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Perception of HIV risk and the quantity and quality of children: The case of rural Malawi

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Abstract

The empirical literature on the impact of HIV on the quality (Q) and quantity (N) of children provides limited and somewhat mixed evidence. This study introduces individual HIV risk perceptions, as a predictor of mortality, into a Q-N investment model. In this model, higher maternal mortality predicts lower N while higher child mortality predicts lower Q. Thus the two effects together make likely negative associations between HIV and both Q and N. Based on longitudinal micro data on mothers and their children in rural Malawi, our results suggest that higher mothers' reported HIV risk reduces both child quality, as reflected in children's schooling and health, and child quantity, when the perceived risk is already moderate or high. The effects are sizable, and, in the case of Q (schooling and health) are found for children and teenagers, both boys and girls, while in the case of N they are found for young and mature women.

Keywords

HIV; child quantity; child quality; Malawi; fertility; schooling; child health

Introduction

High HIV prevalence and infection risks in a number of Sub-Saharan African countries have created considerable concern about the consequences of the epidemic for economic growth and wellbeing. Many consequences of HIV for *infected* adults and their children are fairly-well established, ranging from a decline in schooling and increased malnutrition to changes in sexual behavior².

But HIV rates can also have consequences for the *non-infected* population. There may be macro level impacts of HIV through changes in health care and schooling provision, changes in the income-per-worker level, increases in poverty and of course higher mortality³. All those changes can also induce changes in individual behavior, in particular if

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²Studies that report schooling declines include Evans and Miguel (2007), Yamano et al. (2006) and Case and Ardington (2006). Mishra et al. (2007) analyzes malnutrition while Weinhardt et al. (1999), and Oster (2012) study changes in sexual behavior.

individuals update their expectations about the future based on perceptions of HIV risk (the median time from seroconversion to death is estimated to be around 10 years before antiretroviral therapy; and according to UNAIDS only 37% of people in sub-Saharan Africa eligible for treatment were able to access life-saving medicines in 2009). Thus, though a majority of the population is HIV negative, they still might be affected by the HIV epidemic through their expectations about the future as well as other mechanisms⁴.

The evidence on the associations between HIV risk and child investments is unclear⁵. The results from several studies on the HIV risk-fertility association are mixed⁶. In the case of Malawi, however, different studies found mostly negative associations between fertility rates and HIV rates⁷. The evidence on the HIV risk-education association is scarce; Fortson (2008) and Mevlude and Turan (2013) find a negative association between HIV rates and schooling rates across sub-Saharan countries. There is no evidence about the association between HIV risk and child health.

While there are a certain number of empirical studies on the relation between HIV and child investments, we are aware of no study that provides evidence on the role of expectations of HIV risks on household decisions *within* a quantity (N)–quality (Q) fertility model⁸.

In this paper we undertake such an investigation.

We give special attention to perceived HIV risks as a predictor of higher mortality, an idea commonly mentioned in the studies about the effect of HIV risk. Thus in this article, perception of HIV plays a key role. In a theoretical quantity-quality fertility model such as in Becker and Lewis (1973) and Willis (1973), higher *child* mortality is ambiguously related to child quantity and quality. We add to this type of model the role of *maternal* mortality because higher HIV risk is likely to imply higher mortality for both mothers and their children. We propose that as mothers became more likely to die, children's quality is re-valued in terms of their wellbeing as orphans⁹. Using a simple two-period model, we illustrate that simultaneous rises in maternal and child mortality are likely to produce a negative impact on child quantity and quality.

We use child-level longitudinal data. To our knowledge, this is the first use of this kind of longitudinal data to investigate the impact of mothers' perceptions of HIV risk on the quantity and quality of children. Besides, we add to the previous empirical literature the use

³Some examples include Case and Paxson (2009) on health care, Papageorgiou and Stoytcheva (2008) and Young (2005) on income, and Whiteside (2002) on poverty.

⁴Other mechanisms include supply-side variables, such as teacher and health worker availability (Kelly 2000, Bennell 2005), funding (Grassly et al. 2003, Chen et al. 2004) and services (Case and Paxson 2009). Among the demand-side factors, the expectations about future resources, for example, the expectations about medical costs might influence the way individuals make decisions about investments in children.

⁵An evolutionary perspective intuitively suggests a positive relationship between fertility and the probability of death of children. The literature reviewed in this article, however, did not find a clear relationship between HIV and fertility, nor between mortality and fertility.

⁶Fortson (2009), Kalemli-Ozcan (2012), Kalemli-Ozcan and Turan (2011), Juhn et al. (2008), Fink and Linnemayr (2008) and Young (2005) analyzed regional and local HIV rates, as well as own HIV status among Sub-Saharan African countries, with mixed results.

⁷Durevall and Lindskog (2008), Noël-Miller (2003), and Ueyama and Yamauchi (2009) find that Malawian HIV rates (or self reported risk) are negatively associated with fertility rates, with the exception of young women with no children, for whom the probability of a first birth increases.

⁸In a concurrent study, Shapira (2011) examines the impact of perceived HIV risks on fertility, but does not consider child quality.

⁹De Lannoy (2005) presents related qualitative evidence.

of children's health indicators as well as of their schooling indicators in our representation of their human capital¹⁰.

Our results indicate that mothers' perceived HIV risk is inversely (and sizably) linked to child quality (meaning child education and, albeit less significantly, health) and quantity.

The paper is organized as follows. Section 1 discusses the implications of expected child and maternal mortality rates within a child quantity and quality model. Section 2 presents the data. Section 3 presents *child*-level fixed-effect regressions of the impact of mothers' reported HIV risk on children's schooling and health, and *mother*-level fixed-effect regressions of the impact on fertility. Section 4 uses mothers with completed fertility to estimate the two-period model introduced in Section 1. The conclusions are presented in the last section.

Section 1: Maternal and Child Mortality in a Q-N framework

The general background for our analysis is provided by the “New Home Economics” (e.g., Becker and Lewis 1973 and Willis 1973) that postulates a trade-off between child quality and child quantity. We assume in our model that survival is uncertain and that mothers maximize their two-period utility by deciding how much to consume in each period (C_1 , C_2), and how much to invest in child quality (Q) and quantity (N) during period one. The mothers' perceived probabilities of dying before reaching period two are H_m for themselves and H_c for their children. Mothers' total utility is a function of a) period 1's consumption, b) period 2's consumption and period 2's quantity and quality of children, if the mother survives to period 2, and c) period 2's children's welfare, if the mother does not survive to period 2. In all cases, it is assumed that the utility derived from children is higher if the children's probabilities of surviving are higher. It is assumed that the overall expected utility from children is decreasing in H_m . Mothers' total utility is:

$$U(C_1) + (1 - H_m) [U(C_2) + (1 - H_c) W^s] + H_m (1 - H_c) W^{ns}, \quad (1)$$

where W^s and W^{ns} are the utilities that mothers derive from their surviving children in the scenario of surviving and not surviving, respectively. Both W^s and W^{ns} are functions of Q , N , and the relative preference of Q versus N . To simplify the discussion, the total utility of mothers is restated as:

$$U(C_1) + f(H_m) [U(C_2) + (1 - H_c) W(Q, N; w)], \quad (2)$$

where $f(H_m)$ is a decreasing positive function of H_m , W is the valuation of children Q and N in period two and w represents the relative valuation of Q over N . w is itself a function of H_m or H_c , because under different scenarios of mother and child mortality the relative valuation of Q and N changes¹¹.

