All for One or Each for Her Own: Do Polygamous Families Share and Share Alike?

November 2009

Kristin Mammen
Barnard College
Columbia University
kmm13@columbia.edu

Abstract: This paper compares unitary and collective models of investment in children in the context of a polygynous family structure (with multiple wives) using a Living Standards Measurement Survey from Côte d'Ivoire. I examine whether the mother's rank in the household - whether she is a senior (first) or junior wife - influences her child's school enrollment, school expenditures, work activities, and educational attainment in early adulthood. I find that being the child of a senior wife positively affects enrollment and school expenditures at the middle school ages, relative to being the child of a junior wife. The children of junior wives participate more in home production, suggesting they are performing tasks that allow the children of senior wives to attend school. Senior children accumulate an additional year of education by their early twenties, leaving junior children at a long term educational disadvantage. The results of fixed effects regressions which take account of unobserved heterogeneity of the fathers are consistent with the evidence of the OLS estimates although imprecisely estimated. This evidence that rank affects investments in children is consistent with the credit-constrained collective model presented in the paper.

Thanks to Chris Paxson, Anne Case and Bo Honoré and to Eric Edmonds, Chrissy Eibner, Angie Fertig, Aprajit Mahajan, Doug Miller, Lalith Munasinghe, Elsie Pan, and Alessandro Tarozzi. Dongshu Ou provided excellent research assistance. All errors are mine.

Keywords: Polygamy, Intrahousehold Allocation, Children, School Enrollment
JEL codes: D13, I29, J12, J13, J16, J22, J24, O15

Correspondence to Kristin Mammen, 8b Lehman Hall, Barnard College, Columbia University, 3009 Broadway, NYC 10027. Phone: 212-854-9150, fax: 212-854-8947, e-mail: *kmm13@columbia.edu*.

Introduction

For many purposes the study of economics has been well-served by the unitary model of intrahousehold allocation, wherein the household behaves as if it is maximizing a single utility function (or total household output) subject to a single budget constraint. In this model, allocations which appear to be inequitable could result from differing returns to investments in different family members. But economics also assumes that individuals have their own preferences, and as many observers have pointed out, extreme imbalances in the relative well-being of different family members give rise to the notion that certain family members have more power within the household and can satisfy their own desires at the expense of others. Collective models capture the idea that differing preferences across household members could create conflict in allocation decisions and result in allocations different than indicated by the unitary case.

The setting of a polygynous household, where a husband has two or more wives, not uncommon in parts of Africa, casts a new light on the question of joint decision making among the adults in a household.[1] Here conflicts can arise not just between two spouses but among multiple spouses. As has been well documented in the anthropological literature, traditional systems of inheritance make it plausible that polygynously married women rely only on their own children for support in old age, not the children of their co-wives, inviting competition among co-wives to get the best for their own children. One extreme example is found among the Dogon of Mali, where it is "widely assumed that cowives often fatally poisoned each other's children…Males are assumed to be the preferred targets because daughters marry out of the patrilineage whereas sons remain to compete for land." (Strassman 1997) Even in less extreme

[1] Polygyny denotes a man with multiple wives, polyandry a wife with multiple husbands. Polygamy refers to both these cases.

situations, if each mother seeks to maximize the household resources invested in her own children, the mother with more "clout" is likely to have higher child investments and better child outcomes. Such clout could arise by virtue of a wife's rank - whether she is the first (senior) wife or a junior wife.

In this paper I compare two models of unitary and collective investment in children in a polygynous family. Using data on children in polygynous families in Côte d'Ivoire, I examine differences in allocations to the children of senior wives relatives to children of junior wives. I find that for middle school aged children, controlling for parental and household characteristics, being the child of a senior wife (relative to a child of a junior wife) significantly increases both the probability of being enrolled in school and expenditures on school given that the child is enrolled, suggesting that senior wives receive more of the family's resources to invest in their children. Children of junior wives are more likely to engage in home production at these ages, suggesting that they take on chores while the children of senior wives attend school. The children of senior wives achieve an additional year of education by their late teens and early twenties, evidence that lower enrollment leads to long term educational disadvantage for the children of junior wives. The evidence that rank matters in child investment is consistent with the credit-constrained collective model presented in the paper.

The next section of the paper discusses models of polygyny. Section 3 presents two models of unitary and collective decision-making for polygynous households. Section 4 discusses the related economics literature. Section 5 presents the data and descriptive statistics. Section 6 presents the empirical results and Section 7 concludes.

Models of polygyny

Most models of polygyny have focused on explaining the circumstances which give rise to polygyny in a society, rather than predicting the allocation of a polygynous household's resources among its members. For example, Boserup (1970) in her seminal book proposed that polygyny arose in those developing countries where women have a large role in agriculture, to provide male farmers with the labor they needed.[2] Models from Becker (1981) and Bergstrom (1994) also focus on how polygyny arises, but they suggest that in equilibrium, the marriage market will dictate that wives will receive the same resources from a husband whether they are sole wives or polygynous wives, assuming women are identical.[3] Grossbard-Shechtman (1993) allows women's productivity to vary along all dimensions, and predicts that more productive wives (such as more educated or higher fertility women) are more likely to be sole wives; however no predictions are made regarding relationships between productivity and rank, if there are multiple wives. Biologists' studies of polygyny among birds and mammals have led to analogous models, the "polygyny threshold" model (Orians 1969) and "resource-defense polygyny" (Emlen and Oring 1977), where fitness – the number of offspring who will survive -- of monogamously and polygynously mated females is predicted to be the same.

These models imply that child outcomes will not vary between the children of senior and junior wives. However, field work in both the avian and anthropological literatures has noted empirical factors which indicate a less than equitable distribution of resources across wives (reviewed in Borgerhoff Mulder 1990, 1992). In many polygynous societies, including Côte d'Ivoire, the senior wife is accorded many traditional privileges which she may use to advantage

[2] Jacoby (1995) used the same data used in this paper to examine this hypothesis and finds that conditional on wealth, men have more wives when female labor contributes a larger share to agricultural income.
[3] Bergstrom (1994) allows women to differ in earnings capacities but assumes wives' fertility functions are identical.

her children (e.g. Clignet 1970, Pilon 1994). On the other hand, men may be able to afford more educated wives later in the life cycle (e.g. Bledsoe 1992, Ssennyonga 1997), and this characteristic may strengthen junior wives' bargaining power.

Negotiation among co-wives over resources is vigorous. A Nyakyusa (Tanzania) man commented "…if you have many wives you always have trouble. If you give a little meat to one the others complain." (Wilson 1977 p. 123). Bledsoe (1992 p. 173) notes for the Mende (Sierra Leone), "If [a husband] gives one wife money to take her desperately sick child to the clinic, the others broodingly recall the times they were told to 'try for themselves' with their own trading endeavors."[4] There are examples of co-wife cooperation (e.g., Bledsoe 1980, Petsalis 1990), but in an ethnographic examination of 69 polygynous cultures, Jankoviak et al. (2005) found no cases where co-wife relations could be termed harmonious.

Despite the evidence of competition among wives, most economic models of polygyny are unitary. Models which explicitly recognize that a household may contain more than one decision maker have been termed "collective." One widely studied example is the "efficient" model (Bourguignon and Chiappori 1992, Browning et al 1994, and Chiappori 1988, 1992) which assumes only that outcomes in households are Pareto efficient.[5] In the next section I present two models for unitary and collective decision making in polygynous households.

Unitary versus collective models of investment in children's education in a polygynous household

The aim of this paper is to consider the different implications for modeling a polygynous household as unitary, where one individual chooses the investment levels for all of the children

[4] Other works which document co-wife strife include Bledsoe 1980, Hakansson and Levine 1997, Karanja-Diejomaoh 1978, Kuper 1982, Price 1984, Wilson 1977.

and the returns are shared with all household members, versus a collective model, where each wife invests only in her own children and keeps the returns to this investment for herself. In the unitary model with no borrowing constraints described below, investments in a child's education will depend on the child's productivity and characteristics of the wives such as education which affect the child's productivity in school, but not on the productivity of the children of the other wives. If I assume that a mother's rank – whether she is the senior wife or a junior wife – is uncorrelated with the child's productivity, investment will not depend upon rank in this model. If borrowing is constrained in the unitary model then sibling rivalry will come in to play: investment in a child could depend on the productivity of the other wives' children, in addition to the child's own productivity and the wives' education. Rank will not affect investment in a child's education even with borrowing constraints.

