The Intra-Household Economics of Polygyny: Fertility and Child Health in Rural Burkina Faso

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1 Introduction

Over the past twenty years, both the theoretical and empirical literature on intra-household decision making has grown rapidly. A major concern of this research has been whether resources within a household are allocated efficiently. On the theoretical side, the unitary model (Becker, 1981), Nash bargaining (Manser and Brown, 1980; McElroy and Horney, 1981), and, more recently, the so-called collective model (Chiappori 1988; 1992) are well-studied approaches that predict efficient intra-household allocations. On the other hand, a certain class of cooperative (Lunderbg and Pollak, 1993) as well as non-cooperative bargaining models (Kanbur and Haddad, 1994) generate outcomes that are not in general efficient. On the empirical side, Browning et al. (1994) derive testable implications of the efficient allocation assumption and, using data from Canada, cannot reject the hypothesis that the resource allocation is efficient, although they can reject the unitary model. For developing countries, Thomas and Chen (1994) conducted the first study on intra household efficiency. As in Browning et al., they reject the unitary model, but not

Pareto efficiency. Udry (1996) compares farm yields of field plots cultivated by different members of the same household. He finds significant differences in yields depending on the gender of the cultivating household member and thus rejects efficiency.

All of these papers are essentially concerned with the income generating process of the household, more specifically labor supply and household production. This paper, in contrast, proposes a test for efficiency based on fertility and child health outcomes. In economic settings where old age security relies almost exclusively on transfers from one's offspring, decisions on fertility and investments into children's health and human capital play a crucial role for smoothing consumption over the life cycle. In support of this hypothesis, much of the existing literature on child mortality and investment into children has found that such outcomes positively depend on the expected returns of a child. A prominent example is the gender bias in child mortality in many parts of South Asia and sub-Saharan Africa, where sons receive more attention than daughters because the former provide the parents' old age support while the latter leave the parental household upon marriage (see, e. g., Arnold, Choe and Roy, 1998; Garg and Morduch, 1998). In a data set of white male twins the US, in contrast, Behrman et al. (1982) find that parents provide more resources to the less able children than is consistent with an investment model, which they take as evidence for a parental concern for earnings equality among their offspring.

A rigorous test for whether fertility and investments into children are efficient in terms of an investment model, however, is hardly feasible with data from monogamous households, in particular in the context of developing countries. First, child-specific expected return functions as perceived by the parents are only poorly observed by the researcher. Second, when pregnancy and child delivery is a major risk to the mother's health, the wife bears an additional cost of fertility which is difficult to measure in monetary terms. This paper avoids both of these complications by focussing on a sample of polygynous households. In that context efficiency implies that, conditional on the characteristics of a given child, the care and the resources devoted to her (or him) are independent of her (or his) mother's identity. We identify a wife's identity by two variables that are likely to affect her bargaining position within the household but not the expected returns of her children. The first one is a measure of the competitiveness in the marriage market recently proposed by Chiappori et al. (2002) while the second one relates to the options she would face in case of a divorce.

To formalize this argument, we develop a model based on Eswaran (2002), where parents have children for old-age support. Households have to decide over both the quantity of children and the expenditures on each child's health. Conflicting interests between husband and wife(s) arise because, with each delivery, a cost occurs to the mother in the form of a deterioration of her health. The Nash bargaining framework is used to analyze how the bargaining position of each adult household member affects the number of children of each wife and the pattern of expenditures on child health. While the number of children born to a given wife depends on both her own and the co-wife's bargaining position, the efficient outcome of this cooperative bargaining game predicts an identical level of expenditures for each child, which implies that an improved bargaining position of one wife has the same effect on the co-wife's children as it has on her own.

We test these predictions with the 1998/99 Demographic and Health Survey from Burkina Faso, where the majority of married women lives in a polygynous union. According to the results, an improved bargaining position of a wife reduces her fertility, while an improved bargaining position of the co-wife has the adverse effect, which is in accordance with the theoretical predictions. In contrast, child survival, which is a function of the care and expenditures devoted to her (or him), is increasing in the mother's own but decreasing in the co-wife's bargaining position, which contradicts the hypothesis of an efficient intra household allocation of resources.

2 Conceptual Background

2.1 Theoretical Framework

In rural areas of developing countries, there are two main economic reasons for having children. First, to add to the labor force employed on the family farm and, second, to provide old age support to their parents. In both cases, parents trade off current consumption against additional future income. To capture this feature, we consider agents who live for three periods. In period zero, she/he grows up consuming resources of the parental household. In period one, she/he has and raises her/his children. In period two, she/he retires and lives of the transfers received from her/his children. We thus focus on the old age security aspect of having children. Further, it is assumed that individuals are not altruistic. Since we are interested in decisions on fertility and expenditures allocated to children within the household, we can neglect the initial period.

Now consider a household made up of two wives and one husband. In terms of their life cycles, each of them finds her/himself in period one. We will assume that, for the three adult household members, the joint household income y has the character of a public good and that household members pool all resources.[1] Each adult member pays a fixed fraction, a say, of the household income toward her/his respective parents' old age support. Each wife, i say, gives birth to n_i children, where, per child, the amount h_i is allocated to expenditures for health and food. Thus, for all three adults, consumption in the first period is

$$c_1 = (1-3a)y - n_1h_1 - n_2h_2.$$

In the second period those children that have survived to adulthood enjoy the same household income as their parental household and each of them transfers the fraction a to her/his parental household. We assume that the survival probability of a child is given by the increasing, concave function $q(h)$. To keep the analysis simple, we treat n_1 and n_2 as continuous variables and assume that the number of children reaching adulthood is non-stochastic and equal to the expected value of this number, which is $n_1q(h_1) + n_2q(h_2)$. Thus, for all three adults, consumption in the second period is

$$c_2 = ay\,(n_1q(h_1) + n_2\,q(h_2)).$$

Period consumption is evaluated by the felicity function $u(\cdot)$, where $u' > 0$ and $u'' < 0$, and, for ease of exposition, there is no discounting.[2] At the beginning of the first period, the husband's utility is

$$U = u(c_1) + u(c_2).$$

Since each delivery puts the health of a woman at risk, particularly in regard of the poor hygienic and medical conditions prevailing in the area studied in this paper, we will assume that the utility of wife i is given by

$$U^i = D(n_i)\,U,$$

where $D(0) = 1$, $D > 0$, and $D' < 0$. Thus, conditional on n_i, wife i's preferences coincide with those of her husband. Her preferences differ from those of her husband, however, when the number of children she gives birth to is concerned. Denote by n the total number of children in the household, i.e. $n = n_1 + n_2$.

