The lion's share. An experimental analysis of polygamy in Northern Nigeria

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Abstract. Although polygamy is common in many parts of the world, most economic analysis of the household focuses on monogamy. We use simple public good games to investigate experimentally theories of household behavior. A unique aspect of our research is that half our sample are polygynous households recruited systematically from villages in rural areas south of Kano, Northern Nigeria, one of the modern heartlands of polygyny. Spouses play two variants of a voluntary contributions game in which endowments are private knowledge, but contributions are public. In one variant, the common pool is split equally. In the other treatment the husband allocates the pool (and wives are forewarned of this). Most partners keep back at least half of their endowment from the common pool, but we find no evidence that polygynous households are less efficient than their monogamous counterparts. We reject a strong form of Bergstrom's model of polygyny in which all wives receive an equal allocation. Senior wives often receive more from their husbands, no matter what their contribution. Thus their return to contributions is higher compared to their junior counterparts. However, the clearest result is that when they control the allocation, polygynous men receive a higher payoff compared to both their wives and their monogamous counterparts.

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I. Introduction.*

Polygamy is a familiar and apparently robust social institution, found in 85% of cultures (Henrich et al, 2012) across many nations and around the world. Its most typical form is polygyny, where a husband has two or more wives, and in this form its incidence is significant in more than 50 countries (Tertilt, 2005, Jacoby, 1995).[i] Though widespread and seemingly integral to the economy of many societies, the empirical investigation of intra-household behavior in polygyny has attracted comparatively little attention; the evidence we have tends to be sparse and often contradictory. Take for example whether polygynous households are efficient. it might be suspected that free-riding and destructive rivalry between competing wives hampers efficiency in polygynous households, (see for example Strassmann, 1997) but there is a lack of clear evidence on whether this is actually the case (Mammen, 2004). Meanwhile, there are, competing views on the allocation of resources within polygynous families in Islamic sub-Saharan Africa, with some writers arguing that Koranic injunctions mean that wives are treated equally (Solivetti, 1994), while others conclude that senior wives obtain more (Ware, 1979) or that it is wives with children who receive greater resources. (Izugbara and Ezeh, 2010).

In this paper we take the research in a new direction, by reporting a lab-in-the-field experiment with polygynous spouses in a northern part of Nigeria, the country with the highest recorded number of such families. Given the lack of pre-existing data, we concentrate on some simple hypotheses. As with monogamous families, the most straightforward questions to consider with polygyny concern household efficiency and intra-household allocation. Are monogamous households more efficient than polygamous– in the sense of coming closer to maximizing household surplus? In polygynous households, which wife receives the greater share of incomes? How are resources allocated? These questions provide a starting point for our design which employs two versions of a one-shot voluntary contribution game: one with a fixed rule of allocating the communal pool and one in which the husband must make the allocation. In addition, we run a follow-up household survey 1-2 months later, in which wives and husbands are interviewed separately. In this way, we tie our experimental results to more traditional forms of household data. To offer a preview

of our results, broadly speaking we find that both types of households in our sample are equally inefficient in their decisions – there is no efficiency penalty or bonus for polygyny. In terms of payoffs, senior wives in polygyny fare no worse than wives in monogamous households, but polygynous husbands do better than their monogamous counterparts. Most clearly, second wives are disadvantaged compared to their co-spouses when men control the allocation of resources.

II. Background

Although polygyny is common and its prevalence has been negatively linked with economic development (Tertilt, 2005), interest in it from an economic perspective has been intermittent and economic theories about behavior within such households are correspondingly rare (see Fenske 2015 for an excellent overview). Most attention has been paid to the conditions under which polygyny is an equilibrium outcome in the marriage market (e.g. Grossbard, 1978). For instance, Becker's (1974 and 1991) pioneering discussion, variation in male productivity is given as one possible reason for polygyny. Total output may be higher when more than one female is matched with some males, compared to a situation where only monogamy matches are allowed. Given such efficiency and a competitive marriage market, polygyny may result

Against this, Becker 1991 raises the possibility of diminishing returns to scale in polygyny because one input (the husband) is fixed. Significant diseconomies might also arise through free-riding in the provision of household public goods or through the constant and destructive rivalry between wives regularly described in qualitative interviews with polygynous families (e.g. Solivetti, 1994 or Strassmann, 1997). Mammen, 2004, for example considers a data set on child mortality for Cote d'Ivoire (see also Kazianga, and Klonner, 2009 for neighbouring Mali), and concludes that intrahousehold competition for resources may lead to inefficient investment in the household's children. Against this picture of rivalry and mutual distrust, there may be some significant economies of scale in marriage size, such as through the division of labor. After all, in standard economic models of the marriage market, it is this division that helps drive the efficiency advantages of marriage over singlehood, and it would seem quite reasonable to suppose that there are continued gains from greater

household size. Either way it would be useful to have some comparative evidence on the relative efficiency of intra-household decisions.

Perhaps the most complete microeconomic model of the allocation of resources within polygyny is provided in Bergstrom's (1994) well-known though unpublished paper. He supposes that for women there are first increasing then decreasing returns to scale in the production of children, f (see Figure 1 where $\hat{r}$ represents a turning point above which the function is concave) from the investment of resources, r. Given a low enough turning point in the production function, it is then optimal for a husband who cares only about his own consumption and the number of his surviving children to marry more than one wife and then allocate resources equally to the spouses when child productivity is symmetric.

[Figure 1 here]

Formally, consider a husband with income Y who must divide it between his own consumption and investments, r_1 and r_2 in the production of children from his two families. He maximizes the payoff function,

$$u(Y - r_1 - r_2) + f(r_1) + f(r_2)$$

Where u(.) is his utility from personal consumption. The first order conditions yield:

$$f'(r_1) = f'(r_2)$$

Where $'$ indicates a first derivative. If all functions are concave (or have low enough turning points), then at the maximum $r_1 = r_2$. That is, the husband allocates equal funds to the two families and produces equal numbers of children, $f(r_1)=f(r_2)$. Consequently in any increment in income the wives receive equal shares.

We view this theory as a useful organizing device and provider of a simple null hypothesis in what follows, but it comes from a deliberately simple and naïve model (Bergstrom describes it as 'a crude caricature of the reality of polygamous marriage markets' which is probably overstating the point). As the author, says, though, "Because the structure is simple and easily understood, it should be quite possible to test it in applications" (p. 18 Bergstrom, 1994) and that is the spirit in which we use it. Nevertheless, there are a number of important ways in which reality differs from the simple model, so it is useful to consider at least some basic extensions. For example,

after some years of marriage the husband will usually have information on his wives' fertility. It suggests the more appropriate maximand is,

$$u(Y - r_1 - r_2) + \alpha_1 f(r_1) + \alpha_2 f(r_2)$$

Where α_i represents the husband's post-experience view of fertility. If resources are currently allocated to maximize this function and the allocation is on the concave part of the production functions, then a higher allocation is given to the more productive wife. For an increment in Y,

$$\frac{dr_1}{dY} \Big/ \frac{dr_2}{dY} = \frac{\alpha_2 f''(r_2)}{\alpha_1 f''(r_1)}$$

Where f'' is the second derivative of f. If, for instance, the elasticity of f(r) is constant, then a higher incremental allocation of income will be given to the wife with the *higher* relative productivity. For instance, suppose that $\alpha_i = \alpha(y_i, n_i / m_i)$ where y_i is the age of the ith wife and n_i/m_i is the number of children per year of marriage. We might expect that α_i is increasing in n_i/m_i and decreasing in y_i (Bongaarts and Casterline, 2013), in which case at the margin resources will be steered towards wives who are a) younger and b) have had more children per year of marriage.

Though this is not a feature of the basic model, the allocation of resources might also depend on the bargaining power of wives. Divorce is common in many polygynous societies, including our target site (see below) and it is often initiated by women (Jackson, 1993). Whether this gives relatively more power to senior or junior wives is not obvious. Women only usually retain custody of young children, suggesting that it is older women who have most to lose from divorce, but divorce can be emotionally and financially disruptive when the bonds between partners are more numerous, making more salient the fear of divorce for a husband in a longer-established family. The overall effects of these forces is unclear, but Izugbara and Ezeh, 2010, quote the view that "… in polygynous marriages in Islamic northern Nigeria, husbands allocate resources to their wives based on the number of children they have; the wife with the most children attracts the greatest proportion of his resources." P. 200 [ii]

These models and concepts relate allocations to demographic factors and measures of bargaining power. As such, they are squarely within traditional economic approaches to explanations of intra-household behavior. Non-economic explanations

of household allocation stress the power of social norms. In particular, in northern Nigeria the Koran provides a powerful guide to social behavior. Solivetti, 1994, attests that local interpretation of Koranic law in northern Nigeria favors equal treatment of wives[iii]. However, Ware, 1979 reporting on polygyny elsewhere in Nigeria finds a perceived norm of preferential treatment for senior wives in the opinions of her small sample of married subjects.

