Mothers' perception of HIV risk and the quantity and quality of children: The case of rural Malawi

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Abstract. Literature about the influence of HIV rates on the quality (Q) and quantity (N) of children shows a negative association for quality and an unclear association for quality. While a number of pathways underlie such associations, HIV rates are commonly cited as a predictor of mortality. We use a quantity-quality model to highlight that higher *mother's* mortality only predicts lower N while higher *child's* mortality predicts lower Q. We use follow-up micro data on mothers and their children in rural Malawi, including mother's reported risk of HIV, and find that variation in HIV risk does produce subsequent negative variation in Q *and* N. Our results for Q are visible for a wide age span and include lower child's education and lower child's health. Because HIV risk is not uniquely interpreted as a predictor of mortality, we estimate a model deeply rooted in this interpretation and confirm the negative association between HIV and quality of children.

Key words: HIV, Children's quantity, children's quality, Malawi.

Introduction

The high HIV prevalence and infection risks in a number of sub Saharan Africa countries have attracted a great deal of concern about the consequences of the epidemic for economic growth and, in general, for individuals well being. The consequences of HIV for infected adults or children, and their relatives, is fairly well established in literature, ranging from of education declines and nutrition deficits to changes in sexual behavior[2].

But HIV rates can also have consequences for the non infected population. There are macro level impacts oh HIV, as changes in health care provision changes, lower levels of income-per-worker, raises in the overall poverty and of course higher mortality[3]. All those changes can also induce changes on individual's behavior, as individuals update their expectations about the future. This is an important point since most of the population is HIV negative but still might be affected by the HIV epidemic.

One of the consequences of HIV for the overall population has to do with the way people invest in children, which is the topic of this article. Different papers study the association between HIV rates and education and the association between HIV rates and fertility. Conclusions appear somewhat

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[2] Education declines: Evans (2007), Yamano (2006), Case (2005); Nutrition deficit: Mishra (2007); Changes in sexual behavior: Weinhardt *et al* (2000), Oster (2007).

[3] Health care: Case (2008); income: Papageorgiou (2004); Poverty: Whiteside (2004).

unclear, specially in the case of fertility. Kalemli-Ozcan (2006) analyzes regional HIV rates[4] among sub Saharan countries and concludes that higher fertility and lower educational attainment is associated with higher HIV rates. Although a pathway is not specified, the author highlights a replacement behavior, where mothers choose higher quantity and lower quality because HIV rates is linked to their expectation on their child mortality.

Forston (2008, 2010) use similar kind of data, but tries to establish causality from HIV to education and fertility. The educational difference between pre and post 1981 birth cohorts is found to be negatively associated with actual HIV rates. Thus, to the extent that actual HIV rates can be reasonably taken as exogenous, the relation HIV rate with low education is confirmed. But, somewhat surprising, the relation seems to operate only in countries where the HIV rate is the lowest, rather than the highest. In the case of fertility, the difference between pre and post 1990 birth cohorts is found to be unrelated to HIV rates. Thus no quantity effect is found. Durevall (2007), in the other hand, focus on Malawian HIV rates and founds them negatively associated with lower fertility rates, except for young woman with no child, for who the probability of a first birth increases.

Those studies look for an overall relation between HIV and children's quantity or quality. Such relation can comprise several pathways, however, so results, either significative or not, can not be easily interpreted. For example, children's quality and quality might be affected by supply side variables, as teachers mortality, school's funding, health's workers mortality, and health services available[5]. It can also be affected by demand side variables, as mothers somehow re optimize their investment decisions. One example is the mentioned change in expected child mortality.

Young (2005) focuses on HIV rates on a country with one of the highest HIV rates, South Africa. He proposes a pathway from HIV to lower fertility produced by higher condom use; this in turn decreases the supply of labor and the subsequent rise in wages decreases fertility even further. Although the characteristics of such change in condom use could be disputed, Young's estimates of his structural equations indicate a negative association between HIV rates and fertility, mainly through the rise in wages[6]. Another pathway is proposed by Grant (2008), who find that Malawian parents who learnt their HIV status in 2004 were more likely to sent their children to school, regardless of the HIV status itself; results are interpreted as the effect of lower uncertainty about HIV.

