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Does Biological Relatedness Determine Household Resource Allocation?

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Background:

AIDS epidemic has left behind a generation of African orphans[1], thus adding significantly to the existing number of children orphaned by Malaria, TB, and civil wars in the continent. As the 1990s unfolded, broad recognition of the immense suffering AIDS would inflict on many nations of Africa (Caraël and Piot 1987) spurred consideration of many policy responses. In Tanzania and Uganda HIV seroprevalence exceeds 10% for low risk populations and 40% for high risk (Brown 1996). One of the foremost concerns has been the plight of orphans (Hunter 1990). Political and financial upheaval as well as endemic diseases already orphan millions of children in Africa. Their ranks are now swollen by an estimated 7.8 million additional AIDS orphans (Way, Schwartlander et al. 1998).

As part of African tradition such orphans are usually fostered in kin families who provide them with the care and support they need (Caldwell, 1997; Foster, G. et al. 1995; Ntozi 1997; Kamali et al., 1996; Urassa, et al., 1997; Rutayuga J.B., 1992; Hunter, S. 1990; Lloyd and Blanc, 1996). Earlier observations on the wide prevalence of child fostering in West Africa (Isiugo-Abanihe 1985; Bledsoe and Brandon 1987) were joined by data showing that 14% of Northwestern Tanzanian households (Urassa, Boerma et al. 1997) and 19% of Southern Ugandan households fostered orphan children (Nalugoda, Wawer et al. 1997). There is broad agreement that homelessness has not been a problem for orphans (Ainsworth and Rwegarulira 1992; Nalugoda, Wawer et al. 1997; Urassa, Boerma et al. 1997).

Despite greatly increased adult mortality, Ainsworth and Rwegarulira (1992) reported no increase in enrollment in the few existing Ugandan orphanages. Considering the advantages and availability of care by the extended family a policy of building more orphanages has never been a serious consideration (Hunter 1990). As Caldwell (1997) notes, "Extraordinarily, the evidence up to now is that the fostering system will probably accommodate the very great numbers of AIDS orphans." However it is not enough to acquiesce that foster care is better than homelessness (Bledsoe and Brandon 1987).

[1] The conventional definition of "orphan" in most studies is child below the age of 15 who has lost one or both parents (Way, Schwartlander et al. 1998).

There are mounting evidences, from Sub-Saharan Africa, that fostered children have lower chances for education (Case A, et al., 2002), less likely to get health care when they need it (Bledsoe C, et al., 1988), have lower nutritional status (Ainsworth and Semali 1998; Bledsoe C, et al., 1988).

Orphanhood is the oldest human tragedy—preventing it and coping with it have been the focus of biological and social adaptations for millennia. It used to be sufficient for researchers to merely document the toll of suffering. Counts of orphans, AIDS orphans, malnourished orphans, unschooled orphans, and homeless orphans abound. But we have recently come to a watershed in our understanding of the relationship of orphanhood to human welfare. Ainsworth and Filmer's masterful study of the inconsistent relationship between orphanhood and school enrollment (Ainsworth and Filmer 2002) testifies that it is time to begin understanding why some societies cope better than others. It is time to start testing theories that explain why orphans suffer deprivation instead of repeatedly measuring deprivation. Although scientific study to repeatedly document adverse outcomes in orphans could be useful for advocacy, more descriptive studies would offer little additional guidance about the determinants of these outcomes and the policies to address them. The question which need to be answered is whether the extended families caring for foster children require outside assistance to optimize their function.

The policy response to rush to the aid of the orphans was tempered by a realization that perhaps the long established African tradition of child fostering might be sufficient to cope with the crisis among the Baganda and elsewhere (Foster, Shakespeare et al. 1995; Kamali, Seeley et al. 1996; Urassa, Boerma et al. 1997).

Given these considerations and the above concerns about the viability of unassisted foster families, what is the proper policy response? Ainsworth and Filmer conclude that, "Orphans are not universally in need of assistance." (Ainsworth and Filmer 2002) They cite an inconsistent relationship between orphanhood and school enrollment to show that orphan status alone is not a good targeting criterion. Clearly there are traditional and institutional coping mechanisms at work to naturally ameliorate the effect of orphanhood on children. Identifying where these coping mechanisms succeed and where they do not is the key to finding what else, besides orphanhood would permit effective targeting of assistance to children who are truly at risk.