2.1 *Locational Background*

Nigeria is one of a significant number of countries where polygyny is common and apparently stable in the sense that it has shown but a slow and erratic tendency to decline in the modern era. According to the 2013 Demographic and Health Survey, [iv] 44.1% of married women in the largely Muslim North-west region of Nigeria (where our study is located) reported having one or more co-wives (National Population Commission and ICF International, 2014). This compares to 41.9% in the 2008 survey and 37.2% in 1999. Conversely, 25.6% of married husbands reported two or more wives in the same region. For husbands, this compares to 24.2% reported for the same region in a 1999 survey and 27.1% in 2008. In other words, there is no sign that in the north-west (and some other northern regions) that polygyny is on the wane. Polygyny is more common in rural areas by about sixteen percentage points, more common amongst lower educated individuals and common at all wealth levels. In the vast majority of polygynous marriages, two wives are married to one man, but nationally 2.6% of married women in 2013 reported having two or more co-wives.

Within Nigeria, marriage practices differ by religion, region and ethnic group. Our sample is drawn from the Hausa people, the largest ethnic group in the north of Nigeria who also live in significant numbers in neighboring countries such as Niger. Hausa are Muslims and practice female seclusion as a cultural norm for married women (Hill, 1969). Hausa is a patrilineal society and one patrilocal extended family normally occupies a single compound with separate dwellings for each wife. Married women often do not go out in daylight except for occasions such as marriage ceremonies or to seek medical help (Calloway, 1984, Robson 2004). Among the Hausa, the reality of female seclusion varies with the nature of the settlement and the prosperity of the family. In general, it is more complete in urban areas and amongst higher income families (Calloway, 1984). In dispersed settlements, away from the

main towns, there can be relatively little seclusion. Although seclusion limits their physical mobility, women have a significant degree of economic autonomy. They engage in various small-scale enterprises and many are highly active producers and traders of craft and food products. In this regard, children act as intermediaries with girls to the fore, hawking goods, passing messages and learning the skills of the marketplace. Robson, 2004, reports that girls spend twice as much time per week on trading as they do on domestic work and four times as much time as boys do.

Within the region, population density is relatively high and most farming is intensive. Crops include wheat, rice, millet, sorghum, maize, cowpeas and groundnuts, but there is also some livestock farming and horticulture. However, the practice of seclusion means that while they engage heavily in agricultural processing activities for their own profit, married Hausa women play little role in cultivation, which is carried out largely by men with the aid of children (Hill, 1969; Jackson, 1985).[v] What money wives earn is usually for themselves, accounts are kept strictly separately from their partners and spent according to their own priorities. "In Kano [the main city of the region], a woman's trade is so individual that a husband will actually buy prepared food from his wife for his meals." Calloway, 1984, p. 440. Meanwhile men are responsible for providing normal consumption goods, housing and investing in agriculture. Divorce is relatively common and frequently initiated by women (in 86% of cases according to Solivetti, 1994). Jackson, 1993, reports a lifetime average of 2.3 marriages per woman amongst Hausa, while Calloway, 1984, concludes that around 50% of women will at some stage in their lives go through the process of divorce, emphasizing that remarriage is the overwhelming norm for pre-menopausal women and occurs rapidly because most women who would otherwise face social isolation. Overwhelmingly, in the survey that accompanies our experiment, both men and women state that, upon divorce men and women typically retain their own property, including land, livestock, tools, cash and housing. Older boys and girls usually go with fathers, while younger children, especially girls, are more likely to go with mothers.

III. Design

To test efficiency and to examine male allocation within polygyny, we have two relevant treatments based upon a simple public good game (see Table 1 for a

summary). We conduct the experiment on both polygynous and monogamous households, though obviously we do not have random assignment to these categories. This creates a 2x2 design with each household playing one variant of the game (i.e. this is a between subjects experiment).

Table 1 here.

The first treatment can be thought of as a benchmark. In treatment 1, each subject, i, separately and privately receives an endowment of E_i = 400 Nairas(approximately $2.7 in 2010 which is approximately 1.9 days of per capita expenditure in this region using the estimates of household expenditure for our survey). Each person then chooses an investment, x_i from the set {0, 100, 200, 300, 400}. The investments of the spouses are summed and multiplied by 1.5 and then each receives an equal fraction of the total together with any money that he or she has not invested. In the second treatment each subject separately and privately receives the same 400 Nairas as in treatment 1 and makes an investment decision from the same choice set. The investments are summed and multiplied in the same manner, but then the husband chooses how much to allocate to each person in the household. The husband's decision is made using the strategy method – i.e., after he has made his investment decision, he must propose a binding allocation of payouts for possible investments by his wife. The monetary payoff for a participant is then the sum of the money allocated by the husband plus any money the person kept back from the investment.

There is an issue in voluntary contribution games about the best way to compare games with different numbers of players. Consider a game where rewards are linear in investments and the common pool is split equally between n players. Suppose that the per person endowment is E(n), and the multiplier for total contributions is m(n). Thus if no-one contributes, per person payoffs are A(n) = E(n) and if everyone contributes all of her or his endowment the per person payoff is B(n) = E(n).m(n). In this case, the private marginal return on investment is c(n) = m(n)/n. It follows that B = nAc, so that not all of A, B and c can be independent of n. If c and B are constant then A = (1/n)(B/c) so that A must fall inversely with n. Similarly if A and c are constant then B must be proportional to n. We took the view that it was most important that, if everyone were completely selfish, each person would end up with the same payoff independently of household size and secondly if the household were unitary, payoff per person would be independent of household size. This dictates that we keep constant the endowment per person across conjugal types and we keep constant m

(=1.5). So, the private marginal return, c = 0.5 in a 3 person game, compared to 0.75 in the two person game.[vi]

The private endowment E_i was known only to individual i, whereas the common account and the final allocation from that account was common knowledge. We told participants that,

> The exact amount will vary between people, but you will receive something between 0 and 400 Nairas. [Show the envelope.] Your husband will receive a similar envelope and he will receive an amount of money between 0 and 400 Nairas. He does not know how much you have in your envelope and you won't be told how much he has in his envelope. (Instruction for a wife in the monogamy case).

As we stated above, in fact within the sub-sample of households in this paper all subjects received exactly 400 Naira. Other monogamous couples were also partaking in the same sessions, in treatments where endowments did differ from 400. As a result, in a typical session about 26% of subjects had endowments other than 400. Our choice of vagueness about the partner's endowment is designed to mimic the typical household situation, in line with Iversen et al, 2011. Asymmetric information about individual resources and spending is a familiar part of household behavior in many cultures, including the Hausa (Calloway, 1984). Our follow-up survey amongst participants confirms this. This instruction was also chosen for ethical reasons, to avoid potential household conflict after the games. It allows an element of plausible deniability for subjects who do not contribute everything to the common pool.

It is worthwhile stressing that in this experiment the total surplus maximizer has no incentive to withhold contributions, even with asymmetric information, but of course players with different motives may wish to hide some or all of their endowment from their partner. Here this could be achieved by not placing some of the endowment in the common pool, but because there are other motives for not investing which apply even if endowments are common knowledge, we cannot interpret all failures to invest as evidence of deceit. The clearest evidence of attempts to conceal resources is provided when the potential investor also controls the allocation (i.e. the husband in treatment 2).

In the case of the strategy method used in Treatment 2, for monogamous couples, each husband made five conditional allocations – one for each possible investment level by his wife. For polygynous couples we would need 25 conditional allocations.

Under the circumstances of the experiment, this was logistically impossible, so we selected a subset of 5 possible investment combinations. If one of these combinations matched the actual pattern of investment, then the conditional allocation was binding. If it did not match, we asked the husband to make an actual allocation once the true investment pattern was revealed to him. The husbands did not know the 5 combinations before they made their investment choices. They were told,

> … you will decide how to split the money in the common envelope. You have to decide how much to give to each of your wives and how much to keep for yourself. In a moment we will give you some time to think about how much money you want to leave in your envelope. After you have made your decision, we will ask you some questions about how you want to divide the money in the common envelope between yourself and your wives.

