Polygyny: Cooperation vs. Competition Among Wives on Child Health

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Selected Poster prepared for presentation at the 2015 Agricultural & Applied Economics Association and Western Agricultural Economics Association Joint Annual Meeting, San Francisco, CA, July 26-28

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Preliminary Draft: Please do not cite or distribute

Abstract

Although the prevalence of polygyny has decreased in the world in recent years, polygyny still remains as a frequent family structure in West Africa. Using 2006 Demographic and Health Survey (DHS) from Mali, we investigate the effects of polygyny on child health. Using the gender of the firstborn as an instrumental variable for marrying an additional wife, we find that a child's nutritional status in terms of height-for-age and weight-for-age z-scores is worse in polygynous households compared to monogamous households. Second, we analyze the effect of mother's rank among co-wives on her own child's health and find that mother's rank has a statistically significant effect on a child's nutritional status. However, the effect of mother's rank changes across different institutions of polygyny: depending on the ethnic group, the co-wife relationship could be more collaborative than competitive. The findings suggest a more nuanced view of polygyny than currently found in the literature: the effect of the institution of polygyny depend upon the rules governing behavior within the institution.

1. Introduction

Although the reported cases of polygyny, the taking of several wives by one man, in Sub-Saharan Africa have decreased in recent years, polygyny remains as a frequent household structure, especially in rural areas (Bove et al, 2014). More than 40% of children still live in polygynous households in countries like Burkina Faso, Mali and Guinea (Wagner and Rieger, 2011). In terms of household resource allocation, polygynous households face additional conflicts among co-wives over their own and their children's welfare. Co-wife competition can be elevated when wives need to depend on their husband's investment decisions on child welfare such as educational and health attainment in a credit-constrained environment. In this paper, we investigate the effect of polygyny on child health in Mali using 2006 DHS dataset. First, we analyze if a child in a polygynous household has better nutritional outcomes than a child in a monogamous relationship using a unique instrumental variable approach. We investigate whether having multiple mothers is detrimental or beneficial to a child's health in terms of a child's height and weight. Second, conditional on being in a polygynous household, we compare these health outcomes of children of a senior wife and those of junior wives. We test the validity of unitary household model in resource allocation by analyzing the impact of wives' ranks on child health outcomes.

There has been a small but burgeoning literature on the effect of polygyny on economic growth, household health and intrahousehold resource allocation. The socio-economic determinants of polygyny have been extensively researched in the past (Boserup, 1970; Ezeh, 1997; Brown, 1981; Grossbard-Shechtman, 1993). Some of the main determinants are: 1) increased labor supply from multiple wives in agrarian society, 2) higher fertility pressure from high infant and child mortality rate, 3) man's wealth and power, and 4) first' wife's child-rearing capability. Using Living Standards Surveys in Cote d'Ivoire (CILSS) conducted by World Bank between 1985 and 1988, Jacoby (1995) develops a structural model separating wealth and substitution effects in demand for polygyny and finds that men have more wives when wives are more productive, conditional on wealth. Using a general equilibrium model of a marriage market, Gould et al. (2008) argues that while inequality in men's productivity increases polygyny, inequality in women's productivity reduces it as the quality of children becomes more important than the quantity as society develops. Tertilt

(2005) finds that polygynous countries have higher fertility rates and lower savings compared to non-polygynous countries. He further argues that polygyny may be a contributing factor in underdevelopment in Sub-Saharan Africa by investing in wives rather than physical capital accumulation, and banning polygyny could improve output per capita by 170 percent.

The effect of polygyny on child welfare is closely related to co-wives' relationships and bargaining powers in intrahousehold resource allocation. If co-wives cooperate and share household resources equitably, then there should not be significant difference between child outcomes in polygynous household and those in monogamous household. In some cases, children could even benefit from having multiple mothers caring for them (Bledsoe 1980; Petsalis 1990). Strassmann (1997) conducted an anthropological study on the Dogon tribe in Mali and finds that co-wife rivalry adversely affects a child's survival on historical observations. Kazianga and Klonner (2009) investigate the effect of the wives' bargaining power on child mortality in Mali and conclude that co-wife rivalry as reported by Strassmann (1997) is responsible for inefficient household resource allocation, and the children of junior wives suffer the most. Using the same dataset as Jacoby (1995), Mammen (2009) investigates co-wives' bargaining power in household resource allocation and finds that the children of senior wives receive more investment in education. Wagner and Rieger (2011) investigate the effect of polygyny on children's physical status using DHS from 28 African countries. They find that a child from a polygynous household has less weight-per-age and height-per-age ratios than a child from a monogamous household. We extend both Mammen (2009)'s and Wagner and Rieger (2011)'s work by utilizing a more exogenous instrumental variable approach in estimating the effect of polygyny and by distinguishing how the children within polygynous households could receive different health benefits depending on their mothers' bargaining power. We further investigate whether the probability of stunting and wasting increases if a child is in polygynous household, or if a child is born by a senior wife compared to a junior wife.

