The Dynamics of Educational Attainment for Orphaned Children in Sub-Saharan Africa: Evidence from Malawi

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Abstract: This paper explores the factors that shape the dynamics of educational attainment for orphans in sub-Saharan Africa. A theoretical model, with a presumption that orphans may experience an immediate negative impact (grade repetition) associated with a parental death, predicts that there are three phases of orphans' educational progression; 1) orphans lag behind in their educational progression after a parental death, 2) yet continue to attend school at younger ages, 3) however, they are more likely to drop out of school at higher ages if they face discriminately circumstances. Empirical analysis examines this prediction by taking into account the timing of losing a parent or both, and shows that in Malawi the patterns of educational progression, particularly for female maternal orphans, follow the predicted pattern. This paper thus lays a foundation of theoretical frameworks to correctly evaluate the long-term impact of a parental death on children's educational achievement in sub-Saharan Africa.

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1. Introduction

Terrible is its immediate detrimental impacts of losing a parent for children, but the loss of a parent may also have a series of long-term consequences that prolong its negative impacts far into the future. A number of researchers, policy makers and practitioners have expressed considerable concerns that parental deaths presumably due to HIV/AIDS may lead to less educational investment among the increasing number of orphans and the destruction of human capital would persist poverty over generations (UNAIDS/UNICEF/USAID 2004, World Bank 2002). The wide spread HIV/AIDS pandemic in sub-Saharan Africa over the recent 20 years and resulting high adult mortality in the region have made international society more concerned about the problem of orphans' educational outcomes (UNAIDS, 2011; 2013).

As these concerns have disseminated, a number of studies have examined the associations between orphan status and school participation with cross-sectional data in various low-income countries. The existing literature, however, does not provide consistent evidence. While some studies show negative associations between orphan status and school enrollment (Case et al. 2004, Yamano et al. 2006), the associations are not necessarily significantly negative in other studies, particularly among primary-school-age children (Ainsworth and Filmer 2002, Ainsworth and Filmer 2006, Bennell 2005). The minimal differences in school participation have often been attributed to the presence of strong family support networks in Africa, which are believed to absorb the adverse effects of parental deaths (Beegle et al. 2010, Foster 2000, Hunter 1990, Lloyd and Blanc 1996, Lloyd and Desai 1992). In addition, a couple of studies reveal that by fostering the orphans of dead relatives, extended family members can improve children's educational outcomes in Africa (Akresh 2009, Zimmerman 2003).

With these mixed results, a growing number of studies have attempted to estimate the causal impacts of adult mortality more rigorously by utilizing longitudinal data. Yamano and Jayne (2005), for example, examine the impact of the death of working-age adult on school enrollment in Kenya and find a significant negative impact even before the death of working-age adults. Ainsworth, Beegle and Koda (2005) show adult mortality and parental death delay school attendance and reduce hours spent in school in north-western Tanzania. Evans and Miguel (2007) also find that the loss of a parent has an immediate adverse effect on the continuation of a child's schooling in Kenya. Furthermore, a series of studies have explored the long-term impact of orphanhood on educational attainment and find adverse effects associated with orphan status, which in the long-run result in fewer years of educational investment in orphaned children (Beegle et al. 2006, Beegle et al. 2010, Case and Ardington 2006). The findings on the adverse impacts of parental deaths, particularly mother's death, from the panel analyses are more pronounced, although panel analysis is also not free from biases (Beegle and De Weerdt 2008).

Despite the enormous efforts, however, how disadvantageous educational outcomes among orphans appear as they get older has not been well investigated. We thus work on this issue in Malawi and add another piece of evidence. In Malawi, Sharma (2006) by utilizing panel data from 2000 to 2004 compare the educational outcomes between orphans and non-orphans with a control of the past educational attainment at the first round of surveys and shows that orphans are more likely to drop out of school with an increase in the grade levels. His study, nonetheless, due to small sample size, fails to disaggregate this tendency by the different types of orphanhood and even by gender, and also does not explicitly incorporate the timing of being orphans into his analysis. Therefore, the mechanism in which orphans' educational progress is made as they grow up is still vague.

The main objective of this study is thus to investigate the factors that shape the long-term educational consequences of a parental death and correctly evaluate the long-term impact of parental deaths on children's educational achievement. Our theoretical model will focus on household decisions regarding children's schooling, and explore how the evaluation of orphans' schooling and labor participation evolve over time and how the optimal level of educational investment, i.e., years of schooling, is determined. The dynamic household model, in which a series of decisions regarding children's schooling and labor participation are made sequentially, could generate a world with three predicted phases. First, orphans experience a negative effect immediately after a parental death and lag behind in their educational progression. Second, in spite of this negative impact, orphans will likely have another chance to attend school if they are fostered by another household that usually possesses wealthier assets than orphans' initial households. Nonetheless, orphans are more likely to drop out of school at higher ages. To derive these implications, our theoretical investigation focuses on two factors related to orphan status. First, by assuming that orphans' educational progression is slower, we analyze how the delay in educational progression influences the optimal level of educational investment in orphans. Second, we analyze how environmental changes after a parental death affect an orphan's school attendance and thus the entire process of human capital accumulation.

Our empirical work then examines this theoretical prediction. The data set used for this study is the second Integrated Household Survey (IHS-2) in Malawi. The survey was carried out by the National Statistics Office (NSO) from March 2004 through March 2005 with technical assistance from the World Bank (GOM 2005b). The number of sampled households is 11,280 in 564 communities[1] all across the country. The survey contains 9,120 rural households in 492 communities, and 2,160 urban households in 72 communities. The IHS-2's sampling strategy adopted a two-stage procedure. First, the number of sampled communities in each district was determined based on the 1998 Population Census, and those communities were randomly selected from a listing of all communities in each district. Then, in each selected community, 20 households are chosen randomly. The data set is cross-sectional, but contains a large scale national representative sample, which allows us to examine differences in the pathway of educational attainment after parental death for different types of orphans, i.e., maternal, paternal and double orphans.

The following section describes circumstances of orphans and educational outcomes in Malawi. In Section 3, we construct theoretical models that allow us to investigate the factors that shape the dynamics of educational attainment for orphaned children. Then, Section 4 provides detailed explanations about the empirical models in relation to the theoretical prediction, and Section 5 presents the estimation results. Finally, Section 6 summarizes the findings of this study and concludes our discussions.

2. Orphan Status and Educational Outcomes in Malawi

Malawi is a sub-Saharan African country which has been greatly influenced by the HIV/AIDS pandemic (Watkins, 2004). The proportion of HIV/AIDS orphans has been very high, although the number of AIDS-related deaths might be reduced due to recent great efforts of disseminating antiretroviral treatment (UNAIDS, 2013). Table 1 shows the proportion of orphaned school-age children, adolescents, and young adults in 2004-05. At age 7, 10.3 percent of female children and 11.5 percent of male children are orphans. The proportion of orphans becomes higher in the higher age groups, and by age 18 as much as 31.2 percent of female and 31.4 percent of male children become orphans. Table 1 also shows the percentage of individuals who fall into the head or spouse status of the family. Up to age 24, as much as 30.2 percent of females who have at least one deceased parent hold the head/spouse status, whereas 16.9 percent of females whose parents are alive are the head/spouse. Likewise, while 11.1 percent of males who have at least one deceased parent are the head, only 5.5 percent of males whose parents are alive are the head.[2] This suggests that on average orphans become independent earlier than non-orphans. These tendencies in the pattern of orphan and head/spouse status are the consequences of Malawi's high adult mortality due to HIV/AIDS, and the international community has been worried about the adverse impacts of high adult mortality that prevent economic activities including educational investment in orphans.

Table 2 shows the proportion of maternal, paternal and double orphans and also the duration of orphanhood. Regardless of age and gender, the proportion of paternal orphans is higher than that of maternal and double orphans. With respect to the duration of orphanhood, there is no significant difference between maternal and paternal orphans, which implies that paternal and maternal orphans lose their parents at around the same age. The duration of double orphans is shorter than the average duration of paternal and maternal orphans because the duration of double orphans is measured by the duration as an orphan.[3] This information is utilized to investigate the dynamics of educational attainment for orphaned children and adolescents.

We next describe education in Malawi. The education system in Malawi is 8-4-4; 8 years of primary education followed by 4 years of secondary education and 4 years of university education. Since 1994, there have been no tuition fees for primary education, nevertheless, households still have school-related expenses such as uniforms, shoes and books, which represent a significant expense for poor families and are arguably a deterrent for enrollment in primary education (Al-Samarrai and Zaman 2007). Secondary schools are not free, and they are often located far from students' villages, incurring additional expenses such as transportation, food and lodging. One can expect, therefore, that much fewer children attend secondary school.

Figure 1 illustrates school attendance ratios by age. Female orphans, compared to children living with both parents, are less likely to attend school at higher ages, whereas no significant difference can be seen for primary-school-age children. Differences between orphans and children with both parents are much smaller among males. Figure 2 shows educational attainment, which is measured by the highest grade attained. Maternal female orphans complete fewer years of education at higher ages indicating that female orphaned children who lost their mother have slower educational progression. Differences among other female children and also among male children are less evident. Figures 1 and 2, however, do not take into account the timing of parental deaths. 18 year-old orphans, for example, range from those who became orphans very recently to those who lost their parent even before the first school entrance. In the following sections, therefore, we examine how much difference shown in Figure 1 and Figure 2 can be attributed to the consequences of parental death and succeeding orphanhood more rigorously.

3. Theory of Educational Investment

3.1 One-Child Model

The basic theoretical framework of child schooling with human capital accumulation is a one-child model in which a household maximizes utility by choosing the optimal level of consumption c_t (per capita) and child's schooling S_t in each period. The child schooling decision S_t takes the value of one if the child attends school in period t and zero otherwise.[4] The human capital is accumulated accordingly and measured by the highest grade successfully completed H_t before period t. We assume that the initial level of human capital H_{t_0} is given exogenously and the household's utility function $u(c_t, S_t)$ is concave and additive.[5] Under these assumptions, the optimization problem for the household is expressed as

$$\max\left\{\sum_{t=t_0}^{T}\beta^{t-t_0}u(c_t, S_t)\right\} \tag{*}$$

subject to

$$A_{t+1} = (1+r)(A_t + y_t - lc_t - \overline{p}_t S_t) \ldots \text{(Asset dynamics: } \lambda_1^t\text{)} \tag{1a}$$

$$H_{t+1} = H_t + S_t \ldots \text{(Human capital accumulation: } \lambda_2^t\text{)} \tag{2a}$$

$$y_t = (1-S_t)w_t + \overline{R}_t \ldots \text{(Income stream: } \lambda_3^t\text{)} \tag{3a}$$

$$S_t(1-S_t) = 0 \ldots \text{(Discrete Choice of Schooling: } \lambda_4^t\text{)} \tag{4a}$$

where $t = t_0, t_0+1, \cdots, T$ and age at t_0 is given exogenously and increases by increments of one in each period β is the discount factor and r is the interest rate. A_t is household assets at the beginning of period t, and the initial level of asset A_{t_0} is assumed to be given exogenously. In this model, when the child goes to school, the household incurs the educational cost $\overline{p}_t$, otherwise the household can earn the wage w_t if they allow the child to work. w_t is an increasing function of human capital accumulation H_t ($\partial w_t / \partial H_t > 0$) and assumed to have diminishing returns ($\partial^2 w_t / \partial H_t^2 < 0$). $\overline{R}_t$ is an exogenous income stream from other household members and thus y_t is the total income of the household in period t. Lastly, l represents the household size and the λ s are the Lagrange multipliers for each constraint.

Note that the model is non-stochastic and can be solved with some more specific conditions. Here, to solve this maximization program, the condition $A_{T+1} = \overline{A}$ is imposed, where $\overline{A}$ is the target level of the asset immediately after the last period T. Also, liquidity constraints are assumed to be never binding.[6] The solution of this model is characterized by the optimal schooling year t^* and the optimal level of human capital accumulation H^*. The optimal schooling decision is that the child goes to school up to period t^*, and after t^* the child works until the last period T, thus H^* can be interpreted as the lifetime educational attainment of the child.

To investigate how the optimal level of educational investment is determined, we consider the FOC with respect to S_t,

$$\lambda_3^t(\bar{p}_t + w_t) + \lambda_4^t(2S_t - 1) = \partial u / \partial S_t + \lambda_2^t \tag{5a}$$

This optimality condition equates the costs and benefits of the educational investment in period t. The left-hand side represents the costs of child schooling. The first term indicates the direct educational cost the household must incur if the child attends school, and the second term is the opportunity cost. The third term denotes a value that adjusts the discrete choice of schooling decisions. The right-hand side, in contrast, represents the benefit from schooling in period *t*. The first term can be interpreted as a contemporaneous utility gain of sending the child to school in period t, and the second term captures the marginal future utility gain from the schooling decision in period *t*.

