces the number of wives demanded. Thus we can assert:

Proposition 4. *If surviving children are an ordinary good, then wives are also an ordinary good.*

[14] See the Appendix for details.

2. Market Equilibrium--Trading Sisters for Wives

In partial equilibrium demand analysis, one explores the effect of prices on supplies and demands. In a general equilibrium model of a closed economy, we work in the opposite direction, solving for the competitive equilibrium price by equating supply and demand in each market. The supply and demand equations are typically complicated by the fact that prices affect incomes as well as the relative costs of goods. In a competitive market for wives and material goods, parents collect the bridewealth received for their daughters and pass it on to their sons in order that the the sons may buy wives.[15] Thus the incomes of males depend not only on their own earnings and their inheritance of durable goods, but also on the bride prices of their sisters. Let us denote the income of male i by $I_i = m_i + ps_i + h_i$, where m_i is i's earnings, s_i is the number of his sisters whose bride prices he is entitled to and h_i is his inheritance of goods.

The case of identical tastes and endowments

Consider a simple equalitarian society, where all males have identical preferences, the same earnings m, the same inheritance h and exactly one sister. Suppose that each woman can earn w with her own labor. In equilibrium, each family would sell its daughter for a price b and give the money to its son. The son's income would then be $m + b + h$, where m is his own earnings, b is the proceeds of the sale of his sister, and h is any additional inheritance that he gets.[16] The net cost of one wife is $p = b - w$. Therefore the budget constraint faced by a son is $x + b - w + r \leq m + b + h$. This budget can be equivalently written as $x + r \leq m + w + h$. If he allows his wife r units of resources, the expected number of his surviving children will be $f(r)$. Therefore he will choose x and r so as to maximize $U(x, f(r))$ subject to $x + r \leq m + w + h$. The budget inequality has a simple and natural interpretation. The left side is the sum of the amount of goods x consumed by the husband and the amount of goods r consumed by the wife and their children. The right side is total family income, consisting of the earnings of the husband plus the earnings of the wife, plus the husband's inheritance (excluding the money received from the bridewealth of his sister.)

Since $U(x, f(r))$ is assumed to be strictly quasiconcave in x and r, a male's optimizing choice of r is uniquely determined by his income $m + w + h$. Let us define $r^d(I)$ to be the choice of r that maximizes $U(x, f(r))$ subject to $x + r \leq I$. A good is said to be a *normal* good if the amount of the good demanded increases when income increases and prices do not change. Suppose that children are a normal good. An increase in family income $m + w + h$, will increase the husband's willingness to pay for a marginal increment in expected offspring. Since in equilibrium, every man has only one wife, the only way that this increased demand can be realized is by spending more

[15] In the economy studied here, the produced goods, children, are not bought and sold. If males are interested only in the surviving children that they themselves have fathered, then there is no role for a functioning resale market in children.

[16] In an agricultural or pastoral society, this inheritance is likely to take the form of land or cattle. In a more industrial society, it might be capital goods or financial claims on capital goods.

resources on this wife and her children. It follows that if children are a normal good, then $r^d(I)$ is an increasing function of total family income $I = m + w + h$.

Having solved for the amount of resources $r^d(m+w+h)$ that is made available to each woman in competitive equilibrium, we can now solve for the competitive equilibrium price. Specifically, let $r^* = r(m + w + h)$. Then, from Equation 2 it follows that the competitive equilibrium bride price is

$$b = w + p = w + \left(\frac{f(r^*)}{f'(r^*)}\right) - r^*. \tag{5}$$

According to Inequality 3 above, $\frac{f(r)}{f'(r)} - r$ is an increasing function of r. It follows that if $r^(I)$ is an increasing function of I, it must also be that in equilibrium the bride price b will be larger, the larger is $m + w + h$.