Consider instead a collective model where each mother is maximizing over an individual utility function, investing only in her own child, and keeping the returns for herself.[6] I assume her individual characteristics, including her rank, give her more or less bargaining power, and therefore a greater or lesser share of total household income. If there are no borrowing constraints, investments in a child's education would depend only on that child's productivity and the wives' education, as in the unconstrained unitary model. But when the mother is constrained from borrowing, bargaining power comes into play, and the mother's rank affects education investments in her child by dictating the share of household income that she receives.

To specify the models, suppose each polygynous household is made up of a husband who has two wives (wife A and wife B – the "other mother"), where each wife has one child (child A

[5] Noncooperative bargaining models allow for inefficient outcomes. Udry (1996) found in Burkina Faso that total agricultural output within households could be increased by reallocating factors of production across plots cultivated by household members, contradicting the idea of Pareto efficiency of resource allocation within the household.
[6] I have used education investments as a framework, but an analogous model could be used for health measures.

and child B respectively). Let x_i represent characteristics of child i such as productivity in school. Let e_i represent the investment in education of child i. I assume that a child's future returns in the labor market that are captured by the household or the mother depend on the investment in the child's education and on the child's productivity, so the child's education returns function is $q_i(e_i, x_i)$. I assume that increasing the child's productivity increases the marginal returns to education investment, so that $\frac{\partial^2 q_i}{\partial e_i \partial x_i} > 0$. Denote wife i's education as z_i and suppose that the education of any wife in the household augments the child's productivity. Specifically, a child's own mother's education increases the child's productivity through both genetics and an improved learning environment, and "other mother's" education affects the child only through an improved learning environment. Therefore x_i is a function of z_i and z_j $(x_i(z_i, z_j))$ and $\frac{\partial x_i}{\partial z_i} > \frac{\partial x_i}{\partial z_j} > 0$. Denote a wife's rank in the marriage by R_i. I assume that the rank of a child's mother does not affect a child's education returns function. Finally, D is the amount borrowed and Y is labor income of the parents, where Y is assumed to be exogenous.

Unitary model

No credit constraints – unitary model

The model considered here is a variation of the model in Garg and Morduch (1998). Suppose there is a single decision maker who cares equally for all the children. The decision maker maximizes household utility over two periods, and the household is able to borrow as much as it wishes. Assume parents work and invest in their children in period 1, and rely on their children's support in the second period. The maximization problem is as follows:

$$\max_{e_A, e_B, D} \quad L = u(c_1) + \phi u(c_2) \qquad \textit{subject to} \qquad c_1 = Y + D - e_A - e_B \tag{1}$$

$$and \qquad c_2 = q_A(e_A, x_A) + q_B(e_B, x_B) - (1+r)D$$

where φ is a positive discount factor, $u(\cdot)$ and $q(\cdot)$ are increasing and concave functions, r is the market interest rate, and c_1 and c_2 are consumption in the first and second periods. Substituting in the budget constraints and maximizing:

$$\max_{e_A, e_B, D} \quad L = u(Y + D - e_A - e_B) + \phi u(q_A(e_A, x_A) + q_B(e_B, x_B) - (1+r)D) \tag{2}$$

yields the unconstrained optimum (assuming an interior solution):

$$\frac{\partial q_A}{\partial e_A} = \frac{\partial q_B}{\partial e_B} = 1 + r \qquad \Rightarrow \qquad e_A(x_A(z_A, z_B), r) \ and \ e_B(x_B(z_B, z_A), r) \tag{3}$$

The unconstrained unitary household equates all marginal returns, and differences in investment levels reflect the relative productivities of the two children as well as differences in their mother's education. Investment does not depend on mother's rank, however.

Now consider the thought experiment of increasing child A's productivity; what effect does this have on the education investment in child A and child B? Using the two equations from the FOC:

$$\frac{\partial q_A}{\partial e_A} = 1 + r \qquad\qquad \frac{\partial q_B}{\partial e_B} = 1 + r \tag{4}$$

I take the total derivative with respect to $e_A, x_A, x_B, z_A,$ and $z_B,$ and solve for the derivatives in Table 1. From row 1 we see that, since $\frac{\partial^2 q_i}{\partial e_i \partial x_i} > 0$ by assumption, increasing child i's productivity increases investment in her while having no effect on investment in child j. The following rows allow us also to consider the effects of increasing own mother's education, other mother's education, and own mother's rank. Notice that there are no income effects if this household is not credit constrained. The effects above result from substitution because increasing one of the endowments x_i, z_i, or z_j increases the marginal return to investing in child i, so that the family

shifts resources away from first period consumption into investment in the child. In the unconstrained unitary case, increasing any of the endowments can never decrease investment in either child's education. In row 2 we see that an increase in either mother's education increases investment in both children, and given our assumption that $\frac{\partial x_i}{\partial z_i} > \frac{\partial x_i}{\partial z_j} > 0$, we see that $\frac{\partial e_i}{\partial z_i} > \frac{\partial e_i}{\partial z_j} > 0$, so own mother's education has a greater effect than other mother's education.

In addition, the child's mother's rank will not affect child investment; given the assumption that rank is not correlated with a child's productivity, $\frac{\partial e_i}{\partial R_i} = 0$.

Credit constraints – unitary model

Consider the case where the household is unable to borrow, or unable to borrow as much as it wishes. Then $\frac{\partial q_A}{\partial e_A} = \frac{\partial q_B}{\partial e_B} = \frac{\partial u / \partial c_1}{\phi \partial u / \partial c_2} > 1 + r$. In this case the optimal e_A and e_B both depend on x_A, x_B, z_A, z_B, and Y. The marginal returns to each child are still equated but are higher than the market interest rate, so that e_A* and e_B* are below the unconstrained optimum. To find the effects of changing child A's productivity, child B's productivity, or own or other mother's education I take the derivative of the following two first order conditions:

$$\phi \frac{\partial u}{\partial c_2} \frac{\partial q_A}{\partial e_A} = \frac{\partial u}{\partial c_1} \qquad \textit{and} \qquad \phi \frac{\partial u}{\partial c_2} \frac{\partial q_B}{\partial e_B} = \frac{\partial u}{\partial c_1}$$

For the constrained unitary model, using the fact that $\frac{\partial q_A}{\partial e_A} = \frac{\partial q_B}{\partial e_B}$ by the first order conditions, I calculate the derivatives in Table 2.

Note that G, H_i, J_i, and Δ are positive. Here an income effect on education investment results when any of the endowments x_A, x_B, z_A, or z_B increases, because the wealth of the family increases. The income effect of increasing any of these endowments is negative, which initially seems counterintuitive. The negative sign results from the fact that the additional wealth is not realized until the second period. Credit constrained families would like to transfer resources from period 2 to period 1 even at the initial level of endowment. In the constrained model the only way to transfer resources between periods is via investment in the children, so to transfer wealth to period 1 the family reduces investment in the children in period 1.