The FOC tells us that as long as the benefits exceed the costs, sending the child to school is the optimal choice, which means that up to period t^* the direct educational cost $\bar{p}_t$ is paid in each period and the opportunity cost w_t is incurred because households expect these costs to be outweighed by higher benefits in the future. After period t^*, however, the costs become larger than the future benefits. As a result, the child can work and earn the labor income $w_t(H^*)$ until the last period T. If the child receives more education than the optimal choice t^*, the wage rate becomes higher but educational costs have to be paid for longer periods and the duration of earning income becomes shorter. Therefore, this alternative plan does not maximize the sequence of family utility and cannot be the optimal educational investment. A tradeoff exists between the costs of educational investment and its returns, and the optimal choice is determined by balancing this tradeoff. [7]

3.2 Two-Child Model

The one-child model can be extended to incorporate the case in which there are two children in the household, which allows us to investigate sibling effects on the other child's educational outcomes. The theoretical schooling model with two children (child 1 and child 2) assumes a household maximizes family utility each period beginning in period t_0 and ending at the last period T_1 (the time when one of the children leaves the family) by choosing the optimal level of consumption c_t (per capita) and child i's (i=1,2) schooling decision S_{it} in each period. The model can be expressed as

$$\max\left\{\sum_{t=t_0}^{T_1}\beta^{t-t_0}u(c_t, S_{1t}, S_{2t})\right\} \quad (**)$$

subject to

$$A_{t+1} = (1+r)(A_t + y_t - lc_t - \overline{p}_{1t}S_{1t} - \overline{p}_{2t}S_{2t}) \ldots\text{(Asset accumulation: } \lambda_1^t) \quad (1b)$$

$$H_{i(t+1)} = H_{it} + S_{it} \ldots\text{(Human capital accumulation: } \lambda_{2i}^t) \quad (2b)$$

$$y_t = (1-S_{1t})w_{1t} + (1-S_{2t})w_{2t} + \overline{R}_t \ldots \text{(Income stream: } \lambda_3^t) \quad (3b)$$

$$S_{it}(1-S_{it}) = 0 \ldots \text{(Discrete Choice of Schooling: } \lambda_{4i}^t) \quad (4b)$$

where $t = t_0, t_0+1, \cdots, T_1$. In this model, the initial level of human capital (H_{1t_0} and H_{2t_0}) is given exogenously for each child. Since we assume that the utility function is additive,[8] the FOC with respect to S_{it} is

$$\lambda_3^t(\overline{p}_{it} + w_{it}) + \lambda_{4i}^t(2S_{it} - 1) = \partial u/\partial S_{it} + \lambda_{2i}^t \quad (5b)$$

The first best choice is made by considering the costs and benefits of educational investment for each child. If the term $\partial u/\partial S_{it}$ is negligible and liquidity constraints are not binding, then the schooling decision for one child is independent from the decision for the other child. However, the presence of the term $\partial u/\partial S_{it}$ eliminates the separability and yields an association of schooling decisions between the two children through the marginal utility of wealth. Under the assumption of binding liquidity constraints, in addition, one child might be able to assist with the other's schooling by earning additional income or, alternatively, one child might exploit family resources and adversely affect the other's school attendance. Note that in this model we assume that the second child will stay in the family longer after the last period T_1, and therefore $\lambda_{42}^{T_1} > 0$ whereas $\lambda_{41}^{T_1} = 0$.[9]

3.3 Orphan vs. Non-orphan

Based on the theoretical model constructed above, we will discuss how parental deaths influence schooling decisions. We focus on two factors: 1) slower educational progression and 2) environmental changes due to parental deaths. First, we consider the effect of slower educational progress. Orphans may experience an immediate negative impact after a parental death and are more likely to repeat grade levels. As a result, the process of human capital accumulation might be interrupted and their educational progress may lag behind, i.e., $H_{t_0}^{(orphan)} < H_{t_0}^{(non-orphan)}$. This delay in educational progression, in turn, seems to influence children's schooling decisions. In order to further investigate the effect of the delay, we consider the FOC with respect to H_{t+1}.

$$\lambda_{2i}^{t} = \lambda_{2i}^{t+1} + \lambda_{3}^{t+1}(1 - S_{i(t+1)})\frac{\partial w_{i(t+1)}}{\partial H_{i(t+1)}} \qquad (6)$$

Equation (6) explains how the utility-maximizing household evaluates the marginal future gain from the schooling decision in period *t*. The household sums up the marginal gains of educational investment backward from the last period T up to time t to calculate the marginal future gain λ_2^t, and thus the value of λ_2^t relies on the characteristics of the wage function $w(H_t)$. Since we assume that the wage function exhibits diminishing returns, when the child lags behind in educational progression in period t, there should be an increase in the marginal future gain from the schooling decision in period t, therefore, the household will choose to enroll the child in more years of school. When we examine the cost side, we find that delaying human capital accumulation reduces the opportunity cost which, in turn, also allows children to stay in school longer. In sum, we find that under the assumption of a diminishing returns wage function, slower educational progression leads to more time spent in school but does not result in completing a higher level than that with no delay because the child is repeating grade levels.[10]

Next, we discuss environmental changes resulting from parental deaths. After being orphaned, the child may live with the remaining parent; otherwise s/he will be fostered by another household. If both parents pass away, s/he must be fostered by another household. Living in another household can adversely affect the optimal of level of educational investment in orphans in two ways. First, if the host family obtains a lower utility level by sending orphans to school, i.e., $\partial u / \partial S_t^{(orphan)} < \partial u / \partial S_t^{(non-orphan)}$, the optimal level of educational investment in orphans is lower than in non-orphans. Second, if the host family expects to benefit from income earned by an orphan for shorter amount of time or if they expect that orphans become independent earlier than non-orphans, i.e., $T^{(orphan)} < T^{(non-orphan)}$, the optimal schooling years for orphans should also be less.

We have found that, under the discriminatory circumstances, environmental changes negatively affect orphans' educational outcomes, whereas slower educational progression leads to longer duration of school attendance. Therefore, the patterns of educational attainment for orphans depend on these effects. The possible patterns are illustrated in Figure 3. The theoretical model predicts the pattern 1, in which orphans can catch up with non-orphans when the positive effect of slower educational progression expels the adverse effect of the discriminatory environmental changes. When the adverse effect exceeds the positive effect, we predict that pattern 2 is most likely and expect that orphans continue to attend school up to a certain age. Yet, orphans above such an age are more likely to drop out of school causing the gap in the educational attainment between orphans and non-orphans to widen as children become older. Lastly, if orphans are heavily discriminated against, the model predicts pattern 3 implying that orphans never have a chance to go back school after a parental death. These hypothetical patterns of educational progression are empirically tested in the following two sections.

4. Empirical Models

4.1 Educational Attainment

This section considers empirical models suitable for testing the theoretical predictions drawn from the discussions in the previous section. First, we consider an empirical model for educational attainment measured by the highest grade level attended. A traditional approach is to utilize a linear regression model with the dependent variable of years of educational attainment (Taubman, 1989). Yet, this model requires, for example, an assumption that current input measures can be proxy for the whole history of inputs (Todd and Wolpin 2003), which seems to be very strong. We relax this assumption by introducing a non-linear function of age as part of explanatory variables. More precisely, we employ the following semi-parametric models.[11] We first consider an equation of educational attainment for non-orphans.

$$H_i^0(a_i, X_i) = f_0(a_i) + \sum_a \delta_a \cdot 1(a_i = a) + X_i\beta, \tag{7}$$

where a_i is age of child *i* and X_i is a vector of other individual and household characteristics. f_0 is a non-linear function of age, which is to be estimated along with β coefficients in the linear form. δ_a coefficients represent age cohort fixed effects, whereas $1(\cdot)$ is the indicator function.

Next, for single orphans, suppose that child *i* was a non-orphan up to age j_i and lost one parent at age $j_i + 1$. Then, for practical purposes, we construct the following four groups; the first group experienced a parental death after 14 years old ($c = 1$), the second group became a single orphan at age 11 up to 14 ($c = 2$), the third group did at age 8 up to 10 ($c = 3$), and the fourth group is those who lost one parent at age 7 or below ($c = 4$). For each group, we have

$$H_i^c(a_i, X_i, j_i \mid c) = f_0(j_i) + f_c(a_i - j_i) + \Delta_c + \sum_a \delta_a \cdot 1(a_i = a) + X_i\beta, \tag{8}$$

where f_c is a non-linear function of age for single orphans, which is to be estimated with β coefficients in the linear form, and Δ_c represents fixed effects for each group.

For double orphans, j_i denotes the age after which child *i* became a single orphan, and furthermore let k_i be age after which s/he *i* lost the remaining parent and $\tilde{f}_d$ be a non-linear function of age for double orphans. Then, we have the following equations:

$$H_i^{c,d}(a_i, X_i, j_i, k_i \mid c, d) = f_0(j_i) + f_c(k_i - j_i) + \Delta_c + \tilde{f}_d(a_i - k_i) + \tilde{\Delta}_d + \sum_a \delta_a \cdot 1(a_i = a) + X_i\beta, \tag{9}$$

where $\tilde{\Delta}_d$ represents fixed effects for the following groups; the first group lost the remaining parent after 14 years old ($d = 1$), the second group became a double orphan at age 11 up to 14 ($d = 2$), the third group did at age 8 up to 10 ($d = 3$), and the fourth group lost both parents before age 8 ($d = 4$).

Now, let us define a set of dummy variables D_i that comprises of D_i^0, D_i^c, $\tilde{D}_i^c$ an $\tilde{\text{Đ}}_i^d$ ($1 \le c \le 4$ and $1 \le d \le 4$). D_i^0 takes the value of one if child *i* is a non-orphan and zero otherwise. D_i^c is a dummy variable that takes the value of one if single orphan *i* belongs to the c_{th} group , and zero otherwise. $\tilde{D}_i^c$ and $\tilde{\text{Đ}}_i^d$ are dummy variables that takes the value of one if double orphan *i* belongs to the c_{th} group and the d_{th} group respectively, and zero otherwise. By using these dummy variables, we have the following empirical model:

$$H_i(a_i, X_i, j_i, k_i, D_i) = D_i^0 \cdot f_0(a_i) + \sum_{c=1}^{4} D_i^c \cdot (f_0(j_i) + f_c(a_i - j_i) + \Delta_c)$$

$$+ \sum_{d=1}^{4} \sum_{c=d}^{4} \tilde{D}_i^c \cdot \tilde{\text{Đ}}_i^d \cdot (f_0(j_i) + f_c(k_i - j_i) + \Delta_c + \tilde{f}_d(a_i - k_i) + \tilde{\Delta}_d) + \sum_a \delta_a \cdot 1(a_i = a) + X_i \beta + \varepsilon_i, \quad (10)$$

where ε_i is an error term assumed to be random.

In the linear part of the regression model, other child characteristics and household characteristics are controlled for. First, two dummy variables for living arrangements are included to capture potentially disadvantageous conditions for non-orphans living separately from their biological parents.[12] Next, the ratios of older siblings up to 20 years old to household size are also utilized to capture birth-order effects. Schooling of earlier-born children may be more preferred by parents and/or siblings may compete for limited resources that tend to be directed toward older siblings. By contrast, the presence of older siblings may be helpful for younger siblings to study at home. In addition, particularly in poor family, one sibling can quit schooling earlier and works to earn supplemental income to assist another sibling attend school. Thus, the birth-order effects on educational outcomes can be either positive or negative (Behrman and Taubman 1986, Emerson and Portela 2008).

Household characteristics include categorical variables representing age of the household head, which capture household experience and knowledge that may affect the degree of appreciation for children’s schooling. The highest grade levels attained by female and male adult members (older than 20 years old) are also included. The higher levels of education achieved by household adult members might improve the capability of perceiving the benefit from children's education. In addition, the size of household and the ratios of working-age female and male adults to household size are included to capture household demographics that may have some influences on the valuation of children's labor force. Furthermore, the level of per capita household consumption expenditure, as a proxy for family income or a measure of wealth, is controlled for. Finally, to control for unobserved heterogeneity due to regional-level characteristics, district dummy variables are included.