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[1] Notice that the nature of y assumed here leaves no room for transfers between spouses, which is the subject of Rasul (2002).

[2] Introducing a discount factor that is common to all agents does not affect the results.

Proposition 1

For any n_j, where $j \neq i$,

(i) wife i desires a smaller number of children born to her, n_i, than both wife j and the husband;

(ii) the husband and wife j desire the same number of children born to wife i;

(iii) conditional on any number of children in the household, n, all three adults desire the same level of expenditures on each child's health, h, irrespective of the identity of a child's mother, and this expenditure level is decreasing in n.

The first part of Proposition 1 follows from the properties of D, that is the prospect of a deterioration in health associated with each delivery make each wife desire less children born to herself than the other two adult household members. The second part is a consequence of the separability of U^i. Conditional on n_i, U^i induces the same preferences over n_j as those expressed by U. Finally, part (iii) is a consequence of the resource pooling assumption and, again, of the connection between U and U^i.

We will now model the household decision on the fertility of each wife and child health expenditures within a Nash bargaining framework. Introduced to household decision making problems by Manser and Brown (1980), this approach has become the common methodology to approach conflicting interests and joint decisions within a household.[3] In particular, we will assume that the household decision is the solution to an asymmetric, trilateral bargaining game, that is that the choice of n_1, n_2, h_1 and h_2 maximizes

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[3] See Maitra (2002) and Rasul (2002) for recent applications of the Nash bargaining framework in the context of fertility and child health expenditure decisions.

(1) $j\ (n_1, n_2, h_1, h_2) = \log(U - \overline{U}) + g_1 \log(U^1 - \overline{U^1}) + g_2 \log(U^2 - \overline{U^2})$.

$\overline{U}$, $\overline{U^1}$ and $\overline{U^2}$ represent the husbands and each wife's threadpoint, respectively. The husband's bargaining weight is normalized to unity and, consequently, g_1 and g_2 represent each wife's bargaining weight relative to the husband's. Denoting the solution to this maximization problem by n_1*, n_2*, h_1* and h_2*, it follows from part (iii) of Proposition 1 that

$$h_1^* = h_2^* \equiv h.$$

We may thus simplify the analysis by considering the problem

(2) $\max_{n_1, n_2, h} f(n_1, n_2, h)$,

where $f\ (n_1, n_2, h) = j\ (n_1, n_2, h, h)$. Since, conditional on any pair n_1 and n_2, all three adults desire the same level of health expenditures for each of the children in the household, maximizing f over n_1, n_2 and h will yield the same result as maximizing $j\ (n_1, n_2, h_1, h_2)$ over n_1, n_2, h_1 and h_2.

Proposition 1 states that the adult household members' preferences over the number of children born to each wife differ. For the empirical analysis, we are interested in the comparative static properties of the solution to (2). The following proposition sheds light on how the bargaining outcome reflects the household members' conflicting interests. Denote by n_i^j* the number of children born to wife i desired by adult $j \in \{0,1,2\}$, where 0 stands for the husband.

Proposition 2

(i) $n_1^1 < n_1* < n_1^2$;

(ii) there exist (sufficiently small) g_1, $g_2 > 0$ such that

$$\frac{dn_1*}{dg_1} < 0, \; \frac{dn_1*}{d\overline{U^1}} < 0 \text{ and}$$

$$\frac{dn_2*}{dg_1} > 0, \; \frac{dn_2*}{d\overline{U^1}} > 0;$$

(iii) if $g_1 = g_2$ and $\overline{U^1} = \overline{U^2}$, then $\left|\frac{dn_1*}{dg_1}\right| > \frac{dn_1*}{dg_2}$ and $\left|\frac{dn_1*}{d\overline{U}_1}\right| > \frac{dn_1*}{d\overline{U}_2}$;

(iv) if $g_1 = g_2$ and $\overline{U^1} = \overline{U^2}$, then $\frac{dh}{dg_1} = \frac{dh}{dg_2} > 0$.

<u>Proof:</u>

(to be added)

Part (i) of Proposition 2 states that the bargaining outcome implies that the number of children born to a particular wife is bigger than the number desired by herself, but smaller than the number desired by her co-wife and the husband. According to the first two multipliers in part (ii) of Proposition 2, this number is decreasing in her own bargaining weight and threadpoint. In the light of part (i) of Proposition 1, this is as expected: an increase in her bargaining position changes the result of the bargaining process in the direction of the outcome desired by herself. Turning to dn_2*/dg_1 and $dn_2*/d\overline{U^1}$, recall from part (ii) of Proposition 1 that each wife has the same preferences as her husband when the number of children born to her co-wife are concerned, and from part (i) of Proposition 2 that she desires a larger number of children to be born to the co-wife than the bargaining outcome implies. Consequently the number of children born to wife *j* is positively affected by the bargaining position of wife *i*.[4] Part (iii) states that, provided the two wives are initially symmetric, an increase in a wife's bargaining position results in a bigger decrease of the number of children born to her than the increase of that number associated with an increase of the co-wife's bargaining position of the same extent. Notice that this also implies that the total number of children in the household decreases as the bargaining position of any one of the wives improves.

Finally, part (iv) states that the level of health expenditures per child increases as the bargaining position of any of the wives increases. The mechanism driving this result is that the total number of children decreases in response to an improvement of one of the wife's bargaining positions, and that, according to part (iii) of Proposition 1, all three adults agree on higher health expenditures per child as the total number of children decreases. The qualitative result corresponding to part (iv) – that wife-specific characteristics cannot affect expenditures on her own children in a different way than expenditures devoted to the co-wife's children – is a consequence of efficient investment into child health. Since Nash bargaining ensures pareto-efficient outcomes, it is also part of the solution of the bargaining game analyzed in this section, where, conditional on the number of children, all parties desire the same level of *h*. It continues to hold, however, under less tighter modeling assumptions as well, namely whenever household income in the second period is the sum of transfers from all children, and each transfer is an

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[4] The condition on the bargaining weights of the wives ensuring this result arises from the fact that the cross-derivatives $U^1_{n_1 n_2}$ and $U^2_{n_1 n_2}$ are positive. For the husband, instead, we have $U_{n_1 n_2} < 0$, so that a sufficient relative bargaining weight of the husband ensures the expected signs of the multipliers.

increasing, concave function of the expenditure devoted to the respective child, where the said function may depend on the child's but not on her (or his) mother's characteristics.