Therefore we can assert the following general equilibrium comparative statics results:

Proposition 5. *Consider a (potentially) polygynous economy satisfying Assumptions 1 and 2 and where children are a normal good. Assume in addition that there are identical tastes and endowments and that every household produces one boy and one girl, both of whom survive to marriageable age. In equilibrium, every man will have exactly one wife. The net cost $p = b - w$ of a wife is uniquely determined and are increasing function of income per family, $w + m + h$.*

Notice that the *difference* p between a woman's bride price b and her the earnings w is an increasing function of total family income. If there were an economy-wide increase in women's earnings, (and if men's earnings and inheritance h remained unchanged) bride prices would increase by *more than* the increase in women's earnings. In contrast, as noted earlier, a cross-sectional difference between the wages of two different women in the same marriage market would be matched by an equal difference in their bride prices.

The case of differing endowments and sibling numbers.

Polygynous markets become much more interesting when there are differences in resource endowments and in the numbers and sexes of one's siblings. To a good approximation the probability distribution of the number of male and female children in a family of given size is the same as the distribution of outcomes of independent tosses of a fair coin. About half of all two-child households will have one boy and one girl, one fourth will have two boys and one fourth will have two girls. Hence about half of all boys in two-child households have no sisters and half have one sister. Similar calculations show that in three-child families, about one fourth of all boys have no sisters, one half have one brother and one sister and one fourth have two sisters and no brother. Thus, even if there were no differences in income from other sources, the differences in numbers of sisters would cause significant differences in the distribution of purchasing power among males desiring wives.

General equilibrium analysis of an economy with heterogeneous wealth and heterogeneous tastes yields few general comparative statics results. The problem is that changes in relative prices could, in general, lead to a redistribution of income among persons with differing tastes. We can abstract from these redistributional complications by assuming that preferences are identical and homothetic.[17] If preferences are identical and homothetic, then although redistributions of income affect the distribution of consumption across consumers, they do not affect the total demand for any good. (This is the case because the extra consumption of any good by income gainers will be exactly offset by reduced consumption of the same good by income losers.)

Since with identical, homothetic preferences, aggregate demand is independent of income distribution, competitive equilibrium prices will also be unchanged by a redistribution that leaves total endowments unchanged. Consider an economy in which different males have different earnings capacities and inheritances. Let female j have earnings w_j and let male i have earnings m_i, inheritance h_i and entitlement to the bridewealth received for s_i female relatives (In households that have daughters but no sons, the bridewealth received for daughters may go to male cousins, or even to their father, to buy additional wives.) Let $\bar{w}$ be the mean earnings of females, let $\bar{m}$ and $\bar{h}$ be the mean earnings and property inheritance of the males in the economy and let $\bar{s}$ be the mean number of sisters to whose bridewealth males have entitlements. Consider now a fictitious economy in which endowments, earnings, entitlements to sisters' dowries, and inheritances are redistributed within the original economy so that everyone is identically endowed. Then each male has earnings $\bar{m}$, property inheritance $\bar{h}$, and is entitled to the bridewealth of $\bar{s}$ female relatives and each female has earnings $\bar{w}$. Proposition 5 can be applied to this equalized economy. Since the competitive equilibrium prices for the equalized economy are the same as the competitive equilibrium prices for the original economy, the comparative statics results of Proposition 5 extend directly to an economy with identical homothetic preferences but differing endowments of wealth and sisters.

Proposition 6. *Consider a polygynous economy where all males have identical, homothetic preferences, where there are equal numbers of marriageable men and women and where children are a normal good. The price of brides is uniquely determined. The difference* $p = b - w$ *between the equilibrium bride price and the earnings of women is an increasing function of average family wealth,* $\bar{w} + \bar{m} + \bar{h}$.

Since preferences are assumed to be homothetic, it must be that the number of wives that individual i purchases is proportional to his total wealth $m_i + h_i + ps_i$. If there are equal numbers of marriageable males and females in the economy, then the average number of wives per husband must be one. Therefore in equilibrium, the number of wives that a man has is equal to the ratio of his total wealth to the mean wealth of males, $\bar{m} + \bar{h} + p\bar{s}$. Where p is the competitive equilibrium

[17] The results found here could probably be obtained under the more general assumption that there is a large economy in which the distribution of preferences of individuals among individuals is independent of the number of sisters and brothers that they happen to have.

bride price, define

$$\theta = \frac{p\bar{s}}{\bar{m} + \bar{h} + p\bar{s}}.$$

Then the assertion that the number of wives a man has is equal to the ratio of his wealth to the mean wealth of males can be expressed as follows:

