# Sharing The Burden of Death: Implicit Family Insurance, Mortality Shocks and Fertility and Child Health*

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**Abstract**

This paper studies the network effects of kinship-based informal insurance on fertility and child health. Using demographic data from Malawi and exploiting differences between the patrilineal and matrilineal kinship in the composition of family network groups, this paper finds that the death of an adult in an insurance network significantly reduces fertility. While we find no evidence of intra-household discrimination against fostered kin orphans in terms of human capital investments, our results show that they provide more on-farm labor than biological children of the insuring parents. OLS regressions suggest positive effects of orphans on child health, but we do not find such effects after doing instrumental variables regressions. Results suggest that the positive orphan effects on household income may offset the pressure on household resources that orphan parenting exerts. However, the fertility effects found in this paper imply that household demand decisions are not independent of insuring network effects when formal insurance markets are missing.

Keywords: Household, Kinship, Family, Preferences, Fertility, Externalities, Extended Families, Malawi, Orphans.

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# 1 Introduction

Many insurance markets are either missing or underdeveloped in most societies in the developing countries. In the absence of formal insurance, most households rely on some form of cooperative labor and transfer of physical and human resources within social networks to mitigate the impact of health and environmental shocks. A large literature exists that demonstrates that households deal with shocks mostly by means of inter-household financial transfers and remittances (Rosenzweig (1988); Guy (2002); Rosenzweig and Stark (1989)) and child fostering (Akresh (2005)) within kinship networks. However, while linkages in these networks prove useful in mitigating risks (Rosenzweig (1988)[1]; Becker (1974)), they imply that individual decision-making is affected by the shocks that affect other members of the networks (Becker (1974)[2]). These network effects, which have not been emphasized in the economic models of demographic behavior or subjected to rigorous empirical analysis in the economic demography literature, are the focus of this paper. In particular, we examine network effects of mortality on fertility and child quality.

The general economic approach to fertility and child quality decisions emphasizes the effects of parents' income and the price of childrearing inputs from the viewpoint of individual property rights and given sets of complete markets. Both the static models and the dynamic models of fertility surveyed in Arroyo and Zhang (1997) view fertility and child quality investment decisions as those of "independent" households that fully bear the costs and solely reap the entire benefits of fertility, taking the prevailing mortality risks, income and a set of prices as given. In the less developed economies where social networks substitute for missing markets, this approach ignores the analytical links between decisions in one household and the shocks experienced by other households in the network through prices that internalize the timing and magnitude of those shocks (Udry 1994)[3].

[1] In a seminal paper, Rosenzweig (1988) found evidence that households treat the kin network system of support and insurance as superior to other forms of risk coping; and concludes that the trust, knowledge and altruism induced by family experience in kinship might sustain income pooling.

[2] The possibility that household decisions internalize network effects was first suggested by Becker (1974). In his theory of social interactions, the stability and efficiency of the resource network in insuring its members against shocks hinges on each member internalizing the within-network externalities. In effect, decision making in a household maximizes the network rather than the household utility

[3] In the study of informal credit contracts in villages in Northern Nigeria, Udry (1994) found that loan repayments are not only conditioned on borrower's shocks, but also on the lender's shocks, and concludes that

The approach in this paper accounts for the links between households in contractual kinship networks. We explore the importance of these links for household behavior by examining the effects of shocks arising from a household on behavior of other households in the network. Insurance effects induce behavior as they are internalized within insuring networks, suggesting clearly that such effects are unimportant for behavior in non-insuring networks. In our identification strategy, we estimate network effects by comparing responses to similar shocks between insuring kin networks and non-insuring kin networks of households. In particular, we compare outcomes between women networks in patrilineal and matrilineal kinship family systems.

Our focus on insurance effects in social networks distinguishes this paper from those which focus on information effects such as herd behavior; where individuals look at the decisions made by others in decision-making (Banerjee 1992), or conversational effects in which repeated interactions in conversation groups influence individual attitudes and preferences (Behrman, Kohler and Watkins 2002). The focus on insurance effects also distinguishes this paper from those which focus on altruism (Altonji, Hayashi and Kotlikoff 1997)[4].

Family network insurance substitute for market insurance for four reasons. First, opportunistic behavior such as reneging on contract terms are limited in family based contracts (Pollak 1985). Second, the trust and knowledge induced by family experience through repeated interaction minimizes or eliminates the informational problems that usually make formal insurance difficult if not impossible to operate in the rural areas of developing countries (Rosenzweig 1988). Third, the possibility of adverse selection is limited since participation is naturally restricted to members of the kinship group and not open to outsiders. Fourth, insurance payments through interhousehold exchanges and transfers are stable even in the event of migration (Rosenzweig and Stark (1989); Caldwell (1976)[5]).

A natural set of events that may be covered by family insurance contracts concerns parental death (Pollak 1985). There are four plausible channels through which death effects are inter-

lending has an insurance component. Temporal prices faced by both borrower and lender households therefore depend on the timing of shocks that affect the other party.

[4]Individuals may be related by birth but may not belong to an insuring network. While sisters will be altruistic toward each other irrespective of whether they belong to the same network or not, insurance effects are only realizable if they are members of the same insuring network.

[5]Caldwell (1976) observed that family residence arrangements have little or nothing to do with the true extended family of mutual obligations and concludes that it is the size and ramifications of these family obligations that are important.

nalized by insuring households in fertility and child quality decisions. First, adult kin deaths induce insurance transfers for funeral expenses. These transfers constitute a negative income shock to related households, and if parents care about the survival chances of their potential births, and are not able to smooth consumption, they may time conceptions at times when they are better able to invest in their nutrition. Second, in addition to the income effect of these transfers, family provision of insurance benefits upon adult death usually entails moving orphans into other residential units, particularly when such deaths affect household structure. Parents who receive orphans into their households may value them as children to a certain extent. In the extreme case where orphans are not valued as children, orphan coresidence constitutes a pure income effect in the household. At the other extreme, kin orphans may be perfect substitutes for biological children, and in such cases, orphan coresidence constitutes a pure substitution effect on household fertility. At intermediate levels of substitution, orphan coresidence will affect parents demand for additional children to the extent that kin orphan coresidence constitutes income and substitution effects. There is usually very limited scope for intrahousehold discrimination against orphaned children in terms of human capital investments in family based insurance. The intuition here is that by the nature of kin insurance, returns to investment in children are shared by the kinship group rather than solely by their parents even while the parents are alive (Todaro and Fapohunda 1988), and therefore parental deaths are unlikely to have significant effects on child investment. To this effect, Foster and Rosenzweig (1996), Lloyd and Blanc (1996), and Lundberg and Mead (2000) find no impact of orphanhood on human capital investment[6]. Third, adult deaths in an insurance network can also affect behavior by raising the level of contingent liability for insurance payments by the other households in the event of future death[7]. Fourth, in societies where common property rights and cooperative farm labor are common, the death of an adult may raise the on-farm labor supply of the surviving adults whose labor may have to substitute for that of the deceased

[6] Other studies in the literature on orphans that found evidence of reduction in human capital investment of orphans when compared to non-orphans attribute the discrimination to coresidence with distant relatives or unrelated caregivers (Case, Paxson and Ableidinger 2004). An unrelated caregiver may discriminate against the orphan because he is not contractually linked with the orphan child in an insurance network and is therefore unlikely to benefit from such investments.

[7] Current death reduces the size of the group that is liable to paying benefits and caring for the orphans of subsequent deaths, thus raising the level of contingent income shocks that the surviving members will experience in the event of future deaths.

in the form of insurance. A rise in on-farm return to labor arising from kin death may induce a change in, for example, the timing of pregnancy such that women time pregnancy into periods of low demand for their labor.

There are also two possible channels through which adult death can affect the quality of biological children in the insuring households. First, if adult kin mortality causes fertility reduction, then the lower fertility may improve child quality either by increasing the spacing of births or by reducing the number of children over which household resources are spread. Second, orphans of working age may contribute to household labor, and any excess of orphan labor income over their consumption and human capital investment translates into higher income for the household, which may improve the nutritional status of young biological children.

If network effects on demographic behavior are strong enough, then policies aimed at developing insurance (and possibly credit) markets may be potent in changing fertility, human capital and population health levels. Understanding the relative strength of the income and substitution components of network effects is also important for the direction of interventions.

In the wake of HIV/AIDS epidemics especially in sub-Saharan Africa, two major issues yet to be understood are the effects of the epidemic on fertility and the externalities of orphan care on the caregiving households. As orphan care takes place almost exclusively within kinship networks ((Case et al. 2004); Evans (2004)), positive income effects might dominate the substitution effects at low levels of child substitutability and thereby raise fertility, or the substitution effects will dominate the income effects at higher levels of substitutability to reduce the demand for children. If income effects are negative, then orphan care might be expected to reduce fertility. Further, since kinship families usually hold communal rights in land and other productive resources, including cooperative agricultural labor; in the absence of intrahousehold discrimination in child investments, young children in the insuring households may benefit from orphan coresidence if orphan children supply more on-farm labor relative to other children, thereby generating a net "surplus" which constitutes a positive income effect for the insuring household.

We exploit the differences in implicit family contracts between the patrilineal and matrilineal family kinship systems to identify the effect of adult kin death on fertility and child quality using women data from the Malawi Demographic and Health Surveys (MDHS). In the patrilineal system, the basic insurance network within which orphan parenting and interhousehold transfers take place consists of the households of a group of brothers, while in the matrilineal system, the households of a group of sisters constitute the network. In addition to other socioeconomic data, the MDHS collects information on the death and orphans of sisters of the sampled women. Our identification assumption is that network effects arising from the death of an adult sister who had at least one child orphan should be observed in the matrilineal kinship system.

In using networks of women who are genetically linked, adult kin mortality may also affect behavior by revealing information about the genetic health of the surviving adults. The change in behavior induced by genetic information is different from, and will confound, family insurance effects. For example, a signal of short lifespan may induce women to reduce their fertility. To isolate insurance effects from pure informational effect of the death of relatives[8], we restrict the analysis to deaths which generate at least one orphan child. However, the death of adults with orphans may have both insurance as well as information effects. To isolate insurance effects from informational effects, we compare behavior between the women insuring networks in matrilineal kinship and women non-insuring networks in patrilineal kinship. Our assumption is that any effect of adult death observable in patrilineal women network is information effect, and that the differences between the matrilineal and patrilineal women network effects is an insurance effect.