The experiments took place on five consecutive days in July 2009. The locations were five villages (i.e. one village per day) selected purposefully in the Kadawa, Garum Malam, Kura, Bunkura and Bebeji districts approximately 1-2 hours south of Kano city. The villages needed to be sufficiently large to generate a sub-sample of 80 households, to be isolated from one another to avoid contamination, to be largely agricultural but still accessible within one day from Kano. An initial site selection and a second visit were made to draw up a census of households in each village including identifiers for the number of wives. Using a random number generator families were invited from this roster, with separate selection of the monogamous and polygynous households. For all households it was made clear that only if all spouses turned up could they be accepted. In the case of polygynous households, households with more than 2 wives were eliminated from consideration. In the rare case of no-shows, we used the same random generator to find a reserve family.

The actual villages were between 4 and 10 km from the next nearest site. Their size was typically 200-300 households and the villages were highly homogeneous in terms of ethnicity and language spoken (Hausa) and religion. Approximately 10-15% of households fitted our requirements for the polygyny sub-sample. Given the state of the roads and our rapid movement from site to site, we do not think that contamination between sites is an issue. Certainly we see no trend in the results over 5 days. In four of the five locations, no suitable public building was available for the

experiments, so maize plantations were used instead with people sitting on the ground. In the fifth location, a village school was available for use.

Our visit to a village consisted of a morning and an afternoon session on one day. Each session had different treatments to reduce the possibility of contamination. We alternated treatments across morning and afternoon across villages. In each session there was one polygynous sub-sample of 8 households and one relevant sub-sample of 8 monogamous couples. In addition to these groups, there were other sub-samples of monogamous couples in the same session who were playing treatments that we do not discuss in this paper, because they have no comparator group of polygynous households. These treatments involved different rules for the allocation or different rules for the endowment and how it was generated. Within monogamous couples, assignment to treatment was random.

The actual experimenters were 12 (6 female and 6 male) local researchers recruited through the advice of local partners from Bayero University, Kano. Most of them had some background in Sociology or Economics. Some of them had experience with the implementation of household surveys. All of them spoke very good English. The experimenters received five days of training. The first day of training was used for explaining the principles of how to run experiments (what to do and what not to do with examples) and presenting all the treatments to be played in Nigeria. On days two and three, experimenters practiced in Hausa (and sometimes in English so that the foreign team leaders could understand). On day four we ran a pilot using a small sample of subjects. The fifth day of training was used to give individual and collective feedback on the pilot, to explain the logistics for the game days and to distribute the material needed for the game days. The experiments used scripts translated into Hausa and then back-translated into English.

After a very short initial briefing provided to all participants, secrecy was ensured by calling one household at a time and separating each person, with the husband going to one location with one researcher and each of the wives going separately to another location with other researchers. We then briefed the subjects on the nature of the task (see appendix for the instructions) and they then faced three test questions to check understanding.[vii] For the investment decision, each spouse removed from their envelope what they wanted to keep for themselves, with the remainder left for the common account. A helper collected their envelopes and recorded the decisions. For

the allocation decision, the experimenter went through each conditional investment in turn and recorded the subject's answers.

IV. Results

Tables 2 and 3 set out background information from the accompanying survey.[viii] Recall that there were 40 households in each cell of the design. This makes 160 men in total and 240 women.

Table 2 here.

The typical polygynous family is larger than its currently[ix] monogamous counterpart, has a higher income and the husband is older. As measured by the number of radios, or other relatively frequently owned assets, polygynous husbands are also wealthier.[x] In our monogamous sample, around 20% of male subjects and 10% of female subjects report having been married before. With spousal death (usually a wife) accounting for 30% of cases in which marriages ended, it suggests that our sample has relatively low divorce rates compared to the standard view of the region (e.g. in Jackson, 1993 or Calloway, 1984). There is some evidence of a bimodal shape in the second wife ages: only 30 out of 220 monogamous marriages involve a wife who married at age 20 or over; only 7 (out of 80) first marriages had the same status, whereas 23 out of 78 second marriages involved women who were at least aged 20. This would be consistent with Last (1992) view of a mixed motive for second marriages, at least some of which were not for the purpose of producing children.

When we asked polygynous spouses about cooperation and allocation practices differences emerged between husbands and wives, as documented in Table 3. Largely, spouses reported equal allocation of time and money to wives, but with some favoring of first wives in decision-making. First wives were less likely to claim a major say in decisions, compared to second wives' perceptions of the first wives' role. Conversely, first wives granted second wives a greater say in decision-making than second wives claimed was the reality.

Table 3 here.

We also asked questions about cooperation, both generally and specifically. Answers were largely consistent between household partners: about 90% agreed that the wives cooperated most of the time, with the remainder stating that the wives cooperated sometimes (the remaining alternatives were rarely and never). For specific tasks, namely for child-rearing, cooking, buying provisions and agriculture the percentages stating that wives cooperated most of the time were lower, but still always the majority response by all three spouses. Meanwhile, around 65% of husbands stated that they would not hide any part of a windfall from their wives. The percentage was very similar for women, across family types, but second wives were slightly more likely to state that they would hide all of a windfall (20.5%) compared to first wives (15%) and wives in monogamy (15%).

We now turn to the experimental results, considering first the investment data.

Result 1. Men and women rarely invest their full endowment.

Table 4 sets out the mean investment levels in the common pool across the experiment at both the household and individual level. A basic feature is that, across all types of spouses in the different treatments and marriages, subjects rarely invest all of their endowments. Thirteen and eleven out of eighty men invest all their endowment in treatments 1 and 2 respectively. For women, the corresponding numbers are just one and two. In fact, the modal investment for women is 25% of the endowment and, overall, a majority of subjects invest half or less of their endowments. Consequently the mean investment rate overall is less than 50%. Though low, these figures are not out of line with similar games played in Uganda (Iversen et al, 2011), Ethiopia (Kebede et al, 2014) and India (Munro et al, 2014).

Table 4 here.

Result 2. Investment rates do not vary significantly between polygyny and monogamy.

A second basic feature of this data is the lack of variation across treatments at the level of the household and the lack of variation across household types. Median tests accept the null hypotheses that rates of household investment are the same across treatments within marital groups and across marital groups within treatments. We do

not reject the null hypothesis that husbands and wives investment the same fraction in monogamy and polygyny. In other words, there is no evidence of an efficiency cost to polygyny even in the treatment where all investment funds are shared equally between all partners. It is also noticeable from the last row of the table, that there is no significant difference between the investment behavior of first and second wives in polygyny.

Result 3. Husbands generally invest more than wives in both polygyny and monogamy.

For men the modal investment is 50% of their endowment. As a result, we generally reject the null hypothesis of equal rates of investment between men and women, although the difference is not significant in treatment 1 for monogamous households.

Table 5 shows mean payoffs, that is total rewards including any part of the endowment that is kept back by the spouse from the common pool. Recall that if all subjects invest no endowment, then the payoff is 400 Nairas per person, while if all endowments are given to the common pool and distributed equally, the result is 600 Naira per person.

Result 4. In treatment 1, payoffs for polygynous wives are significantly higher than husband's payoffs.

Mean rewards cluster around the 500 Nairas per person mark. In treatment 1, polygynous husbands invest more than their monogamous counterparts and more than their wives. The equal split rule enacted for this treatment means that the rewards of their higher investment are shared around the family. As a result, the payoffs for polygynous wives are higher than husbands' payoffs in treatment 1.

Table 5 here.

Result 5. In treatment 2, polygynous men earn significantly more than monogamous men and more than their wives.

In table 5, the final column shows tests of equality of outcomes across treatments. Men do better in treatment 2 and the difference is statistically significant at the 5%

level for monogamous households and at the 1% level in polygyny. In addition, in treatment 2, polygynous husbands invest less than in treatment 1 and less than monogamous men. They also claim more from the eventual allocation and this gives them the greater reward compared to monogamous men. Table 5 uses the actual investment and allocation, but the result does not depend on whether we focus on the conditional allocations or the actual allocations. For instance, in the case where the wives conditionally invest 100, the mean payoff to the husband is 447 Naira under monogamy and 467 under polygyny (t-statistic 0.95, p=0.167); where wives conditionally invest 300, the mean payoffs are 616 and 714 (t-statistic, 5.29, p=0.000) and where wives are posited to invest 400, the mean payoffs would be 691 and 822 (t-statistic, 3.91; p=0.000).