2.2 Testable Predictions

Denote by b_i a measure of the bargaining position of wife i, that is, in terms of the theoretical model, g_i or $\overline{U^i}$. The preceding results imply the following testable hypotheses:

(H1) Wife i's fertility is decreasing in b_i.

(H2) Wife i's fertility is increasing in b_j, $j \neq i$.

(H3) $\left|\frac{dn_i *}{db_i}\right| > \frac{dn_i *}{db_j}$.

(H4) The health of a child of wife i is increasing in b_i.

(H5) The health of a child of wife i is increasing in b_j.

(H6) $dh_i/db_i = dh_i/db_j$.

While hypotheses relating to the wife's own bargaining position relative to the husband (H1) and (H4) have been addressed in previous work (e.g. Thomson et al., 1990; Thomas et al., 1997), the issue of major interest in this study are the interaction effects between the two wives, H2 and H3, and H5 and H6. In particular, a test of H5 and H6 is a test for the efficiency of allocations in a polygynous household because efficiency implies that an increase in the bargaining power of any of the two wives has an identical positive effect on all the children in the household.

3 Polygyny in Burkina Faso: Demographic Background and Data Description

The analysis is based on data from the 1998/99 wave of the Demographic and Health Survey (DHS) from Burkina Faso. The survey is nationally representative and the sample selection uses a two-stage stratified random sampling design. Individual and household level information is collected on a relatively large sample: about 4812 households, corresponding to 31569 individuals. The survey collects information on household and individual characteristics, including access to health and education facilities, literacy and education levels of household members, as well as other individual characteristics. Individual information was collected for women aged between 15 and 49 years, and for men aged between 15 and 59 years. For women between 15 and 49, information on fertility history and antenatal care for each pregnancy is also recorded. Finally, this wave of the survey includes information on the number, the sex and the age of each wife's siblings, and whether they are still alive. Though information on income was not collected, data on household possession, such as bikes and motor bikes, electronic devices such as radio receptors, the type of the roof, the walls and the floors of the buildings the households live in was recorded.

At the time of the survey, about 80 percent of all women aged between 15 and 49 were married, and of those, 55 percent lived in polygynous unions. Subsequently, we restrict our analysis to rural polygynous families. Table 1 summarizes the data for these women. The main characteristics of the sample can be summarized as follows. Fertility is high, as reflected by 4.88 children ever born to each woman (unadjusted for age). The average age is about 30 years and the time spent in marriage about 12, suggesting that these women marry at an early age.

Table 2 summarizes the prevalence of polygyny in Burkina Faso. To gain an insight of the prevalence of polygyny across all age groups, we use the LSM survey which is not administrated selectively like the DHS survey. According to the 1998 LSM, the proportion of currently married women living in polygynous unions was 52 percent, confirming that polygyny is the dominant form of marriage. To provide more insights, we use three measures, which are routinely used by demographers to describe polygyny (Jacoby, 1998; van de Walle, 1968), first, the fraction of polygynist men in the population of married men (p), which measures the incidence of polygyny; second, the average number of wives per polygynist (w), which measures the intensity of polygyny, and, third, the ratio of married women to married men (m). Accordingly, polygyny concerns 33 percent of married men and, on average, each polygynyist is married to 2.4 wives. As expected, the incidence of polygyny is larger in rural areas, where 37 percent of married men practice polygyny as opposed to 11 percent in urban areas. The average number of wives per polygnyist is 2.5 in rural areas, and 2.3 in urban areas.

Since the overall ratio of women to men in Burkina is roughly equal to unity, one might ask how Polygyny can be sustained. Two arguments have commonly been advanced to explain the existence of polygyny in an evenly distributed population. First, in a growing population,[5] social arrangements that make men marry later in life than women can sustain polygyny over time.[6] Hence, at any given time the number of women in the marriage market exceeds that of men, making polygyny necessary to clear the market. Table 3 reports the marital status for men and women at various stages of their life cycles. For example, in rural areas, 39.5 percent of women aged between 15 and 19 years were married, while only 3.3 percent of men in that age group were married. Since the population size was similar across gender (2495 men and 2446 women), such an outcome is only conceivable if women are married to men in higher age groups.

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[5] Population growth rate in Burkina is estimated at 2.3 percent a year.

[6] Bride price is one expression of such arrangements, to the extent that men must accumulate enough wealth before they are able to marry.

Second, male heterogeneity in wealth can explain polygyny (e.g. Becker, 1991). If wives are normal goods, wealth inequality among men will lead to polygyny in equilibrium. Provided that women (or their families) have reservation utility in marriage, men who cannot provide the reservation utility are outbid for wives by their wealthier peers. As a result some men take more than one wife while other men remain unmarried. In line with this argument is the economic contribution of women in Sub-Saharan Africa (Boserup). To the extent that female labor complements physical capital such as land, the shadow price of a wife is relatively smaller for men with a large endowment of physical capital, making them demand more wives on average (Jacoby, 1995).

It is likely that both factors inter-play to sustain the practice of polygyny. In this analysis we take the polygynous structure of households as pre-determined and examine intra household allocations pertaining to the household's children.

3.1 Description of the Data Set

The goal of the empirical exercise of this paper is to estimate the effects of a woman's bargaining position on her and her co-wife's fertility and expenditures on child health. Fertility is readily measured by the number of deliveries of each woman prior to the survey interview. On the other hand, since for most variables pertaining to observable health inputs provided by the parents, such as hospital deliveries, there is little variation in the data set, expenditures on child health will be proxied by the most important child health outcome, mortality. To eliminate potential heterogeneity due to varying intensities of polygyny, we restrict the sample to those households, in which exactly two wives were between 15 and 49 years old at the time of the interview. 75 per cent of these households consist of one husband and two wives while the remaining 25 per cent comprise three or more wives, only two of which are in the just-mentioned age bracket. This leaves us with 593 wives and 2,692 children.

We now briefly discuss other variables that potentially affect the outcomes of interest. Table 1 summarizes these variables used in the estimations. The set of individual characteristics include the age of the wife and the husband, the marriage duration, and the rank of the wife. To the extent that marriage duration and wife rank confer some privileges, omitting these variables may induce omitted variable bias. When child health expenditures are concerned, we also include the gender of the child to account for potential gender bias in parents' allocation of resources.

