Market forces affect patterns of polygyny in Uganda

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Polygynous marriage is generally more beneficial for men than it is for women, although women may choose to marry an already-married man if he is the best alternative available. We use the theory of biological markets to predict that the likelihood of a man marrying polygynously will be a function of the level of resources that he has, the local sex ratio, and the resources that other men in the local population have. Using records of more than 1 million men in 56 districts from the 2002 Ugandan census, we show that polygynously married men are more likely to own land than monogamously married men, that polygynous marriages become more common as the district sex ratio becomes more female biased, that owning land is particularly important when men are abundant in the district, and that a man's owning land most increases the odds of polygyny in districts where few other men own land. Results are discussed with reference to models of the evolution of polygyny.

biological markets | mate choice | operational sex ratio | humans | land ownership

Most human societies historically have allowed polygyny, or the marriage of more than 1 woman to 1 man (1, 2). However, within polygynous societies, many marriages are monogamous, and across polygynous societies there is variation both in the mean and in the variance of the number of wives per married man. What, then, explains how many wives men marry?

The payoffs to polygyny are not symmetric across the 2 sexes. Men always increase their reproductive success by adding an extra wife. In African agriculturalist and pastoralist societies, for example, every extra wife a man has adds to his number of surviving offspring, and most of the variance in men's reproductive success is explained by variation in number of wives (3–6). For women, being polygynously married seems less beneficial because each additional wife subdivides household resources and male investment. Compared with monogamously married women, polygynously married women have lower fertility (7–9), increased child mortality (10), and poorer child growth and development (11, 12). The latter 2 outcomes obviously affect the reproductive success of both parents but fall disproportionately on women, for whom they are not offset by the increased offspring number that men experience in polygynous marriages. The costs of polygyny seem to fall particularly on women of later rank in the union, and their children (6, 13). Thus, it seems that polygynous marriage in African societies is most beneficial to men and most costly to women, especially wives of lower rank.

Situations whereby individuals receive asymmetric payoffs from collaboration and yet continue to collaborate can be conceptualized using the theory of biological markets (14–17). Biological markets operate wherever there are 2 classes of individual (e.g., male and female), with distinct commodities to exchange (e.g., resources and fertility), and where each has the possibility of partner choice. This leads to competition within each class to attract members of the other class. The central prediction of biological market theory is that the "exchange rate" between the 2 commodities will vary as a function of supply and demand. That is, where females are very common and males scarce, males will have greater market power and achieve outcomes more favorable to their interests, whereas where females are scarce and males common, females will be able to drive a harder bargain and achieve outcomes more favorable to theirs (14, 18–20).

Market reasoning leads to the simple prediction that the frequency of polygynous marriages will increase as the local operational sex ratio (OSR) decreases (that is, becomes more female biased; 7, 10, 21). The OSR can be estimated for these purposes by calculating the ratio of men to women aged 15–50 years in each district (22) (although it must be noted that in a polygynous society shifts in this measure have asymmetric effects on the numbers of men and women available for marriage, given that all adult men are available for marriage even when already married, but for women this is not so). However, it is not just the number of men available that is important but also the resources that they offer. Resources, in terms of land or livestock, are sought after in a potential husband and have a positive impact on women's lifetime reproductive success (23). Women may do better becoming the second wife of a man with abundant resources than the first wife of a man with few, leading to a threshold of inequality between men above which polygynous unions will begin to be seen (6, 24). Thus, we can predict that having more resources will increase a man's chances of marrying polygynously and that the effect of having resources will vary according to the characteristics of the local market. Where the OSR is high (i.e., male biased), then competition between men is intensified, and it should become even more important to have resources. The resources of a man's local competitors will also moderate the effect of his own resources. That is, where many men in the local market have a given level of resources, that level of resources will be less effective at attracting more than 1 wife than in a market where few rivals can offer it.

This study examined market effects on polygynous marriage in contemporary Uganda. Uganda is a poor equatorial country (2007 gross domestic product per capita estimated at $900), with most of the population rural (approximately 85%) and most people dependent on subsistence agricultural activity (estimated at 80%; 25). The population (25 million in 2002) is divided among approximately 45 ethnic groups speaking Niger-Congo and Nilo-Saharan languages. Our data source is a 10% representative sample of households from the Uganda Population and Housing Census of 2002. The sample contains family composition and socioeconomic data for approximately 1,107,000 men aged ≥15 years. The sample has limitations in terms of grain of responses—for example, our resources variable is simply owning land vs. not owning it—but more than compensates for this by its unusually large size and national representativeness.