However, for women the outcome in polygyny depends on whether they are first or second wives:

Result 6. First wives in polygynous households do no worse than women in monogamy.

Across both treatments there is no statistically significant difference in the payoffs to first wives compared to payoffs for monogamous wives.

Result 7. Comparing treatments, it is second wives whose earnings are significantly lower when men control the allocation.

In treatment 1, on average second wives take away 528 Nairas, but when husbands control the allocation they receive only 435 Nairas. For first wives treatment 2 rewards are lower than treatment 1, but the gap between treatments is not so large. As a result, second wives earn significantly less than first wives in the treatment where husband allocate resources.

Table 5 uses data on actual allocations. Table 6 uses the full set of strategy information and sets out the patterns of allocation in polygynous and monogamous households in treatment 2. In each cell in the section of the matrix dealing with polygyny, there are three entries, representing the allocation to the husband, to the first wife and to the second wife respectively. With the monogamy column the first of

the two entries is for the man and the second is for the wife. For polygynous families the rows and columns represent the first and second wife's conjectured investment. For monogamy the rows show the wife's conjectured investment level.

Table 6 here.

Result 8. For both monogamous and polygynous households, in all the conditional allocations, men take the largest share of the rewards.

So, men take the lion's share of the proceeds. As investment levels rise, rewards rise for all parties with some sharing of the rewards of greater investment. On the whole, first and second wives earn closely related amounts.

Result 9. Within polygynous households, mean conditional allocations to second wives are always lower than allocations to first wives.

Result 9 which can be seen by looking at the Wife 1 and Wife 2 columns of Table 6, means that the second wife's relative investment does not affect whether she comes out ahead in the allocation. Result 9 is particularly stark in the case where the second wife's investment is four times that of the first. In fact in only one household was the second wife allocated more than the first in any actual allocation.[xi] Out of the full set of conditional allocations there were 13 cases of higher allocations to second wives (4 from the same household), compared to 62 cases of higher allocations to first wives and 125 equal shares. Thus there is neither equal allocation of resources between families nor are there greater transfers to wives with fewer children. [xii]

Still considering treatment 2, for each wife we take the difference between her conditional allocation when she invests 100 and when she invests 400. In the case of polygyny, the other wife's conditional investment is held constant at 100 Nairas. The results are reported in Table 7.

Result 10. Under polygyny and male control of the allocation senior wives earn a higher marginal return than junior wives.

Table 7 also shows that the marginal return to wives is lower under polygyny (though this is not so surprising given the design). It is though notable that wife 1

obtains a higher return than wife 2 even from wife 2's marginal investment, though this difference is not significant.

Table 7 here.

Table 8 shows the *final* returns on investment for partners in the husband-controlled allocation. In other words for each woman we divide her actual allocation by her investment and then average across households. In a few cases, there is no investment, so this is omitted from the relevant sub-sample. For polygynous households we break the sub-sample down further, according to whether the first wife's investment was higher than the second wife's investment etc. A number of features are readily apparent from this table. First, male returns are higher than females for polygynous households. For monogamous households the male and female figures are almost the same. Secondly, within polygynous households, the returns to wife 1 are higher than returns for wife 2. However, this pattern of returns depends critically on relative investment levels. Recall the earlier statement that first wives are rarely allocated less, but that typically both wives are allocated similar amounts by the husband. In this situation, the wife who invests more than her co-wife faces reduced returns. Table 8 shows this by breaking down the polygynous households according to which wife invested more. We can see that when the first wife invests less she does particularly well, relatively. Conversely, when a wife invests more her returns are attenuated by the equalizing nature of male allocation. This we summarize as:

Result 11. In treatment 2, monogamous men earn the same rate of return as their wives, but polygynous men earn a higher rate of return than their wives.

Table 8 here.

4.1 Regression results.

We noted above differing theories about investment and allocation rules in polygyny. In particular allocation may be related to past and future fertility as well as religious norms. In this section we use some of the other data from the accompanying survey to cast further light on behavior within the experiment.

In Table 9, in all cases the dependent variable is the fraction of endowment invested. Since this value is censored at zero and 1, the models estimated are tobit.

The dependent variable is actually categorical but as we do not get qualitatively different results if we use OLS or ordered logit we report the results shown. For men there are 160 observations and for women there are 240 observations, but when we add additional controls, the sample size drops slightly due to missing values for some households.

For the equation with additional controls, we try a large number of variables, very few of which have any explanatory power. The equations shown are representative, in that they include the few variables that have significant explanatory power across many specifications, along with some (insignificant) variables that might be expected to be correlated with investment. For male investment, the variable that stands out is female clothing share. Female clothing share is often used as an indicator of female bargaining power (e.g. Lundberg et al, 1988). Here men invest significantly less when more clothing expenditure is on adult women. For women there is a similar paucity of significant explanatory controls. There is some weak evidence that older women invest more and that higher rates of female land ownership are associated with higher investment. There is stronger evidence that higher male income is associated with higher levels of female investment, whereas when wives perceive their husbands to have more leisure (the alternatives are women have more and equal leisure), they are less likely to invest. Apart from the constant, there are no variables that are significant in both men and women's equations.

Table 9 here.

We turn to the allocation data. For polygynous households in treatment 2, let y_i i = h, w1, w2, be the allocation to the husband, senior wife and junior wife respectively. We are interested in estimating equations of the basic form:

$$y_i = Z\alpha_i + X_i\beta_i + \varepsilon_i$$

Where X is a matrix of explanatory variables that can include features of the marriage, and household characteristics, while Z represents the investment levels of the 3 partners. The symbols α and β represent the corresponding parameter vectors and εs are error terms.

The key issues are whether and why second wives are treated differently from first

wives. As discussed in section 2, the Bergstrom model predicts that wives will be treated equally. In the extended model referred to in the same discussion, the husband updates his priors on the fertility of the wives and channels resources towards the wife with the higher anticipated fertility. Alternatively, it may be that the being second itself directly affects the allocation. Another possibility is that the wives may have some bargaining power and this influences the allocation. Given this, for the additional controls, we select two groups of variables: fertility and wife's age are chosen to reflect the extended Bergstrom model. The other group includes variables that are typically used as proxies for wives' bargaining power (e.g. Kebede et al., 2014): whether the wife's mother is still alive; and the educational level of the wife. The final proxy for bargaining power is the presence of an older female child in the household since, as we noted, these daughters provide a valuable connection between secluded wives and the marketplace (Calloway, 1984, Robson 2004). Additionally we include male age and total household expenditure, since these are standard variables that may affect male generosity.

A feature of the allocation data from treatment 2 is that about 40% (15/40) of polygynous husbands give equal shares to wives on all occasions. Figure 2 illustrates this point, showing the relative allocations of money, (y_{w1} - y_{w2}), by polygynous husbands in all cases where wives had invested different amounts. There is a spike in the data at zero, a feature amplified if the data from all the allocation decisions is included. The difference in behavior between husbands suggests an underlying population that contains a mix of two types: equal splitters – defined as males who always set $y_{w1} = y_{w2}$ in our experiment - and husbands who tend to favor the first wife, but more generally, associate relative allocations (y_{w1} - y_{w2}) to investment levels and other factors. We begin by investigating whether there are factors that can predict whether a husband is an equal splitter.

Figure 2 here.

Table 10 reports a probit model in which the dependent variable takes the value 1 if the husbands are equal splitters and zero otherwise. The sample size is given by the number of polygynous households in treatment 2 less two because of missing data. The explanatory power of this model is limited (though it correctly predicts 79% of outcomes), but it suggests that higher household resources are not associated with a

higher probability of splitting the investment equally. The only variables significantly linked to being an equal splitter are male age (positively linked) and the difference in female age (negatively linked), although this second factor is only significant at the 10% level.

Table 10 here.

Let us now turn to the actual allocation using the husbands who are not equal splitters. In polygyny, the husband must split the allocation between 3 partners, but given total investment, two allocation decisions (e.g. to husband and first wife), must determine the third. To focus further on the relative treatment of the wives we estimate the following pair of equations for Table 11:

$$y_{w1} = Z\alpha_{w1} + X\beta_{w1} + \varepsilon_{w1}$$
$$y_{w2} = Z\alpha_{w2} + X\beta_{w2} + \varepsilon_{w2}$$

Since it is possible that the error terms in the equations are correlated, we therefore use a seemingly unrelated (SUR) one-way random effects model for an unbalanced panel (Biorn, 2004).[xiii] For each of the 25 households there are 5 conditional allocations making 125 observations, but in the case of some households the actual investment by the wives did not match one of the conditional cases. Thus, there are households with 6 observations making the panel unbalanced and giving 141 observations in total.