An orphan's loss of a parent means a heavy reduction in biological relatedness, which may be worsened through placement decisions. Two parent orphans in Western Africa and in the Caribbean face very high rates of placement with unrelated caregivers (Ainsworth and Filmer 2002). In prior work, we have shown that biological relatedness of children to other household members appears to be related to the survival of children in communities with high HIV seroprevalence (Bishai, Suliman et al. 2002). We still do not know if biological relatedness is mediating child survival through household allocation decisions. If it is, then that would suggest the need for policies to both encourage kin placement for orphans and to bypass household decision makers when targeting orphans who are placed with unrelated caregivers.

The objective of this paper is to determine whether biological relatedeness of a child to an adult affects the adult's propensity to allocate resources towards that child wellbeing. The paper will specifically examine adults propensity to allocate resources to children's basic needs, e.g. expenditure on children 's clothing, and demand for health care and education.

Methods:

Let us assume that there is a household with two adults and one child. Assume also that the two adults differ in their degree of biological relatedness to the child as well as their own characteristics. With different tastes and preferences the adults will have utilities, U^1, and U^2 for adult 1 and adult 2, respectively and different threat points A^1, and A^2. Based on the work by Bishai (2003), for this type of household to achieve Nash bargained equilibrium, the equilibrium allocations of adults' consumption, X^1, and X^2 as well as publicly enjoyed child well being (H) occur by maximizing the following utility function:

$$\text{MAX} \quad [U^1 (X^1 , H) - A^1] * [U^2 (X^2 , H) - A^2] \qquad (1)$$

The child well-being production process can be model as:

$$H = h(t^1, t^2, Z, \mu] \qquad (2)$$

Equation (2) indicates that child well being depends on adults time (t), health goods (Z) and the child endowment (μ).

The household budget constraint is:

$$P_x (X^1 + X^2) + P_z Z = F \qquad (3)$$

Where P_x ,and P_z are the prices of good X, and Z, respectively.

The full household income is: $F=A^1 + A^2 + w_1 t^1 + w_2 t^2$

Bishai (2003) states that if we assume the household has arrived at optimal solutions for child well being production at optimal factor demand t^{*1}, t^{*2}, Z^*, then one can conveniently define a shadow price of child well being as follows:

$$\pi_H = P_z (dZ^*/dH) + w_1 (dt^{*1}/dH) + w_2 (dt^{*2}/dH)$$

and shadow budget constraint

$$F=\pi_H H + P_x (X^1 + X^2) \qquad (4)$$

From the first order conditions for equations 1,2 and 4 above and assuming that adult1 is indifferent between his/her utility U^1 and his/her threat point utility A^1 then one can derive the Euler condition, that is the $MRS^1_{HX}=\pi_H/P_x$. Where MRS is the marginal rate of substitution = $(dU^1/dH)/\ (dU^1/dX)$. Similarly, one can derive the MRS for adult 2. In between these two boundary conditions the system of equations run through a complex combination of the two adults utilities (Bishai, 2003). It can be shown (Roth, 1977) that a linear approximation to the contract curve depicting the set of Nash bargained equilibrium can be written as:

$$\theta^1 MRS^1_{HX} + \theta^2 MRS^2_{HX} = \pi_H/P_x \qquad (6)$$

Where θ^1 and θ^2 are parameters depicting bargaining power, e.g. $\theta^1 = A^1 / (X^1 + X^2)$ …etc. With this specification a player has maximal power when his/her unearned income is approximately = the aggregate household consumption (Bishai, 2003).

Bishai (2003) shows that one can implement empirical test of equation (6) by employing utility function of the form:

$U^1 = \log X^1 + A\rho^1 \log H$ and $U^2 = \log X^2 + A\rho^2 \log H$

Where A is a constant for both adults and ρ is a taste parameter for child well being that differs between adults due to several factors including perceived biological relatedness.