From the first cell of Table 2 ($\partial e_i/\partial x_i$), we see that the substitution effect on education investment of increasing x_i is positive given our assumption that $\frac{\partial^2 q_i}{\partial e_i \partial x_i} > 0$. It is positive because increasing x_i increases the marginal return to transferring resources to period 2 by investing in child i. The sign of $\partial e_i/\partial x_i$ will depend on the relative magnitudes of the income and the substitution effects. However, the effect of increasing child i's productivity on investment in child j, $\partial e_j/\partial x_i$, is clearly negative because both the income and substitution effect are negative. The substitution effect is negative because increasing x_i makes investing in child i effectively less expensive, to the detriment of child j. This is where we see Garg and Morduch's sibling rivalry result.[7]

For the effects of changing wives' characteristics on education investment, $\partial e_i/\partial z_i$ and $\partial e_i/\partial z_j$, the signs will depend upon the signs and relative magnitudes of $\partial e_i/\partial x_i$ and $\partial e_i/\partial x_j$. If we consider a family with two children of equal productivity, it can be shown that a change in child

[7] Garg and Morduch find increasing the proportion of girls in a credit constrained family increases investment in all of the children. If I interpret x_i not just as productivity but as any factor that increases returns to education, and assume that boys' returns are higher because of labor market conditions, then $x_m > x_f$ where m denotes male and f denotes female. In the model here, think of a family with a number of children including a boy T. Consider changing this boy to a girl, reducing x_T $(\partial x_T < 0)$. Since $\partial e_j/\partial x_i < 0$, $\partial e_j/\partial x_T > 0$ for all other children j, since $\partial x_T < 0$.

i's productivity or wife *i*'s education will have a larger effect on investment in child *i* than on investment in child *j*. For any family, an increase in wife *i*'s education will affect expenditure on child *i* more than will an increase in wife *j*'s education, as long as $\partial e_i/\partial x_i > 0$ (substitution effect predominates). And since rank does not enter into the unitary model, $\partial e_i/\partial R_i = 0$.

Collective model

No credit constraints – collective model

Suppose that there is no single decision maker in the household but that each wife receives a share of the household income allotted by the husband and that this share is affected by her characteristics and the characteristics of the other wife, including rank; the share of resources that wife *i* receives is $\theta_i(z_i, z_j, R_i, R_j)$, where $\partial\theta_i/\partial z_i > 0$, $\partial\theta_i/\partial z_j < 0$, $\partial\theta_i/\partial R_i > 0$, and $\partial\theta_i/\partial R_j < 0$.[8] Suppose each wife maximizes her own utility over two periods, and keeps her child's returns for herself. For wife A, the maximization problem is

$$\max_{e_A, D} \quad u(c_1) + \phi u(c_2) \qquad \textit{subject to} \quad c_1 = \theta_A(z_A, z_B, R_A, R_B) * Y + D - e_A \qquad (5)$$
$$\textit{and} \quad c_2 = q(e_A, x_A) - (1+r)D$$

so at the unconstrained optimum

$$\frac{\partial q_A}{\partial e_A} = 1 + r \qquad \Rightarrow \qquad e_A(x_A(z_A, z_B), r) \qquad (6)$$

If wife A is unconstrained in her borrowing, e_A will not depend upon her rank but only on x_A, z_A, z_B, and r. Results are exactly as in the unconstrained unitary case (Table 1). Rank does not affect investment in the child in the collective model if there are no credit constraints: $\partial e_i/\partial R_i = 0$.

[8] I am assuming that a child's attributes affect only his education returns, not his mother's bargaining power.

Credit constraints – collective model

If wife A is credit constrained, $\frac{\partial q_A}{\partial e_A} = \frac{\partial u / \partial c_1}{\phi \partial u / \partial c_2}$. Marginal returns will be higher than the market interest rate and e_A will depend on x_A and $\theta(z_A,z_B,R_A,R_B)*Y$. Consider changes in x_A, z_A, z_B, and R_A. Taking the derivative of this first order condition, I calculate the derivatives in Table 3. Note that K, M, N, and Φ_i are positive. For $\partial e_i/\partial x_i$ the substitution effects on education investment of increasing x_i are positive and the income effects are negative, similar to the constrained unitary case. Unlike the constrained unitary case, here $\partial e_j/\partial x_i=0$, because child i's productivity does not enter into the decision making of wife j. The child does not compete with half siblings directly as in the constrained unitary case; here the mothers compete to divert more resources to their children.

For $\partial e_i/\partial z_i$ and $\partial e_i/\partial z_j$, there is now a "bargaining" term which indicates how changing z_i or z_j affects the share of income wife i receives. This term is positive for $\partial e_i/\partial z_i$ and negative for $\partial e_j/\partial z_i$ given $\partial \theta_i/\partial z_i>0$ and $\partial \theta_i/\partial z_j<0$.

Using the results in row 2 it can be shown that $\partial e_i/\partial z_i$ is greater than $\partial e_i/\partial z_j$ if $\partial e_i/\partial x_i>0$; that is, if the substitution effect outweighs the income effect, an increase in wife i's education will have a bigger effect on investment in child i than will an increase in wife j's education. Without knowing the magnitudes of the substitution, income and "bargaining" terms, I cannot unambiguously sign $\partial e_i/\partial x_i$, $\partial e_i/\partial z_i$, and $\partial e_i/\partial z_j$. However, since the wife's rank only affects her income share, we see that an increase in her rank unambiguously increases investment in her child: $\partial e_i/\partial R_i>0$.

Empirical model

The empirical implementation to compare these models is

$$e_{ih} = \beta_0 + \beta_1 R_{ih} + \beta_2 Z_{ih}^1 + \beta_3 Z_{ih}^2 + \beta_4 X_{ih} + \beta_5 S_h + \varepsilon_{ih}$$

for child i in family h, where e_{ih} is a measure of investment in the child; R_{ih} is an indicator for child i's mother being of senior rank; Z_{ih}^1 is a measure of child i's mother's characteristics such as education and age; Z_{ih}^2 of her "other mother's" characteristics; X_{ih} is a vector of the child's characteristics, including age and sex; and S_h is a vector of family characteristics, such as father's age and education, household size, and total household expenditure.

The signs of the coefficients on Z_{ih}^1, Z_{ih}^2 and X_{ih} will not distinguish between the unitary constrained and collective constrained models described above, because the signs of $\partial e_i/\partial x_i$, $\partial e_i/\partial z_i$, and $\partial e_i/\partial z_j$ depend upon the initial endowments of the children and upon the magnitudes of the substitution and income effects in similar ways. Evidence that rank matters, though, is consistent with the constrained collective model where mothers are competing for resources for their children. In this specification, a positive coefficient on R_{ih} indicates that the children of senior mothers fare better, while a negative coefficient indicates that the children of junior mothers are advantaged.

Related literature

The question of whether the unitary or collective model of the household is more apt is an active area of research. A key feature of the unitary model is that resource allocation, whatever the allocation rule may be, does not depend on who receives income within the household. One methodology often implemented is to see if more income in the hands of women, holding total income constant, influences investments in children (e.g. Duflo 2003, Lundberg, Pollak, and

Wales 1997). One such paper using the Côte d'Ivoire data which I will use in this paper is Haddad and Hoddinott (1994). They find that increases in the proportion of cash income accruing to women significantly increases boys' height-for-age relative to girls', contradicting the neutrality of income source posited by the unitary model. Also in Côte d'Ivoire, Duflo and Udry (2004) find that shocks to income from rainfall patterns that affect the output of men's and women's crops differently result in expenditure patterns which are not consistent with a Pareto efficient allocation of household resources.

There has not been much study of the effect of the polygynous family structure on children's outcomes in the economics literature. In two papers on Côte d'Ivoire Strauss examined height-for-age and weight-for-height z-scores. Strauss defined senior wife to be either the sole or senior wife of the household head, so the results are not comparable to the results here, where I study only wives of polygynous husbands, whether the husband is head or non head. Strauss and Mehra (1990) found in bivariate associations that children of junior wives fared somewhat worse in stunting and wasting than those of senior and sole wives grouped together.[9] Strauss (1990) found that children of senior and sole wives grouped together did better than children of junior wives and children of nonheads in height for age. Haddad and Hoddinott (1994) found insignificant effects of being the child of a senior wife on both height for age and weight for height z-scores.[10] Also with the CILSS, Appleton (1995) finds that boys in polygamous households perform better on the primary-school-leaving exam, but does not compare performance by the rank of the mother. In a study of child mortality in Mali (Kazianga and Klonner 2009), the authors reject efficient intra-household allocations for junior wives,

[9] Stunting and wasting designate children who fall two standard deviations below the U.S. median for height for age and weight for height, respectively.