¹⁰The empirical literature on links between HIV rates and child quality focuses on schooling. However, another important investment in children's human capital is in their health, which may have important long-run effects in poor populations (e.g., Hoddinott et al. 2008, Maluccio et al. 2009, Behrman et al. 2009).

¹¹If the mother dies, there are C_2 resources available, for example, for children to consume. The model presented in this section, however, does not include children's consumption explicitly. But the inclusion of children's consumption would not change the major lessons learned in this exercise.

Keeping w constant, a rise in H_m in the above model decreases the total utility derived in period two and thus less resources are allocated to both C_2 and investments in children. Similarly, keeping w constant a rise in H_c decreases the utility from children, W , and thus fewer resources are allocated to investments in children. We call this negative influence of increases in H_m and H_c on investments in children the “*investment effect*”.

In addition, a rise in H_m or H_c can change w , the relative preferences for Q over N . If w changes, the optimal distribution of total investments in children among Q and N changes. A rise (drop) in w implies that more of the total resources invested in children are allocated to Q (N). We call the influence of changes in w the “*relative preferences effect*”. For the sake of simplicity, it is assumed that changes in w do not change the total investments in children¹².

For example, assume $W=N^\alpha Q^\beta$ in equation two, and assume a budget constraint of $T=C_1+C_2+P_nN+P_qQ+P_{qn}NQ$, where T is total income, P_n and P_q are the fixed prices of N and Q and P_{qn} is the quality-quantity dependent price. In this example, β/α plays the role of w , because β and α represent the value of Q and N , respectively. β and α are functions of H_m and H_c . Period two's Q/N ratio, shown in Equation 3, is positively associated with w because w is the relative preferences effect for Q relative to N :

$$Q/N = wP_n / [P_{qn}N(1-w) + P_q] \quad (3)$$

The first-order conditions with respect to C_1 , Q and N , show that while the *investment effect* is negative¹³, the *relative preferences effect* is ambiguous: it depends on the change in w . Figure 1 presents an example where a rise in H_c induces a decrease in w . The TI curves represent all the combinations of Q and N that are attainable at a given level of investment in children, while the Q/N curve, given by Equation 3, represents the optimal combinations of Q and N at a given level of w . Assume that the starting point is A , where the optimization of resources determines a certain level of investments in children represented by TI_0 and together with the original w (w_0) determines the optimal combination of Q and N . Higher H_c induces two changes. First, it induces an *investment effect*, which moves the equilibrium from A on TI_0 to B on TI_1 holding w constant at w_0 . Second, it induces a *relative preferences*

¹²However, changes in the relative preferences between Q and N could change the total amount to be invested in children if the marginal utility of investments in children, W' , changes.

¹³The first-order conditions with respect to C_1 , Q , N , respectively, are:

$$U' - \lambda = 0 \quad (4')$$

$$f(H_m) \left[(1 - H_c) W'^* (\beta N^\alpha Q^{\beta-1}) \right] - \lambda (P_q + P_{qn}N) = 0 \quad (5')$$

$$f(H_m) \left[(1 - H_c) W'^* (\alpha N^{\alpha-1} Q^\beta) \right] - \lambda (P_n + P_{qn}Q) = 0 \quad (6')$$

Equation 5' plus 6' imply Equation 3. Equation 4' plus 5' implies that $f(H_m)[(1-H_c)W'(w_qN^{\alpha\beta}Q^{\beta-1})]/(P_q+NP_{qn}) = U'(C_1)$; If H_m rises then the left side decreases and thus $U'(C_1)$ decreases, which implies that C_1 increases; Because of Equation 3, adjustments in Q and N move in the same direction, so both Q and N decrease. Therefore total investment in children decreases. The analysis shows that a rise in H_c goes along the same lines.

effect as, in this example, w drops from w_0 to w_1 , which moves the equilibrium from B to C keeping investment in children constant along TI_1 .

Expressed in words, the example in Figure 1 shows that the investment effect induces a drop in Q and N , while the relative preferences effect reduces Q further while increasing N . Therefore, the total effect for Q is negative while the total effect for N is ambiguous.

In the framework presented in this section, a *simultaneous* rise in H_m and H_c unambiguously produces a negative *investment effect*, since both investment effects are negative and thus reinforce each other. But it will also produce an ambiguous *relative preferences effect*, since both preference effects could go either way.

The literature suggests that in poor economies higher child mortality H_c decreases the value of Q relative to N because human capital investments in child Q such as schooling take longer to pay back than investments in N (see, for example, Datar, Ghosh and Sood 2007). Thus, a rise in H is likely to be associated with a drop in w , as is the case in the example of Figure 1. A higher likelihood of maternal mortality, on the other hand, noted H_m , may enhance the importance of the wellbeing of children in the case of orphanhood. Thus, if an orphan's wellbeing rises if their human capital is higher, a rise in H_m is likely to be associated with a rise in w . Therefore, H_m and H_c 's *relative preference effects* increase and decrease w , respectively.

As a result, if H_m 's and H_c 's *relative preference effects* counteract each other at least to some extent, while *their investment effects* reinforce each other, it is reasonable to expect that a rise in H_m and H_c will lead to lower levels of Q and N .

Section 2: Data and Measures

The Malawi Longitudinal Study of Families and Health (MLSFH) provided the data for our estimates. To date, six rounds have been conducted of the MLSFH (1998, 2001, 2004, 2006, 2008, 2010)¹⁴, containing rich demographic information on all members residing in the sample households, along with information on money transfers and help, social networks, income, labor market participation, schooling, household wealth and consumption, capital accumulation, attitudes regarding HIV/AIDS, and many other variables.

The initial MLSFH survey in 1998 included approximately 1,500 ever-married women and 1,100 husbands of these women¹⁵. Subsequent rounds were extended to include new spouses (2001), adolescents (2004), and the spouses of married adolescents (2006). In 2006, the MLSFH included more than 3,200 male and female respondents aged 17 to 60 who were interviewed on a wide range of demographic, health, and socio-economic characteristics. Comparisons with the Malawi Demographic and Health Survey showed that the MLSFH sample population is reasonably representative of the rural Malawi population (Anglewicz et

¹⁴The 2010 MLSFH data, and in particular the longitudinal linkages of children across waves, were not yet available at the time of writing this paper.