To examine market effects, we include compositional characteristics of the district in which the man lived, which we take to indicate the conditions of the local marriage market. Uganda was

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Table 1. Descriptive statistics for the variables in the model

Variable	Mean/frequency	SD/percentage
Continuous variables		
District level		
OSR	0.49	0.01
Urbanization	0.58	0.12
Mean age	32.88	1.64
Proportion of landowners	0.7	0.24
Individual level		
Age	27.71	9.57
Years of schooling	5.33	4.01
Categoric variables		
Individual level		
Polygyny		
Polygynously married	110,100	9.95
Not polygynously married	996,637	90.05
Urban–rural status		
Urban	168,850	15.26
Rural	937,887	84.74
Landownership		
Landowners	760,384	68.71
Non-landowners	346,353	31.29

Values are means and SDs for continuous variables, frequencies and percentages for categoric variables.

at this time divided into 56 districts. We calculated the OSR of each district and the proportion of men within it who owned land, and entered these characteristics of the local market into a multilevel model alongside the individual-level characteristics of the man, such as whether he owned land.

Our predictions, based on biological markets theory, were that, controlling for potential confounding variables such as age, education and urbanization: (*i*) Owning land will increase a man's probability of being in a polygynous marriage. (*ii*) Being in a district with a higher (i.e., more male-biased) OSR will decrease a man's probability of being in a polygynous marriage. (*iii*) There will be an interaction between the district OSR and individual land ownership, such that owning land becomes increasingly important for the attainment of polygynous marriage the higher (i.e., more male biased) the local sex ratio. (*iv*) There will be an interaction between a man's land ownership and the proportion of other men in the district who also own land, such that land ownership has a greater effect on the probability of polygynous marriage in districts where few people have land.

Results

The descriptive statistics for all variables are summarized in Table 1. The results for the model are shown in Table 2. There are significant main effects of several control variables, such as age, education, and urbanization. Here, we concentrate on the predicted effects. Prediction (*i*) was for a main effect of individual land ownership. This prediction is confirmed. All else being equal, the odds of polygyny become 2.28 times larger if a male owns land compared with when he does not. Prediction (*ii*) was for decreasing OSR at the district level to increase the probability of polygyny. Again, the prediction is met. The odds ratio of 33.28 means that if the district OSR changes from 0.5 to 0.45, the odds of polygyny increase by a factor of 1.66, all else being equal.

Prediction (*iii*) was for an interaction between OSR and land ownership. This interaction is indeed significant (Table 2). Fig. 1 allows this interaction to be visualized by showing the predicted proportion of men married polygynously according to the district OSR and whether they own land. As the figure shows, in a district with more women than average, a relatively high proportion of men are expected to marry polygynously, and it makes little difference whether they have land. In fact, those without land are predicted to be polygynous slightly more often, which may be an artifact of extending the regression line beyond the range of most of the data. As the sex ratio increases, though, the proportion of polygynous men declines more steeply for landless than landowning men, so that in a relatively male-biased district, landowners are substantially more likely to have multiple wives than are the landless.

Finally, prediction (*iv*) was for an interaction between the proportion of men owning land in the district and individual land ownership. Again, the prediction is met (Table 2). Fig. 2 shows that the ratio of polygnously married landowners to polygynously married landless men is higher in districts where unusually few men own land and declines sharply as the proportion of men with land increases. In fact, in districts where unusually many men own land, landless men are predicted by the model to have a slight advantage, but this may again be a consequence of extending the regression line beyond the range of most of the data. The landownership × proportion of landowners in the district interaction is significantly stronger than the OSR × land ownership interaction [after standardization: $B_{\text{land ownership} \times \text{proportion ownership}} = 0.038$ (SE = 0.0097); $B_{\text{land ownership} \times \text{OSR}} = 0.015$ (SE = 0.0062); $Z = 1.997$; $P < 0.05$].

Discussion

Consideration of market forces, and the differing interests of men and women, led us to predict that the occurrence of

Table 2. Estimates of the parameter estimates in the negative binomial regression for polygyny

