Household economic status, schooling costs, and schooling bias against non-biological children in Malawi

Mussa, Richard

Economics Department, University of Malawi

27 January 2009

Household economic status, schooling costs, and schooling bias against non-biological children in Malawi*

Richard Mussa†

June 21, 2009

Abstract

The paper examines the relationship between household income and schooling costs in the presence of intrahousehold schooling bias against non-biological children. To this end, we construct a two-period model of intrahousehold schooling bias. The model predicts that there is an asymmetry in the impact of changes in costs and income on schooling in the sense that the impact is larger for the non-biological child. It predicts that the asymmetry increases as the relationship distance between the non-biological child and the parents gets wider. It also shows that an increase in cost of schooling leads to a bigger reduction in schooling for poor households, and that the difference in the impact of cost changes between the biological and the non-biological child declines as household income increases i.e. there is convergence. And the convergence is faster the more distantly related to the parents the non-biological child is. An empirical investigation of these predictions using the Second Malawi Integrated Household Survey (IHS2) data, shows that when current enrolment and grade attainment are used to measure schooling, the price and income elasticities of schooling are larger for non-biological children. The results also indicate that households in the lowest income quintile (the poorest) have the largest price elasticities, and households in the highest income quintile (the wealthiest) have the smallest price elasticities. We also find that the price elasticities for biological and non-biological children converge as we move from the lowest income quintile to the highest income quintile, and that the convergence is faster for non-biological children who are non-relatives.

1 Introduction

Parents as primary care givers of children play an important role in the formation of human capital which is vital for the economic development of any country. They do this

*I would like to thank Martin Wittenberg for his invaluable comments. Financial support from the African Economic Research Consortium (AERC) is appreciated. The standard disclaimer applies.

†Department of Economics, Chancellor College, University of Malawi, Box 280, Zomba, Malawi, rimussa@yahoo.co.uk

by investing in the health and the education of their children. The role of parents in providing for the education of both their own off spring as well as non-biological children in developing countries especially sub-Saharan African countries is more critical now given the impact of HIV/AIDS. An estimated 1.7 million people were infected with HIV in 2007, bringing to 22.5 million the total number of people living with the virus in sub-Saharan Africa (UNAIDS 2007). This entails more orphans in the future who have to be educated by extended family or non-relatives. A number of studies find evidence of schooling bias against non-biological children within households in sub-Saharan Africa, suggesting that parents discriminate against non-biological children who stay with them. Case *et al.* (2004), using 19 Demographic and Health Survey (DHS) datasets from 10 African countries, find that orphans are less likely to be enrolled than nonorphans with whom they live. Gundersen *et al.* (2004) and Kabubo-Mariara and Mwabu (2007) find a similar result for Zimbabwe and Kenya respectively. Shapiro and Tambashewe (2001) find that children living in households headed by someone other than their father or mother tend to have somewhat lower educational attainment in the Democratic Republic of Congo. They find this to be more evident for the ages 10–14[1].

Thus, while there is a plethora of economic studies which show evidence of discrimination against non-biological children, the literature is scanty on the possible sources of this discrimination. For example, Case *et al.* (2004) show that the probability of school enrollment is inversely proportional to the degree of relatedness of the child to the household head, regardless of whether the child is an orphan or not. There has been an almost exclusive focus on gender bias by studies which attempt to offer sources of intrahousehold bias in schooling (e.g. Behrman *et al.* 1986; Davies and Zhang 1995; Alderman and Gertler 1997; Alderman and King 1998; Echevarria and Merlo 1999; Rose 2000; Pasqua 2005). In addition to the paucity of economic studies on sources of schooling bias against non-biological children, to the best of our knowledge there is no study which addresses the issue of what happens to schooling bias following household income and cost changes. The contributions of the study are threefold. Firstly, the study proposes a theoretical model which offers possible sources of schooling bias against non-biological children. The second contribution of the study is that it theoretically demostrates in the presence of discrimination, how households respond to changes in household income and school costs, and how the household's response to cost changes varies with household income. The final contribution of the study is that it empirically investigates the theoretical predictions. Specifically, the empirical analysis seeks to examine using Malawian data, how households respond to changes in household income and school costs, and how a household's response to cost changes varies with household income. The theoretical and empirical

[1]While in a number of countries there is evidence of schooling bias, in others households exhibit no discrimination. For example, Zimmerman (2003) finds that South African households treat foster children as they do their own children in terms of human capital investment.

analyses conducted by the study are significant. They not only contribute specifically to the understanding of schooling bias against non-biological children, but they also add to the available literature on intrahousehold schooling bias in general. Knowledge of the factors which cause intrahousehold schooling bias as well as how schooling changes as household income and school cost change, and how a household's response to cost changes varies with household income would no doubt go a long way in the formulation of strategies to fight schooling bias at the household level. More crucially, this knowledge takes on an added significance in the light of the increasing number of orphans due to HIV/AIDS in sub Saharan Africa who mostly end up living with extended family and other non-relatives[2].

To understand why there may be schooling bias against a non-biological child in a household, we construct a two period model of the family in which parents work in the first period and retire in the second period. In the first period, they allocate their income between consumption and investment in the schooling of a biological child and non-biological child. In the second period, parents consume from the income transfers that the two children make when they are adults. The income transfered depends on the schooling invested in the two children in the first period. Thus, there are both investment and consumption motives to educating the children. The two children are assumed to be of the same sex. The model predicts two broad sources of schooling bias against a non-biological child, one attributable to non-preference based conditions, and the other due to a pure preference bias by parents. In terms of discrimination coming from the non-preference based conditions, the model shows that there will be schooling bias against a non-bioligical child if the cost (direct and opportunity costs) of educating the non-biological child are higher; if the returns to education of the non-biological child are lower; and if the subjective belief about how much will be transferred by the own child when the parents retire is higher compared to the non-biological child's. Further to that, the model predicts that the schooling gap between the biological child and the non-biological child gets wider as the relationship distance between the non-biological child and the parents gets wider. The model also predicts schooling bias arising from preference bias, where parents get more utility from the income of their own child.

The model shows that the impact of a change in costs and income on the amount of schooling investment is bigger for the non-biological child. That is, an increase in the cost (income) leads to a larger reduction (increase) in schooling of the non-biological child relative to the biological child. This suggests that households respond asymmetrically to changes in costs and household income. The model further predicts that the gap between the two children following these changes gets wider the more distantly related the non-

[2]In 2005, the estimated adult (age 15-49) HIV prevalence rate for Malawi was 14.1%. With this prevalence rate, Malawi was ranked number eight in the world (UNAIDS 2006).

biological child is. The model also shows that the change in schooling due to a change in costs falls with income, and falls faster for the non-biological child who is distantly related to the parents. This suggests that an increase in cost of schooling leads to a bigger reduction in schooling for poor households, and that the difference in the impact of cost changes between the biological and the non-biological child declines as household economic status improves i.e. there is convergence.

Using blended households in Malawi, that is households with both biological and non-biological children of school going age, and measuring schooling either as current enrolment or as grade attainment, the empirical results confirm the theoretical predictions. Specifically, we find that when both measures of schooling are used the price and income elasticities of schooling are larger for non-biological children. Further, we find that non-biological children who are non-relatives have higher price and income elasticities. The empirical analysis also indicates that households in the lowest income quintile (the poorest) have the largest price elasticities, and households in the highest income quintile (the wealthiest) have the smallest price elasticities. The study also finds that the price elasticities for biological and non-biological children converge as we move from the lowest income quintile to the highest income quintile, and that the convergence is faster for non-biological children who are non-relatives.

The rest of the paper is structured as follows. Section 2 sets up a model of intrahousehold schooling discrimination and discusses its implications as well as conducts comparative static exercises. In Section 3 we discuss the hypotheses to be tested, the econometric model used, variables used, estimation issues, and data and descriptives. Econometric results are presented in Section 4. We conclude in Section 5.

2 A model of intrahousehold schooling bias

We adapt a model structure used by Alderman and Gertler (1997), and Alderman and King (1998), to study gender schooling bias in households. Consider a society in which parents live in two periods, indexed by $t = 1, 2$ respectively. They work in the first period, and retire in the second period. In the first period, they give birth to a child (b), and in the same period they have a non-biological (nb) child moving into the family[3]. Throughout, we use subscripts $j = b, nb$ to refer to the two children. The children (biological and non-biological child) are of the same sex[4], and approximately of the same age[5]. The parents' consumption in the first period is their income less the investment on schooling

[3]For simplicity, we assume that the movement of a non-bilogical child into the family is exogenous.

[4]This allows us to focus on schooling differences in the household which are not due to gender bias.

[5]This allows us control for the children's future level of earnings.

of the two children[6]. In the second period (during retirement), their consumption depends on the income transfered by the two children, which in turn depends on the schooling investment that the parents made in the first period. Thus, parents' decision to educate children is done both for its own sake as a consumption good, and as an investment good. This entails that there are both investment and consumption reasons for investing in the education of the two children. There is a trade off between current consumption and second period consumption, in that less consumption in period 1, means more schooling for the children, and hence more consumption during retirement. We assume that there are no savings, and no old age pension. We also assume that only parents are responsible for the schooling of the children in the first period, that is there are no private or public scholarships. We assume that there is complete and perfect information meaning that there is no uncertainty[7].

The life time utility function of parents is given as follows;

$$U = G(C_1) + \delta V(W_{2b}, W_{2nb}, C_2) \tag{1}$$

Where; C_1 is their first period consumption, C_2 is their second period consumption, W_{2b} is the income of their child in period 2 (retirement period), W_{2nb} the income of the non-biological child in period 2 (retirement period), and δ is the discount rate or subjective rate of time preference. This utility function says that parents get utility from consumption in the two periods, and also they get utility from the income of the two children in the second period. We assume that the utility function is twice continuously differentiable and has the following conventional properties;

$$\begin{aligned} G' &> 0, V' > 0 \\ G'' &< 0, V'' < 0 \end{aligned} \tag{2}$$

Thus, the utility functions are concave meaning that utility is increasing but diminishing.

Since we have assumed that there are no pensions and savings, parents' second period consumption is given as;

$$C_2 = \theta_k W_{2b} + \theta_k W_{2nb} \tag{3}$$

[6]For simplicity, we don't allow for overlapping generations in which the parents' also transfer part of their income to their parents.

[7]One could also allow for parental uncertainty in the transfers that the children would make when they are adults.

That is, the resources available for consumption by parents in retirement come from the transfers that the two children make when they are adults. The parents have a subjective belief θ_k, about how much of each child's income will be transferred to them when they retire. Where $\theta_k \in [0, 1]$, and k is a measure of the degree of relatedness of the child. For a biological child $k = 1$, and for a non-biological child $k > 1$. A higher k denotes a more distantly related non-biological child. For ease of exposition, we assume that k takes positive integer values. There are a number of reasons why transfers may be made by children when they are adults to their retired parents. As argued by Cigno (1993), there may exist in a society a social norm according to which adults give a fraction of their income to their old parents. The workings of the social norm are aptly explained by López-Calva and Miyamoto (2004, p 491) when the say;

> *"The adult has to decide on whether to transfer money to her retired parents or not. An informal intergenerational contract exists, which can only be enforced through "social punishment." The social perception of the adult's decision shall determine the optimal reaction of her own child and thus whether she herself is going to get a transfer when retired."*

Even in the absence of the said social norm, the non-availability of pension schemes in poor countries entail that old people rely on the resources received from their adult children (Pasqua 2005)[8].

The two children's income when they are adults is;

$$W_{2b} = \pi_b S_{1b} + I_b \tag{4}$$

and

$$W_{2nb} = \pi_{nb} S_{1nb} + I_{nb} \tag{5}$$

where $\pi_b S_{1b}$ ($\pi_{nb} S_{1nb}$) is the biological (non-biological) child's labour income, and I_b (I_{nb}) is the own (non-biological) child's non-labour income. The labour income for the biological child is a linear function of the level of schooling (S_{1b}) invested by the parents in period 1. Similarly, the labour income for the non-biological child is a linear function of the level of schooling (S_{1nb}) invested by the parents in period 1. And π_b and π_{nb} are the returns to education for the biological and non-biological child respectively. Though the innate ability of each child might also affect his/her earnings, for simplicity it not included[9].