The contributions to the literature on the effect of polygyny on household resource allocation are fivefold. First, to the best of our knowledge this is the first paper investigating and finding significant empirical results on the negative effect of polygyny on child health and the statistically significant effect of wife ranking on intrahousehold resource allocation

on the same population sample. Previous literature has either focused on the effect of polygyny over monogamy (Wagner and Rieger, 2011; Jacoby, 1995; Gould et al., 2008) or to the lesser degree on the effect of co-wife ranking on intrahousehold resource allocation (Mammen, 2009; Strauss and Mehra, 1990; Kazinga and Klonner, 2009). By utilizing the same dataset and same control variables, we investigate and make more explicit causal relationship between polygyny and resource allocation inefficiency. Second, this is the first paper controlling for the environmental effects on child health at the time of the survey. Implementing a cross-sectional survey of a given country takes its time. In 2006, Malian DHS was conducted from April to December, over 9 months period. Therefore, health conditions of a child who was measured at the harvest season would likely be different from those of a child who was measured at the end of the dry season, especially in the rural area where most workers are involved in agricultural activities.

The third contribution of this research is methodological. We use an instrumental variable approach in predicting a man taking an additional wife, as the reasons behind polygyny are likely correlated with unobserved household, parental and child characteristics. We exploit paternal preference for sons as a possible cause for polygyny.[1] Since the gender of a child is exogenously given, we use the gender of the first child as an instrument for polygynous household and estimate using 2SLS model. Using the gender ratio of children as an instrument has been practiced previously in economics (Angrist and Evans, 1998; Angrist et al., 2010; Wagner and Rieger, 2011). However, this is the first time using the gender of the first born as an instrument for a polygynous household. Using a gender ratio of children is inappropriate in this case, since after the birth of the first child, precise gender composition prior to taking another wife and circumstances may not be strictly exogenous.

Fourth, this study contributes to the growing literature empirically evaluating women's bargaining power in polygynous households. The majority of the literature finds empirical evidence for co-wife rivalry, with junior wives with the least bargaining power in polygynous households. In an empirical study closely related to ours, Strauss (1990) examined height-for-age and weight-for-age z-scores of children in Cote d'Ivoire and found

[1] OECD Development Center's Social Institutions and Gender Index (SIGI) ranks Mali with high preference for sons (SIGI, 2014).

that the children of junior wives had worse health outcomes when senior wives and sole wives were grouped together. However, we do not presume that the characteristics of senior wives and sole wives are the same in our study. While sole wives bargain with their husbands in resource allocation, senior wives need to negotiate with their husbands and other wives as well. While we find similar results by grouping senior wives and sole wives together as Strauss did, we find opposite results when we compare junior wives with senior wife only in their respective child health outcomes. In our study, children having junior wives as mothers had better health outcomes in terms of height-for-age and weight-for-age z-scores, as well as in the probabilities of stunting and wasting. Therefore, we challenge the notion that junior wives have the weakest bargaining position in polygynous households. Fifth, we link anthropological studies with economic literature by controlling for wives' ethnicity. Societal norms and traditions play an important part in household relationships, and each ethnic group has its own unique culture. In the case of the Dogon in Mali, Strassman (1997) finds not only extreme co-wife rivalry but also lower survival rate of children of the first wife. Madhavan (2002) contradicts two Malian ethnic groups: the Fulani and the Bambara. While she finds co-wife collaboration among the Bambara, she finds co-wife rivalry and fierce competition among the Fulani. We exploit and control for the differences in ten major ethnic groups in Mali, with particular analysis involving the Dogon, the Fulani and the Bambara. In line with previous anthropological studies, we find that the children of the junior wives of the Dogon and the Fulani having a better long-term health outcomes whereas the children's health outcomes of Bambara wives are more equivalent.

The remainder of this paper is divided as follows. The next two sections outlines the theoretical framework for intrahousehold resource allocation in polygynous households and the empirical framework for our analysis. Section 4 describes the datasets for the study in Mali, and Section 5 presents the main results. Section 6 explores robustness checks, and section 7 discusses the implications of the findings and concludes.

2. Theoretical Framework

In this section, we discuss various implications for two household resource allocation models in polygynous households. We develop a conceptual framework in which either a head of a household makes all health investment decisions maximizing total household

utility, or each wife maximizing her own utility. Based on Mammen (2009), we apply her unitary and collective household resource allocation models to a child's health investment decision-making.

In a unitary model, a head of the household makes all health investment decisions maximizing household utility. All wives collaborate to care for all children to maximize household utility. Without loss of generality, we can illustrate the implications of unitary model on a child's health with the following polygynous household environment in a two-period model: one husband with two wives, with wife ranking variable R=S for a senior/first wife and R=J for a junior/second wife, and one child for each wife (child S from a senior, child J for a junior). In this two-period utility function, each polygynous household receives utility u from consumption x_t in each period t. We assume that the household discounts each future period by a constant discount factor β and each amount borrowed B by r. We also assume that the household income Y_t during the first period results from adults' work, whereas Y_{t+1} is entirely from children's work in the future, supporting elders in the household. Furthermore, we assume that the future child returns q_i is dependent on health investment h_i, mother's characteristics m_i, child characteristics c_i, any external weather shocks affecting child's health T_i for each child i. Then, the household maximizes its utility,

$$\max_{h_S, h_J, \mathrm{B}} U = u(x_1) + \beta u(x_2)$$

$$\text{subject to} \quad x_1 \le Y_1 + B - h_S - h_J, \qquad (1)$$

$$x_2 \le Y_2 - (1+r)B$$

$$\text{with } Y_2 = q_S(h_S, c_S, m_{\mathrm{S}}, T_S) + q_J(h_J, c_J, m_J, T_J)$$

where $u(\bullet)$ and $q(\bullet)$ are both increasing and concave functions. Then, solving the first order conditions yields,

$$\frac{\partial q_S}{\partial h_S} = \frac{\partial q_J}{\partial h_J} = \frac{\partial u / \partial x_1}{\partial u / \partial x_2} \ge 1 + r, \text{ with strict inequality with credit-constraint.} \qquad (2)$$

The unitary household equates all marginal returns to each child health investment. In a credit-constrained environment, the marginal return would be higher than the market interest rate, so that the optimal health investments h_A* and h_B* are below the unconstrained optimum. Note that in a unitary household resource allocation model, mother's rank does

not factor into utility maximization as it is assumed not to be correlated with future child returns. In other words, $\frac{\partial q_i}{\partial R_i} = 0$.