4.2 School Attendance

Next, we consider an empirical model for school attendance so that we can further explore the relationship among the history of orphan status, past educational progression and current school attendance. For this analysis, in addition to the categorical variables that represent the entire history of orphan status defined in the previous sub-section, we construct a measure of past educational progression. The measure is defined as (the highest grade attended by the preceding year) / (age at the time of last school attendance - 5), which takes the value between zero and one. With this measure, our empirical model can be expressed as follows:

$$\Pr(S_i = 1 \mid a_i, X_i, D_i, I_i) = F(\gamma_0 \cdot D_i^o + \sum_{c=1}^{4} \gamma_c \cdot D_i^c + \sum_{d=1}^{4} \tilde{\gamma}_d \cdot \tilde{D}_d + \alpha \cdot I_i + \sum_a \delta_a \cdot 1(a_i = a) + X_i \beta), \qquad (11)$$

where S_i is school attendance at the time of survey and I_i is the measure of the past educational progression. a_i is age of a child *i* and X_i is a vector of other observable characteristics that affect school attendance at the time of survey. D_i denotes a set of dummy variables for orphan status. γ and α coefficients are the parameters of interest that are to be estimated along with β coefficients. δ_a coefficients represent age cohort fixed effects. We estimate this model by running the logistic regressions.[13]

We run regressions for those aged 7 to 14 and aged 15 to 18 separately because the influence of the factors that affect schooling decisions are highly likely to differ for these different age groups. Moreover, in addition to the measure I_i, the coefficients on the interaction terms between I_i and orphan status at the time of last school attendance are also estimated so that we can examine how responses to the measure of past educational progression vary depending on the types of orphan status when they decided to quit their schooling. Note that, however, the measure of past educational progression is highly likely to be affected by orphan status, and the history of orphan status might correlate with both contemporaneous unobserved characteristics and also those in the past. For these reasons, the interpretation of the coefficients on these variables has to be made with cautions. Lastly, because the measure of past educational progression takes the value of zero for those who have never enrolled in formal education regardless of their age, we exclude such children from this analysis and consider an empirical model for the analysis of the characteristics of such children in the following sub-section.

4.3 Never Enrolled in Formal Education

The last attempt is to explore how the history of orphan status is associated with the educational outcome of being never enrolled in formal education. In sub-Saharan Africa, a significant number of children still do not have any chance to go to school in their whole life. In Malawi, the IHS2 data set indicates that 9.3 percent of females and 10.3 percent of males fall into this category among children aged 7 to 18, and thus it is worth investigating these children. We employ the following model:

$$\Pr(H_i = 0 \mid a_i, X_i, D_i) = F(\gamma_o \cdot D_i^o + \sum_{c=1}^{4} \gamma_c \cdot D_i^c + \sum_{d=1}^{4} \tilde{\gamma}_d \cdot \tilde{D}_i^d + \sum_a \delta_a \cdot 1(a_i = a) + X_i \beta), \qquad (12)$$

where H_i is the highest grade level attended. a_i is age of a child *i* and X_i is a vector of other child and household characteristics that affect the status of being never enrolled in formal education. D_i denotes a set of dummy variables for the history of orphan status. γ coefficients are the parameters of interest that are to be estimated along with β coefficients. δ_a coefficients represent age cohort fixed effects. This model is also estimated by the logistic regressions.

In some existing studies, children who have not enrolled in school are excluded from the analyses. In Kenya, for example, Evans and Miguel (2007) utilize school survey data and analyze only children who were enrolled in schools at baseline and find a small effect of parental deaths on children's schooling prior to the death. Yamano and Jayne (2005) on the other hand, employ household survey data and find significant negative effects on children's school attendance before adult deaths. One can conjecture that this gap could be explained by the difference in their survey designs and sampling methods. We investigate the characteristics of those who have never enrolled in formal education in Malawi because our knowledge about such children in sub-Saharan Africa is still scarce.

5. Estimation Results

5.1 Educational Attainment

For data analysis, the information on children aged 7 to 18 is utilized. The sample is made up of 7,977 females and 7,879 males, and the average age is 11.9 for both females and males. In Table 3, the information about orphan status of these children and summary statistics of other explanatory variables used in the following regression analysis are shown. Figure 4 summarizes the estimation results by illustrating the predicted values of mean educational attainment for children with the history of orphans status D evaluated at the mean values of other covariates X, i.e., $\hat{H}(a, \bar{X}, D)$, in comparison with non-orphans who live with both biological parents, where D contains the information about the type of orphan and the timing of parent's death. We focus on the trajectories of mean educational attainment for children who became orphans before age 15.

We begin with the estimation results for maternal orphans. The estimation results show that mother's death after age 10 results in an immediate decline in the mean educational attainment for both females and males. The loss of their mother at earlier ages, on the other hand, seems to have contrastive impacts by gender. For females, mother's death leads to slower educational progression and ends up with a large decline in educational attainment, whereas such detrimental impacts cannot be seen for males. The impacts of father's death are much smaller than those of mother's death, which is consistent with the evidence that Beegle et al. (2010) find in Tanzania. Our estimation results, however, suggest that father's death at younger ages may have an adverse impact on the dynamics of educational attainment particularly for male children. Their educational progression becomes slower after they lose their father. Double orphans experience compounded effects caused by the parental deaths. Becoming a double orphan after age 10 has contrastive impacts by gender. While the loss of the remaining parent at higher ages has significant adverse effects on females, no significant effect can be seen on males. Losing both parents at younger ages leads to slower educational progression, but keep up with two parent children up to age 18 with slower educational progression.

Let us argue two major issues relating to these estimation results. First, we control for only contemporaneous inputs in the linear part, and thus our estimation results of the non-linear functions of age might be biased if historical inputs were correlated with the history of orphan status. For example, it is said that orphans are more likely to be fostered by wealthier households, which implies that the income level of their original households might be lower when they were non-orphans. In our estimation, we treat such children as non-orphans from wealthier households prior to their orphanhood, even though they in reality might live in much poorer households. This creates a downward bias to an estimated non-linear function of age for non-orphans. Thus, we may underestimate the negative impacts of parental death. Second, biases are also caused by unobserved individual characteristics (Cameron and Heckman 1998, 2001). For this problem, Evans and Miguel (2007) show that, in evaluating the impacts of parental death in Tanzania, inability of controlling for individual fixed effects using cross-sectional data would cause biases toward zero. For these two reasons, we regard our estimation results for the adverse effects of parental death as conservative estimates.

Among the other covariate (Table C1 in Appendix C), the ratio of older female siblings and ratio of female adults are positively associated with educational attainment of female children. These findings suggest that the higher availability of women’s labor would help female children study more and complete higher educational achievement. The highest levels of education that female and male adult family members achieved are consistently and positively correlated with educational attainment of children regardless of gender, which suggests that better educated households appreciate education more and their utility gain from sending their offspring to school is higher than poorly educated households. Both household size and the level of total expenditure per capita are also positively correlated with educational attainment.

5.2 School Attendance

We have estimated the trajectories of mean educational attainment for orphans, and will further disentangle the mean educational outcomes. In doing so, we examine the factors associated with current school attendance and employ three different sets of explanatory variables. The first model does not include the measure of past educational progression so that we can have a baseline regression result. The second model involves the measure of past educational progression, which is assumed to have the identical coefficient for any type of children. The third model utilizes the interaction terms between the measure of past educational progression and orphan status at the time of last school attendance. Table 4 shows the estimation results for children aged 7 to 14. Among this age group, the probabilities of attending school by female orphans who lost their mother at age 7 or below and male orphans who lost their mother at age 8 to 10 are significantly lower. After controlling for the measure of past educational progression and its interaction terms, it has turned out that some orphans with slower educational progression are less likely to attend school, but the majority of them are equally likely to attend school.

With respect to the other variables, the estimation results are shown in Table C2 in Appendix C. Living separately from their biological mother has negative coefficients for females and positive coefficients for males, which suggests that females are exploited as alternative labor for mother in such households. The investigation of the birth-order effect reveals that the presence of older sisters positively influences younger brother’s school attendance. Because the school attendance ratio for older sisters is low, we can guess that by increasing hours of work older sisters help younger brothers study at school. No birth-order effect is detected for female children. Furthermore, similar to the regression results for educational attainment, the highest levels of education attained by adult members are positively and significantly correlated with school attendance of both female and male children, whereas age of the household head and the level of household total expenditure per capita are significantly correlated with male children’s school attendance.

Table 5 shows the estimation results for children aged 15 to 18. The estimation results from the baseline model show that female maternal orphans and male paternal orphans who lost their parent at age 7 or below are less likely to attend school. Also, female paternal and double orphans and male maternal orphans who lost their parent in the middle of schooling are less likely to continue to attend school. The inclusion of the measure of past educational progression and its interaction terms with orphan status at the time of last school attendance gives us very interesting findings. The measure of past educational progression and current school attendance are negatively correlated among non-orphans. Yet, the negative correlations are offset among orphans and even become positive, particularly among female double orphans and male orphans. While the degree of past educational progression is not associated with schooling decisions among female single orphans, slower past educational progression raises the probability of terminating school attendance among female double orphans. This tendency is more pronounced among male orphans. Male orphans with faster educational progression tend to continue to attend school, whereas those with slower educational progression are more likely to terminate their schooling. Suppose that the measure of past educational progression is correlated with unobservable child characteristics such as learning ability. The estimation results suggest that, while male orphans with high ability are more likely to survive, those with low ability are more likely to quit schooling. Innate learning ability rather than orphanhood seems to be a more influential factor for the continuation of their schooling, although the measure of past educational progression itself might be influenced by the history of orphan status.

The estimation results for the other covariates are shown in Table C3 in Appendix C. Both female and male non-orphans living separately from their biological mother are less likely to attend school. Male non-orphans living away from their biological father also have lower school attendance ratio, whereas father's absence does not negatively affect the school attendance of female non-orphans. The scenario we postulate for orphans may also apply to non-orphans who have already left their original household. The birth-order effect reveals that the presence of older sisters positively influences younger sister's school attendance. The higher ratios of working age female members also have a positive influence on female children's school attendance. The higher availability of women's labor would assist female children attend school. The highest levels of education attained by adult members are positively and significantly correlated, and the level of household total expenditure also has positive and significant coefficients for both female and male children at higher ages.

5.3 Never Enrolled in Formal Education

By now, we have examined the two mechanisms that yield the trajectories of mean educational attainment for orphans shown in Figure 4. One is that orphans lag behind in their educational progression due to grade repetition[14] and the other one is that orphans are more likely drop out of school even with a control of past educational progression. In this last sub-section, we explore the factors associated with the status of being never enrolled in formal education. The estimation results are shown in Table 6. We run the regressions for all children aged 7 to 18, and the 7-14 age group and the 15-18 age group separately. The estimation results indicate that at around the time of school entrance orphans are not less likely to enroll in formal education, but children who did not enroll in school are more likely to experience a parental death later. These findings are consistent with those in Yamano and Jayne (2005). Because of a rise in the shadow wage of children due to the presence of a sick parent in the family, they are less likely to enroll in formal education at the age of school entrance. This analysis thus suggests us the third mechanism that orphans' educational attainment appears to be slower. Note that the raised shadow wage due to the need of caring for sick parents even before their orphanhood also yields a downward bias to an estimated non-linear function of age for non-orphans. This also leads us to an underestimation of the negative effects associated with parental deaths.

The estimation results for the other covariates are shown in Table C4 in Appendix C. Female non-orphans living separately from their biological mother and male non-orphans living away from their biological father are more likely to be categorized into this group at higher ages suggesting that labor substitutability among the same gender group at higher ages is much stronger. The birth-order effect reveals that the presence of older sisters negatively influences younger sibling's school enrollment at younger ages. In addition, among female children aged 7 to 14, household demographic variables such as the ratio of female adults and household size are significant, which suggest that young females are mo re susceptive to labor demand in the household. The highest levels of education attained by adult members significantly reduce those who have never enrolled in school. Also the higher level of household total expenditure per capita lowers the probability of being never enrolled in formal education.

6. Conclusion

This paper explores the factors that shape the dynamics of educational attainment for orphans in sub-Saharan Africa. A theoretical model, with a presumption that orphans may experience an immediate negative impact (grade repetition) associated with a parental death, predicts that there are three phases of orphans' educational progression; 1) orphans lag behind in their educational progression after a parental death, 2) yet continue to attend school at younger ages, 3) however, they are more likely to drop out of school at higher ages if they face discriminately circumstances. Empirical analysis examines this prediction by taking into account the timing of losing a parent or both, and shows that in Malawi the patterns of educational progression, particularly for female maternal orphans, follow the predicted pattern. This indicates that female maternal orphans are most vulnerable to a shock of parental deaths.