[8] We assume here that the subjective belief is exogenous.

[9] Apart from investing in schooling, the parents may also indirectly affect the earnings potential of the two children through other child specific inputs such health and nutrition. We do not model this indirect channel.

In period 1, the parents face the following budget constraint;

$$C_1 + P_{1b}S_{1b} + P_{1nb}S_{1nb} = Y \tag{6}$$

where P_{1b} and P_{1nb} are indirect and direct costs of schooling of the biological and non-biological child respectively, and Y is parental labour and non-labour income. We normalize the price of consumption to one. The budget constraint, equation 6 says that in period 1, parents allocate their income on current consumption and the schooling investment of their own child and the non-biological child.

2.1 Equilibrium

Parents choose the level of schooling of the two children, S_{1b} and S_{1nb} to maximize their life time utility as given by equation 1, subject to transfers that the two children will make in retirement represented by equation 3, and subject to the budget constraint 6. Substituting equations 3 to 6 into equation 1, the utility maximization problem of the parents is formally expressed as;

$$\begin{aligned} \underset{S_{1b},S_{1nb}}{Max\ U} &= G(Y - P_{1b}S_{1b} - P_{1nb}S_{1nb}) \\ &+\delta V(\pi_b S_{1b} + I_b, \pi_{nb}S_{1nb} + I_{nb}, \theta_k(\pi_b S_{1b} + I_b) + \theta_k(\pi_{nb}S_{1nb} + I_{nb})) \end{aligned} \tag{7}$$

The first order conditions are (compare with Alderman and Gertler 1997, and Alderman and King 1998);

$$\frac{\partial G}{\partial C_1}P_{1b} = \frac{\partial V}{\partial W_{2b}}\pi^b + \frac{\partial V}{\partial C_2}\pi_b\theta_k \tag{8}$$

and

$$\frac{\partial G}{\partial C_1}P_{1nb} = \frac{\partial V}{\partial W_{2nb}}\pi_{nb} + \frac{\partial V}{\partial C_2}\pi_{nb}\theta_k \tag{9}$$

We assume that $\delta = 1$ for simplicity. The two first order conditions suggest that parents will invest in the education of each child until the marginal cost of sacrificing consumption in period 1 (left hand side) is equal to the marginal benefit in period 2. And the marginal benefit in period 2 is equal to the utility the parents derive from a marginal increase in each child's human capital plus the marginal utility of second-period consumption multiplied by the subjective belief about future transfers per unit of school investment.

2.2 Implications

We now turn to the implications of the model for intrahousehold schooling bias against a non-biological child. The model predicts two broad sources of intrahousehold schooling bias against a non-biological child. Bias could be due to non-preference based factors favouring the biological child, and secondly, it could arise from preference bias against the non-biological child. These two predictions are formally expressed in the next two propositions.

Proposition 1 *If parents exhibit no preference bias against the non-biological child, the non-biological child will receive less schooling i.e.* $S_{1b} > S_{1nb}$ *when at least one of the following holds:*

i) *Direct and indirect costs of educating the non-biological child are higher than those of the biological child i.e.* $P_{1b} < P_{1nb}$.

ii) *Returns to education of the non-biological child are lower than those of the biological child i.e.* $\pi_b > \pi_{nb}$.

iii) *The subjective belief about how much the non-biological child will transfer in old age is lower than that of the biological child i.e.* $\theta_1 > \theta_k$ for $k > 1$. *Further to this, the schooling bias worsens, if the subjective belief decreases as the relationship with the non-biological child becomes distant i.e.* $\theta_1 > \theta_2 > \theta_3, ...$

Proof. Assuming that the marginal benefit (right hand side of 8 and 9) is the same, $S_{1b} > S_{1nb}$ holds only if $P_{1b} < P_{1nb}$. No preference bias means $\frac{\partial V}{\partial W_{2b}} = \frac{\partial V}{\partial W_{2nb}}$, and $\frac{\partial^2 V}{\partial W_{2b}^2} = \frac{\partial^2 V}{\partial W_{2nb}^2}$, when $S_{1b} = S_{1nb}$. Now assuming that the marginal cost (left hand side of 8 and 9) is equal, means that $\frac{\partial V}{\partial W_{2b}}\pi_b + \frac{\partial V}{\partial C_2}\pi_b\theta_k = \frac{\partial V}{\partial W_{2b}}\pi_{nb} + \frac{\partial V}{\partial C_2}\pi_{nb}\theta_k$. With $\pi_b > \pi_{nb}$, this equality holds only if $S_{1b} > S_{1nb}$, due to the concavity of schooling in the parents utility function. Similarly, with $\theta_1 > \theta_k$ for $k > 1$, and concavity of schooling, this equality prevails only if $S_{1b} > S_{1nb}$. Thus, $S_{1b} > S_{1nb}$ (bias) occurs if i) $P_{1b} < P_{1nb}$ or ii) $\pi_b > \pi_{nb}$ or iii) $\theta_1 > \theta_k$. Further to this, when we have $\theta_1 > \theta_2 > \theta_3, ...$ the schooling gap must be widening. ■

The cost especially the indirect opportunity cost of educating a non-biological child may be higher than that for the biological child owing to the possibility that a non-biological child is more likely to be sent out to work (child labour) to supplement household income. The forgone income from the non-biological child makes it more costly to send him/her to school. The returns to schooling for the non-biological child may be lower in Africa where most of the non-biological children are orphans due to parental death caused by HIV/ AIDS. For example, Case *et al.* (2004, p 484) argue that;

> *"orphans may also be more likely than nonorphans to have HIV/AIDS because of maternal-child transmission, which could depress schooling. In addition, the returns to schooling could be reduced by the experiences surrounding the death of a parent, including time lost from school during the parent's illness and death and emotional scarring that may compromise the child's ability to learn."*

The stigma that often follows those children whose parents died of HIV/Aids may leave emotional scars which could quite possibly affect their future returns to education. As Gachuhi (1999) contends, the psychological effects of having to cope with pervasive illness and death, and the debilitating impact of the stigmatization associated with HIV/AIDS can be a detriment to learning. Since parents can cannot observe *a priori* a child's future transfers to them in old age, they form a subjective belief that due to the biological ties, their own offspring will transfer a higher fraction of his/her income, than the non-biological child with whom they have weaker ties, and the ties with the non-biological child get weaker and weaker the more distant is the relationship. The idea that biological relatedness matters is aptly expressed by evolutionary biologist Hamilton (1964a,b) in what is called Hamilton' rule which is expressed as follows;

> "*The social behavior of a species evolves in such a way that in each distinct behavior evoking situation the individual will seem to value his neighbors' fitness against his own according to the coefficients of relationship appropriate to that situation.*"(1964b, p 19.)

The rule suggests that the degree of altruism is an increasing function of biological relatedness, that is a child would care more about his parents than a distant relative[10]. At the empirical level, Case *et al.* (2004) show that the probability of school enrollment is inversely proportional to the degree of relatedness of the child to the household head, regardless of whether the child is an orphan or not[11]. Thus, intrahousehold discrimination

[10]It should be pointed that the standard Hamilton coefficient of relatedness works the other way i.e. low values of the coefficient imply low values of biological relatedness. Our reformulation where higher k denotes a more distantly related non-biological child does not affect the spirit of the Hamilton's rule.

[11]Biological relatedness transcends schooling, for example, Bishai *et al.* (2003), find that reduced biological relatedness is associated with reduced child survival in Uganda. Case *et al.* (2000), find that households in which a child is raised by an adoptive, step or foster mother, less is spent on food in the US and South Africa.

against a non-biological child can arise due to the aforementioned non-preference based conditions. Schooling bias in households can also arise if parents have preference bias against the non-biological child, this is formally expressed in the following proposition.

Proposition 2 *If parents exhibit preference bias against the non-biological child, the non-biological child will receive less schooling i.e.* $S_{1b} > S_{1nb}$.

Proof. Preference bias means $\frac{\partial V}{\partial W_{2b}} > \frac{\partial V}{\partial W_{2nb}}$, and $\frac{\partial^2 V}{\partial W_{2b}^2} > \frac{\partial^2 V}{\partial W_{2nb}^2}$, when $S_{1b} = S_{1nb}$. Now assuming that the marginal cost (left hand side of 8 and 9) is equal, and $\pi_b = \pi_{nb}$ means that $\frac{\partial V}{\partial W_{2b}}\pi_b + \frac{\partial V}{\partial C_2}\pi_b\theta_k = \frac{\partial V}{\partial W_{2nb}}\pi_b + \frac{\partial V}{\partial C_2}\pi_b\theta_k$. Therefore, with preference bias this equality holds only if $S_{1b} > S_{1nb}$, since utility is concave in school investment. ■

Thus if parents get more satisfaction from the income of their own child relative to the biological child, the non-biological child receives less schooling. In summary, the model predicts four possible sources of intrahousehold schooling bias against a non-biological child. Firstly, a non-biological child will receive less schooling if the cost (direct and indirect) of educating him/her is higher than that of the own child. Secondly, there will be less schooling investment in a non-biological child relative to a biological one if the returns to education for a non-biological child are lower. Thirdly, there will be schooling bias against a non-biological child if the belief of how much the own child will transfer in old age is higher than that of the non-biological child. Further, schooling bias against a non-biological child is worse, the more distantly related he/she is to the parents. Finally, the non-biological child will have less schooling if parents exhibit preference bias against him/her, in the sense that they get more utility from the income of the own child if the income is the same.

2.3 Comparative statics

As discussed earlier, the study seeks to investigate differences in the human capital formation (schooling) of the biological child and non-biological child following changes in the cost of schooling as well as changes in household income. In addition, the study examines the differences in the relationship between household income and the change in school investment due to cost changes for the two children. We answer these questions by conducting comparative static exercises. The results of the comparative exercise are summarized in the next two propositions.

Proposition 3 *Assuming that* $P_{1b} = P_{1nb} = P_1$, *and the bias sources discussed earlier prevail, the following holds;*

i) *an increase in costs leads to a bigger reduction in schooling for the non-biological child relative to the biological one.*

ii) *an increase in household income leads to a bigger increase in schooling for the non-biological child relative to the biological one.*

iii) *and the gap between the two children following these changes gets wider the more distantly related the non-biological child is.*

Proof. Using the implicit function theorem to differentiate the first order conditions as given in equations 8 and 9, with respect to cost P_1

we get $\frac{\partial S_{1b}}{\partial P_1} = \frac{\frac{\partial G}{\partial C_1}}{\frac{\partial^2 G}{\partial C_1^2}P_1^2 + \frac{\partial^2 V}{\partial W_{2b}^2}\pi_b^2 + \frac{\partial^2 V}{\partial C_2^2}(\pi_b\theta_k)^2} < 0$,

and $\frac{\partial S_{1nb}}{\partial P_1} = \frac{\frac{\partial G}{\partial C_1}}{\frac{\partial^2 G}{\partial C_1^2}P_1^2 + \frac{\partial^2 V}{\partial W_{2nb}^2}\pi_b^2 + \frac{\partial^2 V}{\partial C_2^2}(\pi_{nb}\theta_k)^2} < 0$. Therefore, with preference bias or $\pi_b > \pi_{nb}$ or $\theta_1 > \theta_k$ for $k > 1$, the following is true $|\frac{\partial S_{1b}}{\partial P}| < |\frac{\partial S_{1nb}}{\partial P}|$. Similarly, differentiating 8 and 9, with respect to household income Y, we get $\frac{\partial S_{1b}}{\partial Y} = \frac{\frac{\partial^2 G}{\partial C_1^2}P_1^2}{\frac{\partial^2 G}{\partial C_1^2}P_1^2 + \frac{\partial^2 V}{\partial W_{2b}^2}\pi_b^2 + \frac{\partial^2 V}{\partial C_2^2}(\pi_b\theta_k)^2} > 0$ and $\frac{\partial S_{1nb}}{\partial Y} = \frac{\frac{\partial^2 G}{\partial C_1^2}P_1^2}{\frac{\partial^2 G}{\partial C_1^2}P_1^2 + \frac{\partial^2 V}{\partial W_{2nb}^2}\pi_b^2 + \frac{\partial^2 V}{\partial C_2^2}(\pi_{nb}\theta_k)^2} > 0$.Therefore, with preference bias or $\pi_b > \pi_{nb}$ or $\theta_1 > \theta_k$ for $k > 1$, the following holds $\frac{\partial S_{1b}}{\partial Y} < \frac{\partial S_{1nb}}{\partial Y}$. It must be the case that the gap following these changes widens when we have $\theta_1 > \theta_2 > \theta_3, \ldots$. ■

Thus, when there is intrahousehold schooling bias against a non-biological child originating from the sources discussed earlier, the schooling of a non-biological child is more sensitive to changes in costs and income. This suggests an asymmetry in the way a family would respond to cost and income shocks to the household. That is, if a family experiences a shock to their income, the schooling of the non-biological child in the house will suffer more relative to the biological children. The same implication holds with respect to cost shocks. Further, this non-neutrality in household response to income and cost changes for the two children gets more asymmetric the more distantly related the non-biological child is. This suggests that a non-biological child who is not related to the parents would have his/her schooling suffer more following cost increases and a decline in a household's economic status. In terms of policy interventions, the theoretical predictions imply that efforts aimed at fighting poverty would go a long way in improving the schooling of non-biological children.