In a collective household model, on the other hand, each wife maximizes her own utility and benefits from her own child's returns in the future. A head of the household allocates a share of household resources among his co-wives. Now, unlike in a unitary model, each wife's share is not only affected by her own characteristics but also her co-wife's as well, including wife ranking. Each wife does not consider the welfare of other wife's child, only her own. Therefore, each wife's utility function includes her own child's characteristics only, not the other wife's. Each wife competes to have more resources allotted for her and her child. Therefore, unlike in the unitary model marginal returns to health investment is not the same for all children in this case. If the household resource distribution is affected by each wife's bargaining power due to her rank, the allocation is not optimal for the household, i.e. $\frac{\partial q_i}{\partial R_i} \neq 0$.

3. Empirical Framework

In an efficient household, whether a child's mother is in a polygynous relationship or not, or if in a polygynous relationship whether her rank is senior or junior among co-wives, should not be correlated with an investment in a child's health.

3.1. Monogamy vs. Polygyny

One of the major identification issues with investigating the effect of polygyny is that having multiple wives is likely to be endogenous with unobserved household characteristics. In order to account for potential bias due to endogeneity, I implement an instrumental variable to predict polygynous relationship:

$$Poly_{ij} = \alpha + \beta S_{ij} + \delta H_{ij} + \chi M_{ij} + \gamma C_{ij} + \eta T_{ij} + \mu_{ij} + \varepsilon_{ij} \tag{3}$$

where *Poly* is a binary variable representing whether a child *i*'s mother is in a polygynous relationship or not, with *Poly=1* specifying a polygynous relationship. I also control for child *i*'s household characteristics *H*, mother's characteristics *M*, child characteristics *C*, weather shocks *T* at the time of interview, as well as cercle-fixed effects μ. The error term ε_{ij} is clustered at the cercle-level.

As for the instrumental variable S_{ij}, I use the gender of the firstborn of the senior wife in child i's household, with S_{ij}=1 denoting a female child. The gender of a child is exogeneously given, and it does not violate the exclusion restriction: it is not correlated with the error term in the second stage regression in equation (4) below. It is highly unlikely that the gender of the firstborn of the senior wife has any deterministic relationship with children's gender-adjusted health status.

In the second stage regression, I use the instrumental variable S_{ij} for the effect of polygyny on child health status:

$$ChildHealth_{ij} = \alpha + \beta \widehat{Poly_{ij}} + \delta H_{ij} + \chi M_{ij} + \gamma C_{ij} + \eta T_{ij} + \mu_{ij} + u_{ij} \qquad (4)$$

where *ChildHealth* represents two health and nutrition status per child i in cercle j: Height-for-Age Z score (HAZ) and Weight-for-Age Z score (WAZ). The variables H, M, C,T and μ have the same representation as in equation (3) in the first stage regression.

3.2. Senior vs. Junior Wife in Polygyny

In order to investigate the effect of wife ranking on child health and nutritional status in polygynous households, we limit our observations to only children in polygynous households. Then, we estimate the following OLS regression model:

$$ChildHealth_{ij} = \alpha + \beta R_{ij} + \delta H_{ij} + \chi M_{ij} + \gamma C_{ij} + \eta T_{ij} + \mu_{ij} + \varepsilon_{ij} \qquad (5)$$

where *ChildHealth* represents three health and nutrition status per child i in cercle j (HAZ, WAZ); H, M, C, T, and μ have the same representation as in equation (3). R_{ij} is a binary variable specifying child i's mother being a senior or a junior wife, with R_{ij}=1 denoting a junior wife. If the coefficient of R_{ij} is significant, it indicates the ranking of a wife affects a child's health investment, consistent with collective household model with credit constraint. If β is positive, it implies that a child of a junior wife receives more health investment, whereas β<0 indicates that a child of a senior wife has a higher bargaining power on a child's health investment.

4. Data Description

In order to test our hypotheses regarding the effect of polygyny on child health and nutritional outcomes in a credit-constraint environment, we utilize two datasets from Mali: Demographic Health and Survey (DHS) dataset from 2006 and weather data in 2006 from Climate Hazard group InfrRed Precipitation with Station (CHIRPS). Mali is a landlocked

country of 14.5 million in the Sahel region of West Africa, whose economy is heavily dependent on agricultural sector. Over 80% of the Malian population are engaged in agricultural activities, and more than 70% survive on a subsistent level. The fertility rate remains high at 6.1 children per woman with only 9.9% prevalence rate of modern contraceptives (CPS, 2014).