[10] Using the CILSS data, Sahn (1994) and Thomas *et al.* (1996) study child health outcomes; Tansel (1997) examines influences on educational attainment.

consistent with anecdotal evidence that junior wives have the least bargaining power in polygynous households.

Data and Descriptive Statistics

The data used in this paper come from the Côte d'Ivoire Living Standards Survey (CILSS) conducted from 1985 to 1988 by the Department of Statistics of Côte d'Ivoire with support from the World Bank. A random sample of 1600 households was interviewed each year, except for 1985, when only 1,588 interviews took place (Oh and Venkatamaran 1992 p. 63).[11] In my estimation I pool the data and control for year effects. The CILSS records relationship to the household head for all household members; each member can also be linked to his or her father, mother, and spouse if they reside in the household.

Table 4 presents some standard demographic measures of the prevalence of polygyny for Côte d'Ivoire: p is the proportion of husbands who have more than one wife; f is the proportion of all married women who are in polygynous marriages; m is the ratio of currently married women to currently married men; and w is the number of wives per polygynist (van de Walle 1968, Goldman and Pebley 1989). Polygyny is common in Côte d'Ivoire. About 25% of married men in the sample are polygynists, with an average of about two and a half wives per polygynous husband. Over 40% of married women are married to polygynists, and 24% of children in the sample aged 19 and under are children of polygynous marriages.[12] If we find effects of mother's rank on investments in children, the number of women and children affected is not insubstantial.

[11] There was a rolling panel element in the data; in the second, third and fourth years, 800 households from the previous year were to be reinterviewed and 800 new households chosen (World Bank 1996).

[12] Goldman and Pebley (1989) report similar numbers for Cameroon and Senegal; and Timaeus and Reynar (1998) report f-values for Ghana, Kenya, Senegal, Uganda and Zambia ranging from 17.7 % to 47.3%. In addition Jacoby (1995) found little historical decline in polygyny in Côte d'Ivoire through 1988.

Table 5 presents descriptive statistics for polygynous households, where a polygynous household is defined as one comprising at least one polygynous marriage. Although in the estimation I focus only on children of polygynous marriages, descriptive statistics for monogamous households are provided in Table 5 for comparison. About 25% of households contain at least one polygynous marriage (the majority of polygynous husbands are heads of households, but there are some non-heads). Polygynous households are larger, more likely to be rural, and have lower per capita expenditure. The heads and wives of heads in polygynous households are less likely to have any education. In polygynous households, 13 to 16 year olds are less likely to be enrolled in school, and expenditure on their schooling is lower (both differences significant at the 10% level).

Table 6 presents average characteristics of senior and junior wives in the sample. Marriage histories are not collected in the CILSS, so I categorize the oldest wife as the senior wife and the younger wives as junior wives.[13] The number of senior wives is greater than the number of polygynous households in Table 5 because a household may contain more than one polygynous marriage. Comparing the senior and junior wives is important given my assumption that the rank of a mother will not be correlated with the productivity of her children. Column 5 shows the raw differences between senior and junior wives. Senior wives are older on average than junior wives and their husbands are about the same age. Senior wives are slightly less likely to have any schooling than junior wives, and they are on average lighter and shorter than junior

[13] The ages of the women in polygynous marriages in Côte d'Ivoire are probably good proxies for the dates they married the husband, because men seek younger women to be later wives (Clignet and Sween 1969). Even if marriage dates were available, they would not necessarily be more precise because marriage is not a discrete event in Côte d'Ivoire, but rather typically proceeds in stages (Meekers 1992). The sequencing of union formation events such as onset of sexual activity, cohabitation, and marriage ceremony differ for different women and there is no one even which universally divides single from married women.

wives.[14] However, the differences in column 5 are affected by the fact that senior wives are older on average. To allow for age and cohort effects, I regress each wife characteristic on an indicator for being a senior wife and a full set of indicators for age. The coefficient on the indicator dummy and its standard error, presented in column 6, give the age-adjusted difference between senior and junior wives and its significance. When the effects of age are controlled for, we see that the junior wives' husbands are older on average than senior wives' husbands: if we consider a senior wife and a junior wife who are of the same age, the senior wife's husband will be about 8 years younger than the junior wife's husband. Heights and weights are not significantly different, but junior wives are slightly more likely to have some education, at the 10% level of significance.

Results

In the analysis I focus on children 13 to 16 years old, of an age to be attending middle school, because it is plausible that resource constraints are more binding at these ages than for younger children. In Côte d'Ivoire, primary education lasts for 6 years, starting at age 6 or 7. At the end of primary school, students take a national exam to obtain a diploma (*certificat d'étude primaires* or CEPE) which is used for selection of students for secondary schools. Lower secondary school (which I will refer to as "middle school") has 4 grades, upper secondary 3 grades. Repetition of grades is common (Vijverberg 1993). School attendance was not compulsory during the time of the survey (Tansel 1997 Appendix). Middle school requires greater outlays for fees, books, and uniforms than does primary school, and the opportunity cost of children's time is greater at these ages because they are more productive than younger children

[14] I include height and weight as crude measures of the co-wives' health endowments, which may affect their children's health and productivity in school.

in work inside or outside the home. For this reason I look at children's work activities as well as educational outcomes.

Table 7 presents means of characteristics that might affect selection into the analysis sample or illustrate differences between senior and junior children that would give them differential returns to schooling. These means are obtained by regressing the binary dependent variable in each of the 3 panels on indicators for senior child and female; the omitted categories are junior child and male respectively. It is important to control for gender because it is well known to be correlated with children's welfare measures in the developing world. In the second column the regressors are interactions of gender and rank, with junior girl the omitted category.

In the first panel the dependent variable is living away from home, because children in Côte d'Ivoire and other African countries are commonly fostered out, living with extended family for work or school (Ainsworth 1996). Respondents in the CILSS were asked to enumerate their children under the age of 30 who were living elsewhere. Consistent with Ainsworth's findings for younger children, the table shows that girls are more likely to be fostered than boys. However, fostering does not differ by the rank of the child's mother, suggesting that selection in this dimension is not an issue for the 13-16 year olds.

To examine whether there are differences in enrollment prior to middle school, the second panel shows results for being currently enrolled for 7 to 12 year olds. Again, rank makes no difference, suggesting that similar enrollment rates for the 13 to 16 year olds did not differ by rank when they were younger.

The third panel presents some evidence that the assumption that the rank of the mother is uncorrelated with the child's productivity is a plausible one. For the 13 to 16 year olds who have attained at least six years of education, we see that junior and senior children are equally likely to

have obtained the *Certificat d'Études Primaires*, the diploma given for the primary school leaving exam. While this is a select group (only about 45% of children aged 13 and over of polygynous marriages have obtained six years of education), by this measure, these children's productivity in school is unrelated to their mother's rank. Consistent with findings in Appleton (1995), girls are less likely to obtain this diploma than are boys. The information in Table 7 tells us that children of senior and junior wives live at home or away in similar proportions at ages 13 to 16, so the 13 to 16 year old analysis sample is not likely to be biased in this dimension. The similar proportions enrolled by rank at ages 7 to 12 suggest that past inequities in enrollment are not contributing to difference we may find for the 13 to 16 year olds. Finally, the similar rates for obtaining the CEPE demonstrates there is no observable difference by rank in the children's ability in school at might affect their returns to education.

Table 8 presents the results on outcomes for the 13 to 16 years olds.[15] Each panel presents four specifications for the dependent variables listed on the left. In the first two columns, rank and gender are controlled for separately, first in an OLS specification and then with father fixed effects. In the third and fourth columns, rank and gender are interacted, with junior girl the omitted category, again, first in an OLS specification and then with father fixed effects. Unreported controls are listed in the table notes. The prediction of the collective model of section 2 is that the coefficient on the indicator for being a child of a senior wife will be significant if the rank of the mother affects the proportion of household resources she receives to invest in her child. Coefficients in the OLS regressions may be biased by the fact that children are not randomly assigned to be in polygynous marriages or to be senior or junior children; unobservable characteristics of the father may influence both his marriage choices and the way

[15] About 6% of the children of polygynously married mothers are not identified as being the children of their mother's husbands. These children have been excluded from the analysis.

he treats his children. The fixed effects specifications difference out the fathers' unobservable heterogeneity. If the heterogeneity causes important bias in the OLS coefficients we expect the magnitudes of the fixed effects coefficients will be different. If the fixed effects coefficient on the senior child indicator is very similar to the OLS coefficient, it suggests that unobserved heterogeneity may not be an important bias in the OLS estimate.