¹⁵Detailed descriptions of the MLSFH sample selection, data collection, and data quality are provided on the project website <http://www.malawi.pop.upenn.edu/>, in a Special Collection of the online journal Demographic Research that is devoted to the MLSFH (Watkins et al. 2003), and in a recent follow-up publication that incorporates the 2004 and 2006 MLSFH data (Anglewicz et al., 2009).

al. 2009). Data from Round 3 (2004), 4 (2006) and 5 (2008) are used in this paper, and the longitudinal data across these various MLSFH rounds will allow us to control for fixed effects in our estimates, such as those that might distort the estimated impact of mothers' subjective survival probabilities on children's human capital.

Data from the MLSFH was matched across three rounds to create the data used in this paper. Matching children in the 2008 round with the same children in 2006 and the same children in 2004 was made possible using data with the first and last names of the people listed in the household rosters. Children were matched using names, ages, sex, and birth order. Because not all data were available in every round, and because the spelling of names is not always exactly the same across rounds, the matching was not undertaken with a computerized algorithm, but was done case-by-case instead. Two processes were undertaken simultaneously. First, names were designated as the principal matching variable; so to be considered matched, a minimum similarity-in-spelling requirement was established. Second, a quality indicator for the quality of the match was assigned to each matched child, with the match being rated as a) low quality, if no other data than the spelling itself was available to establish the match, and the spelling itself was not sufficiently similar across waves, b) medium, if any other variable was available (age, sex, birth order) to establish the match or, if no other data was available but the spelling matched very closely, and c) high, if two or more variables were available to establish the match. Only children with a medium and high quality match are included in this study, which represent 89% of the total matched cases. The number of reported children and matched children with medium and high quality matches per round are reported in Table 1.

Over five thousand three hundred children were matched between the 2006 and 2008 rounds. The number of matched children between the 2004 and 2006 rounds was smaller, restricted by the smaller number of children included in the 2004 round, in which only resident children were included in the household rosters. Regarding the differences between matched and unmatched children, the comparison within wave 2006 reveal the basically the same “% male” and average age, and higher average number of school years, which may introduce some bias in our analysis.

Mothers' perceptions of HIV risks—Our study is based in a high HIV prevalence area, where HIV is widely perceived to be the primary cause of early mortality for prime-age adults. However, choosing a measure of individual-level HIV risks to be used in this study is not straightforward because several possibilities exist in the data. The natural first option might seem to be the current HIV status. Such a measure was collected by MLSFH through blood tests in 2004, 2006 and 2008. But there are some disadvantages in using the current HIV status for the analyses in this paper: First, the key variable in our approach is mothers' survival expectations; and there are reasons to believe that our respondents might not know or might not believe or understand the results of HIV tests¹⁶. Second, there is likely to be self-selection in the decision to get tested¹⁷. Third, the actual HIV infection status at a point

¹⁶Tabulations in De Paula et al. (2010) show that two thirds of individuals receiving HIV positive test results in 2004 classify themselves in the next round in 2006 as zero or low likelihood of having HIV.

¹⁷For example, Matovu et al. (2005) and Nyblade et al. (2001) find self selection in testing in Uganda.

in time does not provide information about the differential risks that those who are not infected at that time have about possible future infections¹⁸.

The MLSFH data provide another option: individuals' perceptions of being infected with HIV, which has been asked repeatedly in the 2004, 2006 and 2008 survey rounds. The wording of the question is: "How likely are you of being infected with HIV now?": 0 (no likelihood) 1 (low), 2 (medium), and 3 (high)¹⁹. This measure shows considerable variability across respondents, and despite some overestimation of the overall probability of being infected with HIV, subjective HIV infection probabilities have been shown to vary consistently with various HIV risk factors, risky behaviors and other predictors of HIV infection (Anglewicz and Kohler, 2009; Delavande and Kohler, 2012).

We use three HIV subjective likelihood variables to compute a measure of HIV risk at the individual level. The three components are current subjective HIV likelihood, subjective likelihood of future HIV infections and spouses' reports on current subjective HIV likelihood. Each of these variables are recoded for our purposes as 1 ("medium" or "high") and 0 ("no likelihood" and "low"), and then the three are summed up. The final variable, thus, goes from zero to three. The reason for recoding each component on a zero/one basis is to focus on extreme answers ("medium" or "high") under the assumption that they are more informative²⁰.

Maternal HIV likelihood is finally rescaled as 0 to 1. For unmarried women, for whom the husbands' likelihood of HIV risk is not observed, the constructed "HIV likelihood" goes from 0 to 2, instead of 0 to 3. This fact is taken into account when rescaling from 0 to 1.

Mothers' health, included as a control in our robustness tests, is taken from a widely-used question: "How well do you rate your general health?": 1 (very poor), 2 (poor), 3 (normal), 4 (good) and 5 (very good). This variable significantly predicts mortality even after controlling for several other health indicators (Idler and Benyamini 1997, Singh-Manoux et al. 2007). As a subjective, self-reported variable, biases may arise if there are variations across individuals in how they relate these categories to different objective health categories. However, we include individual fixed effects to control for unobserved differences across individuals.

Quality of children (Q)—For children's human capital we use two measures: grades of schooling attained (or schooling attainment) and general health level, as reported by the mothers. Schooling attainment is probably a fairly good indicator of the true variable, with

¹⁸Other studies in this discussion have used "HIV prevalence rate" in the geographical area of residence of the individual. This alternative has advantages and disadvantages compared to ours, so we would say that they complement each other. For example, individuals may have a vague idea of the prevalence in their region, just as they may have a vague idea about the "likelihood of contracting HIV," as is asked, in different forms, in the surveys. Another example is the role of unobservables given that HIV rates are not distributed randomly in the geographical areas, while our identification strategy is susceptible to endogeneity bias. In general it is difficult to attribute a measure to specific biases in the methodology, so it is useful to have different methodological approaches to the same problem.

¹⁹The exact wording of the question depends on the language of the interview. Most of the interviews were conducted in Chitumbuka and Chichewa (District of Rumpi, north Malawi), Chichewa (District of Mchinji, central Malawi) and Chiyao (District of Balaka, south Malawi).