Proposition 4 *Assuming that* $P_{1b} = P_{1nb} = P_1, \frac{\partial^3 G}{\partial C_1^3} > 0$,

$\frac{\partial G}{\partial C_1}\frac{\partial^3 G}{\partial C_1^3}P_1^2 > \frac{\partial^2 G}{\partial C_1^2}\left(\frac{\partial^2 G}{\partial C_1^2}P_1^2 + \frac{\partial^2 V}{\partial W_{2b}^2}\pi_b^2 + \frac{\partial^2 V}{\partial C_2^2}(\pi_b\theta_k)^2\right)$,and

$\frac{\partial G}{\partial C_1}\frac{\partial^3 G}{\partial C_1^3}P_1^2 > \frac{\partial^2 G}{\partial C_1^2}\left(\frac{\partial^2 G}{\partial C_1^2}P_1^2 + \frac{\partial^2 V}{\partial W_{2nb}^2}\pi_{nb}^2 + \frac{\partial^2 V}{\partial C_2^2}\left(\pi_{nb}\theta_k\right)^2\right)$,

and the bias sources discussed earlier prevail, the change in schooling due to a change in costs P_1*;*

i) *falls with household income.*

ii) *and the fall is faster for the non-biological child relative to the biological child i.e.there is convergence in the sense that the difference in the impact of cost changes between the biological and the non-biological child declines as household income increases.*

iii) *the more distantly related the non-biological child is, the faster the convergence.*

Proof. Using the result from the preceding proof, it can be shown that $\frac{\partial\left(\frac{\partial S_{1b}}{\partial P_1}\right)}{\partial Y} = \frac{\frac{\partial^2 G}{\partial C_1^2}\left(\frac{\partial^2 G}{\partial C_1^2}P_1^2+\frac{\partial^2 V}{\partial W_{2b}^2}\pi_b^2+\frac{\partial^2 V}{\partial C_2^2}(\pi_b\theta_k)^2\right)-\frac{\partial G}{\partial C_1}\frac{\partial^3 G}{\partial C_1^3}P_1^2}{\left(\frac{\partial^2 G}{\partial C_1^2}P_1^2+\frac{\partial^2 V}{\partial W_{2b}^2}\pi_b^2+\frac{\partial^2 V}{\partial C_2^2}(\pi_b\theta_k)^2\right)^2} < 0$

if $\frac{\partial G}{\partial C_1}\frac{\partial^3 G}{\partial C_1^3}P_1^2 > \frac{\partial^2 G}{\partial C_1^2}\left(\frac{\partial^2 G}{\partial C_1^2}P_1^2 + \frac{\partial^2 V}{\partial W_{2b}^2}\pi_b^2 + \frac{\partial^2 V}{\partial C_2^2}\left(\pi_b\theta_k\right)^2\right)$, and

$\frac{\partial\left(\frac{\partial S_{1nb}}{\partial P_1}\right)}{\partial Y} = \frac{\frac{\partial^2 G}{\partial C_1^2}\left(\frac{\partial^2 G}{\partial C_1^2}P_1^2+\frac{\partial^2 V}{\partial W_{2nb}^2}\pi_b^2+\frac{\partial^2 V}{\partial C_2^2}(\pi_{nb}\theta_k)^2\right)-\frac{\partial G}{\partial C_1}\frac{\partial^3 G}{\partial C_1^3}P_1^2}{\left(\frac{\partial^2 G}{\partial C_1^2}P_1^2+\frac{\partial^2 V}{\partial W_{2nb}^2}\pi_{nb}^2+\frac{\partial^2 V}{\partial C_2^2}(\pi_{nb}\theta_k)^2\right)^2} < 0$ if

$\frac{\partial G}{\partial C_1}\frac{\partial^3 G}{\partial C_1^3}P_1^2 > \frac{\partial^2 G}{\partial C_1^2}\left(\frac{\partial^2 G}{\partial C_1^2}P_1^2 + \frac{\partial^2 V}{\partial W_{2nb}^2}\pi_{nb}^2 + \frac{\partial^2 V}{\partial C_2^2}\left(\pi_{nb}\theta_k\right)^2\right)$.

It therefore must be the case that $\frac{\partial\left(\frac{\partial S_{1b}}{\partial P_1}\right)}{\partial Y} < \frac{\partial\left(\frac{\partial S_{1nb}}{\partial P_1}\right)}{\partial Y}$, if there is preference bias or $\pi_b > \pi_{nb}$ or $\theta_1 > \theta_k$ for $k > 1$. And the fall gets bigger with decreasing biological relatedness i.e. when we have $\theta_1 > \theta_2 > \theta_3, ...$ ■

This result implies that when there is intrahousehold schooling bias against a non-biological child emanating from the sources discussed earlier, the impact of changes in costs on schooling is bigger for low income households compared with high income households. There is therefore an asymmetry between poor households and non poor households regarding how they respond to cost changes. That is, an increase in cost of schooling leads to a bigger reduction in schooling for poor households. The model further suggests that the difference in the impact of cost changes between the biological and the non-biological child declines as household income increases. That is, as households become richer, the impact of cost changes on the schooling of the two children converges. Besides, the model suggests that this convergence as household income increases is faster the more distantly related the non-biological child is. This has policy significance, in that improvements in the economic status of households would lead to a reduction in bias against non-biological children. The assumption that $\frac{\partial^3 G}{\partial C_1^3} > 0$ deserves some comment.

A positive third derivative of consumption implies that $\frac{\partial G}{\partial C_1}$ is a convex function of consumption. And the value $\frac{\frac{\partial^3 G}{\partial C_1^3}}{\frac{\partial^2 G}{\partial C_1^2}}$ is similar to the coefficient of relative prudence by Kimball (1990). In Kimball's theory of precautionary saving under uncertainty, a higher coefficient of relative prudence implies that economic agents become more prudent following an increase in their income by reducing consumption, and hence engange in precautionary saving. In our model, we argue by analogy that the assumption of a positive third derivative of current consumption entails that parents act "prudently" by reducing current consumption and investing more in the education of children following an increase in income. It has to be pointed out though that the analogy is hardly perfect.

3 Empirical analysis

3.1 Hypotheses tested

The purpose of the empirical analysis is to test the predictions of the preceding theoretical model using empirical data. We specifically test the following hypotheses:

1. *An improvement in household economic status has a larger increase in the schooling of non-biological children relative to own children, and the increase is larger the more distantly related the non-biological children are.*

2. *An increase in the cost of schooling leads to a bigger decrease in the schooling of non-biological children relative to own children, and the increase is larger the more distantly related the non-biological children are.*

3. *The decrease in schooling due to cost increases is negatively related to household economic status.*

4. *As household economic status improves, the fall in schooling as a result of cost increases for non-biological children converges to that of biological children, and converges faster the more distantly related the non-biological children are.*

3.2 Model specification

In order to test these hypotheses, we use two measures of schooling outcome namely; the highest grade attained and current school enrolment. These two measures represent different conceptualizations of schooling. They capture different dimensions of schooling, and therefore can be viewed as complementary. Each measure of schooling outcome is modeled using a different econometric model.

3.2.1 Grade attainment

The advantage of grade attainement over current school enrolment is that it represents the cumulative investment in a child's education, that is current school enrolment ignores the fact that current schooling depends on previous levels of schooling. We use the censored ordered probit to model grade attainment. The censored ordered probit model was originally developed by King and Lillard (1987) to study grade attainment. It has subsequently been used to study grade attainment by among others; Glewwe and Jacoby (1994), Alderman *et al.* (1996), Behrman *et al.* (1997), Holmes (1999), and Maitra (2003). The censored ordered probit addresses three problems which are inherent in grade attainment. Firstly, the model allows for the fact that grade attainment represents ordered discrete choices i.e. whether to move to the next grade or withdraw. Secondly, it accommodates the possibility that grade attainment often exhibits a large mass point at zero years of schooling and similar probability spikes at primary and secondary completion levels where graduating to the next grade is impeded by fees or entrance examinations (Holmes 1999). Finally, it addresses the problem that grade attainment is right censored. Right censoring occurs because for those children who are still in school, their final grade attained is unknown and to treat their grade as being equal to those who have stopped at that grade would lead to biased estimates of the effects of regressors on true grade attainment (Glick and Sahn 2000).

Following Holmes (1999) and Maitra (2003), the censored ordered probit is formally expressed as follows;

$$S_i^* = X_i'\beta + \varepsilon_i \tag{10}$$

where S_i^* is a continuous, and unobserved latent variable representing desired level of schooling for child i, X_i' is a vector of variables which explain schooling, β is a vector of parameters including a constant, and ε_i is an error term. The observed level of completed schooling outcomes S_i, has J discrete possible outcomes, $S_i = 0, 1, 2..J$ which follow a natural ordering i.e. grade 2 is higher than grade 1, etc. For those children who have completed schooling (uncensored observations), the observed level of completed schooling S_i is given as[12];

[12] We have suppressed subcript i to avoid notational clutter.

$$
\begin{aligned}
S &= 0 \text{ if } S^* \leq 0 \\
S &= 1 \text{ if } 0 < S^* \leq \mu_1 \\
S &= 2 \text{ if } \mu_1 < S^* \leq \mu_2 \\
&\vdots \\
&= J \text{ if } \mu_{J-1} \leq S^*
\end{aligned} \tag{11}
$$

μs are threshold parameters (cut off points)[13] which denote a transition from one grade to the next where the next grade is higher than the previous, and J denotes the highest attainable schooling grade. For those with no schooling, we know only that the latent variable falls below the lowest threshold, i.e. $S^* < 0$, and for those with the maximum level of schooling, we know that $\mu_{J-1} \leq S^*$. Under the assumption that the error term ε follows a standard normal distribution[14], the conditional probability of observing each schooling outcome is;

$$
\begin{aligned}
\Pr(S=0) &= \Phi(-X'\beta) \\
\Pr(S=1) &= \Phi(\mu_1 - X'\beta) - \Phi(-X'\beta) \\
\Pr(S=2) &= \Phi(\mu_2 - X'\beta) - \Phi(\mu_1 - X'\beta) \\
&\vdots \\
\Pr(S=J) &= 1 - \Phi\left(\mu_{J-1} - X'\beta\right)
\end{aligned} \tag{12}
$$

For all probabilities to be positive, the following condition is imposed;

$$
0 < \mu_1 < \mu_2 < \cdots \mu_{J-1} \tag{13}
$$

The likelihood function for the uncensored observations (L_U) is expressed as;

$$
L_U = \begin{cases} \Phi(-X'\beta) & \text{for } S = 0 \\ \Phi(\mu_S - X'\beta) - \Phi\left(\mu_{S-1} - X'\beta\right) & \text{for } S = 1, ...J-1 \\ 1 - \Phi\left(\mu_{S-1} - X'\beta\right) & \text{for } S = J \end{cases} \tag{14}
$$

If there is no right censoring, the likelihood function L_U, is equivalent to that of the standard ordered probit model. For children who are still enrolled in school (censored

[13] We can alternatively assume that the parameter vector β does not include a constant, and then include it as the first cut off point i.e. the zero is replaced with a constant.