The household characteristics include the household possession of bikes and motorcycles, radio receptors, and the material the household dwelling's roof and floor are made of. These variables are expected to proxy household wealth. In addition to these variables, we include the household head's literacy, ethnic group and religion, which can be viewed as household fixed effects in the sense that they are stable over time. Finally, regional dummies are used to control for spatial variations in the access to health care supply.

3.2 Measuring Relative Bargaining Positions

As Maitra (2002) points out, most empirical studies of economists have used economic resources that are exogenous to labor supply as measures of the bargaining position of a household member. Among these are assets, transfer receipts and payments as well as unearned income. Most of these measures, however, suffer from potential endogeneity problems (Schultz, 1990). Moreover, since this study is relying on DHS data, most of the just-mentioned economic variables are not reported.

More recently, in studies of household labor supply and marriage markets, the sex ratio, the percentage of males within a certain group of individuals, was found to be a significant determinant (Angrist, 2002; Chiappori et al., 2002). The idea here is that a higher fraction of males seeking a spouse improves the position of women who are willing to marry because, in this case, women are scarcer. We think of the sex ratio as a determinant of the intra-household bargaining position in two ways. First, if spouses were able to make binding commitments at the time of marriage, the sex ratio determines the degree of competition among males and can thus be expected to strengthen women's relative bargaining position.[7] Second, if bargaining continues when the marriage is already in place, the sex ratio is an indicator for remarriage possibilities in case of a divorce, which is often assumed to determine the threat point in intra household bargaining games. In both cases, an increase in the sex ratio positively affects the relative bargaining position of a wife.

Our sex ratio index is computed at the regional level. For a given wife, it corresponds to the number of males of her husband's age divided by the sum of that number and the number females of her own age. Thus this indicator measures the competitiveness in a certain segment of the marriage market, namely the one where women of the age of the wife in question compete for men of exactly her husband's age (and vice versa). In practice, of course, there is variation in the age gap between husbands and wives, indicating that males compete for women of different age groups simultaneously (and vice versa). Nevertheless, our measure which focuses on matches between two specific age groups can be expected to at least proxy the marriage market conditions underlying each observed marriage match.

In this study, we also use another demographic indicator relating to a woman's family background, the ratio of male to female siblings. In case of a divorce, which occurs in one percent of the marriages in the study region, it is usual that the woman initially joins the household of one of her adult brothers who is willing to accommodate her. As a consequence, the sex ratio among a wife's adult siblings positively affects her prospects in case of a divorce and thus, as argued above, her relative bargaining position within the marriage.

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[7] Throughout the paper, 'relative' stands for 'relative to the husband', other things being equal.

Another straightforward measure of relative bargaining power available in our data set is a wife's educational attainment compared to the husband's as measured by literacy, although estimating the impact of this variable is flawed by the small number of literate women in the data set. Of the 493 women used for the estimations, only eight are literate, which compares to fifteen literate husbands in the sample. There is, moreover, not a single household in the sample, where both the husband and at least one of the wives are literate. Thus the inclusion of a regressor for the difference in literacy between wife and husband is equivalent to the inclusion of a dummy for wife's literacy.

With an eye on the empirical analysis that follows, a comment on the bargaining measures proposed in this section is in order. The first measure, which pertains to the competitiveness in the marriage market can be considered truly exogenous for both fertility and child health because it arguably does not affect either of the two if not through the relative bargaining position of the wife.

The sex ratio among a wife's siblings, in contrast, may not only affect fertility and child health outcomes through the bargaining position of the wife, but also directly if, for example, the presence of many sisters who can assist in child care positively affects child health outcomes, other things being equal. In terms of the model of Section 2.1, this corresponds to an upward shift of the q function. Such a change of the relationship between costs and benefits of investments into children could, of course, also affect fertility decisions. If such effects are present, the sex ratio among a wife's siblings would continue to be a determinant of fertility and child expenditure outcomes, although it is doubtable whether it should be viewed as a pure bargaining measure. As a purely wife-specific characteristics, however, it should not affect the validity of H4, H5 and H6 of Section 2.2 because, whenever household resources are pooled, the health of a wife's children responds in the same way to spillovers of the sex ratio among her own and among the co-wife's siblings.

4 Estimation

4.1 Empirical Methodology

From the predictions outlined in Section 2.2, we are led to the following basic set of estimation equations:

(3) $$N_{i,k} = F(\boldsymbol{B}_{i,k}, \boldsymbol{B}_{j,k}, \boldsymbol{X}_{i,k}),$$

(4) $$H_{l,i,k} = G(\boldsymbol{B}_{i,k}, \boldsymbol{B}_{j,k}, \boldsymbol{X}_{l,i,k}).$$

$N_{i,k}$ denotes the number of children born to wife i in household k. $\boldsymbol{B}_{m,k}$, $m = i, j$, is a vector of measures of wife i's bargaining position relative to her husband, and $\boldsymbol{X}_{i,k}$ is a vector of household and wife-specific characteristics. $H_{l,i,k}$ is a measure of the health expenditures allocated to the l'th child born to wife i in household k, and $\boldsymbol{X}_{l,i,k}$ is a vector of household and child-specific characteristics.

The process underlying equation (3) is readily estimated by a Poisson regression model, which takes into account that the dependent variable assumes only non-negative discrete values.[8] When child health expenditures are concerned, the present dataset has very little variation in variables directly relating to health expenditures, such as prenatal care, hospital delivery and vaccination. We therefore use child mortality as a proxy for the expenditures devoted to child care. We do not use other common health indicators, such as height for age as left hand side

[8] With more degrees of freedom, the use of a less rigid structure, such as a proportional hazard model (see Maitra, 2002) would be more desirable.

variable in (4) because, as argued by Pitt (1997), inference for such variables is flawed by selection problems, which we do not have the means to control for with the available variables.

4.2 Estimation Results

The estimation results for fertility are set out in Table 4. Each observation refers to one wife in a household with two wives aged between 15 and 49. The 493 observations thus correspond to about 250 households. We denote by S the sex ratio of the wife's siblings and by SO the sex ratio among her co-wife's siblings. B stands for the measure of competitiveness in the marriage market corresponding to the wife while BO denotes that measure for her co-wife. All estimations are conducted both with and without the measures of literacy, which, as explained above, are flawed by very little variation within the sample.