The dependent variable in the first panel is an indicator for being enrolled in school. In column 1, the coefficient on the indicator for being a child of a senior wife is positive and significant at the 10% level (p= 0.063). Senior children appear to be advantaged by their mothers' rank: they are 9 percentage points more likely to be enrolled. Girls are 19 percentage points less likely than boys to be enrolled. The fixed effects coefficient on senior child in column 2 is slightly larger than the OLS coefficient, but is less precisely estimated and is not significant. The interactions of rank and gender in column 3 show that the effect of rank is driven by boys. The cross superscript on the senior boy coefficient indicates that it is significantly larger than the coefficient on junior boy. Although the coefficient on senior girl is positive, it is not significantly different than the omitted category of junior girl. The fixed effects coefficients show a similar pattern but again are less precisely estimated, so that the only significant difference is between senior boys and junior girls.

The second panel presents regressions on schooling expenditure in the last year for children who are currently enrolled in school or were enrolled in the past year. These expenditures over the last 12 months were recorded individually for each child and included contributions to parent's associations, uniforms and sports clothes, books and school supplies, transportation to school, cafeteria, board and lodging, tuition and registration fees, and other. The results show greater expenditure on senior children's schooling than on junior children's.

Rank affects both boys and girls: in contrast to the enrollment, senior girls have more spent on them than do junior girls.

Next I examine work activities of children; work questions were asked of all household members aged 7 and over (World Bank 1996 p. 8). Market work is measured as an indicator equal to one if the child reports work at her main job in the past week, defined as "the work on which you spend the most time during the past 7 days, even if you were not paid for it." Home production is an indicator for any days working in the home in the past seven days, "for example, cleaning the house, preparing meals for your family, washing the family's clothes, buying food or clothes, fetching water or wood for cooking?" In panel four we see that girls engage more in market work than boys, but that rank makes no difference. Rank does influence home production, in a pattern that mirrors current enrollment. In column 1 we see senior children are 9 percentage points less likely to engage in home production than are juniors, significant at the 10% level. Girls are more likely to do home production than boys. In column 3, we see that the influence of rank is driven by boys: senior boys are significantly less likely to do home production than are junior boys, whereas the home production of senior girls and junior girls is not significantly different. For the work activities we see similar patterns for the OLS and fixed effects coefficients but the larger standard errors for the fixed effects preclude the differences from being significant. The evidence that the mother's rank affects investment in her children is consistent with the predictions of the constrained collective model.

The last three panels of Table 8 present evidence that the lower enrollment of junior children at the middle school ages results in long term educational disadvantage for them. Here the dependent variable is grade attained (measured in years of school completed), the regressions are run on three different age groupings, and age is controlled for with a full set of indicators

rather than linearly. In panel 5, for ages 13-16, no difference by rank is apparent, although girls are already substantially behind boys, by about 1.5 years. For 17 to 21 year olds in column 1, senior children have about one year more of education than junior children, significant at the 10% level (p= 0.086). In column 3, senior boys have about one more year of education than junior boys, but the difference is not significant; senior girls have more than junior girls and this is significant at the 10% level (p= 0.053). For 20 to 25 year olds in the last panel, senior children have 1.4 more years of education, significant at the 10% level (p= 0.070); in column 3 the difference is significant for boys by rank at the 10% level (p=0.091) but not for girls. In the fixed effects models in columns 2 and 4, the differences by rank are not significant. Given the assumption that the junior children are equally likely to be productive in school as the senior children, this inefficiency in schooling investments will have implications not only for the future well being of the polygynous families but also for Cote d'Ivoire as a society.

Robustness checks

The results in Table 8 are robust to a number of specification checks. Probit models give qualitatively similar results to the linear probability models presented. The current specifications control for mother's age entered linearly; using more flexible specifications (age categories or age indicators) yields similar results. A question about the religion of the household head was added after the 1985 round; results are robust to controlling for religion and using only the 1986-1988 rounds. The ethnicity of the household head is available; I used this to classify household as matrilineal or patrilineal as described in Meekers (1992), or from other countries. Controlling for descent customs with these indicators did not change the results. The analysis examines investments in children conditioning on the current composition of the household; I control for characteristics which are likely to be endogenous, such as the number of children of the child's

own mother and the number of children of the other wife who has the most children. Results are robust to excluding these fertility variables. I keep them in the specifications presented because I want to examine the family's decision making given its current constraints (Garg and Morduch 1998).

Discussion and conclusion

I have presented evidence that mother's rank affects education investments in children of polygynous marriages, consistent with the predictions of the credit-constrained collective model outlined earlier. Being the child of a senior wife positively affects enrollment and school expenditures at the middle school level, relative to being the child of a junior wife. The children of junior wives are more likely to be doing home production, suggesting they are performing tasks that allow senior children to attend school. Senior children in Côte d'Ivoire therefore accumulate an additional year of education by their early twenties, leaving junior children with a long term educational disadvantage.

Some alternative explanations for these findings cannot be completely ruled out with the data available. Quisumbing (1994) illustrates for the Philippines that daughters receive less education, land, and total inheritance from their parents than son, but are compensated with nonland assets. It is possible that junior children receive investments not observable in this data, although I can find nothing in the ethnographic literature that supports this notion. It is also possible that there are differential returns to education for senior and junior children, which would result in efficient but lower educational investments in junior children even with a unitary decision-maker. However, the information that we have on junior wives does not support the idea that their children will be less able in school. Clignet (1970) states that in Côte d'Ivoire, more privileged older males take the most valuable brides as junior wives, while younger males

take less valuable candidates as their first (senior) wives. The results in Table 6 showed that after adjusting for age effects, junior wives were more likely to have some education than senior wives. This suggests that junior children would be if anything more able in school than children of senior wives. The direct evidence that we have on children's school productivity, the CEPE passing rates in Table 7, shows no differences between children by rank.

If junior and senior children are equally productive in school, it may still be the case that junior and senior wives are different in ways uncorrelated with their children's productivity. For instance, women who become junior wives may be those women who are less in demand in the marriage market, and have to settle for a situation where they know *a priori* that their children will receive lower investment than the children of the senior mother, regardless of their children's productivity. If this is the case, then we would see the empirical results I find for junior children even if the household had only a single decision maker (presumably the husband). But in this case the husband is not investing efficiently in his children: if the senior and junior wife each have a child with identical productivities, but the husband invests less in the junior child only because of the mother's rank, investment in that child will be below efficient levels and the household will not be investing optimally.

In this paper, I find evidence that their mother's rank affects allocations to children in these households. This evidence is consistent with the notion that co-wives compete for resources from the husband and invest only in their own children, which may result in inefficient investments in the household's children. While polygyny is a rare and unusual family structure in the United States, one characteristic of polygyny is increasingly common in the U.S. – the phenomenon where a father has sets of children with multiple wives. In the U.S. case, the first wife and children do not continue to reside with the father, but as in polygynous families

anecdotal evidence suggests wives compete for resources from the husband to invest in their own children. The common thread is that children's access to fathers' resources is crucial to their well-being.

References

Ainsworth, Martha. 1996. ‘‘Economic Aspects of Child Fostering in Côte d’Ivoire.’’ In Research in Population Economics, edited by T. Paul Schultz. Greenwich: JAI Press Inc.

Appleton, Simon. 1995. “The Interaction Between Poverty and Gender in Human Capital Accumulation: The Case of the Primary Leaving Examination in Côte d’Ivoire.” *Journal of African Economies* 4(2): 192-224.

Becker, Gary. 1981. A Treatise on the Family. Cambridge: Harvard University Press.