[14] Assuming that the error term follows a logistic distribution, would give us a censored ordered logit.

observations), the highest grade attained is unknown. However, we know that a currently enrolled student will ultimately attain at least his or her current grade. Thus, the current grade level represents a lower bound, which means that the desired level of schooling S^* is bounded from below i.e. $S^* \geq \mu_{S-1}$. The probability of achieving at least the current grade is therefore;

$$1 - \Phi\left(\mu_{S-1} - X'\beta\right) \quad \text{for } S = 0, 1, 2..J \tag{15}$$

Thus the likelihood function for censored observations (L_C) is;

$$L_C = 1 - \Phi\left(\mu_{S-1} - X'\beta\right) \tag{16}$$

The likelihood function for the sample (L) is therefore given as[15];

$$L = \prod L_U \prod L_C \tag{17}$$

If there is no right censoring and $J = 1$, the likelihood function L reduces to that of a probit model. So the probit model is a special case.

Since the hypotheses we are testing rely on the magnitude of coefficients as well as their direction, we use elasticities. And the elasticity of probability for each grade in the censored ordered probit is expressed as;

$$\begin{aligned} \frac{\partial E(S|X)}{\partial X}\frac{X}{E(S|X)} = & \left(\frac{\partial \Pr(S=0)}{\partial X}\frac{X}{\Pr(S=0)}\right) * 0 \\ & + \left(\frac{\partial \Pr(S=1)}{\partial X}\frac{X}{\Pr(S=1)}\right) * 1 \\ & + \left(\frac{\partial \Pr(S=2)}{\partial X}\frac{X}{\Pr(S=2)}\right) * 2 \\ & \vdots \\ & + \left(\frac{\partial \Pr(S=J)}{\partial X}\frac{X}{\Pr(S=J)}\right) * J \end{aligned} \tag{18}$$

In this study, the elasticities of probability are computed at the sample means of the regressors.

[15] The estimation of the censored ordered probit was done by using Stata code written by Haaga O (2003), and available online at
http://www.stata.com/statalist/archive/2003-08/msg00426.html

3.2.2 Current school enrolment

The advantage of current enrolment status over grade attainment as a measure of schooling is that it allows us to accommodate time varying effects. Using current school enrolment enables us to better capture the contemporaneous effect of household structure and income which change overtime (Glick and Sahn 2000). In terms of household structure, the arrival of new children either through new births or fostering, may alter the allocation of time to schooling and household work, and this may affect schooling outcomes of the children. Besides, since we are looking at the schooling of non-biological children (in relation to biological children), their grade attainment may not reflect the schooling investment of their current care givers. In this study, we model the enrolment decision using a probit model.

3.3 Variables used

For highest grade attained, in this study we have four discrete and ordered categories defined for each child as;

$$S = \begin{cases} 0 \text{ if no education attained} \\ 1 \text{ if highest education attained is junior primary} \\ 2 \text{ if highest education attained is senior primary} \\ 3 \text{ if highest education attained is secondary} \end{cases} \tag{19}$$

Junior primary corresponds to standards 1 to 5, and senior primary corresponds to standards 6 to 8. For secondary, we have merged junior secondary (forms 1 and 2) with senior secondary (forms 3 and 4), because in our dataset there are few children we have gone as far secondary school. Current school enrolment is a dummy variable defined for each child as;

$$Enrol = \begin{cases} 1 \text{ if currently enrolled} \\ 0 \text{ otherwise} \end{cases} \tag{20}$$

What this effectively means compared to grade attainment, is that every child who is in school is given a one, and a zero is given to those who should be in school but are not. Both grade attainment and enrolment status are defined by age, we discuss the details later.

The key explanatory variables for this study are annual household income and school cost. We use the log of per capita annual consumption expenditure as our measure of household economic status other than actual household income[16]. To measure the cost of schooling, we use local child wages prevailing in the area, that is we use the average community level child wage (measured in Malawian Kwacha)[17]. Local child wages represent the opportunity cost (indirect cost) of sending children to school if the alternative is to work in the farm, family business or other market work (Tansel 1997)[18]. Other explanatory variables included in the two models are; age and sex of the child, mother's and father's employment status, mother's and father's education, mother's and father's age, household size. We include a rural dummy to control for possible rural-urban differences. We also control for regional fixed effects by including regional dummies. A full description of the explanatory variables used in the empirical analysis is given in Table A1 in the appendix.

3.4 Estimation issues

The log of per capita expenditure is potentially endogenous, and this may lead to biased and inconsistent results. One possible channel of endogeneity is that the log of per capita expenditure and spending on education can be jointly determined through labour supply decisions in the sense that a decision to send children to school may be jointly determined with a decision to send the children to work to supplement household income. Another route for endogeneity would be that parents with a good taste for the education of their children may work harder so they are able to pay for their schooling (Kingdon 2005).

We address this problem in both the probit and censored ordered probit by using the Rivers and Vuong (1989) procedure. The procedure is done in two stages. In the first stage, a reduced form regression of an endogenous variable is regressed using ordinary least squares (OLS) on exogenous variables including instruments and residuals are predicted. In the second stage, the predicted residuals are included in the probit or the censored ordered probit including the endogenous variable. A simple t-test of the coefficient on the residual, tests the null hypothesis of exogeneity. We use household assets namely hectares

[16] We use consumption expenditure other than income for two reasons. First, particularly in an agricultural economy such as Malawi, income is often very lumpy. Farming households receive a large amount of cash income in May and June after the harvest, and receive very little the rest of the year. In contrast, households are constantly expending their income and consuming. Consumption expenditure is a smoother measure of welfare through time than is income. In other words, consumption can be viewed as realized welfare, whereas income is more a measure of potential welfare (Murkhejee and Benson 2003). Second, in Malawi much of household income is derived from self-employed business or subsistence-oriented agricultural production. Assigning income values to the proceeds of these enterprises is often problematic (Hentschel and Lanjouw 1996).

[17] This is measured as follows; for those children who work, the survey data has information on the wages that they get, we use these wages (after annualising them to ensure comparability with the other variables) to then compute a community level average wage.

[18] The two types of children face the same local child wages. Recall, that our comparative static exercise was based on the assumption that the biological and non-biological child face the same school costs i.e $P_{1b} = P_{1nb} = P_1$.

of land, and its square as instrumental variables for log of per capita expenditure[19]. An instrumental variable (IV) must be correlated with the endogenous variable (log of per capita expenditure in our case), but uncorrelated with the error term for the probit or the censored ordered probit i.e. the IV must be redundant in the probit or the censored ordered probit once log of per capita expenditure is included. Thus, the effect of the IV on schooling must work through log of per capita expenditure only. As is shown later land and its square are correlated with log of per capita expenditure. Land is an illiquid asset, and therefore is unlikely to be sold in the short term to cover schooling expenses (Kingdon 2005).

3.5 Data and descriptives

The data used in the study is obtained from the Second Malawi Integrated Household Survey (IHS2). This is a nationally representative sample survey designed to provide information on the various aspects of household welfare in Malawi. The survey was conducted by the National Statistical Office from March 2004 -April 2005. The survey collected information from a nationally representative sample of 11,280 households. This data contain detailed information on socioeconomic and demographic characteristics of the households. The survey collects information on the education status of all children such as the highest grade attained and current enrollment status. It records the relationship of each child to the household head. This allows us to distinguish in each household, biological children from non-biological ones. It further enables us to separate the non-biological children into whether they are related or unrelated to their care givers. Since we are focussing on intrahousehold schooling bias against non-biological children, we restrict our sample to blended households, that is households which have both biological and non-biological children. For grade attainment, we restrict the children's ages to between 10 and 19. This restriction is necessitated by the fact that this enables us to some extent to separate out non-enrolment from late enrolment which is common in Malawi. Non-enrolment could either be due to late entry into school or parents not deciding to send a child to school at all. The lower age limit 10 therefore ensures that a child who has not enrolled in school by the age of 10 will never do so. The upper age limit of 19 is driven by the fact that this helps us to some extent to mitigate the problem of sample selection where older children are absent from home[20]. For current school enrolment, we restrict children's ages to between 6 and 19. We have a total of 10241 children of whom 8347 (representing 82%) are biological, and 1894 (representing 18%) are non-biological. Of the non-biological children, 1534 (representing 81%) are relatives, and the remainder

[19] Similar instruments are used by Glewwe and Jacoby (1994), and Glewwe and Ilias (1996).

[20] Similar sample restrictions are imposed in other studies e.g. Glick and Sahn (2000), Maitra (2003), Kabubo-Mariara and Mwabu (2007).

360 (representing 19%) are non-relatives.

We now look at the descriptive statistics. In Table 1, we report grade attainment rates of biological and non-biological children, and the results show that biological children have consistently higher attainments at all schooling levels. The results also indicate that non-biological children that are not related to the people who keep them fare badly in terms of attainment as compared to those who are related. We also notice that attainment declines with age, and the decline is more pronounced for non-biological children who are not relatives. For instance, the results indicate that 7.8% of biological children attained secondary education compared to 2.17% of non-biological children who are not relatives. The widening gap in attainment between biological and non-biological children as they get older may be a reflection of early withdrawals from school by the non-biological children or grade repetition. The withdrawals may increase with age due to the fact that as the children get older they can be a source of labor for agriculture and other income generating activities to supplement household income. And this need for child labour is stronger for non-biological children especially those who are not relatives. There may be a direct cost dimension to this as well, in the sense that at lower ages (coinciding with primary school) education is free in Malawi, and at higher ages (coinciding with secondary school) parents have to pay fees among other things which might discourage attainment of secondary education. Either way, this may suggest bias against non-biological children, and that this bias gets worse when a child is not a relative. When we use current enrolment to measure schooling (see Table 2), a similar picture emerges. For example, for the age range 15-19, the results show that 78.% of biological children are still in school compared to just 63.8% and 51.2% of non-biological children who are relatives and non-biological children who are not relatives respectively.

Table 3, reports enrolment rates by income quintile. We observe that children in the wealthiest households have higher enrolment rates regardless of whether they are biological or not. For all quintiles, the results consistently show that biological children have higher enrolment rates. For instance, for the lowest quintile and comparing biological children with non-biological children, the results indicate that biological children have a higher enrolment rate of 94% compared to 76.9% for non-biological children. Looking at the highest quintile and comparing biological children with non-biological children, the results show that biological children have a higher enrolment rate of 96.2% compared to 93.1% for non-biological children. The results also show that non-biological children who are not relatives have consistently lower enrolment rates across all quintiles. The relationship between enrolment rates and the opportunity cost of schooling as measured by local child wages is presented in Table 4. The results show that the enrolment rate for all children declines as the opportunity cost of schooling increases. Comparing the lowest cost bracket (0-100) with the highest cost bracket (801+), we find that the enrolment rate of non-biological children drops more sharply compared to that of biological children[21]. Descriptive statistics of the explanatory variables used in the econometric analysis are presented in the appendix Table A2.

4 Econometric results

The descriptive results show that the schooling of non-biological children however measured is worse than that of biological children. We pursue this matter further by testing the hypotheses highlighted earlier. As earlier discussed, the log of per capita expenditure is potentially endogenous, we therefore conducted exogeneity tests in the probit as well as the censored ordered probit models using the Rivers and Vuong procedure outlined before. We reject the null hypothesis of exogeneity of the log of per capita expenditure in all probit models estimated. For all censored probit models estimated, we find that the log of per capita expenditure is exogenous. The reduced form regressions of log of per capita expenditure reported in the appendix Table A3, show that the instrumental variables land and its square perform reasonably well as they are significantly correlated with the log of per capita expenditure.

We now look at the four hypotheses outlined earlier. We test the hypotheses by computing elasticities of probability for the censored ordered probit and the probit models estimates using children who stay in blended households. The elasticities of probability are computed at the sample means of the regressors. While controlling for the parental and household characteristics of the children's care givers, we estimate separate regressions for all biological children, and all non-biological children, who are further demarcated into non-biological children who are relatives and non-biological children who are non-relatives. The relationship between raw coefficients ($\hat{\beta}s$) and elasticities of probability in an ordered probit model deserves some mention. The elasticity of probability of the first outcome (no education) with respect to any regressor has the opposite sign to that of the regressor's coefficient. The elasticity of probability of the highest outcome (secondary education) with respect to any regressor has the same sign as the regressor's coefficient. For the intermediate outcomes there is no simple relationship between the elasticities of probability with respect to any regressor and corresponding regressor coefficients. Thus, for the lowest and highest education outcomes, the relationship between the elasticity of probability with respect to any regressor's coefficient is unambiguous[22].