The coefficients pertaining to the wife's own bargaining position, S and B, have a positive sign, implying that an increase of a wife's relative bargaining position results in a decrease in her fertility. This is in line with the prediction of the theoretical model (see H1 in Section 2.2), where each wife desires to have less children than desired by the husband and the co-wife because she has to incur a cost of child bearing that does not occur to the husband and the co-wife. As the wife's bargaining position improves, her preferences have a higher weight in the bargaining process and thus result in a decrease in her fertility. The coefficients for SO and BO, in contrast, have a negative sign, indicating that a wife's fertility increases in response to an improvement of the co-wife's bargaining position. Again, this in accordance with the theoretical predictions (H2). Further, the values of all four coefficients discussed in this paragraph are in line with H3 of Section 2.2, that a change in the wife's own bargaining position has a stronger effect on her fertility than a change of the same extent in the co-wife's bargaining position. According to the point estimates the effect of a change of own bargaining power is about twice as big as an identical change of the bargaining power of the co-wife.

Turning to child care and expenditure (see equation (4)), Table 5 gives the results of a Poisson regression with the number of antenatal visits of the mother preceding the birth of a child as the dependent variable. Table 6 contains the results of a probit estimation with hospital delivery as the dependent variable. Since, as explained above, information on observable expenditures on child health is limited in the present data set, we also estimate the health outcome child survival as an important proxy for child care and expenditure. Table 7 and Table 8 give the results of a Weibull survival model with the child's survival spell as the dependent variable, where the observations for male and female infants are pooled in the former and estimated separately in the latter. Notice that in all four models estimated here, a positive coefficient implies that the explanatory variable in question positively affects the respective outcome. For all four estimations, each child of the 593 wives in the data set accounts for one observation.

In line with the predictions of the Nash bargaining model, in Table 5, Table 6 and Table 7, both the B and the S measure of bargaining power of a wife affect the resource allocation in favour of her child, whereby the marriage market measure attains higher levels of significance. According to the theoretical model and in line with the estimated coefficients in the fertility regression, an increase in a wife's bargaining power reduces the total number of children in the household and, consequently, the husband and both wives agree on higher child care expenditures per child. An increase in the co-wife's bargaining power, on the other hand, does not have a significant positive effect on any of the outcomes.

In the survival model, moreover, the SO measure, which relates to the sex ratio among the co-wife's siblings, has a significant negative coefficient, thus increasing the mortality of the other wife's children. This staunchly contrasts an important implication of efficient intra household allocations, namely that the extent of child care and expenditure is independent of the identity of the mother. The signs of the coefficients in Table 7, in contrast, suggest that each wife uses her bargaining position to allocate household resources in favor of her own children and to the disadvantage of her co-wife's offspring. More formally, efficiency as expressed in H6 can be statistically tested by restricting the coefficients pertaining to B and BO, and S and SO to have the same value, respectively. We conduct tests where the null hypotheses are $b_{B} = b_{BO}$ and $b_{S} = b_{SO}$, both separately and jointly. We are led to reject all three varieties of the null hypothesis for the survival model and also the hypothesis $b_{B} = b_{BO}$ for the model pertaining to antenatal visits.

We now turn to Table 8, where the sample is split by the gender of the child. According to these estimates, an increase in the marriage market measure of bargaining power, B, works such that resources are diverted from the co-wife's daughters to the own sons. An increase in the S measure, on the other hand, is associated with less resources allocated to the co-wife's sons while both own daughters and sons benefit to a similar extent.

5 Concluding Remarks

In this paper, we have developed a model of decision making on fertility and expenditures devoted to child care within a polygynous household, where parents have children for the sake of old age support. Conflicting interests between husband and wife(s) arise because, with each delivery, a cost occurs to the mother in the form of a deterioration of her health. The Nash bargaining framework has been used to analyze how the bargaining position of each adult household member affects the number of children of each wife and the pattern of expenditures on child health. While the number of children born to a given wife depends on both her own and the co-wife's relative bargaining position, the efficient outcome of this cooperative bargaining game predicts an identical level of expenditures for each child, which implies that an improved bargaining position of one wife has the same effect on the co-wife's children as it has on her own.

These predictions have been tested with the 1998/99 Demographic and Health Survey from Burkina Faso, where the majority of married women lives in a polygynous union. According to the results, an improved bargaining position of a wife reduces her fertility, while an improved bargaining position of the co-wife has the adverse effect, which is in accordance with the theoretical predictions. In contrast, child survival, which is a function of the care and expenditures devoted to the child, is increasing in the mother's own but decreasing in the co-wife's bargaining power, which contradicts the hypothesis of an efficient intra household allocation of resources. The results suggest that, within a bigynous household, child care expenditures are biased in favour of the children of the wife with relatively higher bargaining power. Our explanation for this violation of the efficiency of investment decisions is that resources in the household are in fact not pooled, but that a wife expects higher future returns to herself from her own than from her co-wife's children.

The present results extend the findings of Udry (1995), who was the first to discard the intra household efficiency paradigm by showing that farming households in Burkina Faso do not achieve a pareto efficient allocation of resources in agricultural production. Based on data from the same country, this study suggests that pareto efficiency also fails to be achieved in polygynous households when child care and expenditures on child health are concerned, which play an important role for life cycle consumption smoothing in the absence of formal security systems.

References

[to be added]

Table 1 Descriptive Statistics

	Mean	Std. Dev.	Min	Max
Women				
Children ever born	4.88	2.66	1.00	14.00
Age	29.94	7.06	15.00	47.00
Marriage duration	12.39	6.93	1.00	30.00
Husband age	42.89	8.45	22.00	59.00
B	0.34	0.07	0.16	0.51
BO	0.27	0.07	0.10	0.47
S	0.47	0.31	0.00	1.00
SO	0.49	0.32	0.00	1.00
literacy wife	0.02	0.13	0.00	1.00
literacy co-wife wrt to husband	-0.02	0.22	-1.00	1.00
literacy wrt husband	-0.02	0.22	-1.00	1.00
literacy husband	0.03	0.18	0.00	1.00
Child				
Mortality	0.16	0.36	0.00	1.00
Hospital delivery	0.23	0.42	0.00	1.00
Antenatal visits	1.78	1.95	0.00	18.00
Child age (months)	26.08	18.20	0.00	59.00
Average age at death	9.71	10.80	0.00	48.00
Male	0.51	0.50	0.00	1.00
Household and region dummies				
regiond2	0.26	0.44	0.00	1.00
regiond3	0.26	0.44	0.00	1.00
regiond4	0.35	0.48	0.00	1.00
radiod1	0.30	0.46	0.00	1.00
biked1	0.04	0.19	0.00	1.00
mbiked1	0.67	0.47	0.00	1.00
floord3	0.18	0.38	0.00	1.00
religiond1	0.19	0.39	0.00	1.00
religiond2	0.56	0.50	0.00	1.00

Standard errors for dummies: sqrt(m(1-m)) where m is the mean.