Our analysis does not allow us to separate network effects into transfer and orphan components because we do not observe transfers in our data. However, the results suggest that orphan parenting effects are larger than other network effects.

## 2 Institution: Kinship Systems in Malawi

Most societies in the low income countries operate in large extended families or lineages (Caldwell 1976) within which cooperative labor and insurance exchanges take place. Family network in Malawi is either patrilineal or matrilineal. In the patrilineal system, a household comprising the husband, wife and children is an integral part of the husband's lineage and

[8]Hamermesh (1985)and Smith, Taylor and Sloan (2001) show that the death of a relative is the single most important factor determining the updates of individuals' assessment of their own life expectancies.

children are accounted in his lineage. Husbands remain in their villages of birth or natal compound and wives move to join the husbands upon payment of the bride price in a move that is considered as changing affiliation from her natal kin to that of the husband (Tew 1950). Farmland belongs to the husband's family, having been obtained from his lineage except where the land is purchased. Women exercise little or no control over resources and their access to land is usually through their husband. The basic lineage group consists of a group of brothers under the headship of their father or the eldest son in the family. Upon the death of a woman, the children remain with their father or with their paternal kin in the event that their father was no longer alive. Therefore a woman's appropriate insurance network is her husband's kinship rather than her natal kinship network. This pattern of marriage and family organization is observed among the Tumbuka, Sena, Nkonde and Ngoni ethnic groups of Malawi.

In the matrilineal system, a household comprising the husband, wife and children is an integral part of the wife's lineage rather than that of the husband, and children are members of their mother's matrilineage. At marriage, a husband pays no bride price, and often moves from his parents' household or village to live with his wife and relations in her village, and exercises little control over his children and productive resources[9]. The farmland cultivated by the household also belongs to the woman, which is usually allocated by her lineage. The effective descent group, also referred to as the sorority group, is the *mbumba*, a small unit consisting of a group of sisters of the same mother and their children under the leadership of the women's eldest brother referred to as *nkoshwe* (Richards 1950). In this paper, the *mbumba* constitutes the basic insurance group within the larger matrilineage. The *nkoshwe* regulates and oversees his sisters' access to productive resources; and the healthcare, education and general welfare of their children. He is also responsible for arranging marriages and overseeing funerals in the case of death. Barring these responsibilities, the household of the *nkoshwe* does not belong to the *mbumba* which he oversees but to that of his wife. Upon the death of a woman, her children passes onto her sisters in the *mbumba* who take responsibility for their

[9]A variation of the matrilineal system is also practiced mainly in the Chewa ethnic group. The husband pays no bride price but a gift is given to the wife's parents. In this instance, the man's village can become the matrimonial home. However this practice, although becoming common, is reserved for the village chief or a brother who oversees a clan of sisters to enable him stay close to the clan. However, upon the death of a man, the widow and the children of return to the widow's village, and upon the death of a woman, the family of the deceased assume care of the children since they belong to their (the women's) matrilineage.

care. A grandmother who is still active may also have orphaned grandchildren living with her along with or without other adults. The widowed husband returns to his village, and the land being cultivated by the household returns to the woman's family along with all other inheritable property. This pattern of marriage and family organization is observed among the Yao, Chewa, Lomwe, Tonga and Anyanja ethnic groups.

The differences in family organization implies that in contrast to the matrilineal system, women's interaction and insurance exchanges with their siblings are extremely limited in the patrilineal system. Lesthaeghe (1989) observed that female independence and reliance on own kin increase as one moves away from strong forms of patrilineal organization in the direction of matrilineages. While women generally have low status in the patrilineal family systems, women in matrilineal systems are more independent and tend to possess more bargaining power in household decisions, even in fertility determination (Takyi and Dodoo 2005).

## 3 Model of Family Insurance and Fertility

We consider a simple model that captures the basic features of family network insurance. To simplify the model, we assume that parents' utility defined over quantity and quality of children and physical consumption is given by:

$$U = U(n, q, z) \tag{1}$$

where $n$ is the number of children, $q$ is child quality, and $z$ is the rate of consumption of a composite good, and the utility function is assumed to be concave in its arguments. We do not assume that children are clearly perfect substitutes and characterize the "effective" quantity and quality of children in the household by

$$\begin{aligned} n &= n_b + \alpha_n n_k; \quad 0 \leq \alpha_n \leq 1 \\ q &= q_b + \alpha_q q_k; \quad 0 \leq \alpha_q \leq 1 \end{aligned} \tag{2}$$

where $n_b$ is the quantity and $q_b$ is the quality of biological children. Similarly, $n_k$ is the quantity and $q_k$ is the quality of kin-related children in the household. $\alpha_n$, $\alpha_q$ reflect the degree of substitution of quantity and quality respectively between biological children and kin-related children. In respect of number of children, $\alpha_n$ captures the extent to which kin children can be counted as own children particularly in terms of returns to child investment. For child quality, $\alpha_q$ captures both the extent to which the household benefits from the returns to kin child quality and the externalities of kin child quality on the level of household child quality. Children are often raised together when they are substitutable to some extent to parents. This joint rearing constitutes an avenue for child quality spillovers.

If $\alpha_n = 1$, in which case children are perfect substitutes, then kin children exert only substitution effects on the demand for biological children. On the other hand, if $\alpha_n = 0$, implying that women do not value their sister's children as own children at all, then kin children only constitute a pure income effect on the household. For intermediate values, $0 < \alpha_n < 1$, there are both income and substitution effects from kin children. For each child, a fraction $t_w$ of time is allocated to wage earning work and the remaining fraction $t_q = 1 - t_w$ is allocated toward human capital accumulation. Human capital production function is given by

$$q_i = q(X_i, t_q);\ \ i = b,\ k \tag{3}$$

where $X$ is a child quality input good. The function $q$ is assumed to be concave in the quantity of investment good and in child time devoted to human capital production.

In each period, the household budget constraint is given by

$$I + w(n_b t_w^b + n_k t_w^k) = n_b(c + X_b P_x) + n_k(c + X_k P_x) + z \tag{4}$$

where $p_z = 1$. Household income is made up of parents income $I$ and income generated by children from labor activities $w(n_b t_w^b + n_k t_w^k)$, where $w$ is the wage rate[10], $t_w^b (t_w^k)$ is the fraction of time devoted to wage work by biological (kin) children, and $n = n_b + n_k$ is the total number of children in the household. Household expenditure consists of investment in children and parents' consumption of the composite good $z$. Cost per child $c$ is identical for biological and kin children, and $X_b$ and $X_k$ are the allocations of quality goods to biological and kin children respectively at given price $P_x$. For simplicity, we assume that children are identically productive in both wage work and in the production of human capital, that is, $w^b = w^k$; and

[10] If children are generally put to on-farm work, then $w$ is the shadow wage rate.

$q^b = q^k$.

The first order conditions for maximizing the utility function defined by (1), (2) and (3) subject to the budget constraint (4) implies that[11]

$$\alpha_n = \frac{c + X_k P_x - w t_w^k}{c + X_b P_x - w t_w^b};\ \alpha_q = \frac{n_k}{n_b}\left(\frac{q_x^{'}(X_b, t_q^b)}{q_x^{'}(X_k, t_q^k)}\right) \tag{5}$$

that is, the degree of substitution of kin for biological children is equal to the ratio of kin child net costs (or net benefits if we reverse both numerator and denominator) to biological child net cost, and the degree to which kin child quality raises effective quality is proportional to the ratio of the number of kin children to biological children. If parents discriminate against kin children in the allocation of human capital goods, then children are less substitutable and, conditional on the ratio of child types, the quality effects of coresidence with kin children are higher. On the other hand, conditional on the ratio of child types, if parents discriminate against kin children in labor supply by making them provide more on-farm labor than biological children, which reduces both the net cost of kin children to the household and the amount of time available for the production of kin child quality, then effective child quality is higher.

We assume that lifetime utility of each woman is maximized by $n^*$ effective children. Of these, we assume that a woman demands $n_1$ children in the first period and additional $n_2 = n^* - n_1$ children in the second period. However, depending on the degree of substitutability of own and kin children, a woman may end up with more than $n^*$ physical quantities of children in the household.

In our model, a group of sisters enter into a family contract to insure their orphans in the event of death. Each woman lives for three periods. She is fecund in the first two periods but infecund in the third period. The insurance contract takes effect from the beginning of the first period of life and each woman faces a positive mortality rate of $\theta$ only at the end of the first period. We first consider an insurance group of two women. Each woman anticipates

[11] The first order conditions for maximizing the utility function subject to the budget constraint are given by:

$$n_b : MU_n = \lambda(c + X_b P_x - w t_w^b);\ n_k : MU_n = \frac{1}{\alpha_n}\lambda(c + X_k P_x - w t_w^k)$$

$$q_b : MU_X = \lambda\left[\frac{n_b P_x}{q_x'(X_b, t_q^b)}\right];\ q_k\ : MU_X = \lambda\frac{1}{\alpha_q}\left[\frac{n_k P_x}{q_x'(X_k, t_q^k)}\right]$$

where $MU$s are the marginal utilities and $\lambda$ is the marginal utility of money income.

the death of her sister at the end of the first period, and anticipates that she will receive her sister's orphans in the second period if she dies. She also anticipates her own death and cares about the care of her children by her sister if she dies at the end of the first period. If both women survive, then there is no interhousehold transfer of children.

In the first period of life, survival probabilities are common knowledge, and each woman makes her fertility decision taking into account the possibilities of death after the first period and the desired fertility $n^*$. We assume that this choice is made under rational expectation of mortality possibilities[12]. Fertility choice in the first period only limits desired fertility to $n^* - n_1$ in the second period.

In the second period, conditional on each woman's survival, there are two possible states of survival of the sister. In the first state, the sister survives, and in the second period each wpmen produces additional $n_2 = n^* - n_1$ children. Denoting own first period births by $n_b$ and sister's first period births by $n_k$, in the second state where the sister dies, the woman receives her sister's $n_k$ first period births who are now orphans. The optimal number of biological children demanded in the second period is therefore $n_2 = n^* - n_1 - \alpha_n n_k$. The reasoning is as follows. For every kin child that the woman will parent, she will reduce her births by $\alpha_n$, which totals $\alpha_n n_k$ for $n_k$ children. If $\alpha_n = 1$, in which case children are perfect substitutes, then the surviving woman demands only $n^* - n_1 - n_k$ biological children in the second period. For example if $n^* = 2$, and both women have one child in the first period ($n_1 = 1$ and $n_k = 1$), then the surviving woman will have no birth in the second period, and will satisfy her demand for two "effective" children in her lifetime; one biological child and her sister's only orphan. There will be no income effects from fostering the orphan. On the other hand, if $\alpha_n = 0$, that is, women do not value their sister's children as own children at all, then the surviving woman will have one more child in the second period, and will therefore satisfy her demand for two "effective" children which, in this case, are both biological children. In addition, she will parent her sister's orphan who does not constitute a child but will constitute a pure income effect in the household. At intermediate values of $\alpha_n$, orphans will generate both income and substitution effects.