4.1. Demographic Health and Survey (DHS) Data in Mali, 2006

Demographic and Health Surveys (DHS) are nationally-representative household surveys that provide data for monitoring and impact evaluation indicators in the areas of population, maternal and child health, gender, literacy and education, malaria, HIV/AIDS and nutrition. The MEASURE DHS (Monitoring and Evaluation to Assess and Use Results Demographic and Health Surveys) project is funded by U.S. Agency for International Development (USAID) and implemented by ICF International. In Mali, surveys were conducted in cooperation with the Department of Statistics and Information (Cellule de Planification et de Statistique (CPS) Direction Nationale de la Statistique et de L'Informatique (DNSI)) with a sampling of approximately 10,000 women of ages between 15 and 49 years old. According to DHS in 2006, 36.2% of children under the age of five at the time of the survey had their mothers in a polygynous relationship in Mali. If we restrict the sample to the rural area, the occurrence increases to 40.8% (CPS, 2006).

Table 1 presents descriptive statistics from 2006 survey for children born within five years and having their weight and height measured at the time of the interview. Then, 7,844 children were grouped into two sub-samples: 5,030 children living in monogamous households and 2,814 children in polygynous households. We examined the differences in a child's health and nutritional outcomes, mother's characteristics and household characteristics between these two groups.

A child's health and nutritional outcomes are analyzed in relation to his/her height and weight measured at the time of the interview. Weight-for-age Z score (WAZ) is often used as an indicator of short-term health reflecting transitory income and health shocks, whereas height-for-age Z score (HAZ) is used as a proxy for relatively long-term accumulation of health comparable across different age groups, gender, households and countries (Rieger and Wagner, 2011). A Z-score of zero indicates that a child has the same health outcomes

as the reference population.[2] A Z-score of -1 indicates that a child' health status is one standard deviation below the reference population. Table 1 illustrates that while children in polygynous households had a lower HAZ and WAZ than those in monogamous households by 0.252 and 0.114, respectively. Furthermore, United Nations Children's Fund (UNICEF) defines stunting as below -2 HAZ and wasting as below -2 WHZ (Weight-for-Height Z score), both describing moderate to severe malnutrition. On average, children in polygynous households showed higher prevalence of stunting and wasting than those in monogamous households, although only the difference in stunting was statistically different between the two groups.

Some key characteristics of parents in monogamous and polygynous relationships were also examined. In our analysis on the effect of polygyny on a child's health, we controlled for the following mother's and father's characteristics which could affect a child's health outcome: 1) mother's age, education, height, total number of children, whether the mother is the head of the household, and whether the mother is able to make medical-related decisions regarding children, and 2) father's age and education. Table 1 illustrates that mothers in polygynous households were typically older and have attained lower education, were less likely to be the head of the household or to be able to make medical-related decisions compared to mothers in monogamous households. Total number of children born by the same mother was also higher for children in polygynous households. Fathers in polygynous households were typically older and have attained lower education than fathers in monogamous households.

Because a child's health and nutritional outcomes are highly correlated with certain household characteristics, we also control for the following: household wealth, total number of household members, total number of children under five in a household, whether the residence is urban or rural, and distance to the nearest healthcare facilities. Compared to monogamous households, polygynous households typically resided in rural regions and

[2] Z scores were calculated according to the World Health Organization (WHO) method (WHO Multicenter Growth Reference Study Group, 2006). Using a reference population of children from Brazil, Ghana, India, Norway, Oman and the United States, the WHO provides the normalized distribution of height, weight and weight-for-height conditional on gender and age of children.

further from health facilities, reported having less wealth accumulation, and had more household members and children under five.

Since a child's current health is related to his/her birth status, we control for a child's gender, birth size, birth order, and birth interval from previous birth by the same mother. We didn't observe any statistical difference in birth size or birth order between children from monogamous and polygynous households, but the birth interval was longer in polygynous households. Furthermore, a child was more likely to be a girl in polygynous households. In fact, the first born of the first wife was more likely to be a girl in polygynous households, an insight we further explore in our choice of an instrumental variable in determining polygyny.

Table 2 presents summary statistics and pair-wise statistical difference between senior and junior wives among polygynous households. While there was no significant difference in HAZ, WAZ, stunting and wasting, junior wives in general were younger and less likely to be the head of the household, had more education, and had a shorter birth interval for the current children under five.

4.2. Weather Data

The DHS used in this study includes geographical coordinates of all the clusters, the smallest units where each household is grouped together.[3] For our study, we obtain daily Mali climate data during the survey period from two sources: Climate Hazard group InfrRed Precipitation with Station (CHIRPS) and CRU TS3.10. First, we use the CHIRPS data archive to map each cluster coordinates with daily and monthly precipitation estimations during the survey period. We have selected CHIRPS dataset because it uses both new resources of satellite observations, such as gridded satellite-based estimations from NASA and NOAA, and also in situ precipitation gauge observations from ground stations to build a high resolution (0.05^0) estimation model. Second, we use CRU TS3.10 for daily and monthly average, min/max temperature estimation for 0.5^0 resolution.[4] CRU TS3.10

[3] In order to ensure confidentiality of the respondents, the latitude and longitude of the cluster coordinates were randomly displaced, with urban clusters maximum of 2km and rural clusters maximum of 5km (with 1% of rural clusters up to 10km displacement). All displacements are within the boundaries of the country and district regions.

[4] Higher resolution for temperature measurement is not publicly available.

updates previous CRU TS3.00 with observations at meteorological stations across the world's land areas up to December 2009. Station anomalies were interpolated into 0.5^0 latitude/longitude grid cells covering the global land surface (excluding Antarctica).