Parameter	B	SE	Wald	*P*	Exp(B)
(Intercept)	−4.2634	0.2594	270.1272	<0.0001	0.0141
Mean age district (y)	−0.0377	0.0027	194.8048	<0.0001	0.9630
Proportion of land owners (0→1)	0.7414	0.0333	495.4211	<0.0001	2.0989
OSR (1→0)	3.5050	0.5057	48.0321	<0.0001	33.2822
Urbanization (% urban) (0→1)	−0.2961	0.0326	82.6585	<0.0001	0.7437
Age (y)	0.0601	0.0003	34,145.1404	<0.0001	1.0620
Years of schooling (y)	−0.0388	0.0009	1,953.9085	<0.0001	0.9619
Urban household (rural→urban)	−0.2591	0.0144	324.2463	<0.0001	0.7717
Landowner (no→yes)	0.8276	0.2849	8.4364	0.0037	2.2878
Ownership × proportion landowners	−0.1576	0.0402	15.3918	<0.0001	0.8542
Ownership × OSR	−1.3938	0.5826	5.7240	0.0167	0.2481

Exp(B) are the odds ratios. The Wald statistic allows evaluation of the significance of individual parameter estimates. Note that the parameter and odds ratio for OSR variables are for OSR decreasing from 1 to 0, rather than increasing from 0 to 1, for ease of interpretation.

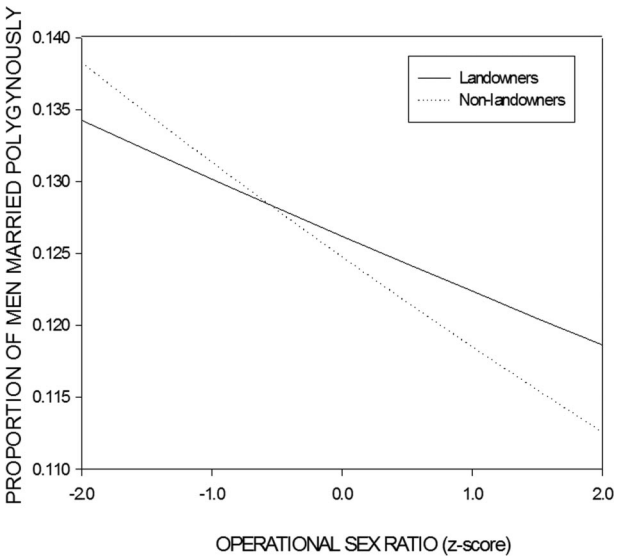

Fig. 1. Predicted proportions of men marrying polygynously by individual land ownership and the OSR of the district. The units of the horizontal axis are SDs of the district OSR, thus 0 represents an average district sex ratio, 1 represents an SD more men than average, and −1 an SD fewer men than average. All other variables are set to the mean.

polygynous marriage in Uganda would vary with men's land ownership, with the land ownership of his rivals, and with the local sex ratio. These predictions were borne out in a large sample of households within districts. Having land more than doubled men's chances of having more than 1 wife, other things being equal. As the district OSR became more male biased, fewer men were able to marry polygynously. Such shifts affected all men, but the brunt fell on the landless particularly hard. Having land was particularly influential in districts where few other men had land, implying that what matters is not just the number of competitors but also their resources. This is suggestive of a polygyny threshold process, with women moving to become second wives where the resource offer of some men is much better than that of others. Overall, the predictions from the theory of biological markets were well supported within this large dataset, illustrating the utility of conceptualizing marriage in humans, as well as other forms of collaboration between unrelated individuals, as trading situations (15–17, 20).

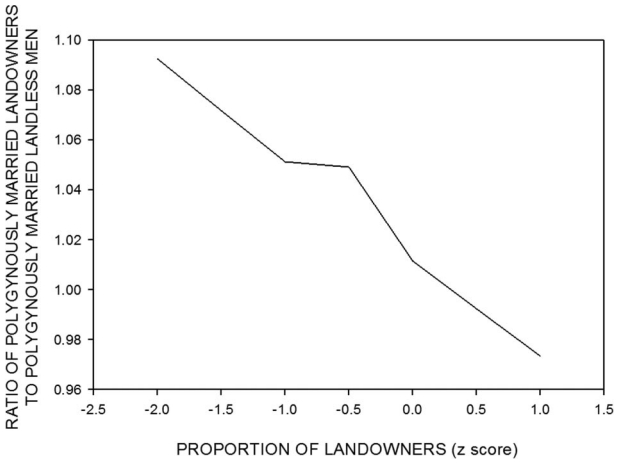

Fig. 2. Predicted ratio of polygynously married landowners to polygynously married landless men, as the proportion of landowners in the district varies. The units of the horizontal axis are SDs of the district proportion of men owning land, thus 0 represents an average district, 1 represents an SD more landowners than average, and −1 an SD fewer landowners than average. All other variables are set to the mean.