[12] In the first period, each woman can predict her fertility in the second period in the event that her sister dies or not, and given mortality, decides rationally on the number of children.

In equilibrium, conditional on the woman surviving into the second period, her first and second period births are given in the table below.

$$\begin{array}{ccc} Mortality & 1st\ Period & 2nd\ Period \\ sister\ survives\ (s) & n_1\ ,\ n_k & n_2^s = n^* - n_1 \\ sister\ dies\ (d) & n_1\ ,\ n_k & n_2^d = n^* - n_1 - \alpha_n n_k \end{array} \tag{6}$$

If the woman dies at the end of first period while her sister survives, her orphans will coreside with her sister. If both women die, then the children will be parented by distant relatives. We may assume that women derive utility from their children's quantity and quality after death, and that this may be the objective of insurance. However accounting for this utility does not provide any further insight into behavior in the model. Our data also does not observe cases where a woman dies in the second period. Therefore we do not explicitly model the state where the woman does not survive into the second period.

From the table in (6), it is clear that $n_2^d \leq n_2^s$ for $\alpha_n \geq 0$. That is, for positive degrees of children substitutability, woman's fertility in the second period when the sister dies is less than her fertility when her sister survives. In terms of total fertility, it also implies that $n^d = n_1 + n_2^d \leq n_1 + n_2^s = n^s$. That is, total lifetime fertility is lower when the sister dies.

The results hold whether or not the women are identical in age. If the women are identical, the results are straightforward. If they differ in age, the results remain the same as long as the older woman has not lived beyond the second period[13]. In the case where the older woman's fertility reaches $n^*$ before the death of the sister, orphan parenting does not provide any utility and the substitution effects cease to operate.

We now extend the model to the case of three or more women in a family contract. With more than two women in the family, the probability of a woman receiving orphans depends on the number of sisters, her spatial proximity to the affected household, and her birth order. Chirwa (2002) suggests that the seniority of "surrogate mothers" is an important factor in deciding responsibility for orphan care at the family level in Malawi. Since spatial proximity is not available in our data, we restrict the determinants to the number of sisters ($k$) and

[13] As long as the older women remains within the fecund lifespan, the death of a younger sister will exert the income and substitution effects on her fertility.

rank among sisters ($r$) which are both observed in our data. To account for these effects in the likelihood of receiving orphans, we discount the total number of orphans arising from the death of a sister that each woman may parent by the factor

$$\beta = \beta(k, r) \tag{7}$$

where $0 < \beta \leq 1$. From anthropological account, $\beta_k < 0$ and $\beta_r < 0$, that is, the number of orphans that a woman may parent is potentially lower as the number of siblings increase, and elder sisters are more likely to receive orphans than younger sisters. The equilibrium outcomes are given below.

$$\begin{array}{ccc} Mortality & 1st\ Period & 2nd\ Period \\ sister\ survives\ (s) & n_1\ ,\ n_k & n_2^s = n^* - n_1 \\ sister\ dies\ (d) & n_1\ ,\ n_k & n_2^d = n^* - n_1 - \alpha_n \beta(k, r) n_k \end{array} \tag{8}$$

where $n_k$ is the total first period fertility of sisters who die. In effect, (8) implies that at positive levels of substitutability among children in parent's utility function, the death of sisters will reduce second period fertility. Further, conditional on the death of a sister, the reduction in second period fertility is lower for women in large families. With respect to birth order, the negative effects of orphans on second period fertility reduce as birth order increases.

We now turn to child quality effects. From the first order conditions, the quality parameter, $\alpha_q = \frac{n_k}{n_b}\left(\frac{q_x'(X_b, t_q^b)}{q_x'(X_k, t_q^k)}\right)$ implies that any intrahousehold differences between orphans and biological children in time allocation will generate quality effects on biological children. If orphan children provide more labor than biological children such that less of their time is allocated to production of quality, then conditional on the quantity of child types, a decrease in $t_q^k$ relative to $t_q^b$ raises $\alpha_q$, which raises the quality of biological children. In addition, the death of a sister implies that the assets of the deceased comes into the parenting household along with the orphans. received in the household are generally older than the biological children who are born in the second period, and are also likely to supply more labor. This implies that the surplus generated by orphans constitutes a higher income for the household, which will produce quality effects on biological children. Biological children might either receive higher allocation of quality investment good or provide lower amount of labor time, which are both inputs into the production function for child quality.

# 4 Identification and Estimation Strategies

## 4.1 Orphan Parenting

In this section, we examine the determinants of having a coresident orphan in a household. Our assumption is that women receive their sister's orphans in the matrilineal system. Since children who lost their mothers can be only maternal orphans if they still have the other parent or double orphans if they have lost their fathers, we examine maternal and double orphans separately. Our model is given by

$$N_{pijr} = H_{jr}\beta + \gamma r_i + \alpha D + \phi(D_i * r_i) + Z_{ir}\lambda + \mu_r + v_{ijr} \tag{9}$$

where $N_{pijr}$ is the number of children of ages 0 to 14 present in household $j$ of which woman $i$ is a member, and have lost a parent of type $p = m, b$ where $m$ represents mother and $b$ represents both parents; in region $r$. These orphans are defined as "other relative", "adopted/foster child" of the household head. $H_{jr}$ is a vector of household regressors including the sex of head, number of adult men and women in the household, the household composite level of wealth and whether it is rural or urban. $Z_{ir}$ is a vector of woman's regressors which includes the number of surviving siblings, education and marital status. $r_i$ is the woman's birth order, $D$ is a measure of sisters deaths and potential orphans in the family, and $v_{ijr}$ captures woman's unobservables. $\mu_r$ is an unobservable region effect, which may affect both adult deaths and the placement of orphans in the households, such as prices and other biological factors[14]. Since birth order is an important factor in having orphans coreside in the household, and that elder women are more likely to receive orphans than younger ones, we expect that $\phi$ will be positive.

However, while families may desire to follow the family system in placing orphans in other residential units[15], a number of factors may make this difficult. Evans (2004) identified the

[14] If regional biological factors make births less likely, then women may be more likely to coreside with orphans. For example if regional factors affect fecundity, women that are less fertile are likely to coreside with maternal orphans in the household, even if those orphans are not from her sisters.

[15] Chirwa (2002) outlines the pattern of genetic relationship and orphan care in Malawi in which surviving parents and older siblings of the orphan are primary caregivers. Next to them are siblings of the parents of the child commonly referred to as senior and junior parents followed by the grandparents, and then distant

correlation of death itself across households within the kinship group as a factor that determine orphan corresidence in Kenya. If all other relatives were dead then orphans might just be placed with a non-relative. Orphans may also be placed with the nearest relative if those who should receive him reside in remote distance.

### 4.2 Fertility

The prediction from the model that is the focus of this paper is that women who experience sister's death reduce their fertility in the second period as well as total fertility. In order to empirically investigate these effects, we employ two strategies. In the first approach, we limit the second period to 24 months. That is, we consider the effect of siblings death in the last 24 months on current birth decisions in a dynamic framework. In the second approach, we allow the second period to last till the time of survey, and we consider the effects of the number of sisters who have died on women's total fertility using the fixed effects Ordinary Least Squares (OLS) regression.

In order to empirically isolate the effects of orphans on fertility we estimate a reduced form econometric model given by

$$F_{it}^{*} = X_{it}\beta + \eta_t d_{it} + \delta(d_{it} * r_i) + \mu_i + v_{it} \tag{10}$$

where $F_{it}^{*}$ is latent fertility of woman $i$ in time $t$, $X_{it}$ are vectors of exogenous regressors that determine latent fertility including age and education, $d_{it}$ is adult deaths at time $t$, and $r_i$ is woman $i$'s birth order. The error term $\epsilon_{it} = \mu_i + v_{it}$ contains a heterogeneous component of health known to women $\mu_i$ as well as nonsystematic shocks $v_{it}$.

The variable $d_{it}$ is defined the number of sisters who had at least one child and died at ages between 13 and 40[16] within the 24 months prior to the month of probable birth. The prediction from our theory is that $\eta_t < 0$ and $\delta > 0$.

relations. Orphans of women who die between ages 13 and 40 are unlikely to have grown up sibling that might care for them. Thus the first primary caregiver is the surviving parent. For a maternal orphan in patrilineal kinship, children's first place of care is in their father's residence or that of his brothers in case the father is dead. In contrast, in the matrilineal system, the surviving parent, which is the father in this case does not remain in the household, but leaves for his natal village after the death of his wife. Maternal orphans first choice of corresidence is therefore with their maternal junior or senior mothers. In case the junior and senior mothers are unable to care, the child may corresride with the maternal grandmother.

[16] At this age range women are still likely to have young children which will require orphan care.

The measure of fertility in this paper is whether or not a woman has a birth in given month in the birth history of sampled women. The model requires, for consistency, that the initial conditions of the process that generates fertility are nonstochastic, and that the initial conditions are not generated by the process that generates the panel data (Heckman 1980). These requirements imply that estimation uses a panel data that is not sampled from the beginning of births, but from the first time that a woman is at risk of pregnancy or birth. Since this paper investigates the effect of adult kin mortality on fertility, they require that the beginning of the birth process is not determined by kin mortality. For example if sibling death can delay or hasten a woman's time of marriage, observations from the time of first marriage or first birth will amount to sampling from the midstream and will not yield consistent estimates. Therefore we allow the process to begin at the time when a woman reaches the age of menarche (age 13) which is determined by an entirely biological process. While there are obvious ways in which sister's death can affect the time of marriage or first birth, it is not clear how it may affect the time of menarche. Therefore in estimating the dynamic model, the fertility observations for each woman consist of whether or not she had a birth in each month since the month of reaching age 13. Since we are interested in birth decisions independent of whether the outcome is twin or not, we treat the birth of twins as the same birth.