From this, we extract weather conditions at the time of the interview and child's anthropometric measurement. While long-term health status in terms of height-for-age ratio is not easily affected by immediate weather shocks, short-term nutritional status in terms of weight-for-age ratio is more vulnerable to weather shocks and seasonality affecting disease environment and income-generating activities. In our analysis, we control for the rainfall and temperature shocks during the month and preceding months of anthropometric measurement. For rainfall controls, we use total rainfall amount in the interview month, previous two months and previous three months. For temperature controls, we use the average temperature during the interview month, previous two months and previous three months.

5. Empirical Results

We find significantly negative effects of polygyny and mother's rank on child health, measured in short-term nutritional status WAZ and WAZ. This provides some evidence that household resource allocation is inefficient regarding child health investment.

5.1. Monogamy vs. Polygyny

Table 3 presents the first stage results of 2SLS model estimating the effect of polygyny on child health and nutritional outcomes. Column (1) indicates that the instrument is a good predictor of polygynous households, since it is significantly correlated with a child's mother being in a polygynous relationship. Having a girl as the first child increases the probability of husband taking more wives by 5.4%.[5]

The second stage results are presented in Table 4. Columns (1) and (2) show the effect of a child being in a polygynous household on his/her health and nutritional outcomes proxied by HAZ and WAZ, respectively. The results indicate that living in a polygynous household has a significant effect on both long-term health status proxied by HAZ and short-term nutritional status proxied by WAZ. HAZ score for a child in a polygynous household

[5] When the instrumental variable S_{ij} is used in second stage OLS estimations, we find that the F-statistics of the first stage to be sufficiently large (greater than 100) across all regressions.

compared to one in a monogamous household is lower by 0.21. This implies that a child's HAZ is reduced by 10.9% of its sample standard deviation by living in a polygynous household.[6] In terms of WAZ score, a child's short-term nutritional status is negatively affected by his/her mother being in a polygynous relationship as well. WAZ score is lower by 0.17 for a child in a polygynous household, a reduction of 12.5% of its sample standard deviation. This suggests that household decision-making on child health investment is influenced by the family structure, and unitary household model cannot adequately describe intrahousehold resource allocation.

5.2. Senior vs. Junior Wife in Polygyny

We then investigate whether a mother's rank among co-wives affects child health and nutritional outcomes. Table 5 presents the results on outcomes for children of senior wife and for those of junior wives in terms of HAZ and WAZ. Column (1) shows that a mother's rank has a statistically significant effect on long-term health proxied by HAZ. Having a junior wife as a mother increases HAZ by 0.18, approximately 9.7% of its sample standard deviation. While WAZ also increases by having a junior wife as a mother, it was not statistically significant. This implies that the mother's rank affects the amount of household resources for her own children in the long-term.

Table 6 presents the interaction effect between mother's rank among co-wives and their ethnic groups. We restrict our observations to three ethnic groups: the Dogon, the Fulani and the Bambara. Based on anthropological study by Strassman (1997) and Madhavan (2002), we empirically test whether children of junior wives of the Dogon, Fulani and Bambara have better health outcomes. Strassman (1997) observed that children in polygynous households have lower survival rate among the Dogon, especially those of the first wives. In her ethnological research, Madhavan (2002) witnessed that while co-wife collaboration was noticeably present among the Bambara, there was a fierce competition and co-wife rivalry among the Fulani. Our analysis on a child's long-term health affirms their findings. There is a statistically significant and positive effect of being a child of a junior wife among the Dogon and the Fulani on long-term health, proxied by HAZ. On the

[6] For a child with HAZ of -1.361, mean HAZ value among children in monogamous households, moving to a polygynous household would reduce HAZ by 15.4%.

other hand, there is a statistically significant and negative interaction effect between having a junior wife as a mother and mother's ethnic group being the Bambara. In fact, the marginal effect due to having a Bambara junior wife as a mother effectively equalizes all children's long-term health in a Bambara polygynous household. This implies that unobserved characteristics due to ethnicity could influence co-wife relationship and bargaining power in a child's health investment.

6. Robustness Checks

Instead of using health and nutritional outcomes as continuous variables, we use a child's health status of being stunted or wasted as a binary dependent variables in a linear probability model. The results are robust in both cases. First, a child in a polygynous household has an increased probability of being stunted by 34.8% (Table 7). Second, a child having a junior wife as a mother has 3.5% lower probability of being stunted compared to a child of a senior wife (Table 8).[7]

We also investigated different model specifications. The current specifications control for weather effects during the month of the interview. Changing the weather effects averaging previous two to three months do not change the results on HAZ. Furthermore, controlling household wealth as a continuous variable rather than a categorical one yields similar results. Controlling mother's education, father's education or household wealth as dummy variables did not change the results. Instead of grouping all junior wives together, we restrict polygynous households to be one senior wife and one junior wife, and observe similar children's health outcomes.

7. Discussion and Conclusion

Using the DHS data with 7,844 children in monogamous and polygynous households, we have investigated the following research agenda: 1) do the children of polygynous households fare better in terms of health and nutritional outcomes than the children of monogamous households, and 2) do the children of senior wives have better health and nutritional outcomes than the children of junior wives? Motivated by collective model of intrahousehold resource allocation, we have presented new empirical evidence that not only

[7] Qualitatively similar results were obtained using probit models.

the family structure in Mali has a significant effect on child health, but also mother's rank affects health investments in children in polygynous households.