²⁰We are not aware of evidence about the better predictive power of these extreme answers; Idler and Benyamini (1997) summarize evidence in relation to self reports on health.

studies in other contexts suggesting noise-to-signal ratios of 10% or less (e.g., Ashenfelter and Krueger 1994; Behrman et al. 1994; Behrman et al. 2011). In 9.3% of the cases, the gain in schooling between 2008 and 2006 was “minus one”; zero gain in schooling was assumed in those cases. In 3.0% of the cases, the gain in schooling between 2008 and 2006 was lower than minus one; those cases were eliminated.

Maternal reports on children's health are likely to incorporate larger measurement errors, as they are subjective perceptions. The child health variable used in this study is computed from the answers to “What is your child's general health?”²¹, “is your child usually ill?”, and “has your child been ill in the past six months?” The first of these variables is recoded as 0: “very good” or “good”, and 1: “poor” or “very poor”, while the latter two are coded as 1 (“yes”) and 0 (“no”). Each variable is then summed up for each child. Children's health is finally rescaled to range from 0 to 1. There is the possibility of a spurious association between maternal HIV likelihood and child health reports if maternal HIV likelihood is correlated with mothers' health, and mothers in bad health are more likely to report their children as having bad health for a given objective health status (Waters et al. 2000). This effect could be mitigated by including mothers' health and fixed effects as control variables.

Quantity of children (M)—For our analysis of the quantity of children, only mothers who were not pregnant and did not have children less than one year of age in period one (2006 survey) are considered. Women who were already pregnant or had children less than a year old at the time of the 2006 survey probably had smaller possibilities of being pregnant again in 2008, and thus the effect of changes in perceived HIV risk may be too small to be detected with our sample size²².

For the women whom we consider, a dichotomous fertility variable is used with a “1” if pregnant in 2008 or if they gave birth between 2006 and 2008, and “0” otherwise. The information on pregnancy in 2008 is taken directly from a survey question, while births after 2006 are inferred from the information in the household rosters.

Descriptive statistics—The main descriptive statistics are in Table 2:

Between 2006 and 2008, mothers' perceptions of HIV risk decreased by about a tenth, mothers' perceptions of child health on average hardly changed, and reported child schooling attainment increased by an average of 0.8 grades, which is consistent with a substantial proportion of children observed in 2006 attending school afterwards and also a 56% proportion not completing school grades afterwards.

Section 3: Regression of Q and N on Mothers' Perceived HIV Risk

Our basic regression has a dynamic structure:

$$Y_t = \alpha + \beta^* H_{t-1} + \gamma^* H_{t-1}^2 + \delta^* \text{controls}_{t-1} + C + e_t, \quad (4)$$

²¹Recoded as 0: “Very good” or “Good”, and 1: “poor” or “very poor”.

²²Indeed, our data do not show significant results for these women.

where Y_t is child schooling attainment, child health or mothers' fertility in 2008 or 2006; H_t is mothers' perceived risk of HIV in 2006 or 2004, included in level and squared form to allow for nonlinear effects; $controls_t$ are observed conditions in 2006 or 2004 that are described below, C is a child-level fixed effect, and e is an exogenous shock that is assumed to be random. Child fixed effects might include, for example, risk aversion or ability, which might affect the levels of both maternal perceived HIV risks and the dependent variables directly. We note that these fixed-effect estimates are significantly different from random-effect estimates for all regressions in this study²³.

We include changes in four *controls* for possibly confounding factors that are observed in the data²⁴. First, the prior level of child quality might play an important role in determining mothers' decisions, and this role might be correlated with maternal perceived risk of HIV. For example, Datar et al. (2007) show that higher mortality gaps among children in rural India produce, later on, larger gaps in schooling, because of parents' resource allocations. If higher risk of HIV is correlated with child mortality for reasons other than the ones analyzed in this study, omitting this variable might bias the results. Thus, Q_{t-1} is included as a control variable²⁵. It is important to mention the inconsistency of estimators as discussed by Arellano and Bond (1991); the last columns in Table 3 include the results obtained by using the Arellano and Bond (1991) estimator.

Second, shocks in wealth might affect both maternal HIV perceptions and child human capital. Moreover, because all variables used in this study are self-reported, misreporting of other variables such as child human capital could be correlated with the level of reported wealth. The controls for wealth that are included pertain to livestock, an important form of wealth in rural Malawi (that may be adjusted more quickly than some assets): numbers of cows, goats, pigs, and poultry, separately²⁶.

Third, mothers with poor health may underreport their children's human capital (Waters et al. 2000), and might also expect lower wages and higher medical costs, with similar implications to those produced by wealth shocks. Besides, children of such mothers might also be required to stay at home to take care of sick adults or to replace them in household duties, with effects on their Q . Self-reported general health therefore is included to control for mothers' health; household medical expenses as a proportion of total expenses are included to control for overall health of household members.

²³The significance of the differences in the coefficients of interest between the fixed and the random-effects models are investigated by the Durbin-Wu-Hausman test. The random-errors model used to conduct the test also included other regressors: age of the mothers, number of siblings, regional fixed effects (one for each of the three regions included in the survey), and perceived HIV status.

²⁴Women with HIV, whether or not they know it, change their behavior for health reasons. In this case, the dynamic does not have an effect on the main idea guiding the article. In this article, the test results are not included as a control because it is not available for all individuals, but the health of the mother and a measure of medical expenses are included as controls. Regardless of the above, of the people who received the test, approximately 5% tested positive and excluding them from the statistical analysis does not alter the results.

²⁵ Q_2 and Q_1 , as dependent variables, are taken from MLSFH 2008 and MLSFH 2006. Q_1 and Q_0 , as control variables, are taken from MLSFH 2006 and MLSFH 2004. But MLSFH 2004 does not contain the required measure of child health. Thus, the included control for child health (Q_1 and Q_0) is the answers to "is your child ill?" as included in MLSFH 2006 and 2004.

²⁶Another possible wealth indicator is household crop production. However, given that the survey was conducted in the dry season, crop accounts have to rely on retrospective reports that probably have considerable measurement error as usually is the case for near-subsistence agriculture. Also crop production is affected considerably by weather fluctuations that may obscure the relation with longer-run wealth. Nevertheless, crop variables were included in exploratory regression analysis (not shown), although they have little significance.

Fourth, a pure time effect is added to control for changes in the administration of the survey or supply-side changes in schooling or health services.

The results are shown in Table 3. Children are grouped by different age intervals because age is related to different processes of investments, dependence and vulnerability. Also, if children's marginal productivities, which are not observed, affect mothers' decisions, then using age intervals and controls should reduce the unobserved variable bias. Age-intervals used for child health are different from age-intervals used for child education in order to better capture the extent to which HIV has significant effects on child health. However, when using the Arellano-Bond (1991) estimator, no further distinction of sex or gender is used because the instrumental-variables approach of this methodology suggest the use of higher sample-sizes. Nevertheless, results for this estimator are fairly consistent with the ones of fix-effects used for age and sex intervals.