Table 11 here.

The first thing to note about the results is that we accept the null hypothesis that the error terms in the two equations are not correlated. The row marked 'independence test probability' towards the bottom of the table shows the p-value of the results of a test of independence. In other words, little is gained by using the SUR approach. More to the point, it suggests that once the covariates are taken into account, the generosity of the husband towards each of the two wives is not correlated. The first two equations in Table 11 omit additional controls. The results reflect the fact that husbands take the major share of any marginal investment and also treat wives unequally. Essentially, second wives start nearly 60 Naira behind first wives in the allocation and this difference is statistically significant at the 1% level.

Meanwhile, the coefficients on investments are small, given that the sum of marginal returns to a person's investment must add up to 1.5. Beyond this key point, we see that the allocation to the wives is sensitive to their own investment and that made by the husband, but also to the investment of their co-wives. The marginal allocation to each wife is higher out of her own contribution, compared to the allocation to the other wife. The coefficients are almost symmetric, suggesting that at the margin the husbands do not favor one wife over the other. In the next two columns we use data only from the original five questions of the strategy method (and not the sixth question which was asked if the wives' actual investment pattern did not match the hypothetical pattern). We see that the results are not sensitive to this feature.

Adding the additional controls makes some difference to the coefficients on the investment variables, but does not alter the basic conclusion.[xiv] As for the additional control variables, it is worth re-emphasizing that this is a small sample and we should be wary of drawing general conclusions, but that aside three points stand out. First, older husbands are more generous, both to first and to second wives. Second, the variables that were given a justification based on bargaining power play no significant role in explaining the data, either individual or collectively. Third – and in contrast to the previous point – the 'extended Bergstrom' variables do play a role. We report this as:

Result 12. Both first and second wives are allocated more if they have higher historical fertility within the marriage and less if they are older.

Additionally, the coefficients on these variables do not differ significantly between the wives ($p=0.45$ and $p=0.85$ respectively for tests on the equality of the wife's age and fertility coefficients). Nevertheless, the fact that the second wife is typically younger than the first wife is not sufficient to overcome the basic tendency of the husband to steer relatively more resources to the senior wife. For example, when all other variables are at their mean values, a first wife would have to be 20 years older than the second for the predicted allocations to be equal. Alternatively, her fertility would have to be 0.05 children per year of marriage (compared to the actual mean of 0.27) for equal predicted allocation.

V. Conclusions.

Polygynous households are a significant building block of many societies, yet evidence of their economic functioning is scarce. We run an experiment with polygynous and monogamous households in the north of Nigeria and gather survey data on their economic and marital circumstances. In both types of families, spouses rarely invest all their endowments into a common fund. In fact the most common decisions are to invest either half of the endowment or just one quarter. As a result, mean levels of investment are low (and low compared to most other locations in which we have run similar experiments). A key feature of the data though, is the similarity of behavior by spouses in monogamous and polygynous families: as measured by the percentage of total endowment invested into a common pool, there is no efficiency loss with polygamy and no efficiency gain either.

Compared to the situation where the common pool is automatically split evenly amongst participants, male control of the allocation yields higher male investment in monogamy, but lower investment under polygyny. For polygynous women investment is lower in the male control treatment and overall investment levels remain low. Thus, in keeping with much of the survey-based evidence on intra-household allocation in West Africa, our results are therefore incompatible with simple models that assume household efficiency.

If the household is non-cooperative, then some part of the failure to achieve an efficient outcome may be due to risk aversion. If the household is non-cooperative then a player may view the investment as risky since she or he may not see the benefits of their contribution. Even then, risk aversion alone cannot be used to explain male behavior in treatment 2. Since a husband can always keep any investment that he makes there is no risk in investing all of his endowment. Yet few husbands do this, despite demonstrating understanding the mechanics of the game when tested. Possibly, subjects do not wish to place money in a joint envelope that can be bargained over even after the experiment is over. If that is the case then risk aversion can also play a part in their behavior if they are unsure about how ex-post bargaining might play out.

Our experimental results on polygyny are also incompatible with theories such as the basic Bergstrom model in which there is always equal allocation to the wives. Instead, we have evidence of a mixture of households. In some families, rules of equal

splitting seem to be followed, though even here, the lower investment made by senior wives mean they have a higher average rate of return. Amongst families where equal splitting rules are not followed, senior wives have a higher marginal and average rate of return. For these households there is some evidence of a generalized Bergstrom model in the sense that husbands tend to favor wives who are younger and who have higher fertility. This evidence of a mix of households may help reconcile the fragments of geographically scattered yet contradictory evidence on intra-household resource allocation that are available for polygyny. For instance in an early study of Hausa, Barkow, 1972, writes, "A gift to one wife means a gift to all wives and the gifts must be of equal value" p. 322, whereas Leroy et al, 2007, conclude that children of first wives in northern Ghana fare better nutritionally, than their half-siblings. Meanwhile in results that come closest to mirroring ours, Gibson and Maice, 2006, find that controlling for age and other variables, first wives have a higher body mass index (BMI) compared to monogamous women and second wives (who rank last) amongst agro-pastoralists in rural Ethiopia (see also Wagner and Rieger, 2015) .

For the households where the allocation is sensitive to seniority, it seems that both the historical fertility of the wife and her age plays a role in affecting the allocation, though not to the extent that the basic precedence of the first wife is threatened. Our household survey evidence suggests that many households are aware of seniority rules, and there is a corroborating theme running through some of the ethnographic research on local patterns of conjugality.[xv] For instance, Smith, (1971) in describing the Hausa conjugal contract includes the obligation to 'obey his chief wife' (1971: 60) while Cohen, (1971) concludes,

> 'a senior wife is the most authoritative figure among the wives, and faced with one junior wife, the superior position of the senior tends to make her the winner more often than the loser in any competitive struggles that ensue.' (Cohen: 143-4).

What is the value of a seniority rule, why is it stable? We cannot answer that wider question within our experiment, but a number of quite different theories are potentially consistent with the practice. Older wives may have more power, but our data does not supply any evidence that this power derives from 'standard' economic power variables, such as income or separately owned assets or ready access to the

maternal family. It is entirely possible that wives acquire a greater understanding of how to bargain successfully in the marriage or that a norm is enforced through some kinds of community-enforcement. Alternatively, a longer-lasting marriage may produce more sentiment on the part of the husband, but the role of such factors requires further research.

While the forces that determine the relevant treatment of the wives remain unclear, one factor emerges clearly from the male control treatment: the allocation of the common pool made by men favors first wives over their juniors, but above all it favors men, who are the only partners who consistently earn a rate of return above the 1.5 multiple offered by the experimenters to the household as a whole.

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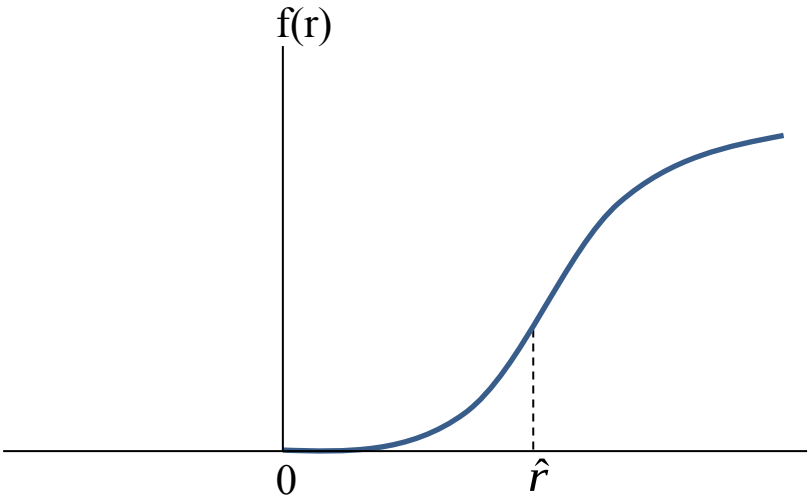

FIGURE 1. BERGSTROM'S MODEL OF THE FAMILY (FROM BERGSTROM, 1994).