Bergstrom, Theodore. "On the Economics of Polygyny" (August 25, 1994). Department of Economics, UCSB. Ted Bergstrom. Paper 1994A.
< *http://repositories.cdlib.org/ucsbecon/bergstrom/1994A* >

Bledsoe, Caroline. 1992. “The Politics of Polygyny in Mende Education and Child Fosterage Transactions.” In Sex and Gender Hierarchies, edited by Barbara Diane Miller. Cambridge, England; New York: Cambridge University Press.

Bledsoe, Caroline. 1980. Women and Marriage in Kpelle Society. Stanford: Stanford University Press.

Borgerhoff Mulder, Monique. 1992. “Women’s Strategies in Polygynous Marriage: Kipsigis, Datoga, and Other East African Cases.” *Human Nature* 3(1): 45 – 70.

Borgerhoff Mulder, Monique. 1990. “Kipsigis Women Prefer Wealthy Men: Evidence for Female Choice in Mammals?” *Behavioral Ecology and Sociobiology* 27; 255-264.

Boserup, Ester. 1970. Woman’s Role in Economic Development. New York: St. Martin’s Press.

Bourguignon, Francois, and Pierre-André Chiappori. 1992. “Collective Models of Household Behavior: an Introduction.” *European Economic Review*, 36:355-64.

Browning, Martin, Francois Bourguignon, Pierre-André Chiappori and Valerie Lechene. 1994. “Incomes and Outcomes: A Structural Model of Intrahousehold Allocation.” *Journal of Political Economy* 102:1067-96.

Chiappori, Pierre-André. 1992. “Collective Labor Supply and Welfare.” *Journal of Political Economy* 100:437-67.

Chiappori, Pierre-André. 1988. “Rational Household Labor Supply.” *Econometrica* 56:63-89.

Clignet, Remi. 1970. Many Wives, Many Powers: Authority and Power in Polygynous Families. Evanston: Northwestern University Press.

Clignet, Remi and Joyce Sween. 1969. "Social Change and Type of Marriage." *American Journal of Sociology* 75(1): 123-145.

Duflo, Esther. 2003. "Grandmothers and Granddaughters: Old Age Pension and Intra-Households Allocation in South Africa." *World Bank Economic Review* 17(1))1-25.

Duflo, Esther and Christopher Udry. 2004. "Intrahousehold Resource Allocation in Côte d'Ivoire: Social Norms, Separate Accounts, and Consumption Choices." National Bureau of Economics Research Working Paper 10498.

Emlen, Stephen, and Lewis Oring. 1977. "Ecology, Sexual Selection, and the Evolution of Mating Systems." *Science*, New Series, 197(4300 July 15):215-223.

Garg, Ashish and Jonathan Morduch. 1998. "Sibling Rivalry." Mimeo, Princeton University.

Goldman, Noreen, and Anne Pebley. 1989. "The Demography of Polygyny in sub-Saharan Africa." In Reproduction and Social Organization in Sub-Saharan Africa, edited by Ron Lesthaeghe. Berkeley: University of California Press.

Grossbard-Shechtman, Shoshana. 1993. On the Economics of Marriage. Boulder: Westview Press.

Haddad, Lawrence and John Hoddinott. 1994. "Women's Income and Boy-Girl Anthropometric Status in the Côte d'Ivoire." *World Development* 22(4):543-53.

Hakansson, N. Thomas and Robert Levine. 1997. "Gender and Life-Course Strategies Among the Gusii," in African Families and the Crisis of Social Change, edited by Thomas Weisner, Candice Bradley, and Philip Kilbride. Westport, CT: Bergin & Garvey.

Jacoby, Hanan. 1995. "The Economics of Polygyny in Sub-Saharan Africa: Female Productivity and the Demand for Wives in Côte d'Ivoire." *Journal of Political Economy* 103(5): 938-71.

Jankowiak, William, Monika Sudakov, and Benjamin Wilreker. 2005. "Co-wife Conflict and Co-operation." *Ethnology* 44(1):81-98.

Karanja-Diejomaoh, W. M. 1978. "Disposition of Incomes by Husbands and Wives: An Exploratory Study of Families in Lagos," pp. 407-432 in Marriage, Fertility and Parenthood in West Africa, Volume 1, edited by Christine Oppong, Gemma Adaba, Manga Bekombo-Priso and John Mogey. Canberra: the Australian National University.

Kazianga, Harounan, and Stefan Klonner. 2009. "The Intra-household Economics of Polygyny: Fertility and Child Mortality in Rural Mali." Mimeo. < *http://mpra.ub.uni-muenchen.de/12859/* >

Kuper, Adam. 1982. Wives for Cattle. London: Routledge, Kegan and Paul.

Lundberg, Shelly, Robert Pollak, and Terence Wales. 1997. "Do Husbands and Wives Pool Their Resources? Evidence from the United Kingdom Child Benefit." *Journal of Human Resources* 32(3): 463-80.

Meekers, Dominique. 1992. "The Process of Marriage in African Societies: A Multiple Indicator Approach." *Population and Development Review* 18(1):61-78.

Oh, Gi-Taik, and Meera Venkataraman. 1992. "Construction of Analytic Variables and Data Sets Using Data from the Côte d'Ivoire Living Standards Survey 1985-88." Washington DC: The World Bank. *<http://siteresources.worldbank.org/INTLSMS/ Resources/3358986-1181743055198/3877319-1190292197799/cot22.pdf>*

Orians, Gordon. 1969. "On the Evolution of Mating Systems in Birds and Mammals." *American Naturalist* 103(934):589-603.

Petsalis, Sophia. 1990. Silent Power: a Portrait of Nigerian Women. Montreal: Meridian Press.

Pilon, Marc. 1994. "Types of Marriage and Marital Stability: The Case of the Moba-Gurma of North Togo." In Nuptiality in Sub-Saharan Africa: contemporary anthropological and demographic perspectives, edited by Caroline Bledsoe and Gilles Pison. Oxford : Clarendon Press ; New York : Oxford University Press.

Price, Sally. 1984. Co-wives and Calabashes. Ann Arbor: University of Michigan Press.

Quisumbing, Agnes. 1994. "Intergenerational Transfers in Philippine Rice Villages: Gender Differences in Traditional Inheritance Customs." *Journal of Development Economics* 43(2):167-195.

Sahn, David. 1994. "The Contribution of Income to Improved Nutrition in Côte d'Ivoire." *Journal of African Economies* 3(1):29-61.

Ssennyonga, Joseph. 1997. "Polygyny and Resource Allocation in the Lake Victoria Basin," in African Families and the Crisis of Social Change, edited by Thomas Weisner, Candice Bradley, and Philip Kilbride. Westport, CT: Bergin and Garvey.

Strassman, Beverly. 1997. "Polygyny as a Risk Factor for Child Mortality Among the Dogon." *Current Anthropology* 38(4):688-695.

Strauss, John. 1990. "Households, Communities, and Preschool Children's Nutrition Outcomes: Evidence from Rural Côte d'Ivoire." *Economic Development and Cultural Change* 38(2):231-61.

Strauss, John and Kalpana Mehra. 1990. "Child Anthropometry in Côte d'Ivoire: Estimates from Two Surveys, 1985 and 1986. " Living Standards Measurement Study Working Paper # 51. Washington, DC: World Bank. < *http://go.worldbank.org/TCF1E3IJX0* >

Tansel, Aysit. 1997. "Schooling Attainment, Parental Education, and Gender in Côte d'Ivoire and Ghana." *Economic Development and Cultural Change* 45(4):825-856.

Thomas, Duncan, Victor Lavy, and John Strauss. 1996. "Public Policy and Anthropometric Outcomes in the Côte d'Ivoire." *Journal of Public Economics* 61:155-192.

Timaeus, Ian, and Angela Reynar. "Polygynists and their Wives in sub-Saharan Africa: An Analysis of Five Demographic and Health Surveys." *Population Studies* 52(1998):145-162.

Udry, Christopher. 1996. "Gender, Agricultural Productivity and the Theory of the Household," *Journal of Political Economy* 104(5):1010-1046..

van de Walle, Etienne. 1968. "Marriage in African Censuses and Inquiries." In The Demography of Tropical Africa, edited by William Brass *et al*. Princeton: Princeton University Press.