Proposition 6. *In a polygynous economy where all males have identical, homothetic preferences, where there are equal numbers of marriageable men and women and where children are a normal good, the number of wives that person i has is*

$$n_i = \theta p \frac{s_i}{\bar{s}} + (1-\theta)\frac{m_i + h_i}{\bar{m} + \bar{h}}.$$

For a society where essentially all males and females married and where the bridewealth of sisters is divided equally among brothers, proposition 6 allows one to calculate a predicted distribution of number of wives, if one can obtain information about the distribution of family sizes and of incomes. Conversely, if the distribution of the number of wives and the distribution of family sizes is known, but the income distribution can not be observed directly, this theory would allow one to make a prediction of the income distribution.

3. Applications and Extensions

Is polygyny ‘‘better for women’’ than monogamy?

In his 1981 book, Gary Becker expressed the view that polygyny is in the interest of women in general. According to Becker:

> ‘‘My analysis of efficient, competitive markets indicates however that the income of women and the competition by men for wives of would be greater when polygyny is greater...This view is supported by the fact that bride prices are more common and generally higher in societies with a greater incidence of polygyny.’’ (1981, p 56)

Becker reports that in this regard, his own teachings coincide with those of Ayatollah Ruhollah Khomeini. In a footnote, Becker quotes Khomeini as follows:

> ‘‘The law of the four wives is a very progressive law and was written for the good of women since there are more women than men. . . Even under the difficult conditions which Islam imposes on a man with two or three or four wives, there is equal treatment, equal affection, and equal time. The law is better than monogamy.’’

Becker’s observation that polygyny generally leads to positive bride prices seems to be well born out by the evidence. Moreover, the payment of dowries by the parents of brides is almost entirely confined to monogamous societies. But in most the polygynous societies of Africa, bridewealth is paid to the parents of the bride, who give the money not to the bride but to her brothers. In this case, high bride prices do not necessarily lead to high incomes for women. In a polygynous marriage market as modelled here, all women receive the same amount of material resources from their husbands. Those women who marry rich husbands will not in general be better off than those who marry poorer husbands, since richer men will divide their wealth among a larger number of wives. In contrast, in a strictly monogamous society, rich men and poor men alike have just one wife. If children are a normal good, a rich man will spend more on his wife than will a poor man. We would expect that in a monogamous equilibrium the women who marry rich men will be better off than they would be in a polygynous society and the women who marry poor men will be worse off.

Our model of polygamy allows an interesting possibility that in polygynous societies where parents control the marriages of their daughters, some women may be made worse off than they would be if they remained single. In our formal model, even if the equilibrium net price p for brides is positive, it could turn out that a woman is able to earn an amount w_j that exceeds the equilibrium provision of resources r^* for women. If this is the case, our model suggests that her husband would pay the bride price $b_j = w_j + p$ for her, but would supply her only with r^* units of resources and would confiscate the amount $w_j - r^*$ from her to spend on his own consumption or on other wives. A man who marries a woman who earns $w_j > r^*$ is no better off than a man who marries a less productive woman. He has to pay for her extra productivity in the form of a higher bride price. The ‘‘exploiters’’ who capture the surplus from this woman’s productivity are her own male relatives who collect the surplus that she produces in the form of a higher bride price.

Notice that nothing in our formal model requires that $r \geq w_i$ for all women i. It may be that in equilibrium, some (possibly even most?) women are supplied with less material resources than they can earn by themselves, with their husbands taking resources from them rather than giving them resources. Although a highly productive woman for whom $r^* < w_i$ would be better off raising children without a husband, she may have no choice in the matter. If her parents seek to maximize the number of their grandchildren, then although they realize that she would have higher fertility by remaining single and supporting her children with her own wage, they would choose to sell her to a husband who will take some of her wages and will restrict her to an income of r^* because the revenue the parents collect from her high bride price can be used to purchase additional wives for her brothers (or perhaps for her father) .