There are plausible reasons why sibling deaths may not be exogenous to fertility decisions. First, if sibling deaths occur during bad weather, and bad weather reduces the likelihood of births[17], then siblings death is not exogenous to birth decision. Weather may also affect household income, particularly in agrarian societies and, if income considerations affect birth decisions, then the effect of sibling death is confounded by weather. Second, adult sibling death might be correlated with mortality in the region. If siblings tend to die in regions of high mortality and women tend to give birth less in those areas, then the effect of sibling death on fertility is confounded by region mortality. Third, if sister's death updates life expectancy as a result of correlated innate health among siblings, and women adjust their fertility downwards as a result of shorter lifetime expectation, then the negative effect of sister's death arising from learning about genetic health is not distinguishable from the effect of orphans. These problems

[17] Weather may have biological effects on birth. The role of extreme summer heat in the seasonality of births have been modelled in Lam, Miron and Riley (1994).

are addressed in the empirical analysis.

We address the first problem by controlling for weather shocks in the estimation. To capture weather effects, we include measures of rainfall shocks for each month of probable birth computed as the deviation of monthly (log) rainfall from the long run average in our regressions[18].

Another factor closely related to rainfall that may determine the likelihood of birth in a given month is the issue of seasonality of births (Lam et al. 1994). If adult deaths tend to be seasonal or exhibit some seasonal pattern, then the parametric estimates of its effects on birth may as well be capturing the seasonality of births. The most cited example is the seasonality of disease. If disease raises adult deaths as well as reduce the likelihood of births, then negative effects of adult sibling deaths on births are not differentiable from that of disease. To isolate the effects of adult deaths from that of seasonality or disease on births, we use two strategies. In the first, we treat rainfall as the only driving force in the seasonal patterns of births and deaths, and computed a measure of long run mean (log) rainfall for each month in each region to account for seasonality effects. In the second approach, we include dummy variables for each month and region with a view to capturing, in addition to seasonality of rainfall, other time related and region specific effects that may affect the likelihood of births such as biology, temperature and prices.

We address the second problem by including controls for regional mortality. For each month in each region, we included age adjusted mortality rates for children (ages 0-5), early adult (ages 15 - 45) and late adult (ages 46-60) using the siblings information of all women in the region provided in the data[19].

We address the life expectancy effect by comparing the effects of sibling deaths on women

[18]We allow rainfall shocks 8 through 11 months prior to a potential birth to have separate effects on the likelihood of birth. Similar to Pitt and Sigle (1997), we restrict the effects of rainfall shocks 12 through 23 months prior to a potential birth to have same effect on birth in the determination of previous year income, since the period coincides with one full year prior to time $t$. To obtain this we first compute the mean annual rainfall in each region, and then obtained the deviation of the sum of rainfall in 12 through 23 months prior to time $t$ from the mean annual rainfall for the region. This way of deriving rainfall shock in the last year does not pose any problem since the months 12 through 23 covers a complete annual rainfall cycle.

[19]For each probable month of conception, we obtained the averages of mortality over the preceding 12 months as a measure of mortality in the last 12 months preceding time $t$. Assuming a gestation period of 9 months, the mortalities relevant for the likelihood of birth at time $t$ is the average of age-adjusted mortalities for time $t-10$ through $t-21$.

birth decisions across kinship systems. A groups of sister of the same mother in the matrilineal kinship system constitute the basic family network, whereas in the patrilineal system, a group of brothers constitutes the network. First, we exclude sisters who died without orphans. Using the death of sisters with orphans, we isolate network effects from longevity effects by comparing coefficient estimates between the two kinship systems. Our assumption is that any effect of sister's death on women in the patrilineal system is informational, and the additional effects in the matrilineal system over the patrilineal system is network effect[20].

### 4.3 Child Quality

To identify child quality effects, we examine anthropometric measures of preschooler children of the surviving women. The simplest way to identify the effect of orphan parenting on health status of biological children would be to estimate an ordinary least squares regression of the anthropometric outcomes of biological children on the number of orphans coresident in the household. However, the obvious problem with such specification is that unobservable characteristics of the household may affect both the likelihood of orphan coresidence and child health outcomes. In addition to that, orphans that have moved out of the household cannot be captured in such regression. We run regressions using the number of orphans in the household and take this as the baseline estimate.

However, since orphans may move into and out of the household, such that some orphans that were in the household may not be present at the time of survey, we run another regression using the potential number of orphans generated by deaths in the woman's network. One advantage of using the potential number of orphans is that we abstract from the unobservables that may determine determine actual orphan coresidence. However, this regression may capture other factors other than orphan coresidence. We focus on the difference-in-differences estimates in these regressions.

To obtain more precise estimates of orphan effects, we instrument coresident orphans. As suggested by the rules of orphan placement in matrilineal family system in Malawi, a woman's birth order determines the likelihood that she receives orphans upon the death of her sisters.

[20]By network principles, women in the patrilineal system do not receive their sisters' orphans but are absorbed into their father's kin network. Therefore using the death of sisters with orphans in the patrilineal system provides estimates of life expectancy effects.

Since birth order is not chosen by the woman, and is not likely a correlate of child health outcomes, orphan placement through birth order is considered exogenous to household characteristics. We therefore instrument coresident orphans by the interaction of potential orphans in the woman's network and her birth order and run a two-stage least squares regression for both matrilineal and patrilineal family systems.

## 5 Data and Setting

The main data used in this paper are from the Malawi Demographic and Health Survey (MDHS) of 2000. The data, collected Macro International with support by the U.S. Agency for International Development[21], contains an array of information about women aged between 15 and 49. In addition to a wide variety of socioeconomic and health related information, the survey collected data on the dates of every birth and mortality in each woman's reproductive history, allowing a study of the timing of those events. The data also contains information on birth, sex and survival history of all maternal siblings of each woman in the sample[22]. For female siblings who have died, information is provided on her age at death, date of death and the number of orphans arising from her death. Information is also provided on the ethnic group of the women.

The data presents unique features that make it suitable for this study. It makes it relatively easy, from anthropological accounts, to identify women with patrilineal and matrilineal kinship systems by providing ethnic identities in the sample. In addition, a sample of 13,220 women from 14,213 households is sufficiently sizeable, relative to population of about 11 million. Malawi's economy is largely subsistence with 86% of its population resident in the rural areas (WorldBank (2001)). Per capita Gross National Product was $190 in 2001, which is about two-fifths of the average for the entire sub-Saharan Africa ($480). Agriculture, which accounts for nearly 40% of Gross Domestic Product and 88% of export revenues in 2001, is mostly rain-fed, which makes household income particularly vulnerable to rainfall shocks and therefore necessitates informal consumption insurance. We will merge the MDHS with rainfall data in

[21] These data are available for most countries of the third world for free at their website www.measuredhs.com

[22] Selected waves in nearly every country where the DHS survey has been conducted collect maternal sibling information.

order to include measures of income fluctuations in our analysis[23]. Female Life expectancy in Malawi was about 38 years (Male: 37) in 2003 down from 40.7 (both sexes) in 1997 (UNICEF (2005)). With Total Fertility Rate (TFR) of 6.1 in 2003, adult female mortality rate was 653 per 1000 women while male mortality rate was 701 per 1000 men in 2000 (WorldBank (2001)).

Table A1 provides a few descriptive statistics from the MDHS 2000 women sample. The average woman in the sample has been married (about 98%), aged 28 and has given birth to 3 children out of which 2 are alive at the time of survey. For each woman, an average of 3 sisters are born alive, only two of whom survive to age 13. Similarly, only 2 out of 3 brothers born alive survive to age 13. Conditional on surviving to age 13, about 8% of all siblings die before age 40. Conditional on having children prior to death, each adult sister that died left an average of 2 orphans. The average woman in the matrilineal system has equal number of siblings born alive as her counterpart in the patrilineal system, and both have an average of 2 brothers and 2 sisters surviving to age 13.

In Table A2, we provide statistics that examine the effect of adult death on fertility by looking at the total number of surviving children of 1,050 women of ages 40-44. From panel 1, a woman who is aged between 40 and 44 years has an average of five children both in the matrilineal and patrilineal systems. It also shows that having sisters provide insurance in the matrilineal system, and therefore raises fertility. In the patrilineal system, the effect is opposite, with women having more children if they have only male siblings. In Panel 2, we do not observe any difference in fertility on the basis of the number of sisters that survive to age 13. The extremely small number of women whose rank among sisters exceed two and have no sister survive age 13 does not permit us to make any further conclusions about the effect of sisters who reach reproductive age on fertility. However, we observe the effect of adult death on fertility in Panel 3. Ignoring the rank of women among their sisters, the difference-in-differences estimate[24] shows that having at least one adult death in the matrilineal network

[23] The lack of income data does not allow us to examine the effect of income fluctuations on behavior. However, income variation is strongly related to rainfall variation. We use rainfall data that is assembled by the National Climatic Data Center (NCDC) of the U.S. National Oceanographic and Atmospheric Administration (NOAA). We identify rainfall stations for each region, and construct average rainfall over all the stations in a region. Our measure of rainfall is the natural logarithm of monthly millimeters of precipitation plus one, as a convenient way of dealing with the prevalence of zero rainfall in dry season months. We use deviations of monthly rainfall from long its run average as a source of income shock in each month.

[24] By using the cohort of women aged 40-44, these estimates are conditional on age but not on any other

reduces fertility by about 1 child[25]. To examine whether the insurance effect works differently or in different directions for different birth orders, we divide the sample into women who are first or second female births (lower births with rank 2 or less) and those who are younger (upper births with rank 3 or more). The estimates show that network effects of deaths mainly reduce fertility of the eldest women, with no identifiable impact on younger women. An examination of the Patrilineal column suggests that life expectancy effects on fertility are indeed significant, implying that fertility increases with adult deaths signifying shorter life expectancies. If the death of a sister signals innate healthiness and causes a downward review of expected lifetime, then the estimates suggests that life expectancy effects are indeed important. We do not observe similar patterns when we compare women fertility on the basis of the death of brothers between ages 13 and 40. In fact, there are no differences in the fertility of women between the kinship systems when we consider the death of their brothers[26]. These results suggest that while sister's deaths in matrilineal women networks generate network effects on fertility, the death of brothers does not generate such effects.