The findings of the largest adverse effects on maternal orphans echo to those of Evans and Miguel (2007) in Kenya and Beegle et al. (2010) in Tanzania, but this study further reveals the mechanism in which orphans disadvantageous educational outcomes appear as they grow up. In the first phase, in addition to female maternal orphans, we have found that in Malawi father's death has a negative impact on male children in terms of educational progression. Furthermore, we have found that double orphans tend to lag behind in their educational progression. The existence of the second phase is evident meaning that, the pace of orphans' educational progression is slower than that of two-parent children, yet the majority of them continue to attend school at younger ages. In this sense, fostering experiences are able to mitigate the adverse effects of parental deaths on children's educational progression, and explain the minimal difference in school attendance among primary-school-age children. In the third phase, however, female maternal orphans are more likely to quit schooling at higher ages regardless of the degree of past educational progression. On the other hand, female double orphans with faster educational progression are more likely to remain in school at higher ages, whereas those with slower educational progression are more likely to quit schooling. The same tendency can be seen among male orphans. While male orphans with faster educational progression tend to remain in school at higher ages, those with slower educational progression are more likely to stop schooling. One can argue that in the African extended family system, child-fostering and adoption decisions are simultaneously made with decisions on various children's activities, including school attendance. It seems that, while female maternal orphans are adopted in response to labor demand for household domestic chores such as cooking, washing and taking care of young children, female double orphans and male orphans are adopted for various reasons including for the purpose of educational investment. Mixed motives for child fostering can coexists (Serra, 2009), and these mixed motives might be able to explain the heterogeneous educational outcomes among female double orphans and male orphans.

The central policy question, based on the investigation of the dynamics of orphans' educational attainment, is the best timing of policy intervention and the effectiveness of support programs that help orphans go to school. These policy recommendations should be country-specific (Ainsworth and Filmer 2006). The one we can draw from our study in Malawi is threefold: 1) an immediate support after a parental death or even before should be provided for both female and male orphans to prevent the delay in their educational progression, 2) more emphasis has to be put on female maternal orphans at higher ages, and 3) assistance for female double orphans and male orphans with slower educational progression at higher ages is also required. The detected patterns of educational attainment for female and male orphans are different, and thus the most effective policy option should also be gender-specific. Since discriminatory educational attainment maintains the poverty structure over generations, ameliorating the negative impacts of parental deaths will support the efforts of poor households to get out of poverty and enhance the capability of alleviating poverty over the next generations.

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Table 1: Orphaned children, adolescents, and young adults in Malawi

Age	Female						Male					
	Non-orphans			Orphans			Non-orphans			Orphans		
	No.	%	% of head / spouse	No.	%	% of head / spouse	No.	%	% of head / spouse	No.	%	% of head / spouse
7	743	(89.7)	0.0	85	(10.3)	0.0	741	(88.5)	0.0	96	(11.5)	0.0
8	715	(85.2)	0.0	124	(14.8)	0.0	719	(86.2)	0.0	115	(13.8)	0.0
9	641	(86.9)	0.0	97	(13.1)	0.0	638	(85.9)	0.0	105	(14.1)	0.0
10	615	(83.1)	0.0	125	(16.9)	0.0	637	(86.3)	0.0	101	(13.7)	0.0
11	691	(83.4)	0.0	138	(16.6)	0.0	613	(82.5)	0.0	130	(17.5)	0.0
12	555	(80.6)	0.0	134	(19.4)	0.0	498	(80.3)	0.0	122	(19.7)	0.0
13	542	(77.0)	0.0	162	(23.0)	0.0	508	(76.9)	0.0	153	(23.1)	0.0
14	476	(76.9)	0.0	143	(23.1)	0.0	444	(73.8)	0.0	158	(26.2)	0.0
15	378	(71.1)	0.0	154	(28.9)	1.3	445	(73.0)	0.0	165	(27.0)	0.6
16	381	(72.8)	2.6	142	(27.2)	3.5	403	(72.7)	0.2	151	(27.3)	1.3
17	364	(73.4)	9.1	132	(26.6)	10.6	342	(72.3)	0.0	131	(27.7)	2.3*
18	337	(68.8)	23.1	153	(31.2)	24.8	352	(68.6)	2.3	161	(31.4)	0.6
19	405	(71.8)	42.0	159	(28.2)	45.9	329	(68.5)	2.1	151	(31.5)	6.0*
20	379	(66.7)	53.6	189	(33.3)	60.8*	295	(68.4)	8.5	136	(31.6)	9.6
21	388	(66.9)	60.6	192	(33.1)	69.3**	318	(66.7)	16.4	159	(33.3)	18.9
22	347	(64.3)	67.4	193	(35.7)	80.3***	287	(66.3)	31.4	146	(33.7)	39.0
23	340	(63.3)	75.9	197	(36.7)	76.6	295	(62.9)	41.7	174	(37.1)	48.3
24	308	(67.4)	76.3	149	(32.6)	81.2	263	(64.6)	53.6	144	(35.4)	54.2
All	8605	(76.3)	16.9	2668	(23.7)	30.2***	8127	(76.5)	5.5	2498	(23.5)	11.1***

Note: ‘Orphans’ are defined as children who have at least one deceased parent under before age 18 (UNAIDS/UNICEF/USAID, 2004). Statistical test results (standard errors are cluster-adjusted at the district level) are shown for the differences between non-orphaned and orphaned individuals; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2: Orphan status and duration of orphanhood

Age	No. of Children	Maternal orphan %	Maternal orphan duration (years) mean	s.d.	Paternal orphan %	Paternal orphan duration (years) mean	s.d.	Double orphan %	Double orphan duration (years) [(a)] mean	s.d.
Female										
7	823	2.2	2.56	(1.58)	6.2	2.55	(1.79)	1.7	1.86	(1.17)
8	836	3.9	2.94	(1.60)	8.6	3.14	(2.05)	2.3	3.47	(2.59)
9	730	2.5	3.89	(2.35)	7.9	2.98	(2.25)	2.5	2.44	(1.62)
10	737	4.2	2.74	(2.54)	9.6	3.96	(2.52)	3.1	2.96	(2.31)
11	825	4.4	3.47	(2.65)	9.0	4.18	(2.72)	3.2	3.77	(2.78)
12	688	3.5	4.21	(3.31)	11.6	4.51	(3.01)	4.4	2.93	(2.20)
13	694	5.6	4.41	(3.48)	12.7	4.60	(3.32)	4.9	3.35	(2.65)
14	613	4.2	4.31	(3.72)	13.4	4.40	(3.03)	5.5	3.62	(2.63)
15	531	5.5	5.79	(4.39)	14.7	5.45	(4.27)	8.7	4.61	(3.17)
16	520	5.2	6.15	(4.31)	13.7	5.28	(3.57)	8.3	4.63	(3.21)
17	493	5.5	4.78	(4.50)	13.0	6.08	(4.55)	8.3	5.15	(3.44)
18	487	6.8	6.91	(5.89)	15.8	6.19	(4.49)	8.6	5.07	(4.36)
All	7977	4.3	4.40	(3.83)	10.9	4.52	(3.45)	4.6	3.95	(3.11)
Male										
7	827	2.5	2.52	(1.44)	7.1	3.02	(1.76)	1.8	1.93	(1.79)
8	828	3.0	2.56	(1.92)	7.9	3.42	(1.96)	3.0	2.56	(1.73)
9	739	4.3	2.56	(2.34)	7.7	3.84	(2.34)	2.0	4.00	(2.20)
10	737	3.5	3.42	(2.12)	7.7	4.02	(2.59)	2.4	3.33	(2.40)
11	736	3.8	3.79	(2.44)	9.8	4.11	(2.99)	3.9	2.72	(2.12)
12	612	5.1	4.03	(3.03)	10.3	4.76	(3.21)	3.9	3.21	(2.02)
13	659	4.6	5.37	(3.59)	14.3	3.88	(2.82)	4.4	3.31	(2.84)
14	598	6.0	4.53	(3.34)	13.2	5.01	(3.75)	6.7	4.60	(2.99)
15	607	7.4	5.20	(4.06)	12.4	5.04	(3.43)	7.2	4.95	(3.09)
16	551	4.9	5.33	(4.13)	15.6	5.59	(3.91)	6.7	4.03	(3.28)
17	472	4.4	5.86	(4.82)	16.9	5.94	(4.24)	6.4	4.10	(3.14)
18	513	6.4	5.94	(4.37)	16.4	5.44	(4.65)	8.6	5.07	(3.49)
All	7879	4.5	4.34	(3.51)	11.1	4.59	(3.44)	4.4	3.89	(2.92)

Note: Sample is individuals with information on orphan status and education.
(a) Duration as a double orphan

Table 3: Summary statistics of explanatory variables

Explanatory Variables	*Female aged 7 to 18 (n=7977)*				*Male aged 7 to 18 (n=7879)*			
	mean	s.d.	min	max	mean	s.d.	min	max
Measure of past educational progression[(a)]	0.450	(0.306)	0	1	0.414	(0.295)	0	1
Orphan Status								
Maternal orphan								
Orphaned at 15 or above (=1)	0.003	(0.054)	0	1	0.003	(0.050)	0	1
Orphaned at 11-14 (=1)	0.009	(0.095)	0	1	0.010	(0.097)	0	1
Orphaned at 8-10 (=1)	0.014	(0.116)	0	1	0.015	(0.120)	0	1
Orphaned at 7 or below (=1)	0.027	(0.162)	0	1	0.027	(0.162)	0	1
Paternal orphan								
Orphaned at 15 or above (=1)	0.005	(0.070)	0	1	0.006	(0.079)	0	1
Orphaned at 11-14 (=1)	0.024	(0.152)	0	1	0.024	(0.152)	0	1
Orphaned at 8-10 (=1)	0.029	(0.169)	0	1	0.030	(0.172)	0	1
Orphaned at 7 or below (=1)	0.067	(0.250)	0	1	0.066	(0.249)	0	1
Double orphan								
Orphaned at 15 or above (=1)	0.003	(0.055)	0	1	0.003	(0.058)	0	1
Orphaned at 11-14 (=1)	0.013	(0.113)	0	1	0.011	(0.106)	0	1
Orphaned at 8-10 (=1)	0.014	(0.119)	0	1	0.013	(0.113)	0	1
Orphaned at 7 or below (=1)	0.016	(0.126)	0	1	0.017	(0.128)	0	1
Living Arrangement								
Non-orphan living away from mother (=1)	0.139	(0.346)	0	1	0.124	(0.330)	0	1
Non-orphan living away from father (=1)	0.232	(0.422)	0	1	0.208	(0.406)	0	1
Other Child Characteristics								
Age	11.88	(3.36)	7	18	11.93	(3.41)	7	18
Ratio of older female siblings (up to 20)[(b)]	0.090	(0.119)	0	0.800	0.091	(0.120)	0	0.750
Ratio of older male siblings (up to 20)[(b)]	0.081	(0.113)	0	0.667	0.082	(0.112)	0	0.600
Household Characteristics								
Age of the household head	45.32	(13.67)	14	104	46.22	(13.46)	14	98
Highest education among female adults (above 20)	3.283	(3.487)	0	17	3.079	(3.422)	0	17
Highest education among male adults (above 20)	5.473	(3.555)	0	17	5.383	(3.591)	0	17
Ratio of female adults (above 20)[(b)]	0.192	(0.097)	0	1	0.194	(0.095)	0	1
Ratio of male adults (above 20)[(b)]	0.160	(0.111)	0	1	0.158	(0.105)	0	1
Log (household size)	1.787	(0.394)	0	3.296	1.812	(0.374)	0	3.296
Log (total expenditure per capita)	9.913	(0.629)	6.870	12.94	9.892	(0.613)	6.870	12.94

Note: Sample is individuals with information on orphan status and education.
(a) Measure is defined as (Highest grade attended by the preceding year) / (age at the time of last school attendance - 5))
(b) Ratios are to household size.