The effect of perceived risk of HIV is displayed at $H=0.5$, which can be interpreted as a medium perceived risk of HIV. In other words, the combined effect of β and γ , evaluated at $H=0.5$, is displayed in Table 3. At lower levels of perceived risk of HIV, the effects are not significant. 27% and 14% of women in our sample, in 2004 and 2006 respectively, have an H of 0.5 or higher. Therefore, when levels of perceived risk of HIV are 0.5 or more, higher maternal perceived HIV risk is clearly associated with lower child quality and quantity. Except for child health, adding controls does not produce a substantial change in terms of significance though some of the magnitudes of the point estimates are affected.

Child health is affected by mothers' perceptions of HIV risks at somewhat different age range than child schooling. The most precise effect for child health is for the 8–12 year age range, while for schooling the age range is 5–16. For both kinds of child quality, the estimated coefficients have similar magnitudes between the two age intervals. Likewise the estimates do not differ significantly by gender of the children. The results for health seem less significant than for education; nevertheless, the parameters are fairly stable between age intervals and between the separate regressions of boys and girls.

Mothers' fertility for very young mothers (18–21) and young mothers (22–25) shows no significant results, while fertility for middle age mothers (26–35 years old) seem influenced by mothers' perceived risk of HIV. The effect on relatively older women (36 to 41 years old), is smaller and not significant, perhaps due to sample size since fertility in that age range is in general very low. The lack of significant results among the younger mothers might be related to the “hastening” fertility behavior of Malawian young women discussed by Noël-Miller (2003), Durevall and Lindskog (2008) and Ueyama and Yamauchi (2009). All these studies conjecture that young women are responding in part to the epidemic by accelerating their marriages and fertility.

It is useful to discuss the interpretation of the magnitudes of the estimates in a little more detail here. The perceived risk of HIV is zero if the women reported no likelihood of current HIV, no likelihood of future infection and the husband also reported no likelihood of current HIV. High likelihood reported for any one of these three variables maps into an increase of 0.33 in the perceived risk of HIV variable. Based on the estimates in Table 3 with controls,

an increase in perceived risk of HIV of 0.33, when the perceived risk of HIV is 0.5 or higher, is associated to a decline of about $0.33 * -0.36 = -0.12$ grades of schooling, i.e. around 10% of the average increase in schooling between 2006 and 2008 for the children in our data²⁷. An increase in the perceived risk of HIV of 0.33 is associated to a decline of $0.33 * -0.18 = -0.06$ in child health over two years, which is comparable to a decrease of 9% in average child health. An increase in the perceived risk of HIV of 0.33 is associated to a change of $0.33 * -0.32 = -11\%$ in the probability of getting pregnant over the next two years for women in the 26–35 year-old range, which is a sizable effect considering that the average probability of getting pregnant during this time interval in our sample was 41%.

Section 4: An estimate of consumption versus child investment

In the previous section we estimated a linear regression of the impact of HIV risk perception on child quantity and quality within a dynamic model with individual fixed effects. However this specification is only loosely related to the Q-N investment model of Equation 1.

In this section we derive and estimate the inter-temporal equilibrium condition implied by the model in Equation 1. For the sake of simplicity, only older women aged 40 or older, whose fertility is presumably completed and thus fixed, are used. This rules out decisions about child quantity. Also, we use the perceived risk of HIV in place of both H_m and H_c . And finally, the following forms of U , W^s and W^{ms} are assumed: $b_u \log(C_1)$, $b_s \log(Q_2)$, $b_{ns} \log(Q_2)$ respectively. All coefficients are nonnegative. Replacing these functions in Equation 1, and using the budget constraint given in Section 2 gives us²⁸ (omitting children's and mothers' subscripts):

$$Q_t = \beta_s * C_{t-1} (1 - H_{t-1})^2 + \beta_{ns} * C_{t-1} H_{t-1} (1 - H_{t-1}) + u_t \quad (5)$$

Where $\beta_s = b_s / (b_c * P_q)$ and $\beta_{ns} = b_{ns} / (b_c * P_q)$. Equation 5 is the equilibrium condition between consumption and the perceived risk of HIV in period one (C_{t-1} and H_{t-1} respectively) and child quality in period two. The disturbance term u_t is included to represent a random shock that affects Q_2 in period two that is not anticipated by the mother when she makes her decisions in period one. H_{t-1} , which is a categorical variable, is mapped into subjective probabilities of dying using the rule that “0” corresponds to 1 percent, “1” corresponds to 10 percent, and values in between follow proportionally²⁹. While the components of β_s and β_{ns} cannot be identified with our data, their sign and significance are given by the sign and significance of β_{ns} and β_{ns} under the maintained assumption that the marginal utility of consumption is strictly positive. This seems a very weak assumption for the very low-income population being studied. As in Section 3, child fixed effects are included in the estimates and the same control variables are used, with the exception of wealth, whose correlation with consumption produced unstable results. The results are:

²⁷0.36 is just the simple average of the coefficients in child education in Table 3.

²⁸For the sake of simplicity, the budget constraint in this section does not contain the $P_n N$ and the $P_{nq} * QN$ components.

²⁹MLSFH 2006 respondents report, by selecting a number of beans from zero to ten, their likelihood of dying within the next one, five or ten years. On average, individuals who reported a high perceived risk of HIV reported a 10 percent higher likelihood of dying, compared to individuals who reported no perceived risk of HIV. We also assume that this represents the children's mortality risk.

Table 4 shows that β_s is generally significant, demonstrating positive sign and magnitude across age ranges and types of child quality, while β_{ns} is not significant and of unstable sign and magnitude across age ranges and types of child quality. That only one β is significant is consistent with the Q-N model because only relatively older women are included in the regression, where N is presumably fixed and so no *relative preferences effect* should be found, and the *investment effect* should be negative. Thus the overall effect, Q_t/H_{t-1} should be negative³⁰. Assuming that β_{ns} is zero, the estimated β_s implies that Q_t/H_{t-1} is negative. The size of the effect, on the other hand, cannot be directly compared with the size of the effect in Section 3.

Conclusion and Discussion

While children and adults infected with HIV are disadvantaged in several dimensions, non-infected individuals could also be affected by the HIV epidemic. This is an important point because most of the population in different countries, even in the AIDS belt in Sub-Saharan Africa, is HIV negative. One possibly important, but previously under-explored channel for such effects is the impact of maternal perceived HIV risk, interpreted as mortality risk, on investments in child quantity (N) and child quality (Q). This is the channel considered in this paper. It is worth mentioning that the association between longevity expectations and inter-temporal choice is fairly well established (see Bíró 2013).