Using instrumental variable approach with the sex of the firstborn predicting the likelihood of an additional wife, we find that the children in polygynous households have worse health and nutritional outcomes in terms of height-for-age and weight-for-age z-scores, as well as a higher probability of stunting and wasting. This is in contradiction to Becker (1981)'s hypothesis that women's welfare might be better when polygyny is allowed than when monogamy is enforced in a society with bridal price.[8] In a polygynous marriage market with competitive bride price, men attempt to maximize the number of surviving offspring with their limited resources (Bergstrom, 1994). Therefore, men need to consider the trade-off between allocating additional resources to the care of the current wife and her offspring and the purchase and support of an additional wife and her future offspring. This results in monogamous fathers having fewer offspring than polygynous fathers, thus each offspring might be more valued. Furthermore, in the context of Mali, co-wife rivalry can lead to generally poorer health status for children in polygynous households than for those in monogamous households. There are extensive reports of co-wife aggression towards each other's children in Malian courts (Strassman, 1997). Co-wife aggression further creates a stressful environment, which could negatively affect the well-being of especially young children (Flinn and England, 1997).

After establishing a causal relationship between polygyny and a child's health, we analyze the intrahousehold resource allocation among co-wives in credit-constrained environment. Contrary to previous findings by Strauss (1990), we observe that junior wives have a greater bargaining power in terms of health investment on their children. Strauss finds that children of junior wives are more likely to experience stunting and wasting. This result seems to be mainly driven by how the comparison groups are selected, however. When comparing the health outcomes of children of junior wives, Strauss includes the children of monogamous wives together with those of senior wives in polygynous households and finds that the children of junior wives have worse health outcomes. In our

[8] Becker asserts that if polygyny is allowed, than the demand for wives would move upward, leading to a higher bridal price for women. However, it should be noted that women themselves do not benefit from the higher bridal price, because "property right" is with the father of the bride, not with the bride herself.

previous analysis of the effect of polygyny on a child's health, we concluded that the children in monogamous households had better height-for-age and weight-for-age z scores. Therefore, by grouping these children with those of senior wives in polygynous households, Strauss might have obtained biased results.

We have replicated Strauss' grouping of the DHS sample in Mali, and found similar results as Strauss, with the children of junior wives faring worse (Appendix 1). However, when we restricted our sample to be children of senior and junior wives in polygynous households only, we find that the children of junior wives are in a better long-term health, in terms of height-to-age z score and less likelihood of stunting. This suggests that at least with Malian polygynous households, a junior wife's bargaining power is not as weak as previously assumed. This is in line with previous anthropological study by Strassman (1997). She finds that children of senior wives had higher child mortality rate than those of junior wives among the Dogon in Mali. Furthermore, previous anthropological studies suggest that senior wives possess more non-material privileges rather than actual material resources. One hypothesis is that while the first wife is usually arranged by the parents, men have greater influence in choosing additional wives. Therefore, polygynous husbands might prefer and thus allocate more resources to junior wives. Furthermore, since senior wives and their offspring had a period of time to enjoy household resources exclusively until an additional wife is taken by her husband, junior wives might be able to persuade their husbands that it's "their turn" to benefit from household resources. Investigating the effect of polygyny on women's health in rural Mali, Bove (2014) finds that senior wives were less likely to attain medical assistance than junior wives. Because the mother's rank is partially responsible for husband's health investment in children, children of senior wives receive less than efficient level of resource allocation. As a result, polygynous households are not allocating its limited resources optimally.

We also investigate the linkage between the importance of mother's rank and social context represented by mother's ethnicity. There have been extensive anthropological studies on three Malian ethnic groups: the Dogon, the Fulani, and the Bambara. Ethnological research suggests that while co-wife competition is prevalent and quite fierce among the Dogon and the Fulani, there is almost harmonious co-wife collaboration among the Bambara (Strassman, 1997; Madhavan, 2002). We test these ethnological findings

empirically and affirm that there is an empirical evidence that co-wife competition is stronger and benefits the junior wives more in resource allocation among the Dogon and the Fulani, whereas among the Bambara, there is a mitigating effect. Because mother's ethnicity is exogenous and affects resource allocation in a child's health investment, this provide another evidence that polygynous households are not utilizing their resources efficiently.

In summary, we find evidence that children in polygynous households are negatively affected in their health compared to those in monogamous households. Furthermore, we observe that mother's rank in polygynous households leads to inefficient resource allocation in children's health investment, reflected in the health and nutritional outcomes measured in height-for-age z score and likelihood of stunting and wasting. At the same time anthropological and ethnological studies suggest that co-wife competition and collaboration in polygynous households can only be identified within particular sociocultural contexts. In fact, co-wife relationship and its effect on a child's welfare needs to be investigated incorporating different institutional norms of polygyny in each society.