Table 4: School attendance (children aged 7 to 14 who have enrolled in formal education)
– Logistic regressions –

Dependent Variable	Female			Male		
School attendance (=1)	(A)	(B)	(C)	(D)	(E)	(F)
Past educational progression * Orphan status [(a)]						
Highest grade attended by the preceding year) / (age - 5)		-0.015	-0.025*		-0.031**	-0.038**
		(0.012)	(0.013)		(0.014)	(0.016)
* Maternal orphan			0.025			0.056*
			(0.026)			(0.030)
* Paternal orphan			0.068**			0.028
			(0.034)			(0.034)
* Double orphan			0.032			0.059
			(0.059)			(0.074)
Orphan Status						
Maternal orphan						
Orphaned at 11-14 (=1)	-0.013	-0.012	-0.022	0.009	0.011	-0.011
	(0.026)	(0.026)	(0.030)	(0.034)	(0.034)	(0.037)
Orphaned at 8-10 (=1)	-0.017	-0.016	-0.028	-0.037**	-0.036**	-0.059***
	(0.021)	(0.021)	(0.020)	(0.016)	(0.016)	(0.022)
Orphaned at 7 or below (=1)	-0.041***	-0.040***	-0.053***	-0.020	-0.018	-0.041**
	(0.014)	(0.014)	(0.018)	(0.014)	(0.014)	(0.019)
Paternal orphan						
Orphaned at 11-14 (=1)	-0.031	-0.031	-0.057**	-0.016	-0.014	-0.026
	(0.022)	(0.022)	(0.022)	(0.019)	(0.019)	(0.029)
Orphaned at 8-10 (=1)	0.010	0.010	-0.017	-0.012	-0.011	-0.021
	(0.020)	(0.020)	(0.021)	(0.020)	(0.020)	(0.018)
Orphaned at 7 or below (=1)	-0.016	-0.016	-0.042**	-0.013	-0.012	-0.024
	(0.016)	(0.016)	(0.016)	(0.015)	(0.014)	(0.022)
Double orphan						
Orphaned at 11-14 (=1)	-0.025	-0.025	-0.021			
	(0.027)	(0.026)	(0.044)			
Orphaned at 8-10 (=1)	-0.015	-0.015	-0.012	0.006	0.006	0.002
	(0.013)	(0.013)	(0.036)	(0.020)	(0.020)	(0.022)
Orphaned at 7 or below (=1)	0.001	0.001	-0.014	-0.015	-0.017	-0.038
	(0.024)	(0.025)	(0.034)	(0.025)	(0.025)	(0.044)
Control variables	Included	Included	Included	Included	Included	Included
Observations	5146	5146	5146	4910	4910	4910
Pseudo R-sq.	0.158	0.159	0.164	0.138	0.144	0.145

Note: Coefficients on continuous variables indicate marginal changes in the probability evaluated at the mean values, and coefficients on dummy variables indicate changes in the probability when the value of the dummy variables changes from zero to one. Cluster-adjusted standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
Full estimation results are shown in Appendix C (Table C2).
(a) Adjusted by age and orphan status at the time of last school attendance if not attended school in the preceding year.

Table 5: School attendance (children aged 15 to 18 who have enrolled in formal education)
– Logistic regressions –

Dependent Variable	Female			Male		
School attendance (=1)	(A)	(B)	(C)	(D)	(E)	(F)
Past educational progression * Orphan status [(a)]						
Highest grade attended by the preceding year) / (age – 5)		-0.100	-0.150**		-0.140*	-0.220***
		(0.067)	(0.071)		(0.070)	(0.064)
* Maternal orphan			0.150			0.260*
			(0.150)			(0.150)
* Paternal orphan			0.130			0.380***
			(0.084)			(0.120)
* Double orphan			0.320**			0.530***
			(0.130)			(0.190)
Orphan Status						
Maternal orphan						
Orphaned at 15 or above (=1)	-0.082	-0.082	-0.130*	0.017	0.023	-0.086
	(0.057)	(0.056)	(0.069)	(0.081)	(0.082)	(0.089)
Orphaned at 11-14 (=1)	-0.043	-0.046	-0.110	-0.190***	-0.190***	-0.300***
	(0.052)	(0.052)	(0.075)	(0.043)	(0.040)	(0.073)
Orphaned at 8-10 (=1)	0.047	0.046	-0.030	-0.120*	-0.110*	-0.250***
	(0.110)	(0.110)	(0.130)	(0.067)	(0.064)	(0.093)
Orphaned at 7 or below (=1)	-0.110**	-0.120**	-0.180**	0.092	0.091	-0.060
	(0.056)	(0.056)	(0.082)	(0.076)	(0.075)	(0.077)
Paternal orphan						
Orphaned at 15 or above (=1)	-0.089	-0.087	-0.140*	-0.070*	-0.064	-0.230***
	(0.075)	(0.076)	(0.078)	(0.041)	(0.043)	(0.075)
Orphaned at 11-14 (=1)	-0.091***	-0.091***	-0.150***	-0.015	-0.011	-0.180***
	(0.031)	(0.031)	(0.046)	(0.045)	(0.043)	(0.061)
Orphaned at 8-10 (=1)	-0.016	-0.017	-0.080	-0.049	-0.052	-0.210***
	(0.066)	(0.067)	(0.087)	(0.033)	(0.033)	(0.046)
Orphaned at 7 or below (=1)	0.047	0.048	-0.019	-0.110***	-0.110***	-0.290***
	(0.046)	(0.045)	(0.043)	(0.032)	(0.032)	(0.059)
Double orphan						
Orphaned at 15 or above (=1)	-0.002	0.005	-0.079	0.025	0.025	-0.110
	(0.071)	(0.072)	(0.091)	(0.073)	(0.074)	(0.120)
Orphaned at 11-14 (=1)	-0.091*	-0.090*	-0.200**	0.079	0.077	-0.046
	(0.050)	(0.049)	(0.086)	(0.054)	(0.054)	(0.090)
Orphaned at 8-10 (=1)	-0.072	-0.075	-0.190*	-0.072	-0.081	-0.160
	(0.082)	(0.082)	(0.100)	(0.055)	(0.052)	(0.110)
Orphaned at 7 or below (=1)	0.055	0.051	-0.120	-0.045	-0.052	-0.290**
	(0.099)	(0.100)	(0.110)	(0.092)	(0.092)	(0.140)
Control variables	Included	Included	Included	Included	Included	Included
Observations	1878	1878	1878	2000	2000	2000
Pseudo R-sq.	0.233	0.235	0.238	0.124	0.129	0.144

Note: Coefficients on continuous variables indicate marginal changes in the probability evaluated at the mean values, and coefficients on dummy variables indicate changes in the probability when the value of the dummy variables changes from zero to one. Cluster-adjusted standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
Full estimation results are shown in Appendix C (Table C3).
(a) Adjusted by age and orphan status at the time of last school attendance if not attended school in the preceding year.

Table 6: Never enrolled in formal education (children aged 7 to 18)
– Logistic regressions –

Dependent Variable	Female			Male		
	All	7-14	15-18	All	7-14	15-18
Never enrolled (=1)	(A)	(B)	(C)	(D)	(E)	(F)
Orphan Status						
Maternal orphan						
Orphaned at 11-14 (=1)	0.005	-0.019	0.050	-0.042		-0.001
	(0.025)	(0.088)	(0.032)	(0.040)		(0.027)
Orphaned at 8-10 (=1)	0.003	-0.047	0.093**	0.060***	0.077***	0.013
	(0.030)	(0.051)	(0.045)	(0.021)	(0.029)	(0.034)
Orphaned at 7 or below (=1)	-0.035	-0.074***	0.068*	0.014	0.014	0.010
	(0.024)	(0.026)	(0.040)	(0.021)	(0.023)	(0.045)
Paternal orphan						
Orphaned at 11-14 (=1)	-0.015	-0.061	0.024	-0.046	-0.094	0.000
	(0.032)	(0.079)	(0.030)	(0.030)	(0.088)	(0.022)
Orphaned at 8-10 (=1)	0.011	-0.021	0.075**	0.011	0.000	0.033*
	(0.027)	(0.033)	(0.034)	(0.021)	(0.033)	(0.018)
Orphaned at 7 or below (=1)	-0.002	-0.022	0.062	0.025*	0.013	0.052**
	(0.013)	(0.014)	(0.040)	(0.013)	(0.020)	(0.022)
Double orphan						
Orphaned at 11-14 (=1)	0.060*	0.093*	0.024	0.016	0.100*	-0.024
	(0.036)	(0.055)	(0.036)	(0.021)	(0.053)	(0.040)
Orphaned at 8-10 (=1)	0.034	0.069**	-0.076	0.034	0.028	0.028
	(0.026)	(0.033)	(0.068)	(0.027)	(0.041)	(0.049)
Orphaned at 7 or below (=1)	-0.022	-0.038	0.014	0.009	0.002	0.004
	(0.025)	(0.032)	(0.062)	(0.027)	(0.031)	(0.068)
Control variables	Included	Included	Included	Included	Included	Included
Observations	7977	5946	2031	7879	5736	2143
Pseudo R-sq.	0.198	0.218	0.181	0.211	0.218	0.132

Note: Coefficients on dummy variables indicate changes in the probability when the value of the dummy variables changes from zero to one. Cluster-adjusted standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
Full estimation results are shown in Appendix C (Table C4).

Figure 1: School attendance ratios by age cohort

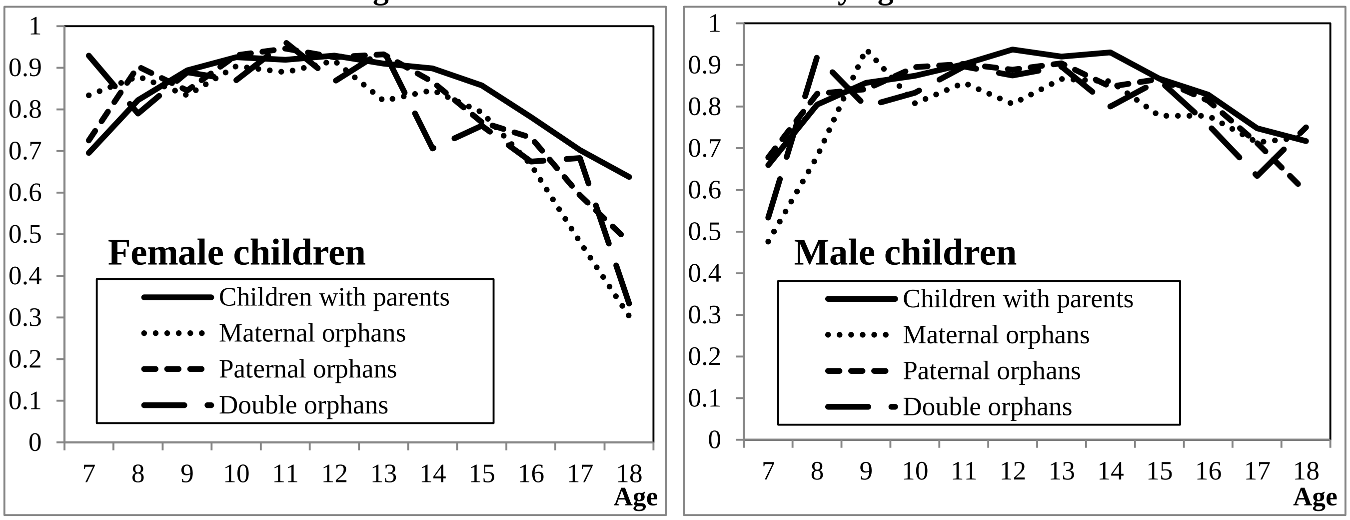


Figure 2: Mean educational attainment (highest grade attended) by age cohort

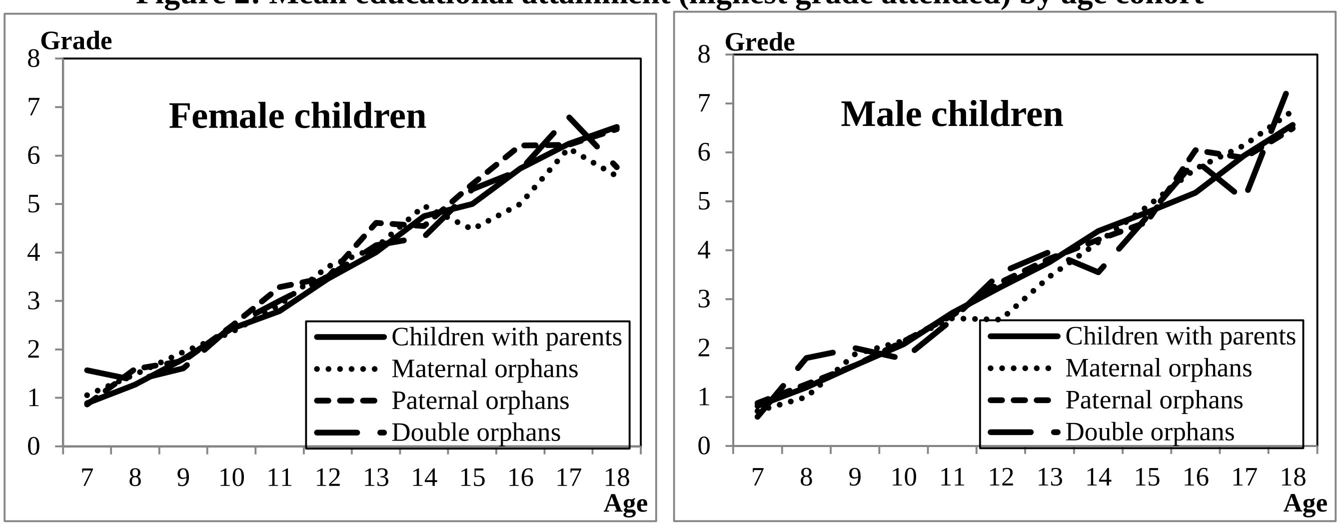


Figure 3: Patterns of educational progression for orphans – theoretical prediction