In this paper we focus on HIV as a predictor of higher mortality, an idea commonly mentioned in this research field. We emphasize that, from theoretical grounds stated in Becker (1976), higher *child's* mortality is ambiguously related to child's quantity and quality. We add to this theoretical ground the role of *mother's* mortality, because HIV risk implies higher mortality for both the mother and the child. We propose that as mothers became more likely to die, more value is placed on their children's quality to improve their wellbeing as orphans[7]. Mother's mortality is also ambiguously related to child's quantity and quality. We illustrate this point using a simple two period model.

Literature on the link between HIV rates and children's quality focuses on education only. However, Children's health is usually found lower among children infected with HIV, or whose parents or any household member is infected with HIV. If this is partially the outcome of a change in investments

[4] Both incidence and prevalence rates, though incidence rates are preferred because his data on prevalence correspond to pregnant women, only.
[5] Teacher's mortality: Kelly (2000), though recent literature refutes these findings, see Bennell (2005); school's funding: Grassly *et al* (2003); Health workers: Chen *et al* (2004); Health services: Case (2008).
[6] Although education does not play a central role in his model, higher education is found as a result of higher income.
[7] Qualitative evidence on this point is discussed by De Lannoy (2005).

in children's quality[8], then children's health should also be related to HIV risk. In this article we include both forms of children's human capital.

To better control for observable and non observable confounding factors, we use child-level follow-up data, including a mother-level measure of HIV risk, to be discussed below. To our knowledge, this kind child-level and mother-level longitudinal data represent an innovation to existing literature. Our results indicate that mother's self perceived risk of HIV is linked to future lower levels of children's quality *and* quantity. Nevertheless, it is important to emphasize that perceived risk of HIV is not uniquely interpreted as mortality expectations. The two period model mentioned above is rooted in this interpretation, though, and using older mothers (whose fertility is somewhat fixed) to estimate it yield the same results for children's education and, though less clear, for children's health.

The organization of the paper is as follows. Section 1 discusses a conceptual link between mother's mortality and children's quality. Section 2 discusses the model of children's quantity and quality under changes in children's and mother's mortality and investments on. Changes in mortality affect the overall level of investments in children, and the relative preferences over quantity and quality. Mother's and Child's mortality might increase the preferences over quality or quantity, respectively. Section 3 introduces the data. Section 4 conducts a simple linear regression of children's education and health on mothers' reported HIV risk, plus child-level fix effects and control variables. Also, mother's pregnancy or delivery is regressed on mother's reported HIV risk, adding mother-level fix effects and controls variables. Section 5 uses mothers of 40 or more years old to estimate the two periods model introduced in section 1. Last section concludes.

Section 1: Mother's mortality and Children's quality.

Assume that there are no fertility-decisions. Mothers chose the level of consumption and investment in child's quality that maximize their two-period utility. Mother's perceived probability of dying before reaching period two is H. Invested resources are transformed into children's period-two human capital, Q_2.

Mother's utility is higher if Q is higher. In the case where the mother does not survive to period two, the orphan's wellbeing is greater the greater is their human capital; this kind of wellbeing is incorporated into the mother's utility function. Thus, the level of Q enters twice into the mother's utility function: it provides utility as any other good and it is also valuated as a mean to protect the child if the mother dies.

$$U(c_1) + (1-H)*(U(c_2)+W(Q_2)) + H*V(Q_2) \qquad (1)$$

$$Q_2=Q_1+I(i) \qquad (2)$$

$$T = c_1+c_2+I \qquad (3)$$

Equation 1 depicts the individual's total utility. Cj and Qj represent consumption and children's human capital in period j, respectively. $W(Q_2)$ represent utility derived from Q_2 if the mother survives. In period 1, the expected mother's utility from Q_2 under the scenario that she dies is represented by $V(Q_2)$. The evolution of Q is shown in equation 2. Q_2 is a function of Q_1, plus the investments made by the individual, noted by *i*, which map into higher Q_2 depending on a function I. The budget constrain is shown in equation 3, where T represent total income.