Vijverberg, Wim. 1993. "Educational Investments and Returns for Women and Men in Côte d'Ivoire." *The Journal of Human Resources* 28:4, 933-974.

Wilson, Monica. 1977. For Men and Elders: Change in the Relations of Generations and of Men and Women among the Nyakyusa-Ngonde People, 1875-1971. New York: Africana Pub. Co. for the International African Institute.

World Bank. 1996. "Côte d'Ivoire Living Standards Survey (CILSS) 1985-1988: Basic Information for Users of the Data." Washington, DC: World Bank. *<http://siteresources.worldbank.org/INTLSMS/Resources/3358986-1181743055198/3877319-1190294521034/CIINFO.PDF>*

Appendix

Symbol definitions for Tables 1, 2 and 3

α_i	$-\frac{\partial^2 q_i}{\partial e_i^{\,2}} > 0$
Δ	$\frac{\partial^2 u}{\partial c_1^{\,2}}\left(\frac{\partial^2 q_i}{\partial e_i^{\,2}}+\frac{\partial^2 q_j}{\partial e_j^{\,2}}\right)+\phi\frac{\partial u}{\partial c_2}\frac{\partial^2 q_i}{\partial e_i^{\,2}}\frac{\partial^2 q_j}{\partial e_j^{\,2}}+\phi\frac{\partial^2 u}{\partial c_2^{\,2}}\left(\frac{\partial q_i}{\partial e_i}\right)^2\frac{\partial^2 q_j}{\partial e_j^{\,2}}+\phi\frac{\partial^2 u}{\partial c_2^{\,2}}\left(\frac{\partial q_j}{\partial e_j}\right)^2\frac{\partial^2 q_i}{\partial e_i^{\,2}} > 0$
G	$-\frac{\partial^2 u}{\partial c_1^{\,2}}-\phi\frac{\partial^2 u}{\partial c_2^{\,2}}\left(\frac{\partial q_i}{\partial e_i}\right)^2 > 0$
H_i	$-\phi\frac{\partial u}{\partial c_2}\frac{\partial^2 q_i}{\partial e_i^{\,2}} > 0$
J_i	$\phi\frac{\partial^2 u}{\partial c_2^{\,2}}\frac{\partial q_i}{\partial e_i}\frac{\partial^2 q_j}{\partial e_j^{\,2}} > 0$
Φ_i	$-\frac{\partial^2 u}{\partial c_1^{\,2}}-\phi\frac{\partial u}{\partial c_2}\frac{\partial^2 q_i}{\partial e_i^{\,2}}-\phi\frac{\partial^2 u}{\partial c_2^{\,2}}\left(\frac{\partial q_i}{\partial e_i}\right)^2 > 0$
K	$\phi\frac{\partial u}{\partial c_2} > 0$
M	$-\phi\frac{\partial^2 u}{\partial c_2^{\,2}}\frac{\partial q_i}{\partial e_i} > 0$
N	$-\frac{\partial^2 u}{\partial c_1^{\,2}}Y > 0$

Table 1
Unconstrained unitary model

	∂e_i	∂e_j
∂x_i	$\frac{\partial e_i}{\partial x_i} = \frac{1}{\alpha_i}\frac{\partial^2 q_i}{\partial e_i \partial x_i} > 0$	$\frac{\partial e_j}{\partial x_i} = 0$
∂z_i	$\frac{\partial e_i}{\partial z_i} = \frac{\partial e_i}{\partial x_i}\frac{\partial x_i}{\partial z_i} > 0$	$\frac{\partial e_j}{\partial z_i} = \frac{\partial e_j}{\partial x_j}\frac{\partial x_j}{\partial z_i} > 0$
∂R_i	$\frac{\partial e_i}{\partial R_i} = 0$	$\frac{\partial e_j}{\partial R_i} = 0$

Table 2
Constrained unitary model

	∂e_i	∂e_j
∂x_i	$\frac{\partial e_i}{\partial x_i} = \frac{1}{\Delta}[\underbrace{(G + H_j)\frac{\partial^2 q_i}{\partial e_i \partial x_i}}_{\text{substitution}} - \underbrace{J_i \frac{\partial q_i}{\partial x_i}}_{\text{income}}]$	$\frac{\partial e_j}{\partial x_i} = \frac{1}{\Delta}[\underbrace{G(-\frac{\partial^2 q_i}{\partial e_i \partial x_i})}_{\text{substitution}} - \underbrace{J_j \frac{\partial q_i}{\partial x_i}}_{\text{income}}] < 0$
∂z_i	$\frac{\partial e_i}{\partial z_i} = \frac{\partial e_i}{\partial x_i}\frac{\partial x_i}{\partial z_i} + \frac{\partial e_i}{\partial x_j}\frac{\partial x_j}{\partial z_i}$	$\frac{\partial e_j}{\partial z_i} = \frac{\partial e_j}{\partial x_i}\frac{\partial x_i}{\partial z_i} + \frac{\partial e_j}{\partial x_j}\frac{\partial x_j}{\partial z_i}$
∂R_i	$\frac{\partial e_i}{\partial R_i} = 0$	$\frac{\partial e_j}{\partial R_i} = 0$
Symbol definitions are in Appendix.		

Table 3
Collective constrained model

	∂e_i	∂e_j
∂x_i	$\frac{\partial e_i}{\partial x_i} = \frac{1}{\Phi_i}(\underbrace{K\frac{\partial^2 q_i}{\partial e_i \partial x_i}}_{\text{substitution}} - \underbrace{M\frac{\partial q_i}{\partial x_i}}_{\text{income}})$	$\frac{\partial e_j}{\partial x_i} = 0$
∂z_i	$\frac{\partial e_i}{\partial z_i} = \underbrace{\frac{N}{\Phi_i}\frac{\partial \theta_i}{\partial z_i}}_{\text{bargaining}} + \frac{\partial e_i}{\partial x_i}\frac{\partial x_i}{\partial z_i}$	$\frac{\partial e_j}{\partial z_i} = \underbrace{\frac{N}{\Phi_j}\frac{\partial \theta_j}{\partial z_i}}_{\text{bargaining}} + \frac{\partial e_j}{\partial x_j}\frac{\partial x_j}{\partial z_i}$
∂R_i	$\frac{\partial e_i}{\partial R_i} = \underbrace{\frac{N}{\Phi_i}\frac{\partial \theta_i}{\partial R_i}}_{\text{bargaining}} > 0$	$\frac{\partial e_j}{\partial R_i} = \underbrace{\frac{N}{\Phi_j}\frac{\partial \theta_j}{\partial R_i}}_{\text{bargaining}} < 0$
Symbol definitions are in Appendix.		

Table 4
Measures of Polygyny

p proportion of husbands who have more than one wife	0.25
f proportion of all married women who are in polygynous marriages	0.41
m ratio of currently married women to currently married men	1.41
w number of wives per polygynist	2.30
proportion children ages 19 and under who are children of polygynous marriages	0.24
proportion polygynous marriages with two wives only	0.76
proportion polygynous marriages with three wives only	0.20
proportion polygynous marriages with four to six wives	0.05

Data: Côte d'Ivoire Living Standards Survey, 1985-1988 (pooled sample).