These yield that $MRS^1_{HX} = \rho^1 X^1/H$ and $MRS^2_{HX} = \rho^2 X^2/H$. Substituting these expressions and the expression for the shadow price in equation (6) and setting $P_x=1$ gives:

$$(\theta^1\rho^1X^1 + \theta^2\rho^2X^2) = \pi_H * H \qquad (7)$$

Depicting consumption shares as $\sigma^1 = X^1 / (X^1 + X^2)$ and $\sigma^2 = X^2 / (X^1 + X^2)$ one can derive:

$$(A^1\rho^1\sigma^1 + A^2\rho^2\sigma^2) = \pi_H * H \qquad (8)$$

Equation (8) indicates that holding the shadow price of child well being fixed, the effect of child well being of each adult's unearned income, A, is mediated by both the adult's taste factor, ρ and the adult's personal consumption share σ. Equation 8 motivates an empirical specification interacting each adult's endowment, taste for child well being, and consumption share in the allocation to child well being. Equation (8) can be utilized to test whether biological relatedness is correlated with adults' taste for child well being.

Econometric Models: Based on equation (8) above I intend to estimate a reduced form demand function for child well being. The theory calls for testing for the presence of an interaction term for biological relatedness and adult's endowment. The econometric model I wish to estimate can be written as follows:

Let, i denotes child, j denotes adult, k denotes household, c denotes community, and t denotes time period. Then, define the **child's biologically based resource claim** on adults in the household as:

$B_{ikt} = \sum_j [(\alpha\, Y_{jkt} + \beta\, G_{jkt} + \lambda\, E_{jkt} + \delta\, D_{jkt}) \times w_{ijkt}]$

Where Y_{jkt}, G_{jkt}, E_{jkt}, and D_{jkt} are unearned income, gender, education, and disability status of adult "j" in household "k", respectively; w_{ijkt} is the coefficient of biological relatedness of child "i" to adult "j" in household "k" and the parameters α, β, λ and δ represent the contribution of each adult characteristic to the biologically based resource claim. We define the variables;

$Y_{kt} = \sum_j (Y_{jkt})$	$Y_{ikt}^* = \sum_j (Y_{jkt} \times w_{ijkt})$	$Y_{kt}^* = \sum_i (Y_{ikt}^*)$
$G_{kt} = \sum_j (G_{jkt})$	$G_{ikt}^* = \sum_j (G_{jkt} \times w_{ijkt})$	$G_{kt}^* = \sum_i (G_{ikt}^*)$
$E_{kt} = \sum_j (E_{jkt})$	$E_{ikt}^* = \sum_j (E_{jkt} \times w_{ijkt})$	$E_{kt}^* = \sum_i (E_{ikt}^*)$
$D_{kt} = \sum_j (D_{jkt})$	$D_{ikt}^* = \sum_j (D_{jkt} \times w_{ijkt})$	$D_{kt}^* = \sum_i (D_{ikt}^*)$

Model (1) can be written as:

$$H_{ikt} = \mu_{ik} + B_{ikt} + \theta X_{ikt} + e_{ikt} \qquad (1)$$

Where,
H_{ikt} is a measure of child i well being at time t;
μ_{ik} is unobserved child specific effects;
X_{ikt} is a vector of child and household control variables;
e_{ikt} is a random error term.

After substitution, Model (1) becomes:

$$H_{ikt} = \mu_{ik} + \alpha Y_{ikt}^* + \beta\, G_{ikt}^* + \lambda\, E_{ikt}^* + \delta\, D_{ikt}^* + \theta\, X_{ikt} + e_{ikt} \qquad (1)$$

In order to test the hypothesis that biological relatedness matters, we nest the above model in a more general model, which allows each of the adult characteristics to affect child welfare directly.

$$H_{ikt} = \mu_{ik} + \alpha Y_{ikt}^{*} + \beta\, G_{ikt}^{*} + \lambda\, E_{ikt}^{*} + \delta\, D_{ikt}^{*}$$
$$+ \alpha'\, Y_{kt} + \beta'\, G_{kt} + \lambda'\, E_{kt} + \delta'\, D_{kt} + \theta'\, X_{ikt} + e_{ikt} \qquad (2)$$

The ratio of the likelihood of regression (2) to regression (1) tests the hypothesis that adult characteristics matter <u>only</u> to the degree that the adults are related to the child. The ratio of the likelihoods of regression (2) to a regression which drops all of the *'ed variables provides a test of the hypothesis that biological relatedness matters for child welfare.