From a quality-quantity perspective, there is a direct link between changes in the perception of HIV risk and changes in child investment, which later on emerge as changes in child human capital.

We first discussed that, under a quality-quantity model with some empirical results, higher *child* mortality predicts lower Q and has no prediction for N . It is important, in the context of undeveloped countries, to note that the literature on the association between child mortality and child education and health³¹ is commonly found to be negative³², while the association between child mortality and fertility shows mixed results.

We add to the aforementioned result the role of mothers' perceived mortality risk because HIV risk implies higher mortality rates for both mothers and their children. We show that, under our approach, higher *mothers'* mortality risk predicts lower N but does not predict Q . Conceptually, the effect of increased child and maternal mortality can be decomposed as the summation of a) an overall reduction in child investment related to the lower likelihood of surviving, and b) a reallocation of child resources to N or Q depending on whether child or

³⁰ $Q_t/H_{t-1} = -C_{t-1} * \beta_s * f(H_{t-1}; b_s)$, where $f(H_{t-1}; b_s) = [(1-H_{t-1})(H_{t-1}+3)/(b_s(1-H_{t-1})^2 + (2-H_{t-1}))]$. f is a positive function, and decreases with H .

³¹ See a brief summary in Datar et al. (2007), and Jayachandran and Lleras-Muney (2009) respectively.

³² The association between mortality and investments in children quantity (fertility) and quality (education and health) has been discussed for long. A substantial fraction of this body of research is focused on developed countries, for which empirical analysis found that A) mortality is linked with fewer investments in child education and health (see a brief summary in Datar, Ghosh and Sood 2007 and Jayachandran and Lleras-Muney 2009 respectively) and B) mortality is not clearly linked with fertility; Preston (1978) identified three conceptual mechanisms for the mortality-fertility link, insurance, replacement and lactation-interruption effects, and Montgomery (2000) included the role of perceptions and social definitions, but the empirical counterpart of such associations remains rather weak and poorly understood (Montgomery 2000, Cleland 2001); Cigno (1998) and Strulik (2003) show that there is a negative relationship between mortality and total fertility when mortality is high, and a positive relationship when mortality is low. Albanesi and Olivetti (2010) found mixed results for the adult mortality-fertility association in the US.

maternal mortality increases. If the child and maternal mortality effects act together, then the a-components reinforce each other, while the b-components counteract each other. Therefore, it is possible that both Q and N will be negatively associated with HIV risk.

We estimate a dynamic linear regression between mothers' HIV risk "today" and children's Q or N "tomorrow". To better control for observed and non-observed confounding factors, we use child and maternal-level longitudinal micro data collected in rural Malawi in 2004, 2006 and 2008. Maternal self-perception of HIV risks is our key right-side variable, though we also control for fixed effects and some important observed variables such as prior child health in our estimates of the impact of risk perceptions on Q .

Our results indicate that mothers' self-perceived risk of HIV is linked to lower levels of child quality *and* quantity, but only when the perception is moderate to high, which covers 27% and 14% of women in our sample from 2004 and 2006, respectively. Child schooling is negatively associated to this perceived risk for boys and girls between 5 and 16 years old. Child health is negatively associated to this risk for boys and girls in a slightly narrower age interval, 8–12, though the association is still visible in the 13–18 age interval. The likelihood of giving birth in the two years after 2006 for mothers who were not pregnant and had not had a recent delivery in 2006 is also found to be negatively associated to the perceived HIV risk. The point estimates imply that each HIV-risk-question answered "high" rather than "low" is associated with a 10% lower increase in child schooling, a 9% decrease in child health, and a 25% reduction in the likelihood of births over a two-year period.

Therefore, increases in individuals' perceived risk of HIV lead to smaller investments in children's health and schooling when the perceived risk is moderate or high. However, a policy that aims at increasing HIV education and awareness could either increase or reduce the perceived risk. Nevertheless, according to our data, perceived levels of HIV risk decreased between 2004 and 2006, so this may have positive effects for fertility and child education and health.

One of the shortcomings of this study is the validity of the reported risk of HIV, a concept that respondents might not understand well. Nevertheless, this variable appears significant in all regressions, consistently yielding negative signs, even when controls for mothers' health, wealth, time effects, medical expenses, and child or mother fixed effects are included. Another problem might be that our small sample sizes, especially for the study of child health, might result in imprecise estimates. Also, due to the limitations of having only three rounds of data, we consider only a limited set of lags in our estimate of the dynamic relations. Another possible source of error is the different dynamics present in the behavior of individuals, since it is assumed that the simultaneous variation of the controls and the perceived risk of HIV does not represent an additional channel through which the risk of HIV investments in children is influenced. Additionally, our estimates may contain bias due to unobserved variables. Among them we can mention interactions between perceived risk and geographical conditions; for example, in communities with higher levels of perceived risk, greater availability of health treatments also exists, such that individuals assume a relatively minor impact of HIV on their lives, the effect discussed in this paper will be underestimated. In addition, we discuss the changes in the case of marital status. These can

have both effects on quality and quantity of children, directly and indirectly, and furthermore, these changes can be correlated with the key independent variable. However, the availability of this variable in the data available for this survey is somewhat limited which makes their inclusion difficult. And finally, the matched children show a higher number of school years than unmatched children (3.8 versus 3.3 in wave 2006), which may introduce some bias in our results.

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References

- Akbulut-Yuksel M, Turan B. Left behind: intergenerational transmission of human capital in the midst of HIV/AIDS. *Journal of Population Economics*. 2013; 26(4):1523–1547.
- Albanesi, S.; Olivetti, C. NBER Working Papers 16146. National Bureau of Economic Research, Inc.; 2010. Maternal Health and the Baby Boom.
- Anglewicz P, Kohler H-P. Overestimating HIV infection: The construction and accuracy of subjective probabilities of HIV infection in rural Malawi. *Demographic Research*. 2009; 20(6):65–96. [PubMed: 19672478]
- Anglewicz P, Adams J, Obare-Onyango F, Kohler H-P, Watkins S. The Malawi Diffusion and Ideational Change Project 2004–06: Data collection, data quality and analyses of attrition. *Demographic Research*. 2009; 20(21):503–540. [PubMed: 20148128]
- Ashenfelter O, Krueger A. Estimates of the economic return to schooling from a new sample of twins. *American Economic Review*. 1994; 84(5 (December)):1157–74.
- Becker G, Lewis H. On the interaction between the quantity and quality of children. *Journal of Political Economy*, Part 2: New Economic Approaches to Fertility. 1973; 81(2):S279–S288.
- Behrman JR, Calderon CM, Preston S, Hoddinott J, Martorell R, Stein AD. Nutritional supplementation of girls influences the growth of their children: Prospective study in Guatemala. *American Journal of Clinical Nutrition*. 2009; 90(November):1372–1379. [PubMed: 19793851]
- Behrman JR, Kohler HP, Jensen VM, Pedersen D, Petersen I, Bingley P, Christensen K. Does more schooling reduce hospitalization and delay mortality? New evidence based on Danish twins. *Demography*. 2011; 48(4):1347–1375. [PubMed: 21842327]
- Behrman JR, Rosenzweig MR, Taubman P. Endowments and the allocation of schooling in the family and in the marriage market: The twins experiment. *Journal of Political Economy*. 1994; 102(6 (December)):1131–1174.
- Bennell P. The impact of the AIDS epidemic on teachers in sub-Saharan Africa. *Journal of Development Studies*. 2005; 41(3):440–466.
- Bíró A. Subjective mortality hazard shocks and the adjustment of consumption expenditures. *Journal of Population Economics*. 2013; 26(4):1379–1408.
- Case A, Ardington C. The impact of parental death on school enrollment and achievement: Longitudinal evidence from South Africa. *Demography*. 2006; 43(3):401–420. [PubMed: 17051820]
- Case, A.; Paxson, C. Research Program in Development Studies and Center for Health and Wellbeing. Princeton University; 2009. The impact of the AIDS pandemic on health services in Africa: Evidence from Demographic Health Surveys.