[8] Alderman, Behrman, Lavy, Menon (2001) highlight the relevance of child health as the outcome of behavioral choices.

Individuals choose the level of C_1 and *i* that maximizes their expected utility. After obtaining the first order conditions it is possible to portrait the two influences of child's quality into of mothers utility (all first derivatives are assumed positive while all second derivatives are negative). In one hand, if mothers care only for the child's quality as non-orphan then dQ/dH<0: If H growths then period two is less likely to happen and mothers, thus, allocate less of their total resources to period two. Thus period two's consumption and Q will drop. In the other hand, if mothers care only for the child's quality as an orphan, then dQ/dH>0: if H growths then period two is less likely to happen, so there is more reasons to investment in child's quality. Note that in this case C_2 will still drop.

Because both elements are present at the same time, the sign of dQ/dH is ambiguous. It is clear that as H grows the orphan component became more influential, and thus dQ/dH is more inclined to be positive. Correspondingly, if H decreases, the non-orphan component became more influential, and thus dQ/dH is less inclined to be positive. Furthermore, at some level of H both effects could cancel each other and thus dQ/dH≈0.

Summarizing, the point of this section was twofold: first, the orphan component became more relevant as H growths and second, changes in mother's mortality have an ambiguous influence on children's quality. The model is left aside now, until section 5, where simple functions for U, W, V and I are assumed, and data on relatively old women are used to estimate the sign of dQ/dH.

Section 2: Mortality and investments on children's quality and quantity

Following the Becker argument that people might choose to have high and low quality cars, but probably not to have high and low quality children, it is assumed here for simplicity that all children are embodied with the same level of quality. Mothers are assumed to allocate resources among three goods: non-children goods, children's quantity (N) and children's unitary quality (Q). Resources invested on children are assumed inter temporal, i.e., investments today have and impact on N and Q tomorrow. For simplicity, mother's decision is conceptualized in two levels: the overall spending on children and the allocation of such spending between N and Q.

Once a mother decided the overall spending in children, the allocation between quantity and quality follow the traditional optimization of preferences given budget constraint. "Preferences" is given by the utility derived from quality and quantity and "budget constraint" is given by the desired overall spending in children given the prices of N, Q and non-children goods. Note that the budget constraint is atypical because the cost of quantity depend in the chosen level of quantity, and vice versa, but this issue does not play a role in our analysis[9].

Now assume that mother's are less likely to survive to period two. First, investments in children as a whole became less attractive, since period two is less likely to happen. Thus investments in children's quantity and quality will be lower. Call this the "income effect", in the sense that resources are going to be allocated more to non-children goods and less to children's Q and N. Second, mother's preferences between Q and N will be slightly rebalanced in favor of Q, because of the orphan component[10]. Call this the "substitution effect". Thus the original indifference curves, called X in

[9] The budget constrain is actually not a straight line. As bigger Qs and lower Ns are chosen, the price of Q-per-child decreases because there are fewer children to be provided for. The same argument goes for higher N and lower Q.

[10] Although N is not included in the model in section 1, the idea is that any good (including Q and N) providing utility in period two became less valuated when mother's mortality increases. The decrease in Q' valuation, however, is slightly counteracted by the orphan component.

Figure 2.a, became the Y curves, because the relative valuation of Q versus N is higher after the rise in mother's mortality.

Now consider a change in child's mortality. First, because children are less likely to survive, they represent as a whole a less convenient investment, thus an "income effect" takes place. Second, if the rise on child's mortality affects more Q than N, or vice versa, a "substitution effect" takes place. Empirical literature sustain that Q takes long to pay back than N, so Q is relatively more affected by the rise in child mortality. Preferences, thus, are slightly rebalanced in favor of N and the original indifference curves, X, became the Z curves.