Models (1) and (2) maintain the hypothesis that adult characteristics affect child welfare linearly. An alternative specification of Model (1) that incorporates the assumption of diminishing returns is given by:

$$h_{ikt} = \mu_{ik} + \alpha''\, y_{ikt}^{*} + \beta''\, g_{ikt}^{*} + \lambda''\, e_{ikt}^{*} + \delta''\, d_{ikt}^{*} + \theta''\, X_{ikt} + e_{ikt} \qquad (3)$$

Where small letters represent the logarithms of the corresponding capital letters.

Blake's (1981) "resource dilution theory" argues that when there are more children in the family, there are fewer economic resources devoted to any given child. A natural extension of this idea to the present context is to hypothesize that the **child's biologically based resource claim** affects his or her welfare only in relation to the total **biologically based resource claim** for all children in the household. One way to capture this idea is to rewrite model (3) as:

$$h_{ikt} = \mu_{ik} + \alpha'''\, (y_{ikt}^{*} - y_{kt}^{*}) + \beta'''\, (g_{ikt}^{*} - g_{kt}^{*})$$
$$+ \lambda'''\, (e_{ikt}^{*} - e_{ikt}^{*}) + \delta'''\, (d_{ikt}^{*} - d_{ikt}^{*}) + \theta'''\, X_{ikt} + e_{ikt} \qquad (4)$$

This last formulation allows a given child's biologically based resource claim to be offset by the claims of other children in the household, but imposes the constraint that the elasticity of h with respect to the child's own resource claim be the negative of the elasticity with respect to the total resource claims. This constraint can be relaxed by allowing the child-specific and the household total resource claims (e.g. y_{ikt}^{*} and y_{kt}^{*}) to have different coefficients.

Endogeneity of the Coefficient of Biological Relatedness: Intuition and economic theory suggest that the biological relatedness of a child could be heavily influenced by household choices related to fostering (Bishai et al., 2003). Findings from research in Sub-Saharan Africa revealed that households might decide to foster children to satisfy demand for child labor in home production (Ainsworth M., 1996; Isiugo-Abanihe, 1985; Andvig, et al., 1990) and to offset demographic imbalances in age and sex composition of it's children (Akresh R., 2003). To account for the potential endogeneity of the coefficient of biological relatedness we instrument it with variables, which we assume are related to biological relatedness, but not to child well being measures we aim to examine. The instrumental variables we propose to use include: number of male and female household members in the age categories, 0-14, 15-59, 60+ years, and sex and age of head of household. Validity of these instruments will be tested by how strongly they correlate with and predict the coefficient of biological relatedness.

Data:

Data for the above models comes from the Kagera Health and Development Survey (KHDS). The KHDS is a longitudinal household survey conducted in the Kagera region of Tanzania during the period 1991-1994. The survey was intended to measure the economic impact of adult mortality on surviving household members and the Kagera region was chosen because it had the highest HIV prevalence in Tanzania at that time. The Kagera region is located in the northwest of Tanzania, boarded by Uganda to the north, Rwanda and Burundi to the west. The region covers and area of approximately 40,838 km with 1.3 and 1.8 million population as of the years 1988 and 1999, respectively (Ainsworth and Semali, 2000; and The Belgian Technical Co-operation 2003). The Population of Kagera is pre-dominantly rural and agrarian. As of 1987 the HIV prevalence in the capital city of Kagera was estimated at 25% and 10% in the surrounding rural areas (Killewo et al., 1990).