Table 2 Polygyny in Burkina Faso

	p	w	M
Burkina	0.33	2.48	1.50
Rural areas	0.38	2.52	1.59
Urban areas	0.16	2.35	1.22

Table 3 Marriage distribution across age groups

	Male		Female	
Age Group	Rural	Urban	Rural	Urban
15-19	3.29	0.44	39.49	11.33
20-24	29.29	4.30	87.79	51.00
25-29	64.34	35.35	94.29	74.77
30-34	85.99	65.47	95.22	88.31
35-39	91.78	86.55	96.31	91.53
40-44	97.10	91.99	97.12	97.79
45-49	97.44	95.17	98.13	96.02
50-54	97.01	95.98	95.96	95.80
55-59	98.05	99.13	96.47	93.15
60 et plus	96.36	96.77	86.96	80.87
Population	11184	4340	12284	3792

Source: Burkina Priority Survey, 1998

Table 4 Determinants of Fertility, Poisson Regression

Fertility	w/o literacy	w/ literacy
age	-0.012	-0.015
	[0.20]	[0.25]
age1	0.002	0.002
	[1.02]	[1.06]
agemduration	-0.005	-0.005
	[1.47]	[1.55]
mduration	0.186	0.189
	[3.09]***	[3.23]***
mduration2	0	0
	[0.22]	[0.26]
hage	0.01	0.011
	[0.63]	[0.66]
hage2	0	0
	[0.71]	[0.78]
hagem	0	0
	[0.12]	[0.02]
S	**-0.155**	**-0.155**
	[4.03]* **	**[4.04]*** **
SO	**0.071**	**0.072**
	[1.77]*	**[1.82]***
B	**-1.381**	**-1.363**
	[1.31]	**[1.29]**
BO	**0.49**	**0.493**
	[1.42]	**[1.42]**
Literacy wrt cowife		-0.052
		[1.04]
Literacy wrt husband		0.022
		[0.21]
litmale		-0.024
		[0.20]
rank== 1.0000	0.203	0.202
	[4.01]***	[3.95]***
rank== 2.0000	-0.115	-0.114
	[2.52]**	[2.50]**
region== 3.0000	-0.037	-0.039
	[0.82]	[0.87]
region== 4.0000	0.068	0.067
	[1.60]	[1.60]
region== 5.0000	-0.022	-0.023
	[0.51]	[0.54]
radio== 0.0000	-0.033	-0.033
	[1.28]	[1.25]
bike== 0.0000	0.057	0.056
	[1.28]	[1.24]
mbike== 0.0000	-0.052	-0.054
	[2.20]**	[2.23]**
floor== 34.0000	0.011	0.014
	[0.46]	[0.58]
religion== 1.0000	0.007	0.006

		[0.19]	[0.19]
religion==	3.0000	-0.003	-0.005
		[0.11]	[0.20]
ethny==	1.0000	0.054	0.057
		[0.92]	[0.98]
ethny==	2.0000	0.306	0.308
		[3.39]***	[3.44]***
ethny==	3.0000	-0.042	-0.039
		[0.63]	[0.59]
ethny==	4.0000	0.129	0.131
		[2.22]**	[2.25]**
ethny==	5.0000	-0.031	-0.033
		[0.56]	[0.60]
ethny==	6.0000	-0.072	-0.071
		[1.16]	[1.14]
ethny==	7.0000	0.002	0.002
		[0.04]	[0.04]
ethny==	8.0000	-0.135	-0.125
		[1.63]	[1.46]
ethny==	9.0000	-0.42	-0.427
		[2.90]***	[3.08]***
ethny==	10.0000	-0.122	-0.127
		[1.27]	[1.33]
Constant		-0.125	-0.113
		[0.12]	[0.10]
Observations		493	493

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5 Determinants of Antenatal Visits, Poisson Regression

Antenatal Visits	w/o literacy	w/ literacy
age	0.035	0.029
	[0.53]	[0.61]
age1	-0.001	-0.001
	[0.65]	[0.81]
agemduration	0.001	0.001
	[0.30]	[0.36]
ageother	-0.027	-0.025
	[0.89]	[1.49]
ageother2	0.001	0.000
	[1.05]	[1.89]*
mduration	-0.038	-0.034
	[0.61]	[0.91]
mduration2	0.000	0.000
	[0.13]	[0.35]
hage	0.000	0.002
	[0.01]	[0.13]
hage2	0.000	0.000
	[1.24]	[1.55]
hagem	0.000	0.000
	[0.33]	[0.38]
B	**2.684**	**2.465**
	[1.54]	**[1.89]***
BO	**-0.983**	**-0.708**
	[0.78]	**[0.84]**
S	**0.048**	**0.052**
	[0.67]	**[1.04]**
SO	**0.016**	**-0.005**
	[0.21]	**[0.10]**
Literacy cowife wrt husband		0.449
		[5.22]***
Literacy wrt husband		0.091
		[0.85]
litmale		0.774
		[5.40]***
rank== 1.0000	0.032	0.020
	[0.31]	[0.39]
rank== 2.0000	0.053	0.060
	[0.65]	[1.41]
region== 3.0000	0.500	0.495
	[3.04]***	[8.86]***
region== 4.0000	-0.320	-0.318
	[1.53]	[4.63]***
region== 5.0000	0.304	0.306
	[1.64]	[5.54]***