We examine the pattern of orphan parenting in Table A3. A child is classified as a maternal orphan if only the mother is dead, paternal orphan if only the father is dead, and a double orphan if both parents are dead. Panel A shows that relative to paternal orphans, maternal orphans are less likely (25% vs 54% paternal orphans) to live with the surviving parent, more likely to live with grandparent only (23% vs 10% paternal orphans), and more likely to be fostered, i.e. live in a household where the child is either classified as "other relative" or "foster/adopted" (28% vs 17% paternal orphans). They are also more likely to live with other non-relatives (3% vs 1.6% paternal orphans).

By breaking the sample into the family types, Panel B shows that in the matrilineal type, maternal orphans are twice likely to live outside of their natal households[27] (40.1%) than to live with the surviving parent (20.2%), whereas paternal orphans are more than twice likely to live with surviving parents (57.1%) than the proportion that live outside their natal house-

observable characteristics of the women or their households.

[25] By comparing with the patrilineal estimate, this estimate of network effects is net of any life expectancy effects which might be generated in the patrilineal women networks.

[26] The MDHS does not provide the number of orphans of brothers who died during the same age group as the sisters.

[27] This comprises those who are classified as other relatives, those who are foster children and those who live with non-relative.

holds (21.7%). Maternal orphans are also more likely to live with a grandparent only (12.0%) than paternal orphans (4.3%). In comparison with the patrilineal family system, maternal orphans in matrilineal family system are much less likely to remain with their surviving parent (20.2% matrilineal vs 36.2% patrilineal), whereas paternal orphans are equally likely to live with mothers in both patrilineal and matrilineal systems. These tables fairly support the implications of the implicit contractual relationships described in section 2 for the parenting of orphan children. Although the statistics in Table A3 do not indicate clearly the relationship between orphans and their caregiver, they fairly support the conjeture that maternal orphans are more likely to be fostered to "senior" or "junior" mothers in the matrilineal kinship system than in the patrilineal family system.

# 6 Results

## 6.1 Orphan Parenting and Intrahousehold Resource Allocation

Table B1 presents estimates of the fixed effects orphan parenting model. In order to examine the effect of family implicit insurance contracts on orphan coresidence, we use different measures of sisters death. In column 1 we use the number of orphans arising from the death of adult sisters of the sampled woman. The results show that the number of potential maternal orphans (in the sense that some of them could have been placed in the household of the sampled woman and others could have been placed elsewhere) significantly predicts the actual number of orphans in the household, and that the marginal effect is numerically higher, about three times likely in the matrilineal family type (0.011) than in patrilineal kinship (0.004). The same effect does not apply to double orphans in column 2 where the potential number of maternal orphans does not predict the coresidence of double orphans.

In columns 3 and 4, we repeat the analysis using the number of dead sisters of the sampled woman instead of the potential number of orphans. The results show that dead sisters explain the placement of maternal orphans in the household, and that maternal orphans are twice likely to be placed in the household of the woman in the matrilineal system than in the patrilineal system for each sister that died between ages 13 and 40 when children are likely to require orphan care. The placement of double orphans also respond to the number of dead sisters, but the interaction term does not suggest any significant difference between the patrilineal and matrilineal households.

We also use a dummy regressor coded as 1 if at least one sister died with orphans during age 13-44 and 0 if otherwise. The result in columns 5 and 6 show that maternal orphans coresidence is predicted by sister's death and the effect on coresidence in matrilineal household is double the effect in the patrilineal household.

In all the models, once we control for the death of adult sisters, the death of an adult brother does not significantly determine the placement of double orphans in the households. Brothers and sisters are usually not in the same network in either patrilineal and matrilineal family systems. In effect, the results suggest that orphans arising from the death of women are placed in households of surviving female siblings in the matrilineal system as the concept of insurance within the *mbumba* suggests[28].

In Table B2, we present the regression results by family type and include the rank of women among their sisters. In columns 1 and 2, maternal and double orphans are significantly more likely to be placed with the eldest women than younger women as the number of potential orphans increase in the family network. Generally, while orphans are more likely to reside with the eldest women in the matrilineal family system, they are less likely in the patrilineal system.

Table B3 presents a household fixed effects regression of child schooling and labor for children of ages 6 to 14 classified by their orphan status and by family type. For the purpose of this paper, we focus on maternal and double orphans. From the results, there is no evidence of intra-household discrimination against maternal orphans in human capital investment both in terms of years of schooling and current enrolment status even when they are fostered.

[28] A comment on the other regressors is useful. As suggested in previous studies, the results show that orphan fostering is sensitive to the presence of adults in the household. While double orphans are more likely to be fostered in a household with more adult males, the presence of male adult is not a significant factor in the fostering of maternal orphans. This might be explained by the fact that maternal orphans are more likely to be placed with a "surrogate" mother rather than a male adult when the child is fostered. However, the number of adult women significantly determines the placement of both maternal orphans and double orphans, a result which is easy to understand since women are usually the caregivers, particularly when the children are young. The number of non-orphan children in the household significantly reduces coresidence of double orphans but has no effect on maternal orphans. Maternal orphans are also more likely to reside in female headed households. Double orphans are likely to be in male headed as in female headed households. There is no evidence that orphans are selectively placed in richer households as measured by the household wealth index computed from factor scores.

However, in matrilineal kinship, double orphans have about 0.3 years of education less than non-orphans and are also less likely to be enrolled. In the patrilineal system, paternal orphans have 0.3 years of schooling less than non-orphans but are as likely as non-orphans to be enroled in school.

Having established the absence of discrimination against sisters' orphans with respect to human capital in households where they are fostered, we examine child labor input in household chores and family farm or business. The data provides for each child aged 6 through 14, the number of hours provided in each of the activities in the last 7 days prior to the survey. In Table 6, results for the matrilineal groups give some weak evidence that maternal orphans do more household chores relative to non-orphans when they are fostered. Indeed, compared to those who live with their grandmothers, maternal orphans fostered into other households (arguably their senior mother's household) supply more on-farm labor than those who live with their grandmothers. The result might suggest that orphans are put to work on the land being cultivated by their natal households which now reverts to the senior mother who takes care of them. Double orphans who live with grandmothers also do less household chores relative to non-orphans but are not different from non-orphans in farm labor supply.

The results suggest that households do not discriminate against orphans in the allocation of human capital goods. However they are treated differently from biological children in time allocation; orphans work more in the home and on the farm than non-orphans. If all children have the same cost and receive equal amount of human capital goods but orphans provide more on-farm labor than biological children as the results suggest, then there is a positive income effect from orphan coresidence. The question of whether the suggested positive income effect from orphans labor will improve household outcomes or merely offset the pressure on household resources arising from orphan parenting will be examined in other sections of this paper.

### 6.2 Effect of Sister's Death on Fertility

We present the results by family types. In Table C1, we provide the random effects probits estimate of the effects of the death of an adult sister on the likelihood of births. In model I, columns 1 and 2 compare the effects in the matrilineal and patrilineal types of families and estimate an interaction term of adult death and rank among sisters, treating the rank effects linearly. While the death of an adult sister reduces fertility in the matrilineal family, the estimates suggest that it does so less for women who are of higher ranks in their family. Column 2 shows no effect in the patrilineal type, which is expected since the responsibilities for parenting orphans do not rest on the sisters of the deceased woman, but her husband's family. In Model II, we interact sisters' death with dummies for each birth order. The results show that sisters' death does not independently affect fertility, but reduce fertility by birth order, the effects being comparatively higher for elder sisters. Interaction of sister death with birth orders higher than those shown in the table are not significant in the regression. The results in column 4 also shows that there are no effects in the patrilineal system. In Table C2, we use a dummy for eldest sisters (whose rank among sisters is either 1 or 2) instead of the individual ranks. The results stay the same, that the eldest sisters who are more likely to parent orphans have reduced fertility in the event of adult death in the family network[29].

In table C3, we estimate OLS regressions of completed fertility for women aged 40-44 where we interact a dummy for matrilineal family with the number of dead adults in the women's network. We also use the ratio of dead adults to the total number of siblings. Both results show that women who experience adult deaths in their networks had less fertility. We use other specifications to test for pure transfer effects, that is, the effects of the death of siblings that do not involve orphans but might involve transfers and other changes in the network. We find no significant effect arising from those deaths[30].

### 6.3 Effect of Orphans on Child Health

We examine the effects of adult sibling deaths on children nutritional status. We show in Tables B1 and B2 that orphan parenting takes place in the extended family network fairly by the contractual obligations inherent in the implicit insurance contracts. The results in Table C1-C3 show that the death of an adult reduces the likelihood of births by her sisters. Transfer

[29] These results are conditional on quadratic age effects and all other controls included in the regression in table C1.

[30] In one specification we examined the effect of death of brothers and in another examined the death of sisters who died without orphans.

payments[31] induced by insurance transfers for funeral expenses constitute a negative income shock, and if parents care about the survival chances of their potential births, such income considerations may generate the observed negative effects on the likelihood of births such that women time conceptions at times when they are better able to invest in their nutrition. In addition, if the death of sisters eventually reduces the demand for children as this paper finds, then the gains in child health associated with reduced fertility might reflect in better nutritional status of children. The results in Table B3 also show that maternal orphans provide more on-farm labor in matrilineal kinship and are not likely to receive more investment in human capital. This suggests that orphans may generate positive income effects on the household that may offset their crowding-out effects on resources in their parenting households.

To examine the net effects of these factors, we examine the effects of orphan coresidence on preschooler children's nutritional status. The MDHS data provides anthropometric measures; height for age, weight for age and weight for height of biological children of ages 0 to 59 months, which is the sample of children who were born within the last five years prior to the survey. It also provides the birth size of the children in ordinal measures coded as "very large", "large", ...., "very small".

For each of the nutritional status measures we present three estimates. First, we estimate a regression by Ordinary Least Squares (OLS). We next estimate a region fixed effects model in order to isolate the effect of prices and other environmental factors from that of adult deaths. Third, we estimate a region times month-of-birth fixed effects in order to capture not only the environmental factors, but also to capture the different histories that may be peculiar to the time of birth of each child. Our main regressor is an interaction of matrilineal dummy and the number of orphans who reside in the household. Other controls include age and sex of the child, mother's age, marital status, schooling and logarithm of percentile height for age, number of adult men and women in the household, sex of household head, household head age effects, household wealth index and a rural dummy. We cluster children by their mother in all the estimates.

First, we run the baseline regressions using the number of orphans resident in the househod

[31] Although we do not observe transfers in the data, they remain a prominent feature of implicit family insurances.

and its interaction with the matrilineal dummy. Next we use the number of potential orphans as the main regressor and include its interaction with the matrilineal dummy. Tables D1 and D2 present estimates of the effects of orphans on the (log) percentiles of child height for age and weight for age.