General Equilibrium with Unequal Sex Ratios

Although the number of males and females are approximately equal at birth, in many societies these ratios are not equal at the time they join the marriage pool. In some societies a large number of young males who die violent deaths in wars or fights. (documentation needed here). In many societies, a large proportion of young males abandon their home villages to seek work in the cities or abroad, leaving a substantial excess of women over men. According to Lesthaege (1986), this is a common pattern in Africa. In other societies, the number of marriageable males exceeds the number of marriageable females. This can be a result of *hypergyny,* where the most desirable females ‘‘marry up’’, leaving their home villages to marry wealthier or higher status males than those in their home village or it may be the result of preferential female infanticide is practiced. (See Dickemann (1979))

If preferences are identical and homothetic, our previous results extend in a very simple way to the case of an arbitrary sex ratio. As in the previous results, the ratio of the number of wives that a man has to the average number of wives in the population is the ratio of his own wealth $m_i + h_i + ps_i$ to the average wealth of males, $\bar{m} + \bar{h} + \bar{s}$. Therefore if the ratio of the total number of marriageable women to the total number of marriageable men is v, then the number of wives that man i will have will be

$$v\left(\theta p \frac{s_i}{\bar{s}} + (1-\theta)\frac{w_i + h_i}{\bar{w} + \bar{h}}\right).$$

On the divisibility of wives

Economists are accustomed to sidestepping the problem of indivisible commodities. As we have suggested, if men have access to actuarially fair lotteries, then they can buy a fraction of an expected wife for a price that is the same fraction of the cost of a complete wife. The formal analysis works exactly as it would if the production function $F(n, z)$ for children displayed constant returns to scale and perfect divisibility of the factors wives and material resources. In some societies direct lottery gambling is officially prohibited, so that it may be difficult or impossible to make bets that are close to actuarially. If this is the case, a young man may resort to illegal gambling or may take his gambles in the form of direct risk-taking, such as emigration, joining the army, going to sea, or moving to the city.

A more direct way to obtain ‘‘a fraction of a wife’’ is time-sharing. Publically sanctioned arrangements for direct sharing of wives are not common, but there are some interesting examples.[18] One example is fraternal polyandry as practiced in parts of Tibet, Nepal, and North India. Tibetan landowners typically hand the estate down to their eldest son. If the eldest son has surviving younger brothers, then some of these younger brothers may marry the same wife, along with him. This is the only marriage allowed in each generation. The land therefore supports only one woman and her offspring from each generation. In a family without sons, the estate passes to the eldest daughter who marries a younger son from another family. Daughters either marry out or remain unmarried as laborers on the estate. (Crook and Crook (1988)) Among the Pahari in North India, it is common for brothers who can not afford a wife of their own to share a wife and later if they acquire more wealth to buy a second and maintain a group marriage. (Daly and Wilson (1982)).[19]

An alternative to wife-sharing in a family where there are several brothers (and some sisters), is for the parents of the brothers to resolve integer problems by assigning the revenue from sale

[18] The ‘‘oldest profession’’, though often officially prohibited, can be viewed as a means of time-sharing of sexual access and of probability of paternity.

[19] It is interesting to note that formal wife-sharing arrangements usually involve brothers rather than two unrelated males. The theory of kin-selection suggests that the incentive problems involved in child support will be smaller if the co-husbands are brothers.

of daughters unequally among the brothers in such a way as to induce integer demands. A poor family with three boys and a girl, for example, after selling the girl might be able to provide enough resources to purchase and support wives for two of the sons if all three brothers pool their earnings. Even if the third brother is not, like the Tibetans and the Pahari, permitted to share sexual activity with his brothers' wives, it may be possible to persuade him not to seek his fortune elsewhere, but to make his contribution to his extended family.

Perhaps the most common way for a man to purchase a fraction of a wife is to have a wife for only a fraction of his adult life. This would allow the possibility of sequential sharing of wives. A full development of this strategy would require a richer model than ours--one in which the timing of events and the overlap of generations is fully modelled. In such a model, one of the decision variables would be the age at which a man marries each of his wives and the age and condition of the wife that he marries. For example, a man who could not afford to buy and maintain a wife from the time he reaches maturity until his death might choose to wait until late in life to marry. If at this time, he marries a young wife, then it is quite likely that he will leave her as a widow before her fertility is exhausted. The widow will now be available as a possible marriage partner to another man. Since she has only a fraction of her lifetime fertility remaining, she would be available for a much lower price than a new wife.[20]