Table 5, presents computed elasticities of probability with respect to income as proxied by the log of per capita expenditure for the censored ordered probit and probit models,

[21] Results for descriptive analysis of grade attainment versus income or opportunity cost of schooling are similar, we have therefore not reported them to conserve space.

[22] These relationships can be seen by partially differentiating equation 18 with respect to any variable.

to examine whether the schooling of non-biological children increases more relative to that of biological children following an increase in household income (first hypothesis). For the non-biological children, we further separate them into whether they are related to the care givers they stay with or not. This separation allows us to further investigate differences in schooling responsiveness to income changes between children who are relatives and those who are not. The raw coefficients for the censored ordered probit and probit models which are used to compute these elasticities are presented in Tables A4 and A5 respectively in the appendix. Using grade attainment as our measure of schooling, the results show that non-biological children have higher income elasticities (in absolute value terms) compared to non-biological children. We observe that the grade attainment of non-biological children who are not relatives is more income elastic compared to non-biological children who are relatives. For example, at the secondary school level, non-biological children who are relatives have an income elasticity of 1.77 compared to 1.82 for non-biological children who are not relatives. A closer look at the magnitude of the elasticities indicates that non-biological children have greater than one elasticities and biological children have less than one elasticities. This implies that the education of non-biological children is considered a luxury good. And education becomes more luxurious if the non-biological children are non-relatives. The computed elasticities for all children also show that the income elasticity increases as we move up the education hierarchy i.e. from no education to secondary education. This means that higher education levels are considered a luxury. Further to that, the income elasticity as one moves up the education system are consistently largest for the non-biological children who are non-relatives, thus suggesting that for children who are non-relatives their further education is considered more of a luxury good relative to non-biological children who are relatives and own children. We get a similar picture when we use current enrolment to measure schooling. These results therefore confirm the hypothesis that an improvement in household economic status has a larger increase in the schooling of non-biological children relative to own children, and the increase is larger the more distantly related the non-biological children are. This finding is invariant to choice of schooling measure. This finding suggests that policies aimed at fighting poverty would improve the schooling outcomes of non-biological children.

In Table 6, we report censored ordered probit and probit elasticities to examine whether the schooling of non-biological children falls more relative to that of biological children following an increase in costs (second hypothesis). Again for the non-biological children, we further separate them into whether they are related to the care givers they stay with or not. The raw coefficients for censored ordered probit and probit models which are used to compute these elasticities are presented in Tables A4 and A5 respectively in the appendix. When we use grade attainment as a measure of schooling the computed price elasticities (in absolute value terms) indicate consistently for all grade levels that the schooling of non-biological children is more price elastic compared to that of biological children. Further to that, the results show that unrelated biological children have higher price elasticities relative to non-biological children who are relatives. For instance, when we look at the secondary level, non-biological children who are relatives have a price elasticity of -0.35 compared to -0.38 for non-biological children who are not relatives. We also note that for all children the price elasticities increase as we move from the lowest educational level (no education) to the highest (secondary education). This suggests that households become more responsive to school cost changes as a child goes up the education ladder. This responsiveness is more pronounced for non-biological children who are not relatives. When we use current enrolment as our measure of schooling we get similar conclusions. So our results confirm the hypothesis that an increase in the cost of schooling leads to a bigger decrease in the schooling of non-biological children relative to own children, and the increase is larger the more distantly related the non-biological children are. And this conclusion is robust to how schooling is measured. This finding has policy relevance in the sense that interventions to end child labour would benefit non-biological children a lot.

Results of tests of hypotheses 3 and 4, are reported in Tables 7 and 8 for the censored ordered probit and probit models respectively. Here we estimate elasticities of probability with respect to price for the two models at different consumption expenditure quintiles to ascertain the relationship between price elasticities as we move up the income ladder i.e. moving from the poorest households to the wealthiest households. Like before, for the non-biological children we further separate them into whether they are related to the care givers they stay with or not. The corresponding raw coefficients for censored ordered probit and probit models which are used to compute these elasticities are presented in Tables A6-A9 and A10-A13 respectively in the appendix. Using grade attainment as our measure of schooling, the results for all children show that the computed price elasticities fall as we move from the poorest households (1^{st} quintile) to the wealthiest households (5^{th} quintile). For example, looking at senior primary education for biological children, the results show that the 1^{st} quintile has a price elasticity of -0.29 compared with -0.15 for the 5^{th} quintile. This indicates an asymmetry in schooling responsiveness following changes in costs between poor households and rich households in the sense that poor households are more price elastic compared to rich households. The results also show that the price elasticities of non-biological children move towards those of biological children as we move up from the poorest households (1^{st} quintile) to the wealthiest households (5^{th} quintile), thus suggesting a convergence of price elasticities as household economic status improves. We further note that this convergence is faster for the non-biological children who are non-relatives. When school enrolment is used, we arrive at similar conclusions. Essentially, these findings lead to the acceptance of hypotheses 3 and 4. That is, the decrease in schooling due to cost increases is negatively related to household economic status, and as household economic status improves the fall in schooling as a result of cost increases converges, and converges faster the more distantly related the non-biological children are. This conclusion is independent of how the schooling of children is measured. This conclusion has policy implications in that efforts to improve the economic status of households would lead to an improvement in schooling of non-biological children.

5 Conclusions

The paper has looked at the intrahousehold schooling bias against non-biological children in a family at both the theoretical and empirical levels. At the theoretical level, we have looked at the possible sources of schooling bias against non-biological children and how schooling responds to changes in household economic status and schooling costs. This has been done by constructing a two period model in which parents work and invest in a biological and non-biological child in the first period, and retire in the second. The parents survive on remittances from both children in old age. The model predicts discrimination against a non-biological child can stem from either non-preference based conditions which favour the biological child, and/or can originate from a pure preference bias against a non-biological child. Specifically, the model shows that parents will invest more in the education of their own child if costs, especially opportunity cost of schooling are higher for the non-biological child, or if returns to education of the own child are higher than those for the non-biological child, or if the subjective belief that parents have about future transfers during retirement is lower for the non-biological child relative to the biological child. Further to that, the model predicts that the schooling gap between the biological child and the non-biological child gets wider as the relationship distance between the non-biological child and the parents gets wider. We have also shown that schooling against non-biological children in a household can be a result of pure preference bias by parents against them, in the sense that they get more satisfaction from the income of their own child relative to the non-biological child.

The model also shows that there is an asymmetry in the impact of changes in costs and income on schooling in the sense that the impact is larger for the non-biological child. We have also shown that an increase in cost of schooling leads to a bigger reduction in schooling for poor households, and that the difference in the impact of cost changes between the biological and the non-biological child declines as income increases. An empirical investigation of these predictions using the Second Malawi Integrated Household Survey (IHS2) data has shown that when current enrolment and grade attainment are used to measure schooling, the price (measured as the opportunity cost of schooling) and income elasticities of schooling are larger for non-biological children. It has been found that non-biological children who are unrelated to their care givers have higher price and income elasticities. The empirical analysis has also indicated that households in the lowest income quintile (the poorest) have the largest price elasticities, and households in the highest income quintile (the wealthiest) have the smallest price elasticities. It has been demostrated that the price elasticities for biological and non-biological children converge as we move from the lowest income quintile to the highest income quintile, and that the convergence is faster for non-biological children who are non-relatives.

The integrated household survey data presents some limitations to the study which are worth mentioning. The survey did not collect information on quality of children such as IQ scores, which might affect grade attainment and school enrolment of biological and non-biological children. Secondly, the survey data does not have information on the past schooling performance of the children. Past schooling performance of the non-biological children before moving to their current care givers may also affect their current schooling in the sense that current care givers may have little incentive to send a non-biological child to school if s/he was struggling academically before coming to them. Since we do not control for these factors in our empirical analysis, our conclusions should be taken with due cognizance of these limitations.

References

Alderman, H., Behrman, J., Khan, S. and Sabot, R. (1996), "Decomposing the regional gap in cognitive skills in rural Pakistan," *Journal of Asian Economics*, Vol. 7, pp. 49-76.

Alderman H, and Gertler P. (1997), "Family resources and gender differences in human capital investments: the demand for children's medical care in Pakistan," In: Haddad L, Hoddinott J, Alderman H (eds). *Intrahousehold resource allocation in developing countries: models, methods, and policy*. Baltimore: Johns Hopkins University Press for the International Food Policy Research Institute.

Alderman H and King E.M (1998), "Gender differences in parental investment in education," *Structural Change and Economic Dynamics,* Vol 9, pp 453-468.

Becker, G, (1974), "A theory of social interactions," *Journal of Political Economy,* Vol. 82, pp. 1063-1093.

Becker, G, (1981), *Treatise on the Family* Cambridge, MA: Harvard University Press.

Becker, G. (1996), *Accounting for Tastes*. Cambridge and London: Harvard University Press.

Behrman, J. R., Pollak, R. A., Taubman, P. (1986) "Do parents favor boys?" *International Economic Review*, Vol 27,33-54.

Behrman, J. R., Khan, S., Ross D. and Sabot, R. (1997),"School quality and cognitive achievement production: a case study for rural Pakistan," *Economics of Education Review*, Vol. 16, pp. 127-142.

Bishai, D., Suliman E.D. , H. Brahmbhatt F, Wabwire-Mangen G, Kigozi, N. Sewankambo,D. Serwaddaa, and Gray R (2003), "Does biological relatedness affect child survival?" Demographic Research, Vol 8(9), [on-line] available at www.demographic-research.org/volumes/vol8/9/8-9.pdf.

Case, A ., Lin I-F., and McLanahan S. (2000), "How hungry is the selfish gene?" *Economic Journal,* Vol. 110, pp. 781-804.

Case, A., Paxson, C., and Ableidinger, J. (2004), "Orphans in Africa: Parental death, poverty and school enrollment," *Demography,* Vol 41, pp. 483-508.

Cigno, A. (1993), "Intergenerational Transfers without Altruism, Family, Market and State," *European Journal of Political Economy*, Vol. 9, pp. 505-518.

Davies J.B , and Zhang J. (1995), "Gender Bias, Investments in Children, and Bequests," *International Economic Review*, Vol. 36, pp. 795-818.

Doss C.R (1996), "Testing among Models of Intrahousehold Resource Allocation," *World Development*, Vol. 24, pp. 1597-1609.

Echevarria, C. and Merlo, A (1999), "Gender Differences in Education in Dynamic Household Bargaining Model," *International Economic Review,* Vol 40, pp. 265-286.

Gachuhi, D. (1999),"The impact of HIV/AIDS on education systems in the eastern and southern Africa regions and the response of education systems to HIV/AIDS: Life skills programmes," UNICEF.

Gertler, P. J. and Glewwe P (1992), "The Willingness to Pay for Education for Daughters in Contrast to Sons: Evidence from Rural Peru," *The World Bank Economic Review,* Vol 6, pp. 171-188.

Glewwe, P. and Jacoby, H. G. (1994), "Student achievement and schooling choice in low-income countries," *Journal of Human Resources*, Vol.28, pp. 843-864.

Glick, P. and Sahn, D. (2000), "Schooling of girls and boys in a West African country: the effects of parental education,income, and household structure," *Economics of Education Review*, Vol. 19, pp. 63-87.

Gundersen, C, Kelly,T, and Jemison ,K. (2004), "The Demand for Education for orphans in Zimbabwe," African Development and Poverty Linkage: The macro-Micro linkage, Forum paper.

Haddad, L and Hoddinott, J. (1994), "Women's Income and Boy-Girl Anthropometric Status in Cote d'Ivoire," *World Development,* Vol 22, pp. 543-553.

Hamilton, W. D. (1964a), "The Genetical Evolution of Social Biology," *Journal of Theoretical Biology,* Vol 7, pp. 1-16.