Table D2 column 1 suggest that new babies are larger in the matrilineal than in the patrilineal households. Orphans reduce the size of child at birth, but in the matrilineal households, orphans seem to have no adverse effect on birth size. Conditional on birth and survival, estimates of child nutritional status in the remaining columns of Table D2 show that while orphan effect on children nutritional status is negative in the patrilineal household, the effect is positive in the matrilineal household. Taking the region-month of birth fixed effects estimates, orphans have a marginal effect of $+0.023$ points in the child's logarithm of percentile weight for age in matrilineal family whereas the marginal effect is a $-0.061$ points in the patrilineal family.

While the regressions using the number of coresident orphans do not overcome the problems of unobservable household characteristics, the regressions using the potential number of orphans may be capturing other factors than orphan parenting. To correct for these bias, we run a two-stage least squares regression where we instrument the number of orphans coresident in the household by an interaction term of women's birth order and the potential number of orphans in the family network. We do this separately for the matrilineal and patrilineal households and present the results in Tables D3 and D4. In the first stage regression in Table D3, the interaction term significantly predicts coresident orphans in the matrilineal system but is not significant in the patrilineal system. Results of the second stage in Table D4 suggest that orphan coresidence improves child anthropometric measures and reduces the likelihood of child stunting and wasting in the matrilineal family system, while the results are the opposite in the patrilineal households. However, the second stage results does not suggest statistically significant effects of coresident orphans on child health[32].

[32] We run both two stage least squares without fixed effects, and a region times month of birth fixed effects.

## 7 Conclusion

This paper examines the effects of family implicit contracts on household demand decisions. In low income countries where many insurance markets are missing, most strategies for risk mitigation are based upon altruistic contracts involving households in kinship networks. These informal contracts, which require the performance of certain contingent obligations by members of the family network are important determinants of household demand behavior. With cooperative labor and interhousehold transfer of resources within insurance networks, welfare reducing shocks to any member are internalized by other members of the kinship network. These links render the methodological individualistic approach to demand analysis not completely plausible.

In this paper, we used women data from Malawi to demonstrate the effect of the mortality of an adult member of the family insurance network on the demand decisions of related households. The evidence shows that the contractual nature of family insurance indeed determine the placement of orphans, and that it sustains investment in the human capital of orphan children. For related households, the death of an adult kin reduces the demand for children through the orphans that such deaths generate. The coresidence of orphans with relatives constitutes a quasi increase in the number of children for surrogate parents as long as the degree of substitution between kin and biological children is positive, and reduces household demand for biological children through this substitution effect . In addition to the substitution effects, orphans also constitute some income effect in the households where they coreside. However these effects do not appear to affect the health status of biological children.

The results suggest that the substitution effects of orphans dominate the income effects in the matrilineal system. In the wake of HIV/AIDS epidemic in sub-Saharan Africa; Malawi numbering among the heavily infected countries, two major issues currently being speculated are the effects of the AIDS epidemic on fertility and the externalities of orphan care on the caregiving households. The results in this paper suggest that increase in the prevalence of the epidemic and subsequently increase in death rates due to AIDS will reduce fertility significantly among the survivors due to the substitution effects that children orphans generate in the households that care for them. While it is common knowledge that orphan care may exert pressure on household resources, and thereby may worsen the health of young children, the reduction in fertility along with the likely positive income effects of orphan labor may reverse the negative effects already being speculated. The emerging nature of relationship between fertility and economic growth in light of the disease pandemic is an interesting question for further study.

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**Table A1**

**Descriptive Statistics**

| | **Matrilineal (1)** | **Patrilineal (2)** | **Difference (1) - (2)** | **t-stat Ho: Diff=0** |
|---|---|---|---|---|
| **sampled women age 15 - 49** | | | | |
| women's age | 28.17 | 28.12 | 0.05 | 0.30 |
| percent married | 83.06 | 81.97 | 1.09 | 1.53 |
| percent married among mothers | 98.09 | 97.08 | 1.01 | 1.53 |
| years of schooling | 3.81 | 5.15 | (1.33) | **20.02*** |
| number of children ever born | 3.07 | 3.04 | 0.03 | 0.60 |
| number of surviving children | 2.37 | 2.44 | (0.07) | **1.72*** |
| percent who have at least one sister | 0.92 | 0.93 | 0.01 | 0.38 |
| **siblings of the sampled women** | | | | |
| sisters born alive | 2.99 | 2.95 | 0.04 | 1.28 |
| sisters who survive to age 13 | 2.06 | 2.10 | (0.04) | 1.31 |
| brothers born alive | 3.00 | 2.91 | 0.09 | **2.64*** |
| brothers who survive to age 13 | 2.02 | 2.02 | (0.00) | 0.11 |
| Conditional on attaining age 13, | | | | |
| Probability that a sister dies before age 40* | 0.09 | 0.08 | 0.01 | **1.93*** |
| Probability that a brother dies before age 40 | 0.08 | 0.08 | (0.00) | 0.36 |
| Probability that a sibling dies before age 40 | 0.08 | 0.08 | 0.00 | 0.43 |
| **number of sisters' orphans** | | | | |
| unconditional | 0.34 | 0.34 | 0.00 | 0.11 |
| conditional on having a sister | 0.37 | 0.37 | 0.00 | 0.14 |
| conditional on having a sister survive age 13 | 0.41 | 0.40 | 0.01 | 0.24 |
| conditional on having a dead sister | 2.27 | 2.43 | (0.16) | 1.28 |
| total number of women | 9,084 | 4,127 | | |

Table A2

| Effects of siblings survival on fertility: number of children per woman aged 40-44 | Matrilineal (1) | N | Patrilineal (1) | N | Difference (1)-(2) | t-stat Ho: Diff=0 |
|---|---|---|---|---|---|---|
| **Panel 1** | | | | | | |
| **woman's sisters' effect:** | | | | | | |
| **all ranks** | | | | | | |
| woman has no sister | 4.76 | *(67)* | 5.35 | *(34)* | (0.59) | 1.30 |
| woman has at least one sister | 4.96 | *(632)* | 4.98 | *(317)* | (0.02) | 0.11 |
| difference | 0.20 | | (0.38) | | 0.57 | 1.10 |
| **Panel 2** | | | | | | |
| **effect of sibling survival by rank among sisters** | | | | | | |
| **all ranks** | | | | | | |
| woman has no sister survive age 13 | 4.92 | *(94)* | 5.07 | *(59)* | (0.14) | 0.39 |
| woman has at least one sister survive age 13 | 4.94 | *(605)* | 5.00 | *(292)* | (0.06) | 0.35 |
| difference | 0.02 | | (0.06) | | 0.08 | 0.20 |
| **woman is rank 1 or 2** | | | | | | |
| woman has no sister survive age 13 | 4.86 | *(87)* | 5.03 | *(55)* | (0.17) | 0.45 |
| woman has at least one sister survive age 13 | 4.91 | *(394)* | 5.07 | *(201)* | (0.16) | 0.75 |
| difference | 0.05 | | 0.04 | | 0.01 | 0.04 |
| **woman is rank 3 or more** | | | | | | |
| woman has no sister survive age 13 | 5.57 | *(7)* | 5.50 | *(4)* | 0.07 | 0.05 |
| woman has at least one sister survive age 13 | 5.00 | *(211)* | 4.86 | *(91)* | 0.14 | 0.49 |
| difference | (0.57) | | (0.64) | | 0.07 | 0.05 |
| **Panel 3** | | | | | | |
| **effect of sibling deaths by rank among sisters*** | | | | | | |
| **all ranks** | | | | | | |
| woman has no sister dead between ages 13 and 40 | 4.97 | *(579)* | 4.90 | *(290)* | 0.07 | 0.44 |
| woman has at least one sister dead between ages 13 and 40 | 4.78 | *(120)* | 5.56 | *(61)* | (0.77) | **2.02*** |
| difference | (0.19) | | 0.66 | | (0.85) | **2.08*** |
| **woman is rank 1 or 2** | | | | | | |
| woman has no sister dead between ages 13 and 40 | 4.92 | *(409)* | 4.94 | *(217)* | (0.02) | 0.11 |
| woman has at least one sister dead between ages 13 and 40 | 4.79 | *(72)* | 5.72 | *(39)* | (0.93) | **1.85*** |
| difference | (0.13) | | 0.77 | | (0.91) | **1.78*** |
| **woman is rank 3 or more** | | | | | | |
| woman has no sister dead between ages 13 and 40 | 5.09 | *(150)* | 4.77 | *(73)* | 0.33 | 0.97 |
| woman has at least one sister dead between ages 13 and 40 | 4.77 | *(68)* | 5.27 | *(22)* | (0.50) | 0.84 |
| difference | (0.32) | | 0.51 | | (0.83) | 1.18 |
| **Panel 4** | | | | | | |
| **effect of brothers on fertility** | | | | | | |
| mother has no brother | 4.84 | *(62)* | 5.45 | *(40)* | (0.61) | 1.29 |
| mother has at least one brother | 4.95 | *(637)* | 4.96 | *(311)* | (0.01) | 0.04 |
| difference | 0.11 | | (0.49) | | 0.60 | 1.19 |
| | | | | | | |
| mother has no brother survive age 13 | 4.67 | *(101)* | 5.49 | *(51)* | (0.82) | **2.06*** |
| mother has at least one brother survive age 13 | 4.99 | *(598)* | 4.93 | *(300)* | 0.05 | 0.32 |
| difference | 0.31 | | (0.56) | | 0.87 | **1.98*** |
| | | | | | | |
| no brother dead between ages 13 and 40 | 4.99 | *(530)* | 4.97 | *(271)* | 0.03 | 0.14 |
| at least one brother dead between ages 13 and 40 | 4.78 | *(169)* | 5.18 | *(80)* | (0.39) | 1.25 |
| difference | (0.42) | | 0.21 | | (0.63) | 1.15 |
| | | | | | | |
| Total Number of Women | | *699* | | *351* | | |