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Tables

Table 1. Summary Statistics and Variables – Monogamous and Polygynous Households

Variable	Monogamous HH (N=5030) Mean	S.D.	Polygynous HH (N=2814) Mean	S.D	Difference-in-Means T-Test
Health Status					
Height/Age Zscore	-1.361	1.924	-1.613	1.835	0.000
Weight/Age Zscore	-1.198	1.380	-1.312	1.370	0.000
Stunting	0.373	0.484	0.417	0.493	0.000
Underweight	0.266	0.442	0.291	0.454	0.015
Wasting	0.158	0.365	0.159	0.366	0.912
Instrument Variable					
First child is a girl	0.478	0.500	0.507	0.500	0.013
Parent Characteristics					
Mother's Height (mm)	1610	66.748	1613	63.574	0.031
Mother's Age (years)	25.304	6.418	28.83	6.926	0.000
Mother's Education	0.207	0.527	0.124	0.389	0.000
Father's Age (years)	37.35	8.919	43.96	9.279	0.000
Father's Education	0.336	0.690	0.233	0.580	0.000
Mother is the head of the household	0.043	0.202	0.029	0.169	0.004
Mother can make a medical decision	0.529	0.499	0.512	0.500	0.163
Household Characteristics					
Head of the household is female	0.057	0.232	0.056	0.230	0.844
Residence is urban	0.306	0.461	0.199	0.399	0.000
Household Wealth Index	3.022	1.344	2.667	1.310	0.000
Distance to Health Facilities	2.231	1.263	2.331	1.212	0.001
Number of Household Members	5.552	2.204	10.31	3.624	0.000
Number of Children under 5	1.877	0.754	3.135	1.353	0.000
Number of Children by Same Mother	4.000	2.342	5.408	2.655	0.000
Number of Women in the Household	1.066	0.415	2.234	0.905	0.000
Child Characteristics					
Child is a girl	0.488	0.500	0.510	0.500	0.063
Child is a twin	0.025	0.155	0.026	0.160	0.656
Birth Size	2.452	1.083	2.482	1.084	0.231
Birth Order	1.370	0.559	1.371	0.561	0.926
Birth Interval (months)	28.89	21.02	33.10	19.96	0.000

Table 2. Summary Statistics and Variables – Senior and Junior Wives in Polygynous HH

	Senior Wife (N=1446)		Junior Wife (N=1362)		Difference -in-Means
Variable	Mean	S.D.	Mean	S.D	T-Test
Health Status					
Height/Age Zscore	-1.643	1.864	-1.582	1.806	0.372
Weight/Age Zscore	-1.299	1.402	-1.325	1.334	0.610
Stunting	0.425	0.495	0.410	0.492	0.402
Underweight	0.292	0.455	0.290	0.454	0.915
Wasting	0.158	0.365	0.159	0.365	0.987
Parent Characteristics					
Mother's Height (mm)	1611	61.997	1615	65.226	0.073
Mother's Age (years)	30.35	6.542	27.2	6.956	0.000
Mother's Education	0.110	0.364	0.134	0.406	0.093
Father's Age (years)	41.85	8.262	46.27	9.716	0.000
Father's Education	0.242	0.595	0.220	0.558	0.318
Mother is the head of the household	0.054	0.226	0.004	0.061	0.000
Mother can make a medical decision	0.510	0.500	0.515	0.500	0.789
Household Characteristics					
Head of the household is female	0.062	0.242	0.048	0.213	0.092
Residence is urban	0.181	0.385	0.214	0.411	0.027
Household Wealth Index	2.668	1.296	2.658	1.322	0.837
Distance to Health Facilities	2.346	1.226	2.319	1.199	0.564
Total Number of Household Members	9.447	3.441	11.24	3.590	0.000
Total Number of Children under 5	3.006	1.307	3.274	1.389	0.000
Total Number of Children by Same Mother	6.147	2.494	4.640	2.595	0.000
Total Number of Women in the Household	2.008	0.836	2.471	0.915	0.000
Child Characteristics					
Child is a girl	0.490	0.500	0.530	0.499	0.035
Child is a twin	0.028	0.164	0.024	0.154	0.568
Birth Size	2.503	1.081	2.459	1.088	0.276
Birth Order	1.373	0.563	1.369	0.560	0.845
Birth Interval (months)	35.859	18.893	30.264	20.624	0.000

Table 3. Polygyny - First Stage Estimate

VARIABLES	(1) Polygynous HH
First child is a girl	0.0539***
	(0.0123)
Mother's Ethnic Fixed Effect	Yes
Cercle Fixed Effect	Yes
Constant	-0.335
	(0.289)
Observations	7844

The First stage includes all covariates used in the second stage regression. Standard errors are in parentheses and clustered at cercle level. *** p<0.01, ** p<0.05, * p<0.1

Table 4. Effect of Polygyny on Child Health (2SLS)

Description	(1) HAZ	(2) WAZ
Polygynous Household	-0.209**	-0.173**
	(0.0955)	(0.0801)
Mother's Ethnic Fixed Effect	Yes	Yes
Cercle Fixed Effect	Yes	Yes
Constant	-0.919***	-0.696***
	(0.126)	(0.111)
Observations	7844	7844
First Stage F-Stat	127.06	127.06

Standard errors are in parentheses and clustered at cercle level. Additional controls include weather shocks (total amount of rainfall and average temperature at the time of interview), parental characteristics (mother's age, education, height, occupation, medical decision, head of the household; father's age, education, occupation), household characteristics (wealth, residence, number of members, water source), child characteristics (gender, age, twin, birth size, birth order, birth interval). *** p<0.01, ** p<0.05, * p<0.1

Table 5. Effect of Mother's Rank on Child Health

Description	(1) HAZ	(2) WAZ
Mother is a junior wife	0.179**	0.0343
	(0.0696)	(0.0519)
Mother's Ethnic Fixed Effect	YES	YES
Cercle Fixed Effect	YES	YES
Constant	-10.69***	-6.542***
	(1.934)	(1.708)
	3,384	3,384

Standard errors are in parentheses and clustered at cercle level. Additional controls include weather shocks (total amount of rainfall and average temperature at the time of interview), parental characteristics (mother's age, education, height, occupation, medical decision, head of the household; father's age, education, occupation), household characteristics (wealth, residence, number of members, water source), child characteristics (gender, age, twin, birth size, birth order, birth interval).