The KHDS interviewed 816 households over four waves at 7-month intervals between 1991 and 1994. The KHDS collected detailed information on household income, consumption expenditure and individual health status and educational attainment. Data on height and weight of household members was also collected. In addition, detailed information was obtained on the mortality of household members. The household sample was random, stratified on geography, community adult mortality rates and household predictors of future adult deaths (Ainsworth and Semali, 2000).

Out of the 816 households 759 completed the 4 waves of interviews, thus resulting in an attrition rate of around 7%. The households interviewed started with 2480 children under age 15 years in wave 1, then 2354 in wave 2, and 2255 in wave 3, and ended up with 2041. The total number of observations for children under age 15 years in the panel of this study is 9130.

Measurement of variables:

Outcome variables

Clothing, nutrition, health care, and education are among the basic needs for humans and hence lack of access to them affects the child's livelihood. Clothing is measured by the amount of money spent on child's clothing over the year preceding the interview, nutrition is measured by the child's height, weight, and age standardized to a reference population proposed by the CDC and accepted by WHO, health care is measured by number of visits to a medical facility, and education is measured by the completed years of schooling.

Predictor variable(s)

Coefficients of biological relatedness:

The focal variable of interest in this study is the coefficient of biological relatedness of an adult to a child in a household (also known in the literature as Wright's coefficient of relatedness, w). The coefficient of biological relatedness is derived primarily on basis of the principle of "Kin Selection" associated with Hamilton (1964)[3]. Table 1 below depicts detailed illustration of possible relationships among household members and the coefficients of biological relatedness associated to it. In computing this coefficient of biological relatedness variable, I

[3] In diploid organisms, every parent transmits 50% of its genetic information to each offspring. On the average, siblings therefore share half of each parent's contribution to their genome, adding to a coefficient of relatedness w=0.5, and share 25% (w=0.25) with their uncles, aunts, grandparents, grandchildren. Likewise, these cousins are related to their common grandparents by ¼ or w=0.25, and so forth. w is a measure for the probability that any given allele is shared by two individuals. In diploid organisms each parent carries 2 alleles of each gene, but passes only 1 allele to the offspring. The child derives the other allele from the other parent.

primarily utilize information on relationships of household members to head of household and the sex and age of members reported in the household roster of the Kagera dataset.

Table 1. Coefficients of biological relationship as a function of relationship to head

	H	W	S1	S2	POH	COH1	COH2	GCH	GNH	N	A
Head (H)	1										
Wife Of head (W)	0	1									
Sibling of head (S1)	0.5	0	1								
Sibling of head (S2)	0.5	0	0.5	1							
Parent of head (POH)	0.5	0	0.5	0.5	1						
Child of head (COH1)	0.5	.5*	0.25	0.5	0.25	1					
Child of head (COH2)	0.5	.5*	0.25	0.5	0.25	0.5	1				
Grandchild of head (GCH)	0.25	.5*	0.125	0.125	0.125	.5‡	.5‡	1			
Grandniece of head (GNH)	0.125	.125*	.125†‡	.125†‡	0.0625	0.0625	0.0625	0.125	1		
Niece/neph of head (N)	0.25	.25*	.25†‡	.25†‡	0.25	0.125	0.125	0.25	.5‡	1	
Adopted child of head (A)	0	0	0	0	0	0	0	0	0	0	1

* Possibly 0 if head is polygynous.
† Possibly 0 if child through spouse's lineage.
‡ Possible that child is direct descendent.
S1 and S2 represent the case where there were multiple siblings of the head—one might have been an uncle/aunt for a child (S1) and another might have been a father (S2).
COH1 and COH2 represent the case where there were multiple children of the head—one might have been a brother/sister for a child (then gets a score of 0.5 as indicated in Table) and another might have been a half-sibling (then gets a score of 0.25, not shown in Table).

I also utilized information on survivorship of parents, information on deceased persons and their siblings and children who currently live in household, to help better identify the relationship among household members. Additionally, I created a variable identifying, which households are polygamous and which are not to help better identify the relationships. All these data were pulled together in a STATA program to generate coefficients of biological relatedness of each child to every adult household member (summary statistics are shown in the results section).