* sisters who died with at least one orphan

**Table A3: Panel 1**

**Orphanhood and Relation of Children to Household Head**

| relationship to head | non-orphans | maternal orphans | paternal orphans | double orphans |
|---|---|---|---|---|
| son/daughter | 79.19 | 24.69 | 53.86 | - |
| grandchild | | | | |
| - no other adult in hh | 4.64 | 22.66 | 9.64 | 25.29 |
| - other adult in hh | 8.63 | 12.51 | 14.14 | 17.76 |
| brother/sister | 1.03 | 7.33 | 2.94 | 13.23 |
| other relative | 4.15 | 24.13 | 10.30 | 32.33 |
| adopted/foster child | 1.40 | 4.28 | 6.85 | 5.36 |
| non-relative | 0.68 | 3.04 | 1.62 | 4.36 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 |

**Panel 2**

**Orphanhood and Relation of Children to Household Head**

**Sample broken down by family type***

| relationship to head | non-orphans | | maternal orphans | | paternal orphans | | double orphans | |
|---|---|---|---|---|---|---|---|---|
| | Matrilineal | Patrilineal | Matrilineal | Patrilineal | Matrilineal | Patrilineal | Matrilineal | Patrilineal |
| son/daughter | 82.07 | 83.55 | **20.15** | 36.17 | **57.14** | 56.75 | - | - |
| grandchild | | | | | | | | |
| - no other adult in hh | 1.75 | 1.20 | 11.98 | 4.26 | 4.25 | 3.28 | 12.20 | 11.48 |
| - other adult in hh | 8.27 | 8.57 | 14.58 | 11.70 | 14.73 | 16.25 | 21.25 | 9.83 |
| brother/sister | 1.00 | 0.81 | 10.94 | 5.32 | 1.61 | 4.74 | 17.42 | 11.48 |
| other relative | 4.17 | 4.20 | **30.99** | 34.04 | **10.67** | 12.96 | 37.63 | 52.46 |
| adopted/foster child | 1.78 | 0.83 | 5.99 | 2.66 | 9.44 | 3.83 | 6.97 | 4.10 |
| non-relative | 0.68 | 0.59 | 3.12 | 5.85 | 1.61 | 1.82 | 3.48 | 7.38 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

* The family types are mapped from the women file onto the household schedule. Some households do not have any woman aged 15 - 49 in the women recode file and such households are part of the full sample but not in breakdown.

**Table B1:**

**Region Fixed Effects Regression of Coresident Orphans**

| **Dependent variable is the number of orphans of a given type coresident with the woman in the household** | **maternal orphan** | **double orphan** | **maternal orphan** | **double orphan** | **maternal orphan** | **double orphan** |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | (0.33) | (0.99) | (0.31) | (0.77) | (0.21) | (0.68) |
| number of adult men | **0.004** | **0.008** | **0.004** | **0.008** | **0.003** | **0.008** |
| | (1.75) | (4.06)** | (1.73) | (4.06)** | (1.70) | (4.03)** |
| number of adult women | **0.008** | **0.009** | **0.008** | **0.009** | **0.008** | **0.009** |
| | (3.60)** | (4.43)** | (3.59)** | (4.41)** | (3.67)** | (4.46)** |
| non-orphan children in hh | 0.000 | **-0.003** | 0.000 | **-0.003** | 0.000 | **-0.003** |
| | (0.35) | (2.80)** | (0.36) | (2.80)** | (0.39) | (2.81)** |
| female head | **0.010** | 0.002 | **0.010** | 0.002 | **0.010** | 0.002 |
| | (2.46)* | (0.57) | (2.37)* | (0.54) | (2.38)* | (0.53) |
| number of surviving sisters | 0.000 | -0.001 | 0.001 | -0.001 | **0.001** | -0.001 |
| | (0.30) | (1.02) | (0.54) | (0.98) | (0.56) | (1.01) |
| number of surviving brothers | -0.001 | **-0.003** | -0.001 | **-0.003** | -0.001 | **-0.003** |
| | (1.29) | (2.60)** | (1.25) | (2.58)** | (1.32) | (2.62)** |
| number of sisters orphans | **0.004** | 0.002 | | | | |
| | (1.67) | (1.12) | | | | |
| matrilineal x number of sisters orphans | **0.007** | 0.003 | | | | |
| | (2.56)* | (1.06) | | | | |
| dead brothers | | 0.008 | | 0.007 | | |
| | | (1.42) | | (1.31) | | |
| matrilineal x dead brothers | | -0.007 | | -0.006 | | |
| | | (1.07) | | (0.95) | | |
| dead sisters | | | **0.024** | **0.015** | | |
| | | | (3.05)** | (2.02)* | | |
| matrilineal x dead sisters | | | **0.019** | -0.001 | | |
| | | | (2.05)* | (0.13) | | |
| brother's dead dummy | | | | | | 0.011 |
| | | | | | | (1.41) |
| matrilineal x brother's dead dummy | | | | | | -0.011 |
| | | | | | | (1.18) |
| sister's dead dummy | | | | | **0.029** | **0.021** |
| | | | | | (2.94)** | (2.20)* |
| matrilineal x sister's dead dummy | | | | | **0.028** | -0.005 |
| | | | | | (2.35)* | (0.41) |
| number of women | 13211 | 13211 | 13211 | 13211 | 13211 | 13211 |

Other controls are woman's marital status, years of schooling, schooling and age dummies for the head of household, household wealth index and dummy for rural residence. Additional controls are whether woman is eldest and its interaction with the matrilineal dummy

**Table B2:**

**Region Fixed Effects Regression of Coresident Orphans: Results by Family Type**

| Dependent variable is the number of orphans of a given type coresident with the woman in the household | maternal orphan | double orphan | maternal orphan | double orphan | maternal orphan | double orphan |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Matrilineal** | | | | | | |
| woman is eldest | -0.007 | -0.001 | -0.003 | 0.000 | -0.002 | 0.000 |
| | (1.55) | (0.28) | (0.72) | (0.12) | (0.79) | (0.06) |
| number of sisters orphans | **0.007** | **0.003** | | | | |
| | (3.93)** | (1.81) | | | | |
| eldest x sisters' orphans | **0.023** | **0.013** | | | | |
| | (5.15)** | (3.19)** | | | | |
| dead brothers | | 0.005 | | 0.005 | | |
| | | (0.88) | | (0.87) | | |
| eldest x dead brothers | | -0.009 | | -0.008 | | |
| | | (1.20) | | (1.09) | | |
| dead sisters | | | **0.035** | **0.010** | | |
| | | | (5.77)** | (1.76) | | |
| eldest x dead sisters | | | **0.041** | 0.019 | | |
| | | | (3.07)** | (1.55) | | |
| brother's death dummy | | | | | | 0.006 |
| | | | | | | (1.13) |
| eldest x brother's death dummy | | | | | | -0.006 |
| | | | | | | (0.79) |
| sister's death dummy | | | | | **0.039** | **0.010** |
| | | | | | (7.22)** | (1.94) |
| eldest x sister's death dummy | | | | | 0.001 | 0.014 |
| | | | | | (0.11) | (1.28) |
| **Patrilineal** | | | | | | |
| woman is eldest | 0.003 | -0.006 | 0.007 | -0.004 | 0.005 | 0.000 |
| | (0.54) | (0.97) | (1.21) | (0.58) | (1.14) | (0.02) |
| number of sisters orphans | **0.005** | 0.004 | | | | |
| | (2.23)* | (1.63) | | | | |
| eldest x sisters' orphans | -0.007 | -0.007 | | | | |
| | (1.27) | (1.26) | | | | |
| dead brothers | | 0.009 | | 0.008 | | |
| | | (1.18) | | (1.02) | | |
| eldest x dead brothers | | 0.000 | | 0.001 | | |
| | | (0.01) | | (0.09) | | |
| dead sisters | | | **0.033** | **0.022** | | |
| | | | (3.91)** | (2.62)** | | |
| eldest x dead sisters | | | **-0.034** | -0.028 | | |
| | | | (1.93) | (1.63) | | |
| brother's death dummy | | | | | | **0.015** |
| | | | | | | (1.76) |
| eldest x brother's death dummy | | | | | | -0.012 |
| | | | | | | (1.03) |
| sister's death dummy | | | | | **0.038** | **0.025** |
| | | | | | (4.58)** | (3.06)** |
| eldest x sister's death dummy | | | | | **-0.033** | -0.026 |
| | | | | | (1.92) | (1.60) |

Other controls are woman's marital status, years of schooling, number of surviving brothers and sisters, schooling, sex and age dummies for the head of household, number of adult men and women, number of non-orphaned children, household wealth index and dummy for rural residence

**Table B3**
**Household Fixed Effects Regression of Schooling and Child Labor**

| | Years of Schooling | | Current Enrolment | | Household chores in past 7 days | | Family farm or business work in past 7 days | |
|---|---|---|---|---|---|---|---|---|
| *comparison group: non-orphans | Matrilineal | Patrilineal | Matrilineal | Patrilineal | Matrilineal | Patrilineal | Matrilineal | Patrilineal |
| child is maternal orphan* | 0.007 | -0.211 | -0.027 | -0.058 | **-1.826** | 1.939 | -0.345 | **1.783** |
| | (0.04) | (0.80) | (0.45) | (0.75) | **(1.75)** | (1.29) | (0.51) | **(1.95)** |
| child is paternal orphan* | 0.074 | **0.437** | -0.03 | 0.058 | 0.424 | **-2.843** | **0.809** | 1.085 |
| | (0.63) | **(2.36)*** | (0.77) | (1.06) | (0.61) | **(2.59)**** | **(1.80)** | (1.64) |
| child is double orphan* | **-0.874** | 0.078 | **-0.252** | **-0.273** | **-2.832** | **-6.389** | -0.185 | 0.948 |
| | **(3.75)**** | (0.18) | **(3.17)**** | **(2.08)*** | **(1.99)*** | **(2.51)*** | (0.20) | (0.62) |
| fostered x maternal orphan | -0.342 | -0.373 | -0.075 | -0.022 | **2.060** | **-4.805** | **1.866** | 0.753 |
| | (1.63) | (1.16) | (1.06) | (0.23) | **(1.64)** | **(2.59)**** | **(2.29)*** | (0.67) |
| fostered x paternal orphan | -0.194 | **-0.728** | -0.048 | -0.065 | -1.192 | **5.212** | -0.342 | -0.001 |
| | (1.19) | **(3.00)**** | (0.88) | (0.91) | (1.22) | **(3.68)**** | (0.54) | 0.00 |
| fostered x double orphan | **0.583** | -0.299 | **0.183** | 0.182 | 2.389 | 3.809 | 0.548 | 1.460 |
| | **(2.24)*** | (0.62) | **(2.06)*** | (1.28) | (1.51) | (1.37) | (0.54) | (0.87) |
| number of children | 9379 | 4516 | 9410 | 4528 | 9244 | 4449 | 9236 | 4443 |