- Chen L, Evans T, Anand S, et al. Human resources for health: overcoming the crisis. *Lancet*. 2004; 364:1984–90. [PubMed: 15567015]
- Cigno A. Fertility decisions when infant survival is endogenous. *Journal of Population Economics*. 1998; 11(1):21–8. [PubMed: 12348436]
- Cleland J. The effects of improved survival on fertility: A reassessment. *Population and Development Review*. 2001; 27:60–92.
- Datar, A.; Ghosh, A.; Sood, N. *NBER Working Paper* No. 13649. 2007. Mortality Risks, Health Endowments, and Parental Investments in Infancy: Evidence from Rural India.
- De Lannoy, A. *Centre for Social Science Research Working Paper* No. 137. University of Cape Town; 2005. There is no other way out”: Educational decision-making in an era of AIDS: How do HIV-positive mothers value education?.
- Delavande A, Kohler HP. The impact of HIV testing on subjective expectations and risky behavior in Malawi. *Demography*. 2012; 49(3):1011–1036. [PubMed: 22744765]
- De Paula, A.; Shapira, G.; Todd, P. *PIER Working Paper* No. 11-005. 2010. How Beliefs About HIV Status Affect Risky Behaviors: Evidence From Malawi.
- Durevall, D.; Lindskog, A. *Country Economic Report* 2008. 2008. Adult Mortality and Fertility: Evidence from Malawi; p. 1
- Evans D, Miguel E. Orphans and Schooling in Africa: A Longitudinal Analysis. *Demography*. 2007; 44.1:35–57. [PubMed: 17461335]
- Fink, G.; Linnemayr, S. Working paper. Harvard School of Public Health; 2008. HIV, education and fertility: long term evidence from Sub-Saharan Africa.
- Fortson J. Mortality risk and human capital investment: the impact of HIV/AIDS in sub-Saharan Africa. *Review of Economics and Statistics*. 2008; 93(1):1–15.
- Fortson J. HIV/AIDS and Fertility. *American Economic Journal: Applied Economics*. 2009; 1(3):170–94.
- Grassly N, Desai K, Pegurri E, Sikazwe A, Malambo I, Siamatowe C, Bundy D. The economic impact of HIV/AIDS on the education sector in Zambia. *AIDS*. 2003; 17(7):1039–44. [PubMed: 12700454]
- Hoddinott J, Maluccio JA, Behrman JR, Flores R, Martorell R. The impact of nutrition during early childhood on income, hours worked, and wages of Guatemalan adults. *Lancet*. 2008; 371(February):411–416. [PubMed: 18242415]
- Idler E, Benyamini Y. Self-Rated Health and Mortality: A Review of Twenty Seven Community Studies. *Journal of Health and Social Behavior*. 1997; 38(1):21–37. [PubMed: 9097506]
- Jayachandran S, Lleras-Muney A. Life Expectancy and Human Capital Investments: Evidence from *Maternal Mortality Declines*. *The Quarterly Journal of Economics*. 2009; 124(1):349–397.
- Juhn C, Kalemli-Ozcan S, Turan B. HIV and fertility in Africa: first evidence from population-based surveys. *Journal of Population Economics*. 2008:1–19.
- Kalemli-Ozcan S, Turan B. HIV and fertility revisited. *Journal of Development Economics*. 2011; 96(1):61–65.
- Kalemli-Ozcan S. AIDS, “reversal” of the demographic transition and economic development: evidence from Africa. *Journal of Population Economics*. 2012; 25(3):871–897.
- Kelly, M. *IIEP Fundamental of Educational Planning*. UNESCO; Paris: 2000. Planning for education in the context of HIV/AIDS.
- Maluccio JA, Hoddinott J, Behrman JR, Quisumbing A, Martorell R, Stein AD. The impact of nutrition during early childhood on education among Guatemalan adults. *Economic Journal*. 2009; 119(April):734–763.
- Matovu J, Gray R, Makumbi F, Wawer M, Serwadda D, Kigozi G, Sewankambo, N. Nalugoda F. Voluntary HIV counseling and testing acceptance, sexual risk behavior and HIV incidence in Rakai, Uganda. *AIDS*. 2005; 19(5):503–511. [PubMed: 15764856]
- Mishra, Vinod, et al. Education and nutritional status of orphans and children of HIV-infected parents in Kenya. *AIDS Education & Prevention*. 2007; 19.5:383–395. [PubMed: 17967109]
- Montgomery M. Perceiving Mortality Decline. *Population and Development Review*. 2000; 26(4): 795–819.