Hamilton, W. D. (1964b), "The Genetical Evolution of Social Behavior," *Journal of Theoretical Biology*, Vol 7, pp. 17-52.

Hentschel, J., and Lanjouw, P., (1996), "Constructing an indicator of consumption for the analysis of poverty:Principles and illustrations with reference to Ecuador," Living standards measurement study working paper no. 124. The World Bank, Washington, DC.

Holmes, J. (1999),"School completion in Pakistan: analysis of censoring and selection bias," Working Paper # 794, Economic Growth Center, Yale University.

Kabubo-Mariara, J and Mwabu D.K (2007), "Determinants of school enrolment and education attainment:Empirical evidence from Kenya," *South African Journal of Economics,* Vol.75, pp. 572-593.

Kimball M.S (1990), "Precautionary saving in the small and in the large," *Econometrica,* Vol. 58 pp. 53-73.

King, E. M. and Lillard, L. (1987), "Education policy and schooling attainment in Malaysia and the Philippines," *Economics of Education Review*, Vol. 6, pp. 167-181.

Kingdon, G. G (1998), "Does the Labour Market Explain Lower Female Schooling in India?" *Journal of Development Studies,* Vol. 35, pp. 39-65.

Kingdon G. G (2005), "Where Has All the Bias Gone? Detecting Gender Bias in the Intrahousehold Allocation of Educational Expenditure," *Economic Development and Cultural Change*, Vol. 53, pp. 409-451.

López-Calva L.F and Miyamoto K. (2004), "Filial Obligations and Child Labor," *Review of Development Economics*, Vol. 8, pp. 489-504.

Maitra, P (2003), "Schooling and Educational Attainment: Evidence from Bangladesh," *Education Economics*, Vol. 11, pp. 129-153.

Mukherjee S and Benson T. (2003), "The Determinants of Poverty in Malawi," *World Development,* Vol. 31, pp. 339-358.

Pasqua, S. (2005), "Gender Bias in Parental Investments in Children's Education: A Theoretical Analysis," *Review of Economics of the Household*, Vol. 3, pp. 291-314.

Rose, E (2000), "Gender Bias, Credit Constraints and Time Allocation in Rural India," *The Economic Journal*, Vol. 110, pp. 738-758.

Shapiro, D., Tambashe, O. (2001), "Gender, poverty, family structure and investments in children's education in Kinshasa, Congo," *Economics of Education Review*, vol 20, pp. 359-373.

Tansel, A. (1997), "School attainment, parental education and gender in Cote d'Ivoire and Ghana," *Economic Development and Cultural Change*, Vol. 45, pp. 825-856.

UNAIDS (2007), *AIDS epidemic update,* [online] available at http://data.unaids.org/pub/EPISlides/2007/2007_epiupdate_en.pdf.

Zimmerman F.J (2003), "Cinderella Goes to School: The Effects of Child Fostering on School Enrollment in South Africa," *The Journal of Human Resources*, Vol 38, pp. 557-590.

Table 1: Grade attainment of children (age 10–19)

Grade	Biological	Non-biological		
		All	Related	Unrelated
No education	11.21	21.25	18.2	24.3
Junior primary	48.3	45.63	46.54	44.72
Senior primary	32.7	29.34	29.87	28.81
Secondary	7.8	3.78	5.38	2.17
Total	100	100	100	100

Table 2: Current school enrolment rates of children (age 6–19)

Age	Biological	Non-biological		
		All	Related	Unrelated
6–8	0.947	0.88	0.913	0.847
9–11	0.948	0.863	0.894	0.832
12–14	0.857	0.738	0.762	0.713
15–19	0.783	0.575	0.638	0.512

Table 3: Current school enrolment rates of children (age 6–19) by expenditure quintile

Quintile	Biological	Non-biological All	Non-biological Related	Non-biological Unrelated
1st	0.940	0.769	0.783	0.754
2nd	0.918	0.812	0.831	0.793
3rd	0.937	0.886	0.916	0.856
4th	0.944	0.922	0.921	0.923
5th	0.962	0.931	0.934	0.927

Table 4: Current school enrolment rates of children (age 6–19) and opportunity cost of schooling

Age	Biological	Non-biological All	Non-biological Related	Non-biological Unrelated
0–100	0.882	0.84	0.864	0.816
101–400	0.891	0.802	0.837	0.767
401–800	0.887	0.687	0.712	0.662
801+	0.844	0.563	0.631	0.494

Table 5: Income elasticities from probit and censored ordered probit models

	Biological	Non-biological		
		All	Related	Unrelated
Current enrolment				
	0.89	1.26	1.25	1.29
Grade attainment				
No education	-0.75	-1.34	-1.33	-1.37
Junior primary	0.79	1.42	1.41	1.43
Senior primary	0.86	1.64	1.62	1.67
Secondary	0.97	1.78	1.77	1.82

Table 6: Price elasticities from probit and censored ordered probit models

	Biological	Non-biological		
		All	Related	Unrelated
Current enrolment				
	-0.24	-0.32	-0.31	-0.36
Grade attainment				
No education	0.12	0.24	0.23	0.27
Junior primary	-0.18	-0.26	-0.25	-0.30
Senior primary	-0.22	-0.34	-0.32	-0.36
Secondary	-0.28	-0.36	-0.35	-0.38

Table 7: Price elasticities from censored ordered probit for different income quintiles

Quintile	No education	Junior primary	Senior primary	Secondary
	Biological			
1st	0.24	-0.27	-0.29	-0.32
2nd	0.20	-0.25	-0.26	-0.29
3rd	0.17	-0.21	-0.23	-0.25
4th	0.13	-0.18	-0.20	-0.21
5th	0.09	-0.12	-0.15	-0.17
	Non-biological: All			
1st	0.29	-0.31	-0.34	-0.38
2nd	0.24	-0.29	-0.30	-0.35
3rd	0.20	-0.22	-0.27	-0.30
4th	0.15	-0.17	-0.19	-0.24
5th	0.10	-0.13	-0.17	-0.19
	Non-biological: Related			
1st	0.37	-0.38	-0.45	-0.48
2nd	0.27	-0.33	-0.41	-0.43
3rd	0.22	-0.29	-0.34	-0.36
4th	0.13	-0.20	-0.22	-0.23
5th	0.11	-0.13	-0.16	-0.18
	Non-biological: Unrelated			
1st	0.39	-0.42	-0.46	-0.48
2nd	0.30	-0.35	-0.38	-0.39
3rd	0.19	-0.21	-0.24	-0.26
4th	0.11	-0.18	-0.20	-0.21
5th	0.09	-0.12	-0.15	-0.17

Table 8: Price elasticities from probit for different income quintiles

Quintile	Biological	Non-biological		
		All	Related	Unrelated
1st	−0.26	−0.33	−0.34	−0.35
2nd	−0.19	−0.27	−0.28	−0.27
3rd	−0.17	−0.21	−0.20	−0.17
4th	−0.13	−0.15	−0.14	−0.12
5th	−0.11	−0.12	−0.13	−0.11

6 Appendix

Table A1: Definition of variables

Variable	Definition
childage	age of a child
childsex	=1 if child is male, 0 otherwise
hhsize	household size
fathwage	=1 if father works for a wage,0 otherwise
mothwage	=1 if father works for a wage,0 otherwise
edufath	Years of education of the father
edumoth	Years of education of the mother
agefath	Age of the father in years
agefath2	Square of the age of the father
agemoth	Age of the mother in years
agemoth2	Square of the age of the mother
lnrexpa	log of per capita household consumption expenditure
wage	community level child wage
rural	=1 if household is in rural area,0 otherwise
north	=1 if household is in the north,0 otherwise.
Centre	=1 if household is in the centre, 0 otherwise.
South[a]	=1 if household is in the south, 0 otherwise.

Notes: [a] denotes reference category.

Table A2: Sample means (standard errors) of explanatory variables

Variable	(1)		(2)	
agechild	10.828	(4.058)	12.166	(4.409)
childsex	0.521	(0.500)	0.473	(0.499)
lnrexpa	9.568	(0.551)	9.664	(0.597)
hhsize	6.794	(2.405)	6.250	(3.013)
fathwage	0.233	(0.423)	0.192	(0.394)
mothwage	0.050	(0.218)	0.043	(0.202)
edufath	2.015	(3.947)	1.843	(3.951)
edumoth	0.715	(2.439)	0.888	(2.780)
agefath	45.007	(10.069)	47.306	(16.588)
agemoth	38.392	(9.271)	48.027	(19.247)
wage	97.394	(136.178)	99.297	(154.182)
rural	0.908	(0.289)	0.901	(0.299)
north	0.166	(0.372)	0.195	(0.396)
centre	0.427	(0.495)	0.386	(0.487)
south	0.408	(0.491)	0.419	(0.494)

Notes: Column 1 corresponds to the current enrolment sample, and Column 2 corresponds to the grade attainment sample.

Table A3: Reduced form regressions of log per capita consumption

Variable	(1)	(2)
agechild	0.007***	0.003*
	(0.001)	(0.001)
childsex	-0.004	0.005
	(0.010)	(0.011)
fathwage	0.060***	0.063***
	(0.013)	(0.013)
mothwage	0.027	-0.009
	(0.026)	(0.029)
edufath	0.026***	0.026***
	(0.001)	(0.002)
edumoth	0.042***	0.043***
	(0.002)	(0.003)
agefath	-0.014***	-0.016***
	(0.004)	(0.005)
agefath2	0.012***	0.000***
	(0.001)	(0.000)
agemoth	-0.015***	-0.015***
	(0.004)	(0.006)
agemoth2	0.024**	0.031**
	(0.003)	(0.004)
land	0.015***	0.011***
	(0.002)	(0.004)
land2	-0.022***	-0.017***
	(0.001)	(0.007)
north	0.019	0.016
	(0.014)	(0.016)
centre	0.304***	0.301***
	(0.011)	(0.012)
constant	9.955***	10.012***
	(0.053)	(0.085)
F-test of joint significance of instruments:		
F-stat	32.71	27.43
Prob> F-stat	0.00	0.00
F-test of overall significance:		
F-stat	22.54	37.39
Prob> F-stat	0.00	0.00
R-squared	0.4532	0.4117

Notes: Column 1 corresponds to the current enrolment sample, and Column 2 corresponds to the grade attainment sample. The instruments for per capita consumption expenditure are land, its square. The significance asterisks are defined as follows: * p<0.10, ** p<0.05, *** p<0.01. Numbers in parentheses are standard errors.

Table A4: Censored ordered probit results of grade attainment by type of child

	Biological	Non-biological		
Grade		All	Related	Unrelated
agechild	-0.246***	-0.146***	-0.246***	-0.147***
	(0.005)	(0.007)	(0.005)	(0.007)
childsex	0.080***	0.077	0.081***	0.078
	(0.028)	(0.052)	(0.028)	(0.052)
fathwage	0.070**	0.023	0.067*	0.019
	(0.035)	(0.072)	(0.035)	(0.072)
mothwage	0.172***	0.066	0.015	0.055
	(0.003)	(0.137)	(0.073)	(0.137)
edufath	0.050***	0.040***	0.050***	0.040***
	(0.004)	(0.008)	(0.004)	(0.008)
edumoth	0.026***	0.037***	0.027***	0.037***
	(0.007)	(0.011)	(0.007)	(0.011)
agefath	-0.003	-0.014	-0.002	-0.014
	(0.012)	(0.015)	(0.012)	(0.015)
agefath2	-0.001	0.003	-0.001	0.003
	(0.003)	(0.006)	(0.004)	(0.002)
agemoth	0.019	0.021	0.018	0.021
	(0.015)	(0.016)	(0.015)	(0.016)
agemoth2	-0.002	-0.002	-0.003	-0.001
	(0.004)	(0.006)	(0.003)	(0.006)
lnrexpa	0.370***	0.142***	0.371***	0.142***
	(0.029)	(0.052)	(0.029)	(0.052)
wage	-0.015***	-0.023***	-0.000***	-0.000
	(0.001)	(0.004)	(0.000)	(0.000)
hhsize	0.033***	0.015	0.034***	0.015
	(0.006)	(0.010)	(0.006)	(0.010)
rural	-0.181***	-0.253***	-0.175***	-0.264***
	(0.050)	(0.088)	(0.050)	(0.088)
north	0.359***	0.546***	0.351***	0.538***
	(0.041)	(0.072)	(0.041)	(0.072)
centre	-0.162***	0.103*	-0.164***	0.099
	(0.032)	(0.061)	(0.033)	(0.062)
Log likelihood	-4321	-5353	-3722	-6167

Notes: Threshold parameters not reported. The significance asterisks are defined as follows: * p<0.10, ** p<0.05, *** p<0.01. Numbers in parentheses are standard errors.