On parental preferences for male or female children

This model suggests a somewhat surprising conclusion about the preferences of parents for the sex of their offspring. For simplicity of discussion, consider an economy without inheritance of wealth other than the transmission of bride prices. Suppose that each male earns the same amount of income m and each female earns income w. Suppose that a family patriarch cares about the number of his surviving grandchildren and about his own consumption. If he has equal numbers of surviving sons and daughters, he can collect the daughters' bride prices and give them to his sons for purchase of wives. In equilibrium, as we showed earlier, each daughter and each daughter-in-law would get $r^d(m+w)$ units of resources. Each of them would have fertility $f(r^d(m+w))$ and so each daughter and each son would give the parents $f(r^d(m+w))$ grandchildren. But suppose that the family has more daughters than sons. Then the revenue from their daughters' bride prices would be more than sufficient to buy wives for their sons. This extra revenue could be given to one or more of the sons to buy an extra wife or wives. Each daughter would again have fertility $f(r^d(m+w))$, but now the average number of offspring of the sons would be greater than $f(r^d(m+w))$. It follows that a family that has at least one surviving son will gain more grandchildren if its additional children are daughters rather than sons. The only case in which families would prefer that their next child be a son rather than a daughter would be in families that have previously given birth to two or more daughters and have no sons. For such

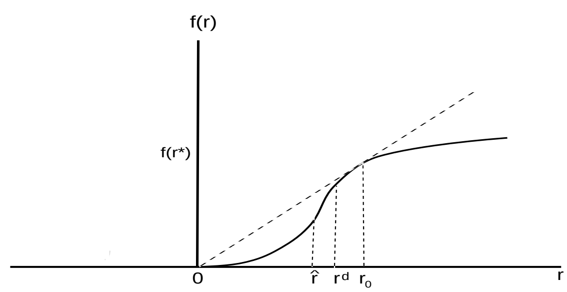
[20] Borgerhoff Mulder presents empirical evidence that lower prices are paid for women who have given birth to the child(ren) of another man than similarly-aged women who have no children.

families, the desirability of having a son becomes larger the greater the number of daughters.[21]

Can there be dowries when polygyny is allowed?

In the economies modelled so far, there is sufficient material wealth so that women are a limiting resource in the production of children. In an economy that is less well off, this need not be the case. Where the fertility function is shaped like that in Figure 3 below, if the amount of material resources available per woman is sufficiently small, women will be a limiting resource in the production of children. (Neither will men be scarce since it is still true that ‘‘sperm is cheap’’.) In this case, the only scarce input is material resources and total fertility is maximized by providing material resources for reproduction to some, but not all of the women.

Figure 3



With the fertility function graphed in Figure 3, total fertility is maximized if some women receive the resources r_0, where $f(r_0) = r_0 f'(r_0)$ and the other women remain single and receive no resources. Recalling Equation 2, we see that r_0 is the amount of material resources that would be supplied to every wife in a polygynous marriage market if the net price of a bride were zero.

In our previous models of market equilibrium, we found that the equilibrium net price for brides was determined as a function $r^d(\bar{m} + \bar{w} + \bar{h})$ of the average earnings of men and women and of inheritance. In this discussion, we implicitly assumed that $r^d(\bar{m} + \bar{w} + \bar{h}) > r_0$, so that the equilibrium net price of a bride was positive. But suppose that $r^d(\bar{m} + \bar{w} + \bar{h})$ is represented by the point $r^d < r_0$ in Figure 3. We claim that in this case, in order to be able to marry, a daughter will have to bring a dowry.

[21] If we allow for variations in the amount of inherited wealth from ownership of resources other than daughters, it remains the case that so long as a family has at least one surviving son it would gain more grandchildren from daughters than from additional sons. But the urgency of having at least one son becomes even greater for wealthy families.