radio== 0.0000	-0.047	-0.039
	[0.64]	[1.13]
bike== 0.0000	0.148	0.143
	[1.31]	[2.42]**
mbike== 0.0000	0.000	0.004
	[0.01]	[0.12]
floor== 34.0000	0.243	0.243
	[3.02]***	[6.32]***
religion== 1.0000	0.453	0.438
	[4.15]***	[9.49]***
religion== 3.0000	0.316	0.310
	[2.65]***	[7.03]***
ethny== 1.0000	0.590	0.624
	[2.51]**	[6.82]***
ethny== 2.0000	-12.945	-12.915
	[13.70]***	[0.06]
ethny== 3.0000	-0.279	-0.257
	[1.21]	[2.68]***
ethny== 4.0000	-0.578	-0.539
	[2.40]**	[6.04]***
ethny== 5.0000	-0.171	-0.177
	[0.80]	[2.00]**
ethny== 6.0000	-2.006	-1.974
	[7.33]***	[3.38]***
ethny== 7.0000	-0.384	-0.363
	[2.12]**	[5.28]***
ethny== 8.0000	0.437	0.394
	[1.45]	[3.72]***
ethny== 9.0000	-13.241	-13.230
	[21.35]***	[0.06]
ethny== 10.0000	-0.163	-0.151
	[0.58]	[1.54]
Constant	-0.289	-0.333
	[0.22]	[0.39]
Tests of H6		
B = BO, chi(1)	**3.81***	**2.83***
S = SO, chi(1)	**0.15**	**0.48**
B = BO and S = SO, chi(2)	**3.87**	**3.16**
Observations	2692.000	2692.000

Absolute value of z statistics in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6 Determinants of Hospital Delivery, Probit

	w/o literacy	w/ literacy
age	0.1170	0.1230
	[0.99]	[1.03]
age1	-0.0040	-0.0040
	[1.53]	[1.54]
agemduration	0.0030	0.0030
	[0.59]	[0.58]
mduration	-0.0930	-0.0960
	[0.96]	[0.97]
mduration2	0.0000	0.0000
	[0.01]	[0.02]
hage	0.0290	0.0290
	[1.04]	[1.06]
hage2	0.0000	0.0000
	[0.77]	[0.79]
hagem	0.0010	0.0010
	[1.93]*	[1.97]**
B	**6.0420**	**6.0660**
	[2.70]* **	**[2.70]*** **
BO	**0.7240**	**0.7920**
	[0.75]	**[0.82]**
S	**0.1220**	**0.1180**
	[1.14]	**[1.09]**
SO	**-0.1120**	**-0.1160**
	[1.14]	**[1.18]**
Literacy cowife wrt husband		0.2580
		[1.34]
Literacy wrt husband		0.4620
		[2.21]**
litmale		0.7670
		[1.73]*
rank== 1.0000	-0.0250	-0.0300
	[0.19]	[0.22]
rank== 2.0000	0.0260	0.0300
	[0.26]	[0.30]
region== 3.0000	0.2480	0.2420
	[1.09]	[1.05]
region== 4.0000	-0.2690	-0.2720
	[0.91]	[0.91]
region== 5.0000	0.0540	0.0450
	[0.23]	[0.20]
radio== 0.0000	-0.0370	-0.0380
	[0.42]	[0.43]
bike== 0.0000	0.0690	0.0710
	[0.45]	[0.45]
mbike== 0.0000	-0.0590	-0.0550

	[0.62]	[0.58]
floor== 34.0000	0.1990	0.2000
	[1.49]	[1.48]
religion== 1.0000	0.4360	0.4220
	[3.34]***	[3.26]***
religion== 3.0000	0.5280	0.5140
	[3.33]***	[3.34]***
ethny== 1.0000	-0.4680	-0.4410
	[0.99]	[0.92]
ethny== 3.0000	-0.7190	-0.6920
	[2.20]**	[2.11]**
ethny== 4.0000	-0.4050	-0.3780
	[1.08]	[1.00]
ethny== 5.0000	-0.4570	-0.4850
	[1.16]	[1.26]
ethny== 7.0000	-0.3170	-0.3000
	[1.06]	[0.99]
ethny== 8.0000	0.0400	0.0100
	[0.10]	[0.02]
ethny== 10.0000	-0.4360	-0.4370
	[1.06]	[1.05]
Constant	-5.2620	-5.4200
	[2.82]***	[2.86]***
Observations	2656.0000	2656.0000
Tests of H6		
B = BO, chi(1)	0.73	0.72
S = SO, chi(1)	2.02	2.03
B = BO and S = SO, chi(2)	2.61	2.63

Table 7 Determinants of Child Survival, Censored Weibull Model

	w/o literacy	w/ literacy
Dummy for Male	0.089	0.087
	[0.43]	[0.42]
age	1.253	1.274
	[3.49]***	[3.54]***
age1	-0.046	-0.046
	[6.21]***	[6.23]***
agemduration	0.065	0.066
	[5.38]***	[5.44]***
mduration	-1.218	-1.241
	[4.42]***	[4.50]***
mduration2	-0.032	-0.033
	[4.27]***	[4.30]***
hage	0.538	0.539
	[2.94]***	[2.91]***
hage2	-0.004	-0.004
	[2.13]**	[2.04]**
hagem	0.009	0.009
	[3.09]***	[3.02]***
B	**57.782**	**58.25**
	[4.58]* **	**[4.58]*** **
BO	**-0.992**	**-0.535**
	[0.29]	**[0.16]**
S	**1.003**	**1.006**
	[2.76]* **	**[2.76]*** **
SO	**-0.973**	**-0.931**
	[2.67]* **	**[2.51]** **
Literacy wrt cowife		-1.056
		[0.76]
Literacy wrt husband		2.615
		[1.33]
litmale		3.775
		[1.70]*
rank== 1.0000	-0.668	-0.729
	[1.57]	[1.69]*
rank== 2.0000	-0.183	-0.149
	[0.49]	[0.39]
region== 3.0000	0.076	0.002
	[0.17]	[0.01]
region== 4.0000	1.433	1.388
	[3.23]***	[3.12]***
region== 5.0000	0.113	0.004
	[0.28]	[0.01]
radio== 0.0000	-0.249	-0.31
	[0.97]	[1.19]
bike== 0.0000	1.203	1.32