Table A5: Probit results of current enrolment by type of child

Grade	Biological	Non-biological		
		All	Related	Unrelated
agechild	-0.214***	-0.267***	-0.218***	-0.220***
	(0.023)	(0.036)	(0.039)	(0.017)
childsex	0.129**	0.430***	0.718***	0.920***
	(0.051)	(0.092)	(0.102)	(0.101)
fathwage	0.444**	0.289	0.102	0.068
	(0.203)	(0.318)	(0.348)	(0.151)
mothwage	0.652***	0.108	0.091	0.070
	(0.141)	(0.259)	(0.300)	(0.272)
edufath	0.138***	0.118	0.072	0.058***
	(0.006)	(0.130)	(0.143)	(0.017)
edumoth	0.246*	0.106	0.012	0.007
	(0.136)	(0.204)	(0.223)	(0.024)
agefath	0.087*	0.047	0.028	0.021
	(0.050)	(0.072)	(0.083)	(0.036)
agefath2	-0.011**	0.001	0.026	0.013
	(0.001)	(0.001)	(0.001)	(0.001)
agemoth	0.105*	0.031	0.008	0.001
	(0.056)	(0.078)	(0.087)	(0.036)
agemoth2	-0.01*	-0.001	-0.003	-0.021
	(0.001)	(0.001)	(0.001)	(0.000)
lnrexpa	0.353***	0.192***	0.664***	0.961***
	(0.053)	(0.007)	(0.008)	(0.008)
wage	-0.217***	-0.321***	0.334***	0.413***
	(0.004)	(0.001)	(0.001)	(0.001)
hhsize	0.019*	0.032*	-0.003	-0.002
	(0.011)	(0.017)	(0.018)	(0.018)
rural	-0.055***	-0.039***	-0.056***	-0.052***
	(0.009)	(0.001)	(0.002)	(0.004)
north	0.185*	0.341**	0.311*	0.303**
	(0.096)	(0.149)	(0.168)	(0.147)
centre	-2.236**	0.980	0.271	0.121
	(0.988)	(1.488)	(1.624)	(0.119)
residcons	6.663**	8.562***	9.515***	7.149***
	(3.252)	(1.911)	(1.365)	(1.06)
constant	-66.159**	28.339	7.804	2.636**
	(32.356)	(48.877)	(53.408)	(1.042)
Log likelihood	-6339	-2167	-4486	-5413

Notes: residcons is the residual from the reduced form of per capita consumption expenditure. The significance asterisks are defined as follows: * p<0.10, ** p<0.05, *** p<0.01. Numbers in parentheses are standard errors.

Table A6: Censored ordered probit results biological children by expenditure quintile

Quintile	1	2	3	4	5
agechild	0.227***	0.234***	0.226***	0.280***	0.314***
	(0.009)	(0.010)	(0.010)	(0.013)	(0.014)
childsex	-0.016	-0.089	-0.010	-0.101	-0.231***
	(0.057)	(0.059)	(0.060)	(0.068)	(0.075)
fathwage	-0.029	-0.026	0.135*	0.223***	0.061
	(0.077)	(0.072)	(0.075)	(0.086)	(0.095)
mothwage	0.087	0.355**	-0.360**	-0.322*	-0.007
	(0.174)	(0.146)	(0.176)	(0.174)	(0.182)
edufath	0.050***	0.041***	0.036***	0.052***	0.068***
	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)
edumoth	0.032	0.014	0.019	0.028*	0.034***
	(0.023)	(0.020)	(0.016)	(0.015)	(0.013)
agefath	-0.047*	0.022	0.009	-0.021	-0.010
	(0.024)	(0.026)	(0.029)	(0.030)	(0.035)
agefath2	0.000	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
agemoth	0.081***	-0.017	-0.015	-0.001	0.020
	(0.028)	(0.031)	(0.034)	(0.036)	(0.042)
agemoth2	-0.001***	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lnrexpa	0.450***	0.651**	0.135	1.124***	0.286**
	(0.142)	(0.328)	(0.369)	(0.355)	(0.116)
wage	0.127***	-0.023***	-0.367***	-0.345***	0.413***
	(0.001)	(0.002)	(0.001)	(0.004)	(0.003)
hhsize	0.023**	0.016	0.043***	0.073***	0.040**
	(0.011)	(0.016)	(0.016)	(0.017)	(0.016)
rural	-0.046	0.055	-0.194	-0.192*	-0.230**
	(0.124)	(0.127)	(0.120)	(0.111)	(0.103)
north	0.465***	0.538***	0.320***	0.214*	0.251**
	(0.078)	(0.086)	(0.096)	(0.113)	(0.119)
centre	-0.155**	-0.229***	-0.223***	-0.153*	-0.003
	(0.072)	(0.069)	(0.068)	(0.079)	(0.092)
Log likelihood	-6567	-5448	-4321	-3389	-5117

Notes: Threshold parameters not reported. The significance asterisks are defined as follows: * p<0.10, ** p<0.05, *** p<0.01. Numbers in parentheses are standard errors.

Table A7: Censored ordered probit results non-biological children by expenditure quintile

Quintile	1	2	3	4	5
agechild	0.158***	0.170***	0.126***	0.158***	0.160***
	(0.017)	(0.019)	(0.015)	(0.016)	(0.016)
childsex	0.240*	0.072	0.066	0.165	-0.081
	(0.123)	(0.134)	(0.119)	(0.116)	(0.116)
fathwage	-0.426*	0.050	0.047	0.088	0.019
	(0.225)	(0.185)	(0.156)	(0.155)	(0.161)
mothwage	0.154	0.406	0.766	-0.643**	0.103
	(0.408)	(0.371)	(0.808)	(0.308)	(0.219)
edufath	0.034	0.016	0.027	0.054***	0.043***
	(0.024)	(0.026)	(0.018)	(0.016)	(0.015)
edumoth	-0.186***	0.105**	0.025	0.074***	0.032*
	(0.071)	(0.041)	(0.029)	(0.025)	(0.018)
agefath	-0.055	-0.046	-0.031	-0.004	0.047
	(0.039)	(0.045)	(0.029)	(0.034)	(0.039)
agefath2	0.001	0.000	0.000	0.000	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
agemoth	0.033	0.042	-0.043	0.040	-0.003
	(0.038)	(0.048)	(0.031)	(0.037)	(0.038)
agemoth2	-0.000	-0.000	0.001*	-0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lnrexpa	0.010	0.437	0.302	-0.363	-0.047
	(0.284)	(0.687)	(0.752)	(0.584)	(0.161)
wage	-0.321***	-0.237***	-0.364**	-0.433**	-0.311***
	(0.001)	(0.004)	(0.001)	(0.001)	(0.001)
hhsize	0.012	-0.023	0.061***	-0.006	0.038
	(0.019)	(0.024)	(0.023)	(0.025)	(0.026)
rural	-0.616**	0.172	-0.269	-0.269	-0.208
	(0.242)	(0.252)	(0.225)	(0.206)	(0.164)
north	0.671***	0.592***	0.576***	0.398**	0.634***
	(0.161)	(0.193)	(0.165)	(0.161)	(0.177)
centre	0.063	-0.163	-0.072	0.184	0.249*
	(0.157)	(0.161)	(0.142)	(0.126)	(0.131)
Log likelihood	-2321	-5478	-6311	-4299	-2139

Notes: Threshold parameters not reported. The significance asterisks are defined as follows: * p<0.10, ** p<0.05, *** p<0.01. Numbers in parentheses are standard errors.

Table A8: Censored ordered probit results non-biological (related) children by expenditure quintile

Quintile	1	2	3	4	5
agechild	0.227***	0.234***	0.226***	0.281***	0.315***
	(0.009)	(0.010)	(0.010)	(0.013)	(0.014)
childsex	-0.017	-0.088	-0.010	-0.104	-0.238***
	(0.057)	(0.059)	(0.060)	(0.068)	(0.075)
fathwage	-0.040	-0.026	0.135*	0.211**	0.054
	(0.077)	(0.072)	(0.075)	(0.086)	(0.095)
mothwage	0.074	0.360**	-0.364**	-0.306*	-0.012
	(0.174)	(0.146)	(0.176)	(0.174)	(0.182)
edufath	0.049***	0.040***	0.036***	0.055***	0.069***
	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)
edumoth	0.032	0.015	0.020	0.024	0.034***
	(0.023)	(0.020)	(0.016)	(0.015)	(0.013)
agefath	-0.045*	0.022	0.009	-0.019	-0.008
	(0.024)	(0.026)	(0.029)	(0.030)	(0.035)
agefath2	0.000	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
agemoth	0.079***	-0.019	-0.014	-0.003	0.021
	(0.028)	(0.031)	(0.034)	(0.036)	(0.042)
agemoth2	-0.001***	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lnrexpa	0.451***	0.638*	0.137	1.121***	0.291**
	(0.142)	(0.328)	(0.369)	(0.356)	(0.116)
wage	-0.223***	-0.314***	-0.421***	-0.023	-0.043
	(0.003)	(0.002)	(0.001)	(0.043)	(0.067)
hhsize	0.023**	0.016	0.043***	0.074***	0.038**
	(0.011)	(0.016)	(0.016)	(0.017)	(0.016)
rural	-0.081	0.069	-0.190	-0.166	-0.236**
	(0.126)	(0.129)	(0.120)	(0.112)	(0.104)
north	0.450***	0.549***	0.317***	0.175	0.252**
	(0.079)	(0.087)	(0.097)	(0.115)	(0.121)
centre	-0.164**	-0.219***	-0.224***	-0.161**	-0.001
	(0.072)	(0.069)	(0.068)	(0.080)	(0.092)
Log likelihood	-3329	-4412	-8342	-7613	-3979

Notes: Threshold parameters not reported. The significance asterisks are defined as follows: * p<0.10, ** p<0.05, *** p<0.01. Numbers in parentheses are standard errors.

Table A9: Censored ordered probit results non-biological (unrelated) children by expenditure quintile

Quintile	1	2	3	4	5
agechild	0.160***	0.170***	0.125***	0.162***	0.160***
	(0.017)	(0.019)	(0.015)	(0.016)	(0.016)
childsex	0.238*	0.055	0.084	0.181	-0.082
	(0.123)	(0.135)	(0.120)	(0.116)	(0.116)
fathwage	-0.452**	0.051	0.085	0.125	0.016
	(0.228)	(0.186)	(0.159)	(0.158)	(0.162)
mothwage	0.150	0.384	0.796	-0.678**	0.099
	(0.409)	(0.374)	(0.810)	(0.310)	(0.220)
edufath	0.033	0.015	0.028	0.051***	0.042***
	(0.024)	(0.026)	(0.018)	(0.016)	(0.015)
edumoth	-0.188***	0.109***	0.022	0.078***	0.033*
	(0.072)	(0.041)	(0.029)	(0.025)	(0.018)
agefath	-0.051	-0.042	-0.034	-0.011	0.046
	(0.039)	(0.045)	(0.029)	(0.035)	(0.040)
agefath2	0.000	0.000	0.000	0.000	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
agemoth	0.031	0.035	-0.043	0.051	-0.003
	(0.038)	(0.048)	(0.031)	(0.038)	(0.038)
agemoth2	-0.000	-0.000	0.001*	-0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lnrexpa	-0.011	0.486	0.227	-0.313	-0.046
	(0.288)	(0.693)	(0.759)	(0.587)	(0.162)
wage	-0.313***	-0.411***	-0.261***	-0.428***	-0.415***
	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)
hhsize	0.013	-0.021	0.060**	-0.003	0.038
	(0.020)	(0.024)	(0.024)	(0.025)	(0.026)
rural	-0.615**	0.227	-0.285	-0.330	-0.210
	(0.250)	(0.262)	(0.225)	(0.213)	(0.165)
north	0.673***	0.604***	0.571***	0.406**	0.611***
	(0.161)	(0.194)	(0.166)	(0.164)	(0.180)
centre	0.075	-0.159	-0.083	0.207	0.232*
	(0.158)	(0.162)	(0.143)	(0.131)	(0.133)
Log likelihood	-5388	-3419	-4358	-6931	-4266

Notes: Threshold parameters not reported. The significance asterisks are defined as follows: * p<0.10, ** p<0.05, *** p<0.01. Numbers in parentheses are standard errors.