There is undoubtedly more than one reasonable way to model equilibrium in a (potentially) polygynous society that has an excess supply of brides at zero. [22] Here, in order to ease expositional burdents, let us consider a model that is much more special than the model considered in the rest of this paper. The main qualitatitive results would, however, be robust to a much more general class of models. Consider an economy in which each set of parents has 3 surviving children. Each male child can earn m, each female child can earn w and the parents have a farm worth K, which they can pass on to their children. Let us further simplify our model by assuming that parents care only about reproduction and not about their own consumption. Provisionally, let us consider the outcome if each family chose to exercise the following strict form of *primogeniture*. The oldest son would inherit the farm and the bridewealth from any daughters who marry. In case a family had no sons, the farm would pass to the oldest daughter. Assume further the contributions of single males and females to their siblings' offspring are equal to the amount of earnings that a married female would contribute to her own offspring. That is, $y = w$. (This last assumption is quite arbitrary, but substantially simplifies exposition and is not likely to affect the main qualitative results of this discussion. It would be interesting to study the effects of different assumptions about the relation between the amount a married person would contribute to his own children and the amount that an unmarried person would contribute to his or her siblings' children. But for this introductory excursion, let us keep things very simple.) An oldest son who inherits a farm and gets the bridewealth from a sister and a contribution y from an unmarried sibling will have total income $m + 2w + K$. Finally, let us assume that this is just enough so that he can afford the ‘‘efficient’’ level of material resources for his wife and her offspring, so that $m + 2w + K = r_0$.

Now we ask whether strict primogeniture would be an equilibrium with a net bride price of zero. If the net bride price is zero, then bridewealth is just $b = w$. Thus a bridegroom has to pay the bride's parents only for the value of his bride's future labor earnings. The son who inherits the farm will also receive the bridewealth from a married sister as well as a contribution $y = w$ from any unmarried siblings.[23] If he marries, the total contribution of his relatives to his wealth will be $K + 2w$ and his earnings will be m. Since the net cost of a wife is 0, he will find that he maximizes his number of offspring by choosing exactly one wife and supporting her at the level $m + 2w + K = r_0$. On average, each family would have two married children and one unmarried child. But if only one child receives all of the inheritance according to the rules of primogeniture, then first-born males would randomly choose their wives from among the population of females who did not inherit farms. A parent who left a small inheritance to a daughter could dramatically increase his number of grandchildren at small cost since she would be sure to find a husband, so long as other women did not get inheritances. If we are to find an equilibrium, therefore, it is going to have to be one in which females who marry also get an inheritance.

In fact, in this simple example, equilibrium differs quite strikingly from strict primogeniture.

[22] Some of the modelling choices would be aided by observation of real-world examples.

[23] A similar story applies in families with no sons, where a daughter inherits the farm.

The equilibrium we seek is one in which two children from each family marry. The farm is worth K and the contribution of the unmarried child is worth $y = w$, so there is a total of $K + w$ units of inheritance to be divided among the boys and girls who marry. We continue to assume that $m + 2w + K = r_0$. Suppose that parents divide the inheritance equally between the two children who marry, giving each $(K + w)/2$. Suppose that the child who will remain unmarried is determined by some convention that does not discriminate between the sexes. Then the pool of persons with inheritances consists of approximately one male and one female for each parental family. A young male and a female who each have an inheriance will be able to pool their resources and their labor incomes to earn $m + w + K + w = m + 2w + K = r_0$. This outcome is an equilibrium. Husbands could not improve their expected fertility either entering fair lotteries. Parents could not increase their number of grandchildren by dividing inheritance among their offspring in any other way.

We have now displayed a polygynous society in which not all women marry and where those women who do marry must bring a dowry to their marriage which is approximately equal to the inheritance of their husbands. It is interesting also interesting to notice that in the results of this theoretical model accord well with Goody's empirical observation that dowry, is paid directly to the newly wed couple as a ''pre-mortem inheritance'', while bridewealth goes not to the bride, but to her male relatives.