Table 5

Household Characteristics

	1	2	3	4	5
	Polygynous households 1,539 obs		Monogamous households 4,849 obs		Difference (polyg. - monog.)
	mean [s.d.]	obs	mean [s.d.]	obs	point est. (s.e.)
household size	11.58 [5.91]	1,539	6.12 [3.79]	4,849	5.46 (0.26)
# children in household under 19	7.31 [4.35]	1,504	4.32 [2.78]	4,087	2.98 (0.19)
proportion rural	0.70 [0.46]	1,539	0.50 [0.50]	4,849	0.20 (0.03)
per capita expenditure	166.62 [102.42]	1,539	267.67 [233.93]	4,849	-101.08 (13.56)
age of head	51.58 [12.69]	1,539	45.46 [14.21]	4,848	6.11 (0.61)
age of senior/sole wife of head	43.59 [12.21]	1,530	36.08 [12.50]	3,561	7.51 (0.55)
proportion heads with any schooling	0.22 [0.42]	1,539	0.40 [0.49]	4,843	-0.18 (0.02)
proportion senior/sole wives of heads with any schooling	0.07 [0.26]	1,514	0.25 [0.43]	3,513	-0.18 (0.02)
proportion kids 13-16 currently enrolled	0.35 [0.42]	973	0.39 [0.45]	2,046	-0.04 (0.02)
school expenditure for 13-16s	22.48 [35.94]	973	27.13 [46.22]	2,046	-4.65 (2.48)

Differences are significant at the 1% level except school enrollment and expenditures which are significant at 10%. n = 6,388 households (pooled sample): 1,588 households were interviewed in the first year, 1,600 in each of years 2-4. Panel households supply two observations, each from a different year. Polygynous households are households which contain at least one polygynous marriage; all other households are classified as monogamous. Expenditures are in 1,00s od 1985 CFA francs and account for regional price differences using the Combined Price Index (World Bank 1996). Means for number of children, proportions of children, and school expenditures are conditional on children in the designated age group being present in the household. School expenditure means are for all children, unconditional on being enrolled in school.

Table 6
Wife Characteristics

	1	2	3	4	5	6
	Senior wives 1,571 obs		Junior wives 2,041 obs		Difference (senior - junior)	Age-adjusted difference
	mean [s.d.]	obs	mean [s.d.]	obs	point est. (s.e.)	point est. (s.e.)
age	43.17 [12.32]	1,571	34.20 [11.55]	2,041	8.97*** (0.27)	--
age of husband	50.98 [12.80]	1,571	51.97 [12.58]	2,041	-0.99*** (0.15)	-7.89*** (0.26)
height in cm	157.32 [6.26]	1,176	158.26 [6.04]	1,457	-0.94** (0.28)	-0.22 (0.30)
weight in kg	54.64 [10.28]	1,176	55.61 [9.46]	1,457	-0.97** (0.38)	-0.08 (0.41)
proportion with any schooling	0.069 [0.25]	1,554	0.102 [0.30]	1,998	-0.032*** (0.009)	0.019* (0.009)

* significant at 10%;8* significant at 5%; *** significant at 1%. Standard errors in parentheses robust to heteroskedasticity and correlation within clusters. In the pooled sample, ranked by age, of 2,041 junior wives, 1,571 are second wives, 383 third, 70 fourth, 14 fifth, and three are sixth wives.

Age-adjusted differences are obtained by regressing the wife characteristic on an indicator for being a senior wife and a full set of age indicators.

Table 7
Means for senior and junior children

		1		2
Living away from home	senior child	-0.00	senior boy	-0.11***
(13-16 year olds)		(0.04)		(0.04)
			junior boy	-0.12***
mean = 0.25				(0.04)
n = 1,471	female	0.11***	senior girl	-0.01
		(0.03)		(0.04)
Currently enrolled	senior child	0.02	senior boy	0.18***
(7-12 year olds)		(0.02)		(0.03)
			junior boy	0.18***
mean = 0.47				(0.03)
n = 2,676	female	-0.16***	senior girl	0.04
		(0.03)		(0.03)
Obtained CEPE, given	senior child	0.04	senior boy	0.19**
completion of 6 years of		(0.05)		(0.08)
education			junior boy	0.16**
(13-16 year olds)				(0.07)
	female	-0.14***	senior girl	0.07
mean = 0.63		(0.05)		(0.08)
n = 484				

* significantly different from the corresponding omitted category (junior child and male for column 1; junior girl for column 2) at 10%; ** at 5%; *** at 1%.
Linear probability models. Standard errors in parentheses robust to heteroskedasticity and correlation within clusters.
The mean of the dependent variable is presented in the first column.
The Certificat d'Études Primaires (CEPE) is the diploma granted upon passing the primary school leaving exam.

Table 8

Child Outcomes

		1	2		3	4
		OLS	Fixed effects		OLS	Fixed effects
Currently enrolled	senior child	0.09*	0.15	senior boy	0.28***†	0.35***
(13 to 16 year olds)		(0.05)	(0.11)		(0.06)	(0.12)
				junior boy	0.19***	0.19
mean = 0.43					(0.05)	(0.12)
n = 1,098	female	-0.19***	-0.21***	senior girl	0.08	0.13
		(0.03)	(0.08)		(0.06)	(0.14)
School expenditure	senior child	14.54**	15.85	senior boy	18.51***†	23.84
(13 to 16 year olds)		(5.75)	(17.31)		(6.47)	(19.55)
				junior boy	7.06	11.62
mean = 51.23					(5.27)	(17.65)
n = 549	female	-2.24	-5.60	senior girl	20.24***†††	22.75
		(3.90)	(12.30)		(7.42)	(18.10)
Market work	senior child	-0.04	-0.10	senior boy	-0.15***	-0.22
(13 to 16 year olds)		(0.05)	(0.12)		(0.06)	(0.13)
				junior boy	-0.11**	-0.11
mean = 0.39					(0.04)	(0.10)
n=1,097	female	0.10***	0.12*	senior girl	-0.05	-0.09
		(0.03)	(0.07)		(0.05)	(0.14)
Home production	senior child	-0.09*	-0.06	senior boy	-0.43***††	-0.43**
(13 to 16 year olds)		(0.05)	(0.13)		(0.06)	(0.14)
				junior boy	-0.28***	-0.34**
mean = 0.62					(0.05)	(0.10)
n = 1,098	female	0.36***	0.37***	senior girl	-0.01	-0.03
		(0.03)	(0.08)		(0.06)	(0.16)
Grade attained	senior child	0.31	1.23	senior boy	1.79***	2.87***
(13 to 16 year olds)		(0.38)	(0.77)		(0.47)	(0.92)
				junior boy	1.66***	1.93**
mean = 5.10					(0.36)	(0.76)
n = 1,098	female	-1.39***	-1.60**	senior girl	0.61	1.60
		(0.24)	(0.50)		(0.48)	(1.00)
Grade attained	senior child	1.10*	0.57	senior boy	3.17***	3.80**
(17 to 21 year olds)		(0.64)	(1.74)		(0.72)	(1.89)
				junior boy	2.27***	3.90***
mean = 5.74					(0.47)	(1.33)
n = 676	female	-2.02***	-3.24***	senior girl	1.33*†	1.12
		(0.35)	(0.89)		(0.68)	(1.70)
Grade attained	senior child	1.41*	-0.42	senior boy	3.09***†	2.99
(20 to 25 year olds)		(0.77)	(2.16)		(0.77)	(2.48)
mean = 5.75	female	-1.77***	-3.32***	junior boy	1.47**	2.97*
n = 479		(0.47)	(1.20)		(0.58)	(1.57)
				senior girl	1.08	-0.64
					(0.79)	(2.47)

Notes for Table 8

* significantly different from the corresponding omitted category (junior child and male for column 1; junior girl for column 2) at 10%; ** at 5%; *** at 1%.

† The senior child coefficient for this gender is significantly different from the junior coefficient for this gender at 10%; †† at 5%; ††† at 1%.

Standard errors in parentheses robust to heteroskedasticity and correlation within clusters.

Expenditures are in 1,000s of 1985 CFA francs and account for regional price differences using the Combined Price Index (World Bank 1996).

Other regressors not reported for columns 1 and 3 include indicators for whether the child's mother has any education, the child's "other mother(s)" has any education, and the child's father has any education; the child's birth order among her father's children; father's age; mother's age; child's age; the number of children of the child's own mother; the number of children of the other wife who has the most children; the difference between the oldest wife's age and the youngest wife's age, and its interaction with being a junior child; household size; total household expenditure and its square*10^{-6} in 1,000s of 1985 CFA francs; indicators for region and year, and a constant. In columns 2 and 4, father's education and age, household size and expenditure, region, and year are excluded because they do not vary within fathers. For attainment, the child age control is indicators; for the other outcomes child age is entered linearly.