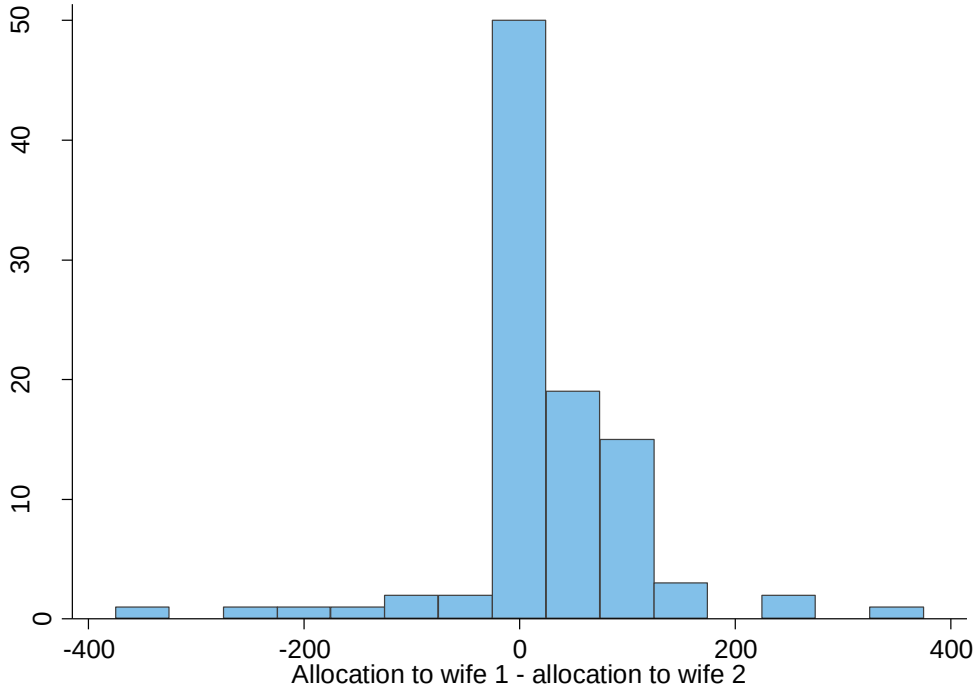

FIGURE 2. ALLOCATION TO WIVES IN TREATMENT 2

TABLE 1. SUMMARY OF DESIGN.

		Treatment 1	Treatment 2
Monogamy	Endowment	400 Naira /person	400 Naira /person
	Investment	0, 100, 200, 300 or 400	0, 100, 200, 300 or 400
	Common Pool Rule	Investments x 1.5	Investments x 1.5
	Allocation Rule	50:50	By husband
	Sample	40 households	40 households
Polygyny	Endowment	400 Naira /person	400 Naira /person
	Investment	0, 100, 200, 300 or 400	0, 100, 200, 300 or 400
	Common Pool Rule	Investments x 1.5	Investments x 1.5
	Allocation Rule	50:50	By husband
	Sample	40 households	40 households

TABLE 2. BACKGROUND INFORMATION ON HOUSEHOLDS.

	Household size	Children	Age of wife at marriage	Age of husband at marriage	Current Age of husband	Husband's Income (Naira per year)
Monogamy	5.9	3.2	16	26	36.7	126,014
Polygyny	10.7	5.1			42.0	203,717
First marriage	6.5	3.4	15	23		
Second marriage	4.1	1.8	18	32		

Note: all variables are means. Income figures exclude household where husbands reported no income.

TABLE 3. PERCEPTIONS OF HOUSEHOLD PRACTICES.

Wives' say in major household decisions (%)	First wife has more say	Both wives have about the same	Second wife has more say	Neither wife is involved	Other, specify	
Husband	40.0	43.8	8.8	6.8	1.3	
First Wife	24.1	50.6	20.3	5.1	0	
Second wife	34.6	52.6	6.4	6.4	0	
How husband splits time spent with wives (%)	All with first wife	Mostly with first wife	Equal time	Mostly with second wife	All with second wife	
Husband	10.0	6.3	83.8	0.0	0.0	
First Wife	1.3	5.1	84.8	8.9	0.0	
Second wife	1.3	2.6	96.2	0.0	0.0	
How husband splits money between wives (%)	All to first wife	75% to first wife	Half to each wife	25% to first wife	None to first wife	Other, specify
Husband	10	11.3	73.8	0	0	5
First Wife	2.5	8.9	84.8	3.8	0	0
Second wife	0	10.3	82.1	7.7	0	0

TABLE 4 MEAN INVESTMENT LEVELS AS A FRACTION OF ENDOWMENT.

	Treatment 1	Treatment 2	Median test, treatments p-value
Overall			
Monogamy	0.459	0.503	*0.311*
Polygyny	0.500	0.469	*0.106*
Husbands			
Monogamy	0.486	0.565	*0.069*
Polygyny	0.594	0.513	*0.043*
Median test within treatment, husbands, p-value	*0.043*	*0.069*	
Wives			
Monogamy	0.431	0.444	*0.644*
Polygyny	0.453	0.447	*0.412*
Polygyny, Wife 1	0.475	0.425	*0.085*
Polygyny, Wife 2	0.431	0.469	*0.644*
Paired test, husbands and wives, monogamy	*0.202*	*0.041*	
Paired test, husbands and 1st wives, polygyny	*0.022*	*0.026*	
Paired test, husbands and 2nd wives, polygyny	*0.018*	*0.222*	
Paired test, wives, polygyny	*0.300*	*0.478*	

Notes: All non-paired tests are tests of medians. Paired tests are signed rank tests. Results are reported as p-values, two sided.

TABLE 5. PAYOFFS (NAIRAS).

	Treatment 1	Treatment 2	Treatment difference
Overall (per person)			
Monogamy	491.9	500.7	
Polygyny	500.0	496.3	
Husbands			
Monogamy	480.6	518.8	*0.037*
Polygyny	462.5	572.5	*0.000*
Median test, p-value, husbands	*0.372*	*0.044*	
Wives			
Monogamy	503.1	482.5	*0.222*
Polygyny, Wife 1	510.0	481.3	*0.027*
Polygyny, Wife 2	527.5	435.0	*0.073*
Paired test, husbands and wives, monogamy	*0.202*	*0.240*	
Paired test, husbands and 1st wives, polygyny	*0.020*	*0.002*	
Paired test, husbands and 2nd wives, polygyny	*0.014*	*0.000*	
Paired test, wives, polygyny	*0.302*	*0.042*	
Wives, monogamy versus first wives in polygyny	*0.820*	*0.780*	

Notes: All non-paired tests are tests of medians. Paired tests are signed rank tests. Results are reported as p-values for a two sided alternative hypothesis.

TABLE 6 MEAN CONDITIONAL ALLOCATIONS BY HUSBANDS IN TREATMENT 2 (NAIRA).

Polygyny					Monogamy		
Wife 1's investment	Wife 2's investment	Husband	Wife 1	Wife 2	Wife's investment	Husband	Wife
100	100	267.5	178.1	161.9	0	206.3	131.3
100	400	472.5	292.6	291.4	100	272.0	215.5
400	100	490.0	308.1	256.9	200	363.8	272.5
300	300	548.8	337.5	317.5	300	441.3	346.3
400	400	627.5	435.6	424.4	400	516.0	422.5

TABLE 7 MARGINAL RETURNS.

	N	Wife 1's investment	Wife 2's investment
		Polygyny	
Return to wife 1	40	0.433	0.432
Return to wife 2	40	0.317	0.382
Return to husband	40	0.742	0.683
		Monogamy:	
Return to wife	40	0.690	-
Return to husband	40	0.810	-

Note: table shows mean marginal return from investment of 1 more Naira. Thus within each household, the sum of returns to spouses equals 1.50.

TABLE 8 RETURNS ON ACTUAL INVESTMENT

	Polygynous					Monogamous
	$\Delta I > 0$	$\Delta I \geq 0$	$\Delta I = 0$	$\Delta I < 0$	All	
Wife 1	1.0	1.39	1.57	2.36 (9)	1.62(38)	1.62
Wife 2	1.75(8)	1.46(28)	1.34	0.87	1.29(39)	-
Husband	2.05	1.88	1.79	2.52	2.02	1.61(37)
N	9	29	20	11	40	40

ΔI = wife 1's investment – wife 2's investment. In each column, the sub-sample size is usually equal to the value of N; exceptions are shown in parentheses and represent cases where the wife or husband made no investment.

TABLE 9 TOBIT MODELS OF FRACTION OF ENDOWMENT INVESTED.