Table A10: Probit results of biological children by expenditure quintile

Quintile	1	2	3	4	5
agechild	-0.269***	-0.267***	-0.213***	-0.146***	-0.336**
	(0.067)	(0.047)	(0.044)	(0.041)	(0.134)
childsex	0.106	0.167	0.192*	0.132	0.266
	(0.103)	(0.103)	(0.115)	(0.131)	(0.180)
fathwage	0.962*	0.878**	-0.520	0.547	-1.326
	(0.568)	(0.404)	(0.373)	(0.381)	(1.174)
mothwage	0.842**	0.485*	-1.389***	-0.155	-0.844
	(0.328)	(0.281)	(0.287)	(0.399)	(0.635)
edufath	0.308	0.366**	-0.100	0.141	-0.439
	(0.247)	(0.171)	(0.156)	(0.149)	(0.498)
edumoth	-0.581	-0.537**	-0.127	0.216	-0.829
	(0.398)	(0.274)	(0.246)	(0.235)	(0.796)
agefath	0.153	0.135	0.155	-0.052	0.266
	(0.137)	(0.103)	(0.097)	(0.092)	(0.275)
agefath2	-0.002	-0.002	-0.002*	0.001	-0.003
	(0.002)	(0.001)	(0.001)	(0.001)	(0.003)
agemoth	0.229	0.265**	0.060	-0.167	0.384
	(0.157)	(0.113)	(0.103)	(0.115)	(0.309)
agemoth2	-0.002	-0.002**	-0.000	0.002	-0.003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
lnrexpa	0.385*	0.109***	0.218	-0.089	0.989***
	(0.223)	(0.005)	(0.679)	(0.678)	(0.352)
wage	-0.321***	-0.219***	-0.365***	0.413***	-0.451***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
hhsize	0.070***	-0.011	-0.022	-0.017	0.008
	(0.022)	(0.026)	(0.028)	(0.027)	(0.030)
rural	0.160	0.398**	-0.018	-0.131	-0.037
	(0.186)	(0.188)	(0.227)	(0.245)	(0.228)
north	0.162	0.029	-0.146	0.502*	0.281
	(0.211)	(0.192)	(0.213)	(0.282)	(0.450)
centre	-4.397	-4.867**	-1.713	1.059	-6.088
	(2.894)	(1.983)	(1.788)	(1.684)	(5.807)
residcons	14.041***	14.820**	8.687***	13.671***	19.261***
	(2.503)	(6.521)	(1.866)	(2.596)	(2.108)
constant	-139.659	-144.169**	-46.604	43.518	-199.378
	(94.693)	(65.244)	(58.351)	(56.283)	(190.196)
Log likelihood	-3221	-4771	-7834	-6389	-7227

Notes: residcons is the residual from the reduced form of per capita consumption expenditure. The significance asterisks are defined as follows: * p<0.10, ** p<0.05, *** p<0.01. Numbers in parentheses are standard errors.

Table A11: Probit results of non-biological children by expenditure quintile

Quintile	1	2	3	4	5
agechild	-0.296*	-0.235***	-0.256***	-0.304***	-0.308*
	(0.177)	(0.081)	(0.066)	(0.093)	(0.173)
childsex	0.303	0.187	0.455**	0.253	1.015***
	(0.251)	(0.227)	(0.222)	(0.229)	(0.242)
fathwage	-0.701	0.006	1.248*	0.252	1.632
	(1.563)	(0.695)	(0.644)	(0.797)	(1.531)
mothwage	-0.609	0.985	0.375	0.117	0.390
	(0.878)	(0.776)	(0.243)	(0.322)	(0.636)
edufath	-0.197	0.204	0.463	0.155	0.583
	(0.662)	(0.289)	(0.368)	(0.512)	(1.017)
edumoth	-0.427	0.403	-0.182	-0.025	-0.179
	(1.090)	(0.462)	(0.132)	(0.184)	(0.341)
agefath	0.143	-0.232	0.002	0.000	0.002
	(0.355)	(0.166)	(0.002)	(0.002)	(0.004)
agefath2	-0.002	0.002	-0.126	0.039	-0.167
	(0.004)	(0.002)	(0.144)	(0.193)	(0.381)
agemoth	0.230	0.030	0.001	-0.000	0.001
	(0.387)	(0.186)	(0.001)	(0.001)	(0.003)
agemoth2	-0.001	-0.000	-0.777	1.100	-0.690**
	(0.003)	(0.001)	(1.406)	(1.178)	(0.291)
lnrexpa	0.212	-0.222	0.002	-0.002	-0.002
	(0.475)	(1.203)	(0.001)	(0.003)	(0.002)
wage	-0.124***	-0.412***	0.335***	-0.179***	-0.472***
	(0.001)	(0.002)	(0.003)	(0.060)	(0.049)
hhsize	0.025	0.002	-0.222	-0.536	0.094
	(0.033)	(0.041)	(0.425)	(0.421)	(0.320)
rural	0.049	0.194	0.728**	0.072	0.679
	(0.378)	(0.450)	(0.335)	(0.406)	(0.516)
north	0.051	0.521	4.389	0.321	4.410
	(0.544)	(0.384)	(2.699)	(3.736)	(7.390)
centre	-2.780	2.213	-12.581	-2.212	-13.612
	(7.725)	(3.318)	(8.913)	(12.283)	(24.411)
residcons	10.380***	-17.633***	24.127***	-0.220***	0.354***
	(1.333)	(2.983)	(2.212	(0.008)	(0.002)
constant	-103.381	82.100	136.409	13.959	147.080
	(252.640)	(111.196)	(92.730)	(122.303)	(242.940)
Log likelihood	-9332	-8178	-1977	-2256	-4038

Notes: residcons is the residual from the reduced form of per capita consumption expenditure. The significance asterisks are defined as follows: * p<0.10, ** p<0.05, *** p<0.01. Numbers in parentheses are standard errors.

Table A12: Probit results of non-biological children (related) by expenditure quintile

Quintile	1	2	3	4	5
agechild	-0.174***	-0.167***	-0.186***	-0.171***	-0.205***
	(0.014)	(0.015)	(0.018)	(0.020)	(0.027)
childsex	0.045	0.105	0.179	0.147	0.180
	(0.093)	(0.097)	(0.114)	(0.129)	(0.156)
fathwage	-0.118	0.016	-0.251*	0.325*	-0.173
	(0.124)	(0.122)	(0.139)	(0.191)	(0.207)
mothwage	-0.465**	-0.097	-1.215***	-0.253	-0.337
	(0.230)	(0.219)	(0.253)	(0.366)	(0.364)
edufath	0.059***	0.025	0.030*	0.045**	0.065***
	(0.020)	(0.017)	(0.018)	(0.019)	(0.022)
edumoth	0.002	0.075	0.069*	0.064	-0.030
	(0.045)	(0.046)	(0.041)	(0.044)	(0.030)
agefath	-0.041	-0.070	0.091*	-0.001	-0.001
	(0.044)	(0.051)	(0.051)	(0.057)	(0.073)
agefath2	0.000	0.001	-0.001**	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
agemoth	0.015	0.043	-0.016	-0.111	0.093
	(0.051)	(0.057)	(0.059)	(0.075)	(0.085)
agemoth2	-0.000	-0.001	0.000	0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
lnrexpa	0.382*	0.080	0.286	-0.089	0.995***
	(0.223)	(0.547)	(0.688)	(0.678)	(0.354)
wage	-0.345***	0.421***	-0.231	-0.453***	-0.413***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
hhsize	0.071***	-0.012	-0.025	-0.017	0.007
	(0.022)	(0.026)	(0.028)	(0.027)	(0.030)
rural	0.166	0.345*	-0.048	-0.131	-0.033
	(0.187)	(0.192)	(0.228)	(0.246)	(0.228)
north	0.426***	0.276*	-0.090	0.434	0.648*
	(0.144)	(0.161)	(0.195)	(0.273)	(0.342)
centre	-0.118	-0.379***	-0.327**	-0.058	-0.219
	(0.111)	(0.111)	(0.128)	(0.145)	(0.189)
residcons	-0.322**	-0.021***	-0.042***	0.324***	-0.237***
	(0.001)	(0.001)	(0.004)	(0.012)	(0.004)
constant	0.142	3.673	-0.289	6.975	-7.707*
	(2.205)	(5.229)	(6.783)	(6.922)	(3.986)
Log likelihood	-8789	-5339	-2778	-4456	-6729

Notes: residcons is the residual from the reduced form of per capita consumption expenditure. The significance asterisks are defined as follows: * p<0.10, ** p<0.05, *** p<0.01. Numbers in parentheses are standard errors.

Table A13: Probit results of non-biological children (unrelated) by expenditure quintile

Quintile	1	2	3	4	5
agechild	-0.227***	-0.292***	-0.351***	-0.320***	-0.400***
	(0.031)	(0.039)	(0.045)	(0.041)	(0.050)
childsex	0.263	0.159	0.533**	0.286	1.071***
	(0.210)	(0.228)	(0.225)	(0.227)	(0.225)
fathwage	-0.084	-0.458	0.579*	0.134	0.804**
	(0.365)	(0.297)	(0.315)	(0.324)	(0.316)
mothwage	-0.327	0.917	0.045	0.054*	0.035
	(0.575)	(0.759)	(0.039)	(0.030)	(0.026)
edufath	0.074*	-0.001	-0.068	0.066	0.018
	(0.042)	(0.044)	(0.052)	(0.053)	(0.032)
edumoth	0.004	0.097	-0.013	0.006	0.008
	(0.352)	(0.070)	(0.049)	(0.062)	(0.072)
agefath	0.002	-0.104	0.000	0.000	-0.000
	(0.062)	(0.080)	(0.000)	(0.001)	(0.001)
agefath2	-0.000	0.001	0.068	0.071	0.040
	(0.001)	(0.001)	(0.055)	(0.071)	(0.073)
agemoth	0.071	0.115	-0.001	-0.000	-0.000
	(0.060)	(0.086)	(0.001)	(0.001)	(0.001)
agemoth2	-0.000	-0.001	-0.676	1.073	-0.691**
	(0.001)	(0.001)	(1.422)	(1.176)	(0.291)
lnrexpa	0.214	0.065	0.002	-0.002	-0.002
	(0.475)	(1.226)	(0.002)	(0.003)	(0.002)
wage	-0.320***	-0.453***	-0.338***	-0.182***	-0.475***
	(0.001)	(0.003)	(0.043)	(0.060)	(0.049)
hhsize	0.025	0.006	-0.246	-0.511	0.090
	(0.033)	(0.042)	(0.418)	(0.425)	(0.320)
rural	0.044	0.281	0.526*	0.066	0.422
	(0.378)	(0.457)	(0.316)	(0.356)	(0.341)
north	0.249	0.468	0.562**	-0.305	0.260
	(0.269)	(0.345)	(0.270)	(0.276)	(0.262)
centre	0.386	-0.023	-0.000	0.000	0.000
	(0.283)	(0.264)	(0.000)	(0.000)	(0.000)
residcons	-0.237***	-0.172***	0.248***	-0.324***	-0.218***
	(0.000)	(0.002)	(0.001)	(0.002)	(0.001)
constant	-0.093	3.411	10.420	-7.847	11.618***
	(4.299)	(11.466)	(14.001)	(11.673)	(3.337)
Log likelihood	-8189	-9747	-2015	-2321	-4775

Notes: residcons is the residual from the reduced form of per capita consumption expenditure. The significance asterisks are defined as follows: * p<0.10, ** p<0.05, *** p<0.01. Numbers in parentheses are standard errors.