	[0.86]	[0.94]
mbike== 0.0000	0.075	0.093
	[0.30]	[0.37]
floor== 34.0000	0.41	0.384
	[1.39]	[1.28]
religion== 1.0000	0.366	0.299
	[1.20]	[0.97]
religion== 3.0000	0.882	0.833
	[3.20]***	[2.97]***
ethny== 1.0000	0.723	0.759
	[1.21]	[1.26]
ethny== 2.0000	-2.025	-1.961
	[2.88]***	[2.76]***
ethny== 3.0000	2.758	2.907
	[2.64]***	[2.75]***
ethny== 4.0000	-0.148	-0.064
	[0.23]	[0.10]
ethny== 5.0000	1.346	1.388
	[2.37]**	[2.42]**
ethny== 6.0000	-0.634	-0.661
	[0.76]	[0.78]
ethny== 7.0000	1.606	1.661
	[3.53]***	[3.63]***
ethny== 8.0000	-0.513	-0.577
	[1.03]	[1.12]
ethny== 10.0000	18.462	19.631
	[0.03]	[0.02]
Constant	-41.976	-42.541
	[4.65]***	[5.11]***
log(a)	-0.295	-0.300
	[5.10]***	[4.71]***
Observations	1762	1762
<u>Tests of H6</u>		
B = BO, chi(1)	**17.30*** **	**17.55*** **
S = SO, chi(1)	**5.98** **	**5.87** **
B = BO and S = SO, chi(2)	**23.78*** **	**23.77*** **

Table 8 Determinants of Child Survival by Gender, Censored Weibull Model

	boys	girls	boys	girls
age	1.335	-0.307	1.282	-0.017
	[2.34]**	[0.33]	[2.24]**	[0.02]
age1	-0.045	0.006	-0.044	0.001
	[3.79]***	[0.26]	[3.76]***	[0.06]
agemduration	0.046	0	0.047	0.005
	[2.51]**	[0.00]	[2.57]**	[0.13]
mduration	-1.089	0.178	-1.09	0
	[2.40]**	[0.23]	[2.41]**	[0.00]
mduration2	-0.018	-0.01	-0.019	-0.009
	[1.84]*	[0.53]	[1.99]**	[0.47]
hage	0.888	-1.563	0.893	-1.681
	[3.88]***	[3.87]***	[3.92]***	[4.18]***
hage2	-0.007	0.012	-0.007	0.013
	[2.94]***	[3.07]***	[2.95]***	[3.42]***
hagem	0.009	0.01	0.009	0.009
	[2.72]***	[2.00]**	[2.74]***	[1.85]*
B	**65.491**	**-14.498**	**66.638**	**-16.058**
	[4.23]* **	**[0.73]**	**[4.21]*** **	**[0.83]**
BO	**2.733**	**-20.903**	**3.028**	**-22.008**
	[0.57]	**[3.70]*** **	**[0.62]**	**[3.94]*** **
S	**0.981**	**1.074**	**1.018**	**1.075**
	[2.14] **	**[1.88]* **	**[2.24]** **	**[1.90]* **
SO	**-1.155**	**-0.041**	**-1.133**	**-0.146**
	[2.49] **	**[0.08]**	**[2.38]** **	**[0.28]**
Literacy cowife wrt husband			25.645	-0.34
			[0.00]	[0.25]
Literacy wrt husband			25.975	3.227
			[0.00]	[2.22]**
litmale			78.582	2.835
			[0.00]	[1.23]
rank== 1.0000	0.897	-1.922	0.88	-2.129
	[1.82]*	[2.97]***	[1.79]*	[3.32]***
rank== 2.0000	-0.927	0.472	-0.919	0.524
	[2.02]**	[0.83]	[2.01]**	[0.94]
region== 3.0000	1.147	-1.066	0.968	-0.957
	[2.15]**	[1.29]	[1.82]*	[1.18]
region== 4.0000	2.653	-0.558	2.614	-0.54
	[4.22]***	[0.77]	[4.19]***	[0.77]
region== 5.0000	1.237	-0.584	1.059	-0.404
	[2.72]***	[0.78]	[2.32]**	[0.55]
radio== 0.0000	-0.652	-0.797	-0.631	-0.869
	[2.35]**	[2.03]**	[2.28]**	[2.29]**
bike== 0.0000	-0.257	30.437	-0.294	27.702
	[0.21]	[0.00]	[0.24]	[0.00]
mbike== 0.0000	-0.88	0.095	-0.83	-0.083

	[2.72]***	[0.25]	[2.59]***	[0.21]
floor== 34.0000	0.48	0.799	0.436	0.831
	[1.15]	[1.78]*	[1.05]	[1.83]*
religion== 1.0000	0.572	0.733	0.492	0.28
	[1.40]	[1.37]	[1.20]	[0.54]
religion== 3.0000	0.295	0.937	0.138	0.987
	[0.79]	[2.26]**	[0.37]	[2.40]**
ethny== 1.0000	0.48	0.82	0.584	1.311
	[0.36]	[1.11]	[0.44]	[1.76]*
ethny== 2.0000	22.929	-1.692	27.102	-1.092
	[0.00]	[1.30]	[0.00]	[0.80]
ethny== 3.0000	3.476	0.826	3.742	0.952
	[2.38]**	[0.71]	[2.55]**	[0.84]
ethny== 4.0000	-0.721	34.341	-0.693	32.025
	[0.94]	[0.00]	[0.91]	[0.00]
ethny== 5.0000	0.643	1.039	0.641	1.412
	[0.91]	[1.43]	[0.89]	[1.93]*
ethny== 6.0000	-6.09	32.525	-6.235	30.033
	[6.41]***	[0.00]	[6.47]***	[0.00]
ethny== 7.0000	0.783	1.831	0.79	2.129
	[1.52]	[3.09]***	[1.54]	[3.65]***
ethny== 8.0000	-2.535	0.072	-2.773	0.476
	[3.48]***	[0.11]	[3.75]***	[0.69]
ethny== 10.0000	23.06	29.02	25.887	26.21
	[0.00]	[0.00]	[0.00]	[0.00]
Constant	-55.097	50.501	-54.947	50.507
	[1.73]*	[2.76]***	[4.76]***	[2.78]***
$\log(a)$	0.866	0.751	0.864	0.768
	[4.82]***	[3.25]***	[1.75]*	[3.01]***
Tests of H6				
B = BO, chi(1)	**16.12*** **	**0.09**	**15.77*** **	**0.08**
S = SO, chi(1)	**5.08** **	**1.60**	**8.56*** **	**1.98**
B = BO and S = SO, chi(2)	**12.96*** **	**2.01**	**23.29*** **	**2.39**
Observations	898	866	898	866

Absolute value of z statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%