	Male	Male, Additional Controls	Female	Female, Additional Controls
Constant	0.501***	0.555***	0.423***	0.337**
	(0.058)	(0.102)	(0.107)	(0.147)
Male control dummy	0.078	-0.032	0.015	0.034
	(0.108)	(0.101)	(0.042)	(0.049)
Polygynous	0.117	0.052	0.027	0.022
	(0.099)	(0.127)	(0.077)	(0.069)
Male control x Polygynous	-0.170	-0.031	-0.019	-0.055
	(0.123)	(0.113)	(0.056)	(0.050)
Second wife			0.008	0.017
			(0.093)	(0.100)
Male has more leisure (own view)		0.018		-0.067***
		(0.064)		(0.021)
Female clothing share		-2.848**		0.204
		(1.190)		(0.468)
Children		0.011		0.003
		(0.010)		(0.005)
Age, Husband		-0.002		-0.002
		(0.002)		(0.003)
Age, Wife		-0.000		0.002*
		(0.001)		(0.001)
Does wife own land in own name?		0.032		0.051*
		(0.035)		(0.028)
Husband's income x 100,000		0.014		0.025***
		(0.011)		(0.007)
Wife's income x 100,000		0.026		-0.012
		(0.066)		(0.017)
Wife has no education		-0.063		-0.024
		(0.061)		(0.040)
Years married		0.002		0.001
		(0.003)		(0.002)
Observations	160	147	240	214
Invest nothing	6	6	7	6
Invest all	24	21	12	11
LR chi-squared value	3.32	22.88	0.11	2.36
Prob	0.33	0.01	0.94	0.009

Standard errors clustered at the village level in parentheses under the estimated coefficient. *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$.

Female clothing share is the share of total clothing expenditure spent on adult females.

The LR chi-squared value is for a test that the equation has a whole has no explanatory power. The corresponding p-value is entered beneath it.

To make the coefficients easier to display, the income coefficients have been multiplied by 100,000.

TABLE 10 EQUAL SPLITTERS

Variable	Probit Equal splitter =1
Constant	-2.758***
	(0.898)
Expenditure / 100,000	0.007
	(0.005)
Male age	0.057**
	(0.026)
Difference, fertility	1.236
	(1.611)
Difference, older girl	-0.899
	(0.836)
Difference, female no education	-0.219
	(0.297)
Difference, wife age	-0.048*
	(0.029)
Difference, mother alive	-0.971
	(0.692)
N	38

Notes. ***Equal splitter*** = 1 if husband always gives wives equal shares of the allocation, 0 otherwise. Standard errors clustered at the village level in parentheses. Independent variables based on husband's answers. Difference always refers to wife1 – wife2 response. *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$.

TABLE 11 RANDOM EFFECT SUR ESTIMATION ON POLYGYNOUS HUSBAND'S ALLOCATION

Variable	No additional controls		No additional controls (5 questions)		With additional controls	
	First wife	Second wife	First wife	Second wife	First wife	Second wife
Constant	62.619**	-6.325	62.119**	7.379	-37.217	-5.148
	(22.750)	(17.974)	(28.122)	(37.681)	(52.577)	(34.642)
Male investment	0.120	0.308***	0.109	0.195	0.264***	-0.297
	(0.095)	(0.076)	(0.125)	(0.175)	(0.089)	(0.180)
Wife 1 investment	0.529***	0.338***	0.480***	0.360***	0.508***	0.362***
	(0.036)	(0.029)	(0.037)	(0.041)	(0.030)	(0.038)
Wife 2 investment	0.386***	0.581***	0.393***	0.540***	0.391***	0.573***
	(0.036)	(0.029)	(0.037)	(0.041)	(0.030)	(0.038)
Expenditure/ 100,000					0.009	0.073
					(0.127)	(0.194)
Husband's age					2.893**	3.528***
					(1.325)	(1.183)
Girl>5 dummy					1.320	27.416
					(9.601)	(26.853)
Wife's mother is alive					-15.647	0.855
					(14.493)	(16.298)
No female education					-8.990	38.078
					(17.032)	(28.580)
Wife's fertility					130.171**	143.365***
					(64.284)	(33.125)
Wife's age					-2.245**	-1.334*
					(0.924)	(0.782)
Independence test probability	0.91		0.53		0.45	
N	141		125		130	
No. groups	25		25		23	

Numbers in parentheses are standard errors. Independence test probability reported is for a Breusch-Pagan test of independence between the equations (1 d.f.). *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$.'No additional controls (5 questions) means only the original 5 strategy method questions are used.

Appendix. English language version of the instructions for the Male control treatment.

Instructions for Participants

[General introduction: To be read at the beginning of ALL investment treatments and sessions. Prior to the experiment you will need to make or buy colored cards for each participant. Say Blue for men and Yellow and Red for women. On entering the venue each man receives a Blue card. Within each household one wife gets Yellow and one wife gets Red. The allocation is random.

Welcome. Thank you for taking the time to come today. [Introduce EXPERIMENTERS and the assistants.] You can ask any of us questions during today's programme.

We have invited you here because we want to learn about how married couples in this area take decisions. We will ask you to make decisions about money. Whatever money you win today will be yours to keep.

What you need to do will be explained fully in a few minutes. But first we want to make a couple of things clear.

- First of all, this is not our money. We belong to a research organization, and this money has been given to us for research.
- Second, this is a study about how *you* make decisions. Therefore you should not talk with others. This is very important. Please be sure to obey this rule because it is possible for one person to spoil the activity for everyone. I'm afraid that if we find you talking with others, we will have to send you home, and you will not be able to

earn any money here today. Of course, if you have questions, you can ask one of us.

- Third, the study has two parts: today's exercise is one, but we will also visit you in your homes in the coming weeks to ask both the husband and the wives a number of questions.
- Finally, make sure that you listen carefully to us. You will be able to make a good amount of money here today, and it is important that the instructions are clear for you so that you can follow them.
- Does everyone in the room have a colored card (check)?

Would wives with red cards now please go with [Thea] and wives with yellow cards please go with [Thelma] and husbands with [Theo]? The task will then be explained to you. [You need to be careful that each room now contains only 1 person from each household]

[Instructions for each wife]

In a moment I will give you an envelope containing money. The exact amount will vary between people, but you will receive something between 0 and 400 nairas. [Show the envelope.] Your husband will receive a similar envelope and he will also receive an amount of money between 0 and 400 Nairas. He doesn't know how much you have in your envelope and you won't be told how much he has in his envelope. The other wife (sister?) will also receive a similar envelope with some amount of money between 0 and 400 Nairas. Again she won't know how much you have or how much your husband has. None of you will know what the others have.

You have to decide how much money to take out of the envelope and how much to leave in. Any money you take out of the envelope is yours to keep. Your husband and sister wife will be making the same decision with their envelopes. You can only take nothing, 100, 200, 300 or 400 Nairas out of the envelope. Other amounts are not allowed. So please remember: you can only take nothing, 100, 200, 300 or 400 Nairas out.

After you have made your decision and your husband and your sister have made their decisions we will bring you together again. We will put all the money that you and you all have left in your envelopes into one envelope. We call it, the common envelope. To whatever is in the common envelope we will add another half again. So, if there are 200 Nairas in the common envelope we will add another 100 Nairas to make the total 300. If there are 800 Nairas in the common envelope we will add another 400 Nairas to make a total of 1200 Nairas and so on.

Each of you will know the total amount of money in the common envelope.

After that your husband will decide how to split the money in the common envelope. He has to decide how much to give to you, how much to give to your sister and how much to keep for herself. In a moment we will give you some time to think about how much money you want to leave in your envelope.

Let me ask some questions to check whether you understood the instructions.

1. If you have 400 Nairas in your envelope and you take out 200 Nairas how much will be left in the envelope? [record the answer, correct participant if necessary]
2. If you each put 200 Nairas into the common envelope how much will there be in total (before we add anything)?
3. How much we will add if there is 400 Nairas in the common envelope?

[Record each answer, correct participant if necessary]

[Responses to common questions: to be used only when subjects ask]

1. If you are asked whether the husband and wives will have the same amounts in their envelopes, answer: possibly, possibly not.
2. If you are asked what ‘what should I do’, you should say that it is ‘your decision and I am not allowed to offer advice’

3. If you are asked precise arithmetical questions then answer them precisely. E.g. if I put in 400 Nairas and my husband and sister puts in nothing how much will you add to the total?' Answer: 200 Nairas.

[Once the experimenter is sure that the participant has understood the activity, give him/her some time to make his/her decision in private. DON'T FORGET TO KEEP RECORD OF THIS DECISION. YOU NEED TO TRANSFER THIS INFORMATION TO THE EXPERIMENTER WORKING WITH THE HUSBAND.]