4. Conclusion

The theoretical model in this paper is at best a crude caricature of the reality of polygamous marriage markets. It is hoped that, much as a few deft strokes of a cartoonist's pen can create a recognizable likeness of Winston Churchill or Ronald Reagan, this simple model will capture enough of the fundamental structure of marriage markets to give a recognizable approximation of actual polygynous societies.[24] While the fundamental economic problem modeled in this paper--the desire of individuals to increase the number of their offspring and descendants in the face of scarce resources--seems universal, the institutions modelled here are most closely patterned after polygynous marriage markets like those in the mixed agricultural and pastoral societies of Africa. The anthropological literature is rich in description of other institutional settings, which raise theoretical issues that have not been broached here. Examples of such institutions include caste systems, hypergyny (upperward mobility of women but not men), matrilineal societies, despotic societies with very large harems, polygyny in hunter-gatherer societies that lack durable stores of wealth and monogamy. [25]

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[24] I confess that in earlier efforts at reading anthropology, I have been bedazzled by an excess of fascinating details--and unable to hold the details together in my head in a useful way. With a crude economic model of polygyny in mind, I find papers in anthropology much more entertaining and informative. Not only does a model allow one able to make reasonable guesses about causal relations, but it serves as a kind of organizational skeleton on which the detailed features of a society are fleshed out and related to other facts.

[25] For example, see Goody (1990) for an encyclopedic account of marriage and family institutions in the pre-industrial societies of Eurasia, for an extensive discussion of matrilineal societies, see Schneider and Gough (1961), see Betzig (1986)

The model in this paper makes a number of strong predictions, including the following: A society that allows polygamy and stable property rights will usually have positive bride prices and some polygynous marriages. In such a society, bride prices will go not to the bride, but to her male relatives and all women be allocated the same amount of resources by their husbands. The greater the amount of material resources available per woman in the society, the higher will be bride prices and the greater the amount of resources allocated to each woman. However, in societies with sufficiently low amounts of resources per woman, instead of positive bride prices there will be dowries, which unlike bridewealth, are paid directly to the newly married couple. In such a society dowries will be of approximately the same size as the inheritance of males who marry.

I expect that some of the predictions of this simple model of society will not coincide with reality for some or perhaps most societies. This is not a matter of great concern if the main elements and emphasis of the theory are correct. Because the structure is simple and easily understood, it should be quite possible to test it in applications and improve it where improvement is needed.

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for an insightful, if hair-raising, historical study of the sexual activities of rulers in despotic societies and see Chagnon (1979) and Hawkes (1990) for interesting observations on mating strategies in hunter-gather societies.

Appendix

Proof of Proposition 1.

We claim first that if a man is maximizing his expected number of offspring given his total expenditures on the purchase and support of wives, then any two wives who receive more than $\hat{r}$ must receive the same amount of support. This follows because according to Assumption 1, $f''(r) > 0$ for $r > \hat{r}$. Therefore if $r_1 \neq r_2$, $r_1 \geq \hat{r}$, and $r_2 \geq \hat{r}$, then $2f(r_1 + r_2) > f(r_1) + f(r_2)$.

Suppose that with some probability, he gives a wife r such that $0 < r < \hat{r}$. At the same cost he could offer a lottery in which with probability $r/\hat{r}$, he provided her with $\hat{r}$ and with probability $1 - r/\hat{r}$ he provided her with zero. The assumption that $f''(r) \geq 0$ for $r \leq \hat{r}$, implies that this lottery would give a higher expected number of offspring than a $f(r)$. Therefore, if he is maximizing his expected number of offspring, he will not choose r strictly between 0 and $\hat{r}$. Moreover, since $f(0) = 0$, if the price of a wife is positive he will not choose $r = 0$ for any wife. It follows that he will always choose to spend and amount $r \geq \hat{r}$ on any wife. But from the argument of the previous paragraph, it then follows that he will spend the same amount on every wife.

Relating the cost per child to the bride price

Since children are produced under constant returns to scale, the cost per expected surviving child is independent of then number of children produced. When the bride price is p, husbands will provide each wife with $r^*(p)$ units of resources. The net cost of buying and supporting a wife who earns w is therefore $p + r^*(p) - w$. The expected number of surviving children produced by a wife is then $f(r^*(p))$ and the cost per expected surviving child is $(p + r^*(p) - w)/f(r^*(p)) = 1/f'(r^*(p)$, where the equality follows from Equation (2). The number of children demanded by a male with income I is found by maximizing $U(x, k)$ subject to the constraint that $x + k/f'(p) = I$. Since $f''(p) < 0$, it follows that the cost $1/f'(p)$ of a child is an increasing function of the bride price.

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