There are some limitations to the current data set. First, we only measured whether the men owned land or not, whereas a continuous measure of quantity of land would allow more detailed and exact tests of polygyny threshold models. Second, we used the district level as our local market. This might not closely reflect the degree of intrasexual competition individuals experience because, on the one hand, people may marry across district boundaries, and on the other, their effective marriage market might be limited to a much smaller area (e.g., the village). However, we were unable to experiment with different-sized geographic units using these data, and we merely assume that the district OSR provides at least some indication of the market competition individuals face. Third, it is possible that the proposed causality actually runs in the opposing direction. For example, polygyny could make it more likely that a man comes to own land. This explanation seems unlikely, given that other studies suggest that it is resources that lead to the recruitment of wives rather than vice versa (3, 4). Finally, we were unable in this study to track the consequences for men and women's reproductive success of entering polygynous vs. monogamous unions. This has been documented by some other studies [e.g., Gibson and Mace (6)], and it would be desirable to do it in this Ugandan population, to follow through the biological market logic, which is that the sex with lower local bargaining power has to accept outcomes less conducive to their reproductive success than the sex with higher bargaining power. However, in the absence of longitudinal data, this is unlikely to be possible using this census. The use of census data not only limits us in determining the consequences of polygynous marriages. We are also unable to examine dynamic aspects of decision making on the marriage market. Many of the key variables will change throughout an individual's life, the sex ratio we modeled is not necessarily the sex ratio at an individual's age of first marriage, and individuals can alter their marriage timing in response to current opportunities. It should thus be borne in mind that the data presented here are but a cross-section and do not reflect these dynamics, for which a longitudinal panel design would be more informative.

There has been considerable debate in the literature on polygyny in humans and in other species about whether it is best viewed as the result of female choice or of male coercion (26, 27). The theory of biological markets is based on the assumption that traders of both types are able to choose their partners, and thus the predictions derived here assume mutual choice (or, at least, that a woman's parents choose on her behalf). We cannot of course exclude that some coercion occurs, although it is not obvious that a coercion-based model would predict the patterns observed here. We note, however, that elements of the coercion view—for example, that polygyny tends to benefit men more than women and that women avoid it if they have good alternatives—are shared by the current market model. The difference is that we view levels of polygyny as being driven up not by the direct coercive power of men but rather from the subtler market power that stems from men, and high-quality men in particular, being scarce relative to the number of women available. Where women are the scarce resource, they gain market power and can drive the level of polygyny down and/or the level of resources demanded up.

Methods

The Ugandan Bureau of Statistics' Uganda Population and Housing Census was conducted by face-to-face interview during 7 days of fieldwork in September 2002 and aimed to reach all individuals present in the country. The 10% sample of households is made available by Integrated Public Use Microdata Series International (28) and is designed to faithfully represent the complete census population. We selected all men aged ≥15 years for whom

data were complete from each of the 529,271 households in the 10% sample (n = 1,106,737). For each man, we coded whether he was in a polygynous marriage or not. We did not further discriminate number of wives owing to declining numbers of cases. We also coded whether men owned land or not, their age, whether their residence was urban or rural, and their completed years of schooling. We used the same data set to estimate the following characteristics of the district within which the men live: the mean age, the proportion urbanized, the proportion of men who own land, and the OSR. Although the OSR is strictly the ratio of individuals of each sex available for marriage, in a polygynous society all adult men are potentially available for marriage, and so we simply used the number of individuals of each sex aged 15–50 years present in the district (as is often done in studies of OSR in humans; 20, 22). We calculated OSR at the district level as the number of men divided by the total number of people. OSR is calculated according to all of the available census data and not the household head data. A balanced sex ratio is thus 0.5, and higher ratios are more male biased. The descriptive statistics for all of the variables used are given in Table 1.

Because our dependent variable (polygyny) is dichotomous and our predictors are a combination of categoric and continuous variables, we used negative binomial logistic regression (29). All variables listed in Table 1 were entered into the model as main effects, and we also tested for 2 predicted interaction effects: land ownership × OSR [prediction (*iii*)] and land ownership × proportion of landowners [prediction (*iv*)]. The resulting model had absolute parameter, loglikelihood, and Hessian convergence. To compare the strength of the 2 predicted interaction effects, we standardized all of the variables. The Bs from the model with standardized variables, unlike those from the model using the raw data, can be compared with each other using a Z test.

In case the effects found were due to one outlying district, we reran the analysis excluding respectively the most male-biased district, the most female-biased district, the district with the highest proportion of landowners, and the district with the lowest proportion of landowners. In no case were the parameter estimates of these analyses significantly different from those presented (data not shown). It is important to bear in mind that although migration between districts is possible, this would make it harder to find the proposed effects.

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