We also include age and sex of the child
Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

**Table C1**
**Random Effects Probit Estimates of Fertility**

| **Dependent variable is whether or not a birth occurs in any given month** | Model I | | Model II | |
|---|---|---|---|---|
| | Matrilineal | Patrilineal | Matrilineal | Patrilineal |
| surviving siblings | **0.006** | **0.006** | **0.006** | **0.006** |
| | (3.77)** | (2.16)* | (3.77)** | (2.16)* |
| adult death | **-0.750** | 0.060 | -0.315 | 0.073 |
| | (2.56)* | (0.38) | (1.06) | (0.34) |
| adult death x rank among siblings | **0.040** | -0.013 | | |
| | (2.81)** | (0.49) | | |
| adult death x rank = 1 | | | **-0.320** | 0.127 |
| | | | (1.91) | (0.53) |
| adult death x rank = 2 | | | **-0.313** | 0.036 |
| | | | (2.23)* | (0.13) |
| adult death x rank = 3 | | | **-0.301** | -0.117 |
| | | | (2.39)* | (0.49) |
| adult death x rank = 4 | | | **-0.285** | -0.155 |
| | | | (2.16)* | (0.62) |
| adult death x rank = 5 | | | **-0.233** | 0.031 |
| | | | (1.70) | (0.14) |
| adult death x rank = 6 | | | **-0.235** | -0.430 |
| | | | (1.85) | (1.04) |
| adult death x rank = 7 | | | -0.209 | -0.343 |
| | | | (1.53) | (1.23) |
| women months | 1060895 | 385893 | 1060895 | 385893 |

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

Other controls:
woman's age and age squared
woman's years of schooling
number of births in the last 24 months
household wealth index
cmc - calendar months since 1900
rainfall shocks and long term risk factors
age adjusted mortality rates
month and region summies

**Table C2**
**Random Effects Probit Estimates of Fertility**

| Dependent variable is whether or not a birth occurs in any given month | Matrilineal | Patrilineal |
|---|---|---|
| surviving siblings | **0.006** | **0.006** |
| | (3.82)** | (2.15)* |
| adult death | 0.060 | -0.058 |
| | (1.38) | (0.70) |
| eldest sister x adult death | **-0.130** | 0.078 |
| | (1.65) | (0.59) |
| women months | 1060895 | 385892 |

*eldest sister is woman with rank 1 or 2 among sisters

**Table C3**
**Region Fixed Effects Regression of Completed Fertility for women aged 40-44**

| Variables | I | II |
|---|---|---|
| education in single years | 0.001 | 0.003 |
| | (0.04) | (0.12) |
| number of brothers | 0.039 | 0.052 |
| | (0.99) | (1.28) |
| number of sisters | 0.054 | 0.063 |
| | (1.31) | (1.52) |
| matrilineal | 0.024 | 0.059 |
| | (0.12) | (0.30) |
| eldest among sisters | 0.071 | |
| | (0.41) | |
| dead adult sisters | 0.407 | |
| | (1.48) | |
| matrilineal x dead adult sisters | **-0.627** | |
| | (1.96) | |
| ratio of dead sisters to siblings | | **2.065** |
| | | (1.66) |
| matrilineal x ratio of dead sisters to siblings | | **-2.828** |
| | | (1.94) |
| number of women | 1050 | 1016 |

**Table D1**
**Effect of orphans on child anthropometry**

| | birth size[+] | Log percentile height for age | | | Log percentile weight for age | | |
|---|---|---|---|---|---|---|---|
| | | **OLS** | **Region Fixed Effects** | **Region times Month of Birth Fixed Effects** | **OLS** | **Region Fixed Effects** | **Region times Month of Birth Fixed Effects** |
| matrilineal | **0.054** | **-0.287** | **-0.168** | **-0.150** | **-0.200** | **-0.117** | **-0.123** |
| | (2.27)* | (4.51)** | (2.34)* | (2.07)* | (4.32)** | (2.19)* | (2.29)* |
| orphans fostered into household | -0.021 | -0.048 | -0.068 | -0.094 | **-0.189** | **-0.197** | **-0.198** |
| | (0.39) | (0.33) | (0.47) | (0.62) | (1.83) | (1.95) | (1.84) |
| matrilineal x orphans fostered into household | 0.045 | 0.087 | 0.080 | 0.082 | **0.226** | **0.226** | 0.203 |
| | (0.69) | (0.48) | (0.44) | (0.44) | (1.72) | (1.74) | (1.51) |
| number of children | 11697 | 9098 | 9098 | 9098 | 9098 | 9098 | 9098 |

children clustered by mother
[+] ordered probit estimates

other controls:
age and sex of child
mother's marital status, age, schooling and log percentile height for age
number of adult men and women in the household
dummies for sex and age of household head, and the household wealth index
rural dummy
Robust z statistics in parentheses
* significant at 5%; ** significant at 1%

**Table D2**
**Effect of orphans on child anthropometry**

| | | Log percentile height for age | | | Log percentile weight for age | | |
|---|---|---|---|---|---|---|---|
| | **birth size**[+] | **OLS** | **Region Fixed Effects** | **Region times Month of Birth Fixed Effects** | **OLS** | **Region Fixed Effects** | **Region times Month of Birth Fixed Effects** |
| matrilineal | **0.051** | **-0.299** | **-0.182** | **-0.165** | **-0.200** | **-0.119** | **-0.128** |
| | (2.15)* | (4.72)** | (2.46)* | (2.26)* | (4.32)** | (2.17)* | (2.37)* |
| orphans 60 months ago | **-0.049** | | | | | | |
| | (2.15)* | | | | | | |
| matrilineal x orphans 60 mths ago | **0.050** | | | | | | |
| | (1.69) | | | | | | |
| orphans during last 60 months | | -0.066 | -0.065 | -0.045 | **-0.074** | **-0.072** | **-0.061** |
| | | (1.13) | (1.15) | (0.81) | (1.92) | (1.85) | (1.72) |
| matrilineal x orphans last 60 mths | | **0.129** | **0.113** | 0.093 | **0.100** | **0.093** | **0.084** |
| | | (1.83) | (1.64) | (1.41) | (2.09)* | (1.93) | (1.92) |

children clustered by mother
[+] ordered probit estimates

other controls:
age and sex of child
mother's marital status, age, schooling and log percentile height for age
number of adult men and women in the household
dummies for sex and age of household head, and the household wealth index
rural dummy
Robust z statistics in parentheses
* significant at 5%; ** significant at 1%

**Table D3**

**First Stage Regressions for Two-Stage Least Squares Estimates of Orphan Effects on Child Health**

**Proposed Instrument: interaction of rank (eldest) and number of sisters' orphans**

| | **Matrilineal** | **Patrilineal** |
|---|---|---|
| woman is eldest | -0.001 | -0.007 |
| | (0.10) | (0.64) |
| number of sisters orphans | **0.012** | **0.020** |
| | (3.96)** | (3.86)** |
| eldest x number of sisters' orphans | **0.030** | -0.015 |
| | (2.70)** | (0.89) |
| number of observations | 8236 | 3685 |

other controls:
age and sex of child
mother's marital status, age, schooling and log percentile of height for age
number of adult men and women in the household
dummies for sex and age of household head, and the household wealth index
rural dummy

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

**Table D4**
**Two-Stage Least Squares Estimates of the Effect of Orphans on Anthropometric Measures**

| | Log Percentiles | | Standard Deviations | | | |
|---|---|---|---|---|---|---|
| | **child height for age** | **child weight for age** | **child height for age** | **childweight for age** | **child is stunted** | **child is under-weight** |
| **Matrilineal** | | | | | | |
| number of orphans | 1.950 | 1.106 | 0.938 | 0.823 | -0.190 | -0.116 |
| | (1.06) | (0.86) | (0.92) | (0.94) | (0.66) | (0.48) |
| child is female | **0.289** | **0.145** | **0.161** | **0.087** | **-0.034** | **-0.021** |
| | (3.82)** | (2.60)** | (3.82)** | (2.53)* | (2.69)** | (1.94) |
| child age in months | **-0.047** | **-0.008** | **-0.029** | **-0.010** | **0.008** | **0.000** |
| | (24.04)** | (5.09)** | (25.09)** | (10.35)** | (22.80)** | (1.65) |
| woman's education in single years | **0.04** | **0.02** | **0.02** | 0.01 | **-0.006** | **-0.005** |
| | (3.12)** | (1.81) | (2.41)* | (1.09) | (2.70)** | (2.38)* |
| woman's log of percentile height for age | **0.249** | **0.171** | **0.136** | **0.103** | **-0.033** | **-0.026** |
| | (11.29)** | (10.54)** | (10.98)** | (10.38)** | (9.42)** | (8.16)** |
| number of children | 6229 | 6229 | 6229 | 6229 | 6775 | 6775 |
| **Patrilineal** | | | | | | |
| number of orphans | -2.619 | -3.702 | -1.610 | -2.425 | 0.216 | 0.518 |
| | (1.02) | (1.36) | (1.07) | (1.46) | (0.58) | (1.27) |
| child is female | **0.186** | 0.065 | **0.110** | 0.050 | **-0.032** | -0.024 |
| | (1.83) | (0.78) | (1.90) | (0.95) | (1.83) | (1.54) |
| child age in months | **-0.044** | **-0.011** | **-0.028** | **-0.012** | **0.007** | **0.001** |
| | (15.14)** | (4.83)** | (16.30)** | (7.79)** | (14.56)** | (1.93) |
| woman's education in single years | **0.083** | **0.075** | **0.039** | **0.047** | **-0.010** | **-0.012** |
| | (3.53)** | (3.33)** | (2.85)** | (3.30)** | (2.71)** | (3.57)** |
| woman's log of percentile height for age | **0.271** | **0.145** | **0.143** | **0.089** | **-0.040** | **-0.019** |
| | (8.78)** | (5.64)** | (8.42)** | (5.72)** | (8.19)** | (4.09)** |
| number of children | 2869 | 2869 | 2869 | 2869 | 3089 | 3089 |

Other controls:
age and sex of child
mother's marital status and age
number of adult men and women in the household
dummies for sex and age of household head, and the household wealth index
rural dummy

Stunting (underweight) is defined as having height-for-age (weight-for-age) more than 2 standard deviations below international reference standards