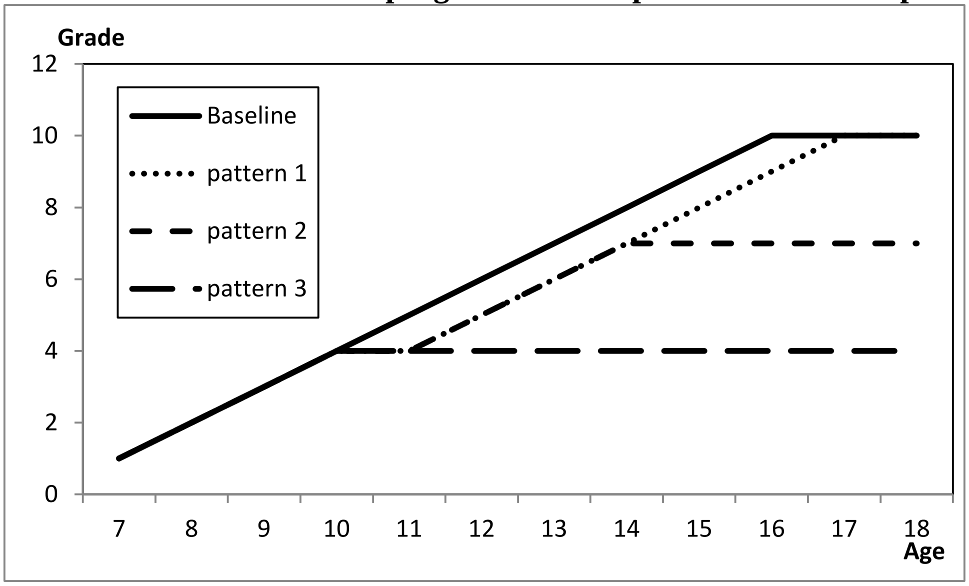
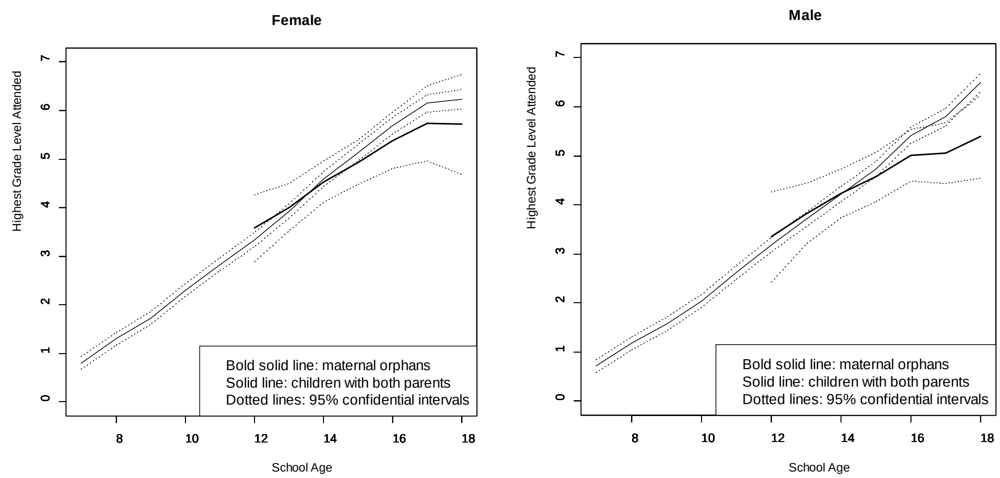
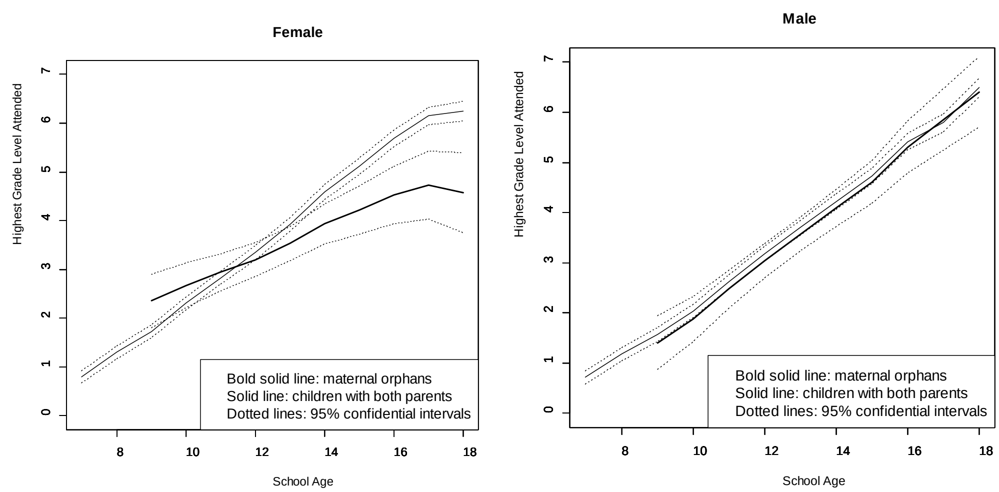


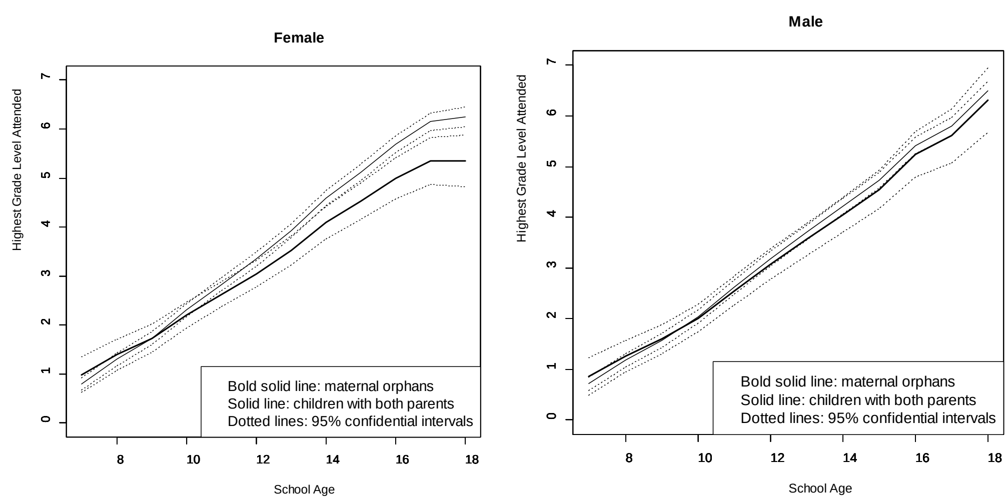
Figure 4A: Predicted educational attainment (highest grade attended evaluated at the mean values) among maternal orphans (7-18)



Orphaned at age 11-14

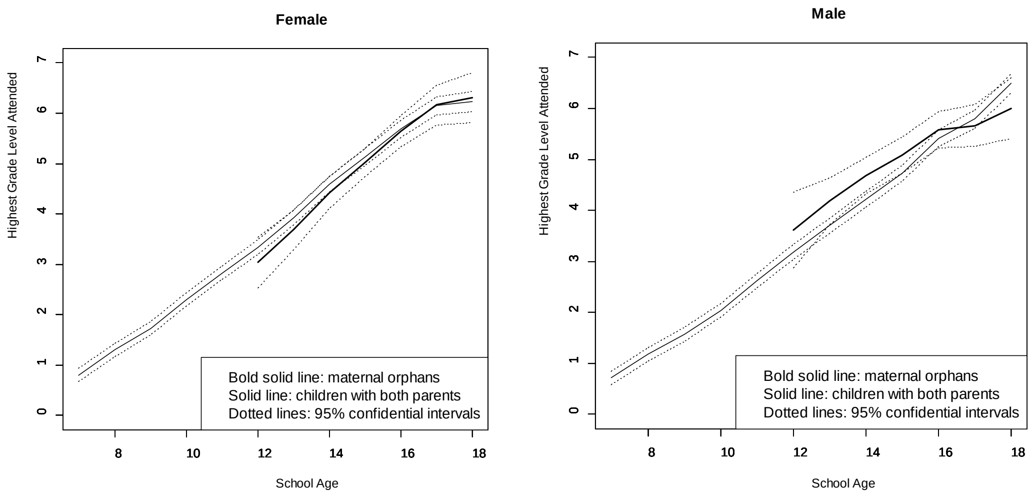


Orphaned at age 8-10

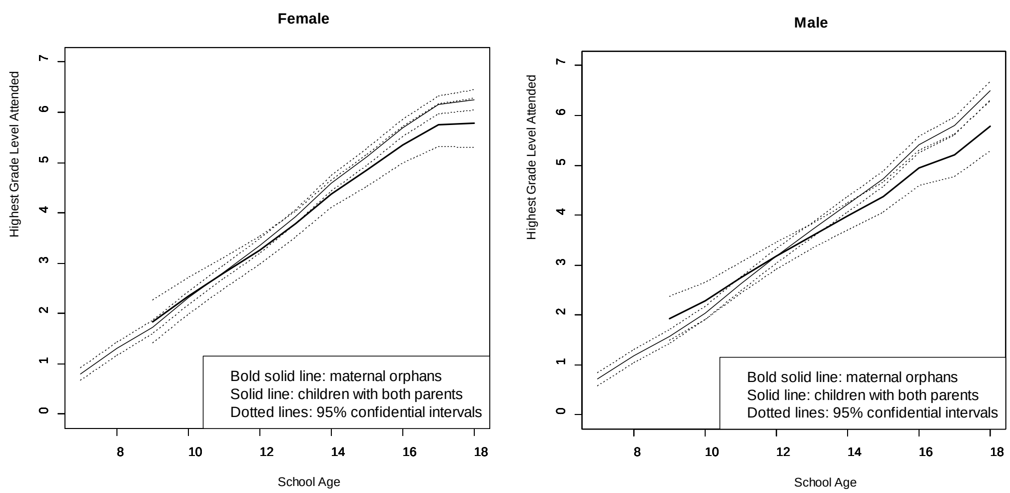


Orphaned at age 7 or below

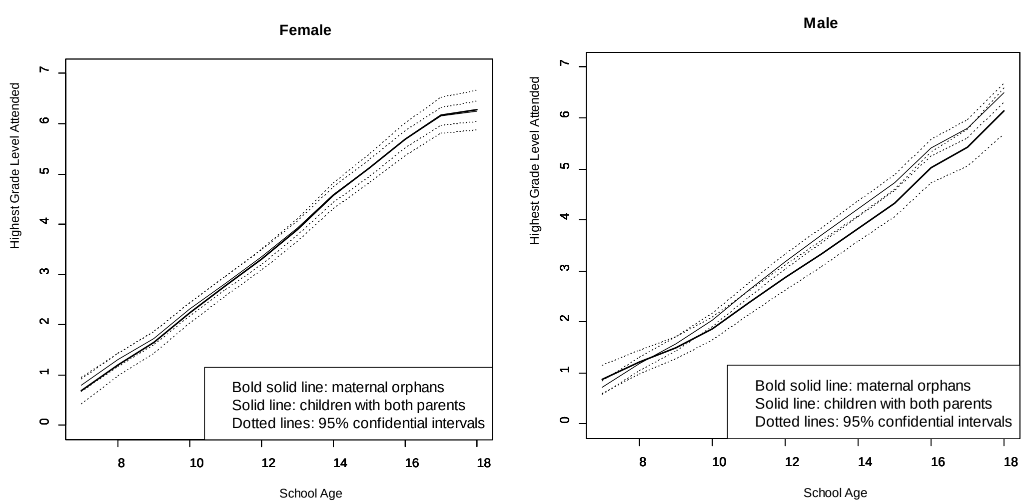
Figure 4B: Predicted educational attainment (highest grade attended evaluated at the mean values) among paternal orphans (7-18)