Unearned income:

This variable is intended to measures how much resources an adult has, in terms of disposable income, and might be willing to spend on a child. The variable is constructed from data on annual cash equivalent amount of remittances or transfers in the form of credits and/or loans received by an adult member. The variable is further refined to only measure the net amount of unearned income. Thus, any amount of money repaid as an obligation to reciprocate for example, or owed to a giver is deducted from the gross unearned income received. Added to that are annual amounts of property unearned income received from pensions, insurance, bank interests, lottery winning, dowry, inheritance, sales of durable goods, and other sources of property.

Unearned income is preferred to the earned income of adults on the basis of the assumption that it is exogenous and not affected by other household choices and a hence assumed to be a better measure of bargaining power of the individual who owns or controls that income (Thomas, D., 1990; Behrman and Deolalikar, 1990; Schultz, P., 1990).

Disability:

Measured by presence of chronic illnesses among adults.

Death:

Measured by death of adult household member and time since death.

Control Variables

Household total annual expenditure:

Measured by the total amount of money spent on all consumption items in a year. To count for the household sizes this variable will be translated in per capita annual household expenditure.

Childs's age and sex:

Measured by the sex of child and the current age.

Gender:

Measured by sex of adult (Female=1). There is justification that gender matters, in regard to resource allocation, as evidenced by studies that show father's income has a lower impact on child well-being than mother's income (Schultz P., 1990; Thomas D., 1990; Thomas D., et al. 1990).

Education:

Measured by adult's number of completed years of schooling.

Results:

We run both OLS model and instrumental variable OLS model (IV-OLS) in which we correct for endogeneity in coefficient of biological relatedness (Biorel). The instrumental variables performed fairly well in predicting biorel (results not shown), but may need to be enhanced with more stronger instruements. The current analysis focuses only on allocating resources to children clothing expenditures. As shown in Table 1, our preliminary analysis reveals that an increase in the child's biological relatedness to adults with disposable income increases expenditure on clothing for a child. The analysis also shows that an increase in the child's biological relatedness to more educated adults, as evidenced by more completed years of schooling, increases expenditure on clothing for a child.

Table 1: Regression results of the factors affecting expenditure on children's clothing, Kagera, Tanzania 1991-1994

Variable	OLS	IV-OLS
Biorel X Adult's unearned income	0.0012	0.0051**
	[1.57]	[5.38]
Biorel X No. of females adults in household	-187.3815	-386.2839
	[1.20]	[0.76]
Biorel X Completed years of schooling by adults in household	74.6624**	123.8738*
	[3.72]	[1.98]
Biorel X No. of adults adults with chronic illness in household	357.6994	-478.6958
	[1.52]	[0.58]
Biorel	-376.7812**	-498.2720**
	[3.23]	[3.30]
Adult's unearned income	-0.0004	-0.0008**
	[1.04]	[3.87]
No. of females adults in household	106.8332	208.4294
	[1.92]	[1.22]
Completed years of schooling by adults in household	3.5988	-12.9519
	[0.50]	[0.58]
No. of adults adults with chronic illness in household	-180.9120	116.7079
	[1.86]	[0.39]
Percapita annual household expenditure [a]	0.0008	0.0008**
	[2.78]**	[2.69]
Child's gender	-117.3154*	-117.8049*
	[2.06]	[2.07]
Child's age (in years)	0.1758	0.7000
	[0.03]	[0.11]
Constant	1,082.1084**	1,142.9636**
	[10.10]	[8.49]
Observations	5263	5263
Number of househols	764	764

Absolute value of z statistics in brackets
* significant at 5%; ** significant at 1%
The coefficient of biological relatedness (Biorel) is instrumented using: No. of males and females in household in each of the following age categories 0-14, 15-59, and 60+ years; gender and age of head of household; and age of adult household member
[a] Percapita annual household expenditure excludes expenditure on children's clothing

Conclusions:

This paper shows some evidencve that biological relatedness mediates household resource allocation decisions. Reductions in the numbers of biologically related adults may reduce resources allocated to children in households experiencing high rates of adult mortality. These results perhaps suggest the need for policies to both encourage kin placement for orphans and to bypass household decision makers when targeting orphans who are placed with unrelated caregivers.

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