1. If your husband had 400 Nairas in his envelope, how much do you think he would take out?

Thank you. We will now rejoin your husband and sister and put the money from your two envelopes into the common envelope.

[Bring husband and wives together & resolve the game.]

[Experimenter looks up the allocation decision and executes it. Subjects are given their money and thanked]

[Instructions for husbands, polygynous case]

In a moment I will give you an envelope containing money. The exact amount will vary between people, but you will receive something between 0 and 400 Nairas. [Show the envelope.] Your wives will each receive a similar envelope and they will each receive an amount of money between 0 and 400 Nairas. They don't know how much you have in your envelope and you won't be told how much they have in their envelopes. None of you will know what the others have.

You have to decide how much money to take out of the envelope and how much to leave in. Any money you take out of the envelope is yours to keep. Your wives will be making the same decision with their envelope. You can only take nothing, 100, 200, 300 or 400 Nairas out of the envelope. Other

amounts are not allowed. So please remember: you can only take nothing, 100, 200, 300 or 400 Nairas out.

After you have made your decision and your wives have made their decisions we will bring you together again. We will put all the money that you and your wives have left in your envelopes into one envelope. We call it, the common envelope. To whatever is in the common envelope we will add another half again. So, if there are 200 Nairas in the common envelope we will add another 100 Nairas to make the total 300. If there are 320 Nairas in the common envelope we will add another 400 Nairas to make a total of 480 Nairas and so on.

All of you will know the total amount of money in the common envelope and who put it in.

After that you will decide how to split the money in the common envelope. You have to decide how much to give to each of your wives and how much to keep for yourself.

In a moment we will give you some time to think about how much money you want to leave in your envelope. After you have made your decision, we will ask you some questions about how you want to divide the money in the common envelope between yourself and your wives.

Let me ask some questions to check whether you understood the instructions.

1. If you have 400 Nairas in your envelope and you take out 200 Nairas how much will be left in the envelope? [record the answer, correct participant if necessary]
2. If you each put 200 Nairas into the common envelope how much will there be in total (before we add anything)?
3. How much we will add if there is 400 Nairas in the common envelope?

[Record each answer, correct participant if necessary]

[Responses to common questions: to be used only when subjects ask]

1. If you are asked whether the spouses will have the same amounts in their envelopes, answer: possibly, possibly not.
2. If you are asked what 'what should I do', you should say that it is 'your decision and I am not allowed to offer advice'
3. If you are asked precise arithmetical questions then answer them precisely. E.g. if I put in 400 Nairas and my wives puts in nothing how much will you add to the total?' Answer: 200 Nairas.

[Once the experimenter is sure that the participant has understood the activity, give him/her some time to make his/her decision in private. DON'T FORGET TO KEEP RECORD OF THIS DECISION.]

[Continuation of instructions for husbands. You need to quietly receive the actual amounts left in their envelopes by the Red and Yellow wives. Put these amounts into the question below,.]

You have left [Y] Nairas in the envelope. In a few minutes we will put all the money into one envelope, the common envelope.

[For the questions which follow, read off the amounts from these tables.

Amount added to common pool										
Y↓	Wives→	0	100	200	300	400	500	600	700	800
0		0	50	100	150	200	250	300	350	400
100		50	100	150	200	250	300	350	400	450
200		100	150	200	250	300	350	400	450	500
300		150	200	250	300	350	400	450	500	550
400		200	100	300	140	400	450	500	550	600

Total amount in the common pool										
Y↓	Wives→	0	100	200	300	400	500	600	700	800
0		0	150	300	450	600	750	900	1050	1200
100		150	300	450	600	750	900	1050	1200	1350
200		300	450	600	750	900	1050	1200	1350	1500
300		450	600	750	900	1050	1200	1350	1500	1650
400		600	750	900	1050	1200	1350	1500	1650	1800

1. Your wife with the Red card has left RED Nairas in her envelope. Your wife with the Yellow card has left YELLOW Nairas in her envelope. We add [read off first table] Nairas to the [Total] Nairas that are already in the common envelope. There will then be [read off second table] Nairas in the common envelope.

[Making the decision.]

You now have to decide how to split the money. You cannot change your mind later on.

1. Your wife with the Red card has left RED Nairas in her envelope. Your wife with the Yellow card has left YELLOW Nairas in her envelope so that there is [read off second table] Nairas in the common envelope. How do you want to split the money? How much for you [write down]; and how much for your wife with the Red card and how much for you wife with the Yellow card. [Write down & check sums]?

[Review and change as is necessary]

Thank you. We will now rejoin your wife and put the money from your two envelopes into the common envelope.

[Bring husband and wives together & resolve the game.]

[Experimenter looks up the allocation decision and executes it. Subjects are given their money and thanked]

[*] This study forms part of "The Intra-Household allocations of resources: Cross-Cultural Tests, Methodological Innovations and Policy Implications", a project jointly funded by the UK's ESRC and DFID (RES-167-25-0251). As such the work has benefited greatly at all stages from the expertise and close cooperation of the other members of the team, Professors Cecile Jackson and Nitya Rao. Alistair Munro's work was also partially supported by JSPS KAKENHI Grant Number JP25101002. We are also grateful for helpful comments received from Takashi Yamano, Yukichi Mano, seminar participants at FASID, Tokyo, Economic Science Association meeting, Melbourne, 2010, ASSA Meeting 2011 Denver, and the World Bank. We are especially thankful to the hard-working efforts of our local team, led by Kabiru Bello and Dr. Habu under the guidance of Dr Wakili, the director of the Centre for Democratic Research and Training in Kano.

[i] This is a conservative figure drawn from various sources including, UN Population Division, 2000, Tertilt, 2005 and Demographic and Health Surveys. In approximately 30 countries, the percentage of married men with two or more wives exceeds 10%. In other 25 or so, the percentage is below 10% but above 5%. In some cases, the data is over 20 years old and therefore may be inaccurate.

[ii] This may not be due to wives' bargaining power, since the needs of children will depend typically on their age profile. As such, a husband may allocate resources differentially to ensure the maximum number of surviving children (Maluccio et al, 2009, Ukwuani et al, 2002).

[iii] The relevant passage is: "And if you fear that you cannot act equitably towards orphans, then marry such women as seem good to you, two and three and four; but if you fear that you will not do justice (between them), then (marry) only one or what your right hands possess; this is more proper, that you may not deviate from the right course." Koran, 4:3.

[iv] 2013 Demographic and Health Surveys (http://www.measuredhs.com/statcompiler); The sample size is 8723 men for the figures given here.

[v] Scattered through areas south of Kano there are villages for Maguzawa, a non-Islamic group that does not practice wife seclusion, and who were sampled separately for our examination of monogamous couples. They are not included in this data set.

[vi] Thus the game mimics a household with constant returns to scale, as if for instance the investment goes towards a joint food budget. If the game were supposed to mimic contributions to a pure household public good such as a communal light source or radio, then it would be more appropriate to allow C to be constant.

[vii] Only two male subjects out of 160 and seven women out of 240 fail our checks of understanding.

[viii] Six of the first marriages were levirate and 1 of the second marriages.

[ix] Some monogamous families may become polygynous at a later date. Since this is not uncommon, men and women may anticipate it in their decision-making.

[x] We have detailed information on ownership of a variety of assets. Some types (e.g. cars) are too infrequently held to be useful indicators of household wealth and some valuations (particularly for land holdings) are not credible. Typically though, measures of wealth are higher with polygynous households; patterns of radio ownership can be seen as a metonymy for this aspect of our data.

[xi] Contrast this with the women interviewed in Calloway, 1984, who "… assert that men are not impartial, and that often disproportionate resources go to support younger wives and their children." P. 404.

[xii] Senior wives have more children, so there is an implicit rejection of the hypothesis that the family with fewer children receives more, but the hypotheses can be rejected explicitly. In only 3 households does the husband have more children with the second wife. So reanalyzing the data on the basis of relative household size does not change the conclusion.

[xiii] There is also the issue of the potential endogeneity of male investment. Using the equation for husband's allocation to self and the independent variables from Table 9 as instruments we run a Hausman test, accepting the null hypothesis of no endogeneity with a p-value of 0.933.

[xiv] The additional variables were selected on the basis that they can be linked to theories about how the allocation might be determined. We have tried incorporating a number of other variables but there is no robust evidence that other, omitted variables drive the allocation.

[xv] Indeed, the translation of the term ‘uwar gida’ is ‘senior or only wife’ in Abraham’s, (1975), dictionary of the Hausa language.