Orphaned at age 11-14

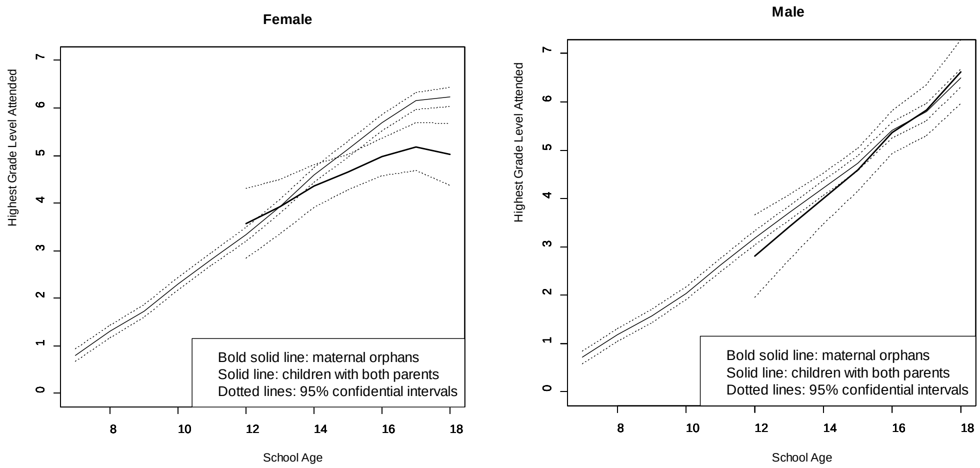


Orphaned at age 8-10

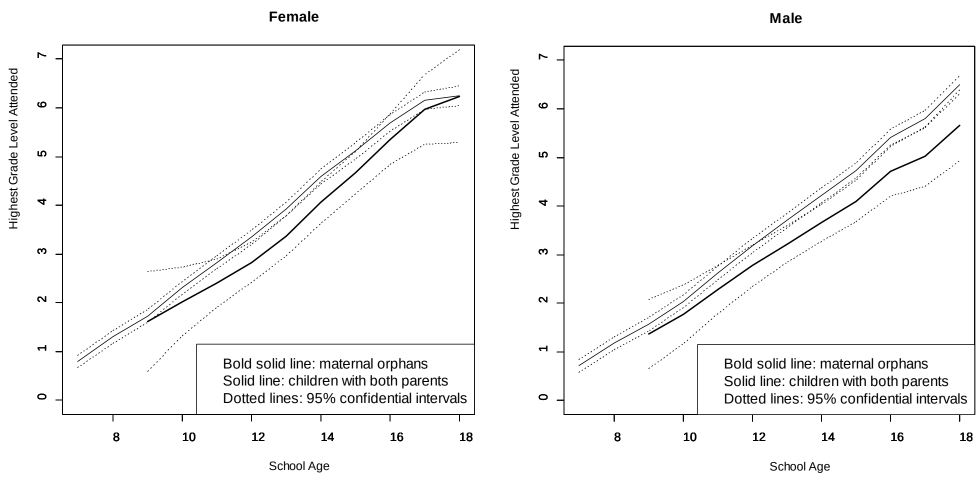


Orphaned at age of 7 or below

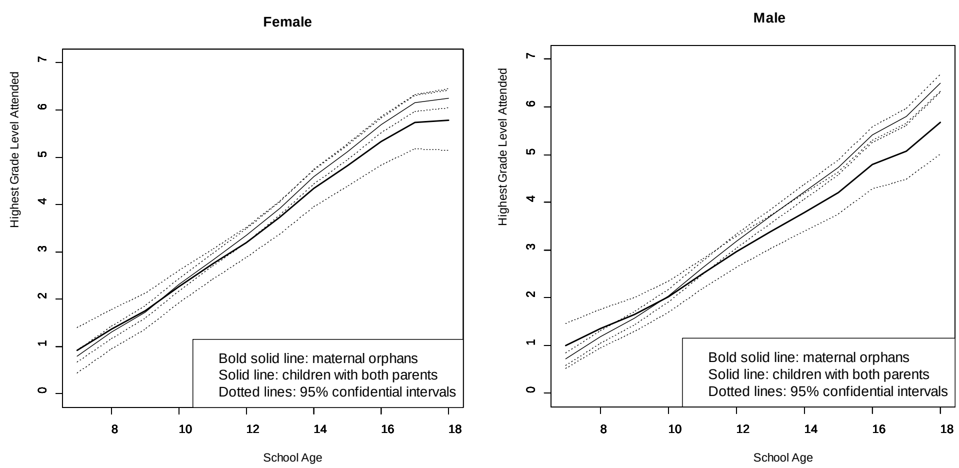
Figure 4C: Predicted educational attainment (highest grade attended evaluated at the mean values) among double orphans (7-18)



Orphaned at age 11-14



Orphaned at age 8-10



Orphaned at age 7 or below

Appendix A: Model of Children's Schooling Decisions (non-stochastic version)

This section illustrates the solution of the theoretical model (1)-(5). The FOC with respect to S_t is

$$\lambda_1^t(1+r)\bar{p}_t + \lambda_3^t w_t + \lambda_4^t(2S_t - 1) = \partial u/\partial S_t + \lambda_2^t \ . \quad \text{(A1)}$$

The FOC with respect to y_t is $\lambda_3^t = (1+r)\lambda_1^t$,

and by ignoring the term $\partial u/\partial S_t$, we have

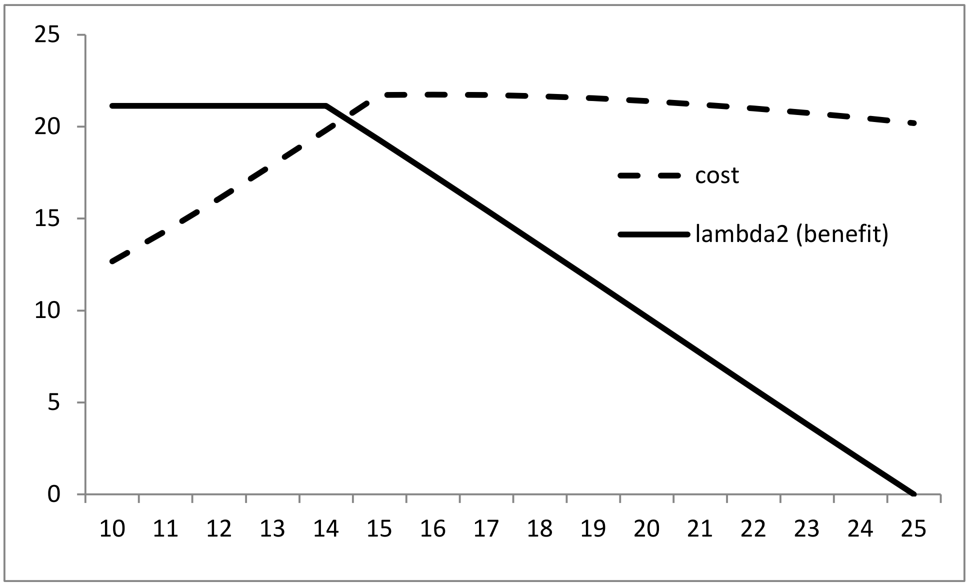
$$\lambda_3^t(\bar{p}_t + w_t) + \lambda_4^t(2S_t - 1) = \lambda_2^t \ . \quad \text{(A2)}$$

The FOC with respect to H_t is

$$\lambda_2^{t+1} - \lambda_2^t = \lambda_3^{t+1}(S_{t+1} - 1)\frac{\partial w_{t+1}}{\partial H_{t+1}} \quad (\le 0). \quad \text{(A3)}$$

Then, the following wage function is employed as an example, and the figure below shows how the cost (right hand side of (A2)) and benefit (left hand side of (A2)) evolve over time. When the cost exceeds the benefit, the child quit schooling.

Example 1: $w_t = 5 \times H \times t$



Appendix B: Model of Children's Schooling Decisions (stochastic version)

Jacoby and Skoufias (1997) construct a theoretical model with uncertainty in the realization of income. Here, a theoretical model that incorporates uncertainty in the realization of successful grade completion is considered. The model can be written as

$$\max E_t \left\{ \sum_{t=t_0}^{T} \beta^{t-t_0} u(c_t, S_t) \right\} \tag{***}$$

subject to

$$A_{t+1} = (1+r)(A_t + y_t - c_t - \overline{p}_t S_t) \quad \text{(Asset accumulation: } \lambda_1^t\text{)} \tag{B1}$$

$$H_{t+1} = H_t + S_t \cdot D_t \quad \text{(Human capital accumulation: } \lambda_2^t\text{)} \tag{B2}$$

$$D_t = 0 \quad \text{(grade repetition at the end of time } t \text{ with probability } q\text{)} \tag{B2a}$$

$$D_t = 1 \quad \text{(grade completion with probability } 1-q\text{)} \tag{B2b}$$

$$y_t = (1-S_t)w_t + \overline{R}_t \quad \text{(Income stream: } \lambda_3^t\text{)} \tag{B3}$$

$$S_t(1-S_t) = 0 \quad \text{(Discrete Choice of Schooling: } \lambda_4^t\text{)} \tag{B4}$$

where $t = t_0, t_0 + 1, \cdots, T$.

In the case of the non-stochastic version of the model, we have

$$V_t(age_t, H_t, A_t) = \max_{c_t, S_t}\{u(c_t, S_t) + V_{t+1}(age_{t+1}, H_{t+1}, A_{t+1})\}$$

$$= \max\{\max_{c_t}\{u(c_t, 0) + V_{t+1}(age_t + 1, H_t, A_{t+1})\}, \max_{c_t}\{u(c_t, 1) + V_{t+1}(age_t + 1, H_t + 1, A_{t+1})\}\}$$

Similarly, for the stochastic version of the model, we have

$$V_t(age_t, H_t, A_t) = \max_{c_t, S_t}\{u(c_t, S_t) + V_{t+1}(age_{t+1}, H_{t+1}, A_{t+1})\}$$

$$= \max\{\max_{c_t}\{u(c_t, 0) + V_{t+1}(age_t + 1, H_t, A_{t+1})\},$$

$$\max_{c_t}\{u(c_t, 1) + qV_{t+1}(age_t + 1, H_t, A_{t+1}) + (1-q)V_{t+1}(age_t + 1, H_t + 1, A_{t+1})\}\},$$

which implies that children who are expected to repeat grade levels with higher probability are more likely to terminate their schooling.

Appendix C: Details of Estimation Results

Table C1: Highest grade levels attended (children aged 7 to 18) – Gaussian

Dependent Variable	Female	Male
Highest grade attended	(A)	(B)
Orphan Status and Living Arrangement		
Maternal orphan		
Orphaned at 15 or above (=1)	-2.364 (1.483)	0.972 (0.679)
Orphaned at 11-14 (=1)	0.231 (0.481)	0.179 (0.688)
Orphaned at 8-10 (=1)	0.937** (0.331)	-0.175 (0.320)
Orphaned at 7 or below (=1)	0.351. (0.204)	0.211 (0.227)
Paternal orphan		
Orphaned at 15 or above (=1)	0.425 (0.805)	1.852*** (0.526)
Orphaned at 11-14 (=1)	-0.291 (0.346)	0.336 (0.570)
Orphaned at 8-10 (=1)	0.225 (0.247)	0.476. (0.256)
Orphaned at 7 or below (=1)	-0.064 (0.142)	0.281 (0.178)
Double orphan		
Orphaned at 15 or above (=1)	3.237** (1.043)	1.081 (1.279)
Orphaned at 11-14 (=1)	0.486 (0.526)	-0.461 (0.521)
Orphaned at 8-10 (=1)	0.133 (0.701)	-0.132 (0.421)
Orphaned at 7 or below (=1)	0.235 (0.277)	0.379 (0.270)
Non-orphan		
Non-orphan living away from moher (=1)	0.212 (0.142)	-0.048 (0.140)
Non-orphan living away from father (=1)	0.038 (0.129)	0.111 (0.131)
Other Child Characteristics		
Age dummies	Included	Included
Ratio of older female siblings (up to 20) to household size	0.548** (0.182)	0.285 (0.181)
Ratio of older male siblings (up to 20) to household size	0.300. (0.169)	0.046 (0.164)

Household Characteristics		
Age of the household head (below 30) (=1)	-0.186*	-0.115
	(0.082)	(0.084)
Age of the household head (40-49) (=1)	0.079	0.048
	(0.052)	(0.051)
Age of the household head (50-59) (=1)	0.098.	0.035
	(0.059)	(0.058)
Age of the household head (above 60) (=1)	0.362***	0.225***
	(0.066)	(0.066)
Highest education among female adults (above 20)	0.119***	0.089***
	(0.007)	(0.007)
Highest education among male adults (above 20)	0.076***	0.094***
	(0.006)	(0.006)
Ratio of female adults (above 20) to household size	0.561*	0.220
	(0.256)	(0.256)
Ratio of male adults (above 20) to household size	0.200	0.251
	(0.232)	(0.247)
Log (household size)	0.421***	0.236***
	(0.069)	(0.070)
Log (total expenditure per capita)	0.668***	0.554***
	(0.036)	(0.037)
Constant	-6.884***	-5.377***
	(0.439)	(0.448)
Regional dummies	Included	Included
Observations	7977	7879
R-sq.	0.626	0.623

Note: Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%
Computations are executed by using the ‘mgcv’ package of R software (version 1.8-3).
The estimation results of non-linear parts are illustrated in Figure 4.