- Nyblade L, Menken J, Wawer M, Sewankambo N, Serwadda D, Makumbi F, Lutalo T, Gray R. Population-Based HIV Testing and Counseling in Rural Uganda: Participation and Risk Characteristics. *Journal of Acquired Immune Deficiency Syndromes*. 2001; 28(5):463–470. [PubMed: 11744836]
- Noel-Miller CM. Concern Regarding the HIV/AIDS Epidemic and Individual Childbearing, Evidence from Rural Malawi. *Demographic Research*. 2003; 1(10):318–349.
- Oster E. HIV and sexual behavior change: Why not Africa? *Journal of Health Economics*. 2012; 31(1): 35–49. [PubMed: 22277285]
- Papageorgiou, C.; Stoytcheva, P. Mimeo. International Monetary Fund; 2008. What Is the Impact of AIDS on Cross-Country Income.
- Preston, SH. The effects of infant and child mortality on fertility. Academic Press, Inc.; 111 Fifth Avenue, New York/New York 10003, USA: 1978.
- Shapria, Gil. unpublished Ph.D. Dissertation. University of Pennsylvania; Philadelphia, PA: 2011. The Effect of Beliefs About Own HIV Status on Fertility.
- Singh-Manoux A, Guéguen A, Martikainen P, Ferrie J, Marmot M, Shipley M. Self-rated health and mortality: short-and long-term associations in the Whitehall II study. *Psychosomatic medicine*. 2007; 69(2):138–143. [PubMed: 17289825]
- Strulik, Holger. Mortality, the Trade-Off between Child Quality and Quantity, and DemoEconomic Development. *Metroeconomica*. 2003; 54(4):499–520.
- Ueyama M, Yamauchi F. Marriage behavior response to prime-age adult mortality: evidence from Malawi. *Demography*. 2009; 46(1):43–63. [PubMed: 19348108]
- UNAIDS. Global Report. 2010. <http://www.unaids.org/globalreport/>
- Waters E, Doyle J, Wolfe R, Wright M, Wake M, Salmon L. Influence of parental gender and self-reported health and illness on parent-reported child health. *Pediatrics*. 2000; 106(6):1422–1428. [PubMed: 11099598]
- Watkins S, Behrman JR, Kohler HP, Zulu EM. Introduction to Research on Demographic Aspects of HIV/AIDS in Rural Africa. *Demographic Research*. 2003; S1(1):1–30.
- Weinhardt L, Carey M, Johnson B, Bickham N. Effects of HIV counseling and testing on sexual risk behavior: a meta-analytic review of published research, 1985-1997. *American Journal of Public Health*. 1999; 89(9):1397–1405. [PubMed: 10474559]
- Whiteside A. Poverty and HIV/AIDS in Africa. *Third World Quarterly*. 2002; 23:313–32.
- Willis R. A New Approach to the Economic Theory of Fertility. *Journal of Political Economy*, Part 2: New Economic Approaches to Fertility. 1973; 81(2):S14–S64.
- Yamano T, Shimamura Y, Sserunkuuma D. Living arrangements and schooling of orphaned children and adolescents in Uganda. *Economic Development and Cultural Change*. 2006; 54(4):833–56.
- Young A. The gift of the dying: The tragedy of AIDS and the welfare of future African generations. *Quarterly Journal of Economics*. 2005; 120(2):423–466.

* Q/N : Optimum path of Q and N when total investments in children change and relative preferences are constant. TI_0 and TI_1 : combinations of Q and N that are attainable with constant levels of investments in children.

Figure 1.

Graphical example. A rise in H_c that induces a drop in w .

Table 1

Reported and matched children

Children reported*:		Children reported**:	
Round 3 (2004)	3,615	Round 4 (2006)	6,285
Round 4 (2006)	6,449	Round 5 (2008)	6,753
Matched***:	2,902	Matched***:	4,837

* Includes only mothers answering both rounds 3 and 4.

** Includes only mothers answering both rounds 4 and 5.

*** Includes medium and high quality matches.

Table 2

Descriptive statistics

	Mean		N. Obs
<i>Survey year</i>	<i>2006</i>	<i>2008</i>	
Children's schooling attainment (grades)	3.8	4.5	1,752
Mothers' perception of children's health	0.66	0.67	1,907
Male child	50%	50%	
% Not pregnant or birth in last year	58%		
Pregnant or birth since 2006*		46%	
<i>Survey year</i>	<i>2004</i>	<i>2006</i>	
Mothers' perceived HIV likelihood	0.22	0.14	844
Mothers' general health	2.41	2.46	
Mothers' age	36.2		
Average number of children**	3.1		
Household consumption (Kwachas)***	2,010	3,243	

* Includes only women who were not pregnant and did not have a child less than one year old in 2006 survey.

** includes all children, even those not included in our sample

*** The data contain consumption in the last three months. 3,000 Kwacha $\approx$ 22 US dollars. This mean value excludes the 12% of the respondents who reported zero.

Table 3

Results of regressing Q and N on maternal perceived risk of HIV. The effect of HIV is displayed at $H=0.5$ *

Without controls				With controls			With controls and a Arellano-Bond estimator for dynamic panels		
Age	Effect at $H=0.5$	p-value	Obs	Effect at $H=0.5$	p-value	Obs	Age	Effect at $H=0.5$	p-value
Child's health									
8–12	−0.03	0.51	1,501	−0.18	0.06	1,061	8–18	−0.12	0.07
13–18	−0.04	0.42	1,241	−0.10	0.25	849			
Child's schooling									
5–9	−0.54	0.00	1,473	−0.32	0.03	1,040	5–16	−0.34	0.05
10–16	−0.39	0.01	1,693	−0.40	0.03	1,132			
Mother's fertility									
18–21	−0.26	0.23	61	0.13	0.29	50			
22–25	0.22	0.42	128	−0.04	0.88	93			
26–35	−0.35	0.00	341	−0.32	0.06	237			
36–41	−0.06	0.30	281	−0.04	0.61	214			
Girls				Boys					
Child's health									
8–12	−0.18	0.10	433	−0.14	0.32	413			
13–18	−0.06	0.71	292	−0.17	0.06	334			
Child's schooling									
5–9	−0.53	0.02	573	−0.65	0.00	567			
10–16	−0.48	0.06	589	−0.39	0.07	621			

* All regressions include the time period, and control for child or mother fixed effects. Other controls include changes in mothers' reported health (categorized), total number of cows, total number of pigs, total number of goats, total number of poultry, the percentage of total consumption dedicated to medical expenses and, in the case of children's quality, the initial child quality. A robust estimator of the covariance matrix is used. The maternal perceived HIV risk takes five values from 0 (very low) to 1 (very high). The regressions for girls and boys in the lower half of the table include controls.

Table 4

Parameters of the inter-temporal equilibrium condition between consumption and child quality (mothers aged 40 or more)

Child's health					
<i>Age</i>	β_s	p-value	β_{ns}	p-value	Obs
8–12	0.019	0.05	0.015	0.97	339
13–18	0.011	0.03	0.277	0.22	471
Child's schooling					
<i>Age</i>	β_s	p-value	β_{ns}	p-value	Obs
5–9	0.017	0.51	−0.404	0.64	216
10–16	0.027	0.08	−0.831	0.12	481

* Linear child fixed-effect regressions are used, with a robust estimator of the covariance matrix. Consumption is measured in thousands of Kwachas, and includes adult spending on fabric, clothes, shoes, agricultural goods and funeral-related expenses. Controls include mothers' reported health (categorized), percentage of total consumption dedicated to medical expenses and initial child quality. Perceived HIV risk is rescaled linearly into the 0%–10% interval.