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

Table 6. Effect of Mother's Rank on Child Health by Ethnicity, with the Dogon and the Fulani as the reference group

	Bambara	
Description	(1) HAZ	(2) WAZ
Mother is a junior wife	0.372***	0.157
	(0.136)	(0.119)
Mother's Bambara	-0.0834	0.00513
	(0.114)	(0.106)
Interaction Effect (Junior x Bambara)	-0.323**	-0.198
	(0.159)	(0.128)
Constant	-9.593**	-7.302**
	(3.756)	(2.859)
Observations	1,761	1,761

Standard errors are in parentheses and clustered at cercle level. Additional controls include weather shocks (total amount of rainfall and average temperature at the time of interview), parental characteristics (mother's age, education, height, occupation, medical decision, head of the household; father's age, education, occupation), household characteristics (wealth, residence, number of members, water source), child characteristics (gender, age, twin, birth size, birth order, birth interval).

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

Table 7. Effect of Polygyny on Child Health, in terms of Stunting, Underweight, Wasting

Description	(1) Stunting	(2) Underweight	(3) Wasting
Polygynous Household	0.348**	0.144	0.152*
	(0.176)	(0.111)	(0.0922)
Mother's Ethnic Fixed Effect	Yes	Yes	Yes
Cercle Fixed Effect	Yes	Yes	Yes
Constant	1.800***	0.743***	0.210**
	(0.167)	(0.131)	(0.0882)
Observations	7,985	7,985	7,985
First Stage F-Stat	2,259	2,259	2,259

Standard errors are in parentheses and clustered at cercle level. Additional controls include weather shocks (total amount of rainfall and average temperature at the time of interview), parental characteristics (mother's age, education, height, occupation, medical decision, head of the household; father's age, education, occupation), household characteristics (wealth, residence, number of members, water source), child characteristics (gender, age, twin, birth size, birth order, birth interval).

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

Table 8. Effect of Mother's Rank on Child Health, in terms of Stunting, Underweight, Wasting

Description	(1) stunting	(2) underweight	(3) wasting
Mother is a junior wife	-0.0350**	-0.00133	-0.00970
	(0.0170)	(0.0164)	(0.0138)
Mother's Ethnic Fixed Effect	Yes	Yes	Yes
Cercle Fixed Effect	Yes	Yes	Yes
Constant	2.668***	1.250**	-0.0131
	(0.479)	(0.532)	(0.409)
Observations	3,384	3,384	3,384

Standard errors are in parentheses and clustered at cercle level. Additional controls include weather shocks (total amount of rainfall and average temperature at the time of interview), parental characteristics (mother's age, education, height, occupation, medical decision, head of the household; father's age, education, occupation), household characteristics (wealth, residence, number of members, water source), child characteristics (gender, age, twin, birth size, birth order, birth interval).

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

Appendix

Appendix 1. Effect of Mother's Rank on Child Health, with Monogamous Mothers Grouped with Senior Wives

Description	(1) HAZ	(2) WAZ	(3) WHZ
Mother is a junior wife	-0.0117	-0.0485	-0.0719**
	(0.0538)	(0.0407)	(0.0342)
Mother's Ethnic Fixed Effect	Yes	Yes	Yes
Cercle Fixed Effect	Yes	Yes	Yes
Constant	-8.321***	-6.461***	-2.613***
	(1.087)	(0.953)	(0.874)
Observations	9,265	9,265	9,265

Standard errors are in parentheses and clustered at cercle level. Additional controls include weather shocks (total amount of rainfall and average temperature at the time of interview), parental characteristics (mother's age, education, height, occupation, medical decision, head of the household; father's age, education, occupation), household characteristics (wealth, residence, number of members, water source), child characteristics (gender, age, twin, birth size, birth order, birth interval).

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

Appendix 2. Effect of Mother's Rank on Child Health by Ethnicity, with Monogamous Mothers Grouped with Senior Wives

Description	(1) HAZ	(2) WAZ	(3) WHZ
Mother is a junior wife	-0.0851	-0.106**	-0.0902**
	(0.0590)	(0.0478)	(0.0415)
Mother's ethnic group is Fulani or Dogon	-0.00770	-0.0642	-0.0712
	(0.0725)	(0.0643)	(0.0524)
Interaction Effect (Junior Wife x Ethnicity)	0.291**	0.232**	0.0808
	(0.111)	(0.0934)	(0.0820)
Cercle Fixed Effect	Yes	Yes	Yes
Constant	-8.154***	-6.226***	-2.444***
	(1.113)	(0.966)	(0.859)
Observations	9,265	9,265	9,265

Standard errors are in parentheses and clustered at cercle level. Additional controls include weather shocks (total amount of rainfall and average temperature at the time of interview), parental characteristics (mother's age, education, height, occupation, medical decision, head of the household; father's age, education, occupation), household characteristics (wealth, residence, number of members, water source), child characteristics (gender, age, twin, birth size, birth order, birth interval).

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