Table C2: School attendance (children aged 7 to 14 who have enrolled in formal education) – Logistic regressions –

Dependent Variable	Female			Male		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
School attendance (=1)	(A)	(B)	(C)	(D)	(E)	(F)
Living Arrangement						
Non-orphan						
Non-orphan living away from mother (=1)	-0.034***	-0.033***	-0.033***	0.018*	0.019*	0.020*
	(0.011)	(0.011)	(0.010)	(0.011)	(0.011)	(0.011)
Non-orphan living away from father (=1)	0.016	0.015	0.015	-0.016	-0.016	-0.016
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Other Child Characteristics						
Age dummies	Included	Included	Included	Included	Included	Included
Ratio of older female siblings (up to 20) to household size	0.017	0.016	0.015	0.077**	0.074**	0.074**
	(0.028)	(0.028)	(0.028)	(0.032)	(0.032)	(0.032)
Ratio of older male siblings (up to 20) to household size	-0.006	-0.008	-0.007	0.006	0.003	0.001
	(0.027)	(0.027)	(0.027)	(0.035)	(0.035)	(0.035)
Household Characteristics						
Age of the household head (below 30) (=1)	-0.002	-0.002	0.000	-0.022*	-0.022*	-0.022*
	(0.010)	(0.010)	(0.011)	(0.012)	(0.011)	(0.011)
Age of the household head (40-49) (=1)	-0.003	-0.003	-0.003	-0.017	-0.016	-0.016
	(0.008)	(0.008)	(0.008)	(0.011)	(0.011)	(0.011)
Age of the household head (50-59) (=1)	0.003	0.004	0.004	-0.029**	-0.029**	-0.029**
	(0.009)	(0.008)	(0.009)	(0.012)	(0.012)	(0.012)
Age of the household head (above 60) (=1)	0.011	0.012	0.012	-0.014	-0.012	-0.013
	(0.010)	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)
Highest education among female adults (above 20)	0.004***	0.004***	0.004***	0.006***	0.006***	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Highest education among male adults (above 20)	0.004***	0.004***	0.004***	0.004***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Ratio of female adults (above 20) to household size	0.042	0.039	0.036	-0.005	-0.008	-0.008
	(0.058)	(0.057)	(0.057)	(0.045)	(0.046)	(0.045)
Ratio of male adults (above 20) to household size	0.068	0.066	0.067	0.047	0.043	0.043
	(0.043)	(0.043)	(0.043)	(0.063)	(0.063)	(0.061)
Log (household size)	-0.003	-0.004	-0.004	-0.003	-0.004	-0.003
	(0.013)	(0.014)	(0.014)	(0.010)	(0.010)	(0.011)
Log (total expenditure per capita)	0.009	0.010	0.009	0.013**	0.015**	0.015**
	(0.008)	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
District dummies	Included	Included	Included	Included	Included	Included
Observations	5146	5146	5146	4910	4910	4910
Pseudo R-sq.	0.158	0.159	0.164	0.138	0.144	0.145

Note: Coefficients on continuous variables indicate marginal changes in the probability evaluated at the mean values, and coefficients on dummy variables indicate changes in the probability when the value of the dummy variables changes from zero to one.
Cluster-adjusted standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table C3: School attendance (children aged 15 to 18 who have enrolled in formal education) – Logistic regressions –

Dependent Variable	Female			Male		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
School attendance (=1)	(A)	(B)	(C)	(D)	(E)	(F)
Living Arrangement						
Non-orphan						
Non-orphan living away from mother (=1)	-0.110***	-0.110**	-0.100**	-0.052*	-0.051*	-0.044*
	(0.044)	(0.044)	(0.044)	(0.029)	(0.028)	(0.025)
Non-orphan living away from father (=1)	-0.043	-0.047	-0.043	-0.047**	-0.052**	-0.051**
	(0.034)	(0.033)	(0.033)	(0.024)	(0.024)	(0.025)
Other Child Characteristics						
Age dummies	Included	Included	Included	Included	Included	Included
Ratio of older female siblings (up to 20) to household size	0.450***	0.450***	0.440***	0.069	0.073	0.091
	(0.150)	(0.150)	(0.150)	(0.140)	(0.140)	(0.140)
Ratio of older male siblings (up to 20) to household size	-0.025	-0.030	-0.032	0.012	0.011	0.035
	(0.110)	(0.110)	(0.110)	(0.160)	(0.150)	(0.150)
Household Characteristics						
Age of the household head (below 30) (=1)	-0.130***	-0.130***	-0.130***	-0.071	-0.070	-0.073
	(0.036)	(0.037)	(0.036)	(0.057)	(0.057)	(0.056)
Age of the household head (40-49) (=1)	-0.009	-0.008	-0.006	0.037	0.036	0.034
	(0.034)	(0.034)	(0.034)	(0.031)	(0.031)	(0.029)
Age of the household head (50-59) (=1)	-0.051	-0.050	-0.049	0.010	0.009	0.012
	(0.039)	(0.040)	(0.038)	(0.029)	(0.028)	(0.025)
Age of the household head (above 60) (=1)	-0.017	-0.015	-0.015	-0.013	-0.007	-0.009
	(0.039)	(0.039)	(0.038)	(0.031)	(0.030)	(0.028)
Highest education among female adults (above 20)	0.009***	0.010***	0.009***	0.007*	0.008**	0.008*
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)
Highest education among male adults (above 20)	0.009***	0.010***	0.010***	0.014***	0.015***	0.015***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
Ratio of female adults (above 20) to household size	0.380***	0.380***	0.370***	0.200	0.200	0.180
	(0.100)	(0.100)	(0.100)	(0.130)	(0.130)	(0.130)
Ratio of male adults (above 20) to household size	-0.140*	-0.130*	-0.120	0.040	0.029	0.024
	(0.073)	(0.075)	(0.075)	(0.100)	(0.100)	(0.099)
Log (household size)	0.037	0.036	0.037	0.051	0.045	0.040
	(0.032)	(0.033)	(0.033)	(0.039)	(0.039)	(0.037)
Log (total expenditure per capita)	0.046**	0.053***	0.050***	0.024	0.034*	0.033**
	(0.018)	(0.016)	(0.016)	(0.018)	(0.018)	(0.017)
District dummies	Included	Included	Included	Included	Included	Included
Observations	1878	1878	1878	2000	2000	2000
Pseudo R-sq.	0.233	0.235	0.238	0.124	0.129	0.144

Note: Coefficients on continuous variables indicate marginal changes in the probability evaluated at the mean values, and coefficients on dummy variables indicate changes in the probability when the value of the dummy variables changes from zero to one.
Cluster-adjusted standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table C4: Never enrolled in formal education (children aged 7 to 18)
– Logistic regressions –

Dependent Variable	Female			Male		
	All	7-14	15-18	All	7-14	15-18
Never enrolled (=1)	(A)	(B)	(C)	(D)	(E)	(F)
Living Arrangement						
Non-orphan						
Non-orphan living away from mother (=1)	0.020	0.001	0.058**	-0.007	-0.009	-0.005
	(0.015)	(0.016)	(0.024)	(0.015)	(0.017)	(0.023)
Non-orphan living away from father (=1)	-0.006	-0.012	0.013	0.014	0.002	0.039***
	(0.013)	(0.015)	(0.024)	(0.009)	(0.012)	(0.014)
Other Child Characteristics						
Age dummies	Included	Included	Included	Included	Included	Included
Ratio of older female siblings (up to 20) to household size	0.046*	0.056**	-0.045	-0.036	-0.040	-0.015
	(0.025)	(0.028)	(0.130)	(0.030)	(0.035)	(0.094)
Ratio of older male siblings (up to 20) to household size	0.037	0.024	0.005	0.052	0.063	0.044
	(0.031)	(0.035)	(0.089)	(0.035)	(0.040)	(0.064)
Household Characteristics						
Age of the household head (below 30) (=1)	0.031**	0.019	0.061***	0.015	0.016	0.011
	(0.012)	(0.017)	(0.018)	(0.013)	(0.015)	(0.031)
Age of the household head (40-49) (=1)	0.009	0.011	0.008	0.011	0.014	0.001
	(0.009)	(0.011)	(0.018)	(0.011)	(0.015)	(0.015)
Age of the household head (50-59) (=1)	0.006	0.016	-0.013	0.007	0.006	0.008
	(0.009)	(0.011)	(0.018)	(0.013)	(0.018)	(0.016)
Age of the household head (above 60) (=1)	-0.025	-0.005	-0.067**	-0.022	-0.021	-0.028
	(0.016)	(0.013)	(0.034)	(0.016)	(0.020)	(0.028)
Highest education among female adults (above 20)	-0.011***	-0.010***	-0.016***	-0.009***	-0.010***	-0.006
	(0.002)	(0.002)	(0.005)	(0.002)	(0.002)	(0.004)
Highest education among male adults (above 20)	-0.006***	-0.006***	-0.005**	-0.008***	-0.009***	-0.007***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
Ratio of female adults (above 20) to household size	0.066	0.130*	-0.038	0.025	0.030	0.044
	(0.056)	(0.070)	(0.066)	(0.055)	(0.078)	(0.068)
Ratio of male adults (above 20) to household size	0.076**	0.073	0.031	0.022	0.014	0.026
	(0.033)	(0.051)	(0.036)	(0.059)	(0.078)	(0.056)
Log (household size)	0.015	0.027*	0.002	0.014	0.013	0.019
	(0.011)	(0.014)	(0.018)	(0.019)	(0.022)	(0.026)
Log (total expenditure per capita)	-0.048***	-0.055***	-0.025*	-0.047***	-0.061***	-0.022**
	(0.007)	(0.010)	(0.013)	(0.007)	(0.008)	(0.009)
District dummies	Included	Included	Included	Included	Included	Included
Observations	7831	5834	1902	7849	5706	1882
Pseudo R-sq.	0.198	0.218	0.181	0.211	0.218	0.132

Note: Coefficients on continuous variables indicate marginal changes in the probability evaluated at the mean values, and coefficients on dummy variables indicate changes in the probability when the value of the dummy variables changes from zero to one.
Cluster-adjusted standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

[1] The word "community" in this paper refers to the enumeration area (EA), which is the primary sampling unit used for the IHS-2 and 1998 Population Census.

[2] These differences are more evident when we compare double orphans with children living with both biological parents.

[3] The total period during which double orphans live as an orphan (either single or double) is longer than the duration of single orphans.

[4] This model is based on the schooling model in Jacoby (1994), but this model explicitly incorporates the utility gain from child's schooling. Also, schooling decisions are discrete and the time horizon is finite.

[5] $u(c_t, S_t) = u(c_t) + u(S_t)$

[6] Even under the prefect credit market condition, the introduction of the term $\partial u/\partial S_t$ breaks the separability between household consumption and schooling decisions. With the term $\partial u/\partial S_t$, schooling decisions become an explicit function of the marginal utility of wealth ($\lambda_3^t = \lambda_1^t(1+r)$). Liquidity constraints will also lead us to the same conclusion.

[7] This calculation is illustrated in Appendix A.

[8] $u(c_t, S_{1t}, S_{2t}) = u(c_t) + u(S_{1t}) + u(S_{2t})$

[9] This model can also be easily extended to the model with multiple children.

[10] The model considers an ex-post coping strategy against slower educational progression, and a model that incorporates an ex-ante coping mechanism is discussed in Appendix B.

[11] Computations are executed by using the 'mgcv' package of R software (version 1.8-3).

[12] One is for non-orphans living separately from their biological father and the other is for non-orphans living separately from their biological mother.

[13] Case et al. (2004) and Yamano et al. (2006) employ household fixed-effects models with the binary dependent variable of school attendance. The basic idea of this approach is to compare educational outcomes among siblings and examine if orphans compared to non-orphans residing in the same household are less likely to attend school. In Malawi, because household size is relatively small compared to the other sub-Saharan African countries, the number of children living in the same household is very small and variations in the same household are limited. In this study, therefore, we employ empirical models with a control of both child and household covariates, which implies that we compare orphans and non-orphans residing in the household having similar socio-economic characteristics.

[14] We also have applied the same empirical methodology explained in the previous section 4.1 to only those who are still in school (81.3 percent of females and 82.1 percent of males in the whole sample) and found that the educational progression of maternal orphans and double orphans tend to slightly lag behind in their educational progression indicating that they are more likely to repeat grade levels than non-orphans living with both biological parents (the results are not shown).