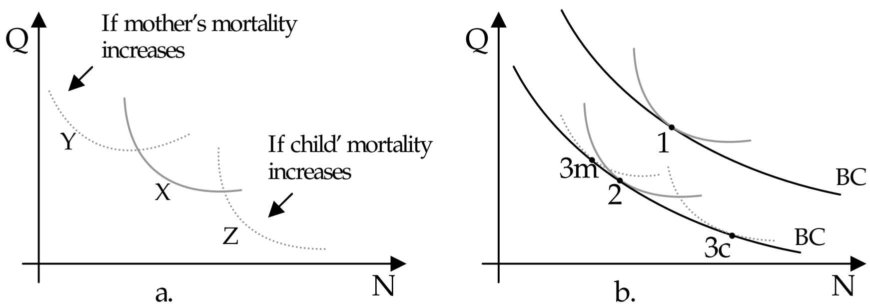

Figure 1: a. Original (X) and new (Y and Z) indifference curves produced by higher mother's or child's mortality, respectively; b. Illustration of the income effect, "1 to 2", and an example of mother's and child's mortality substitution effect, "2 to 3m", and "2 to 3c" respectively.

Still in the traditional diagram of optimization, it is clear that the income effect induce lower levels Q and N, as it represent a movement from "1" to "2" in Figure 1.b. The substitution effect, in the other hand, is not straightforward. Under the mortality of mother's substitution effect, N is lowered even further and Q is raised, which appear in the figure as movement from "2" to "3". The final quality in this example, Q_3, is lower than the initial one, Q_1, but it could have been bigger. Only the final level of quantity, N_3, is unambiguously smaller than the initial one, N_1. Under the mortality of child's substitution effect the situation goes along the same lines, with Q_3 being unambiguously smaller than Q_1 and N_3 being either bigger or smaller than N_1. In the example in Figure 2.b, however, $N_3 > N_1$.

Mother and child's mortality might be acting together, though, so the total effect for N and Q is ambiguous. The only sure thing is that while either N or Q could be bigger than the starting value, than can not happen for both N and Q at the same time.

Section 3: Data and Measures

The Malawi Diffusion and Ideational Change Project (MDICP) provide the data for the estimation. MDICP has conducted so far five waves (1998, 2001, 2004, 2006, 2008), containing rich demographic information on all members residing in the sample households, along with information on transfers of money and help, social networks, income, labor participation, schooling, household wealth and consumption, capital accumulation, attitudes in relation to HIV/AIDS, and many other variables.

The initial MDICP survey in 1998 included approximately 1,500 ever married women and 1,100 spouses of these women. Subsequent waves were augmented to include new spouses (2001), adolescents (2004), and the spouses of married adolescents (2006). Data from Wave 3 (2004), 4

(2006) and 5 (2008) are used in this article. Longitudinal data were collected in part to control for fixed effects, such as those that might confound the estimated impact of mothers' subjective survival probabilities on children's human capital in equation (2).

To match children in wave 2008 with the same children in 2006 was made possible by data on the first and last names of people listed in the household rooster. Children were matched carefully. The match was done case by case, because the principal matching variable, name, appears unstable in its spelling. Ages, sex, birth order, as well as information from the 2004 wave were used. To be considered matched, a minimum similarity in spelling was required. Among matched children, a quality flag for the quality of the match was computed (1, 2 and 3 for low, medium and high). The results are:

Table 1: Matched children

Child reported**:		Child reported***:	
Wave 3 (2004)	3,615	Wave 4 (2006)	6,285
Wave 4 (2006)	6,449	Wave 5 (2008)	6,753
Matched:	3,258	Matched:	5,376

*: Most matched data have a high quality flag. In the case of wave3-4, 11%, 23%, and 65% of matched children have a flag of 1, 2 and 3, respectively. In the case of wave 4-5, 10%, 17%, and 64% of matched children have a flag of 1, 2 and 3, respectively. **: Includes only mothers answering both wave 3 and 4. ***: Includes only mothers answering both wave 4 and 5.

Over five thousand three hundred children were matched between the 2006 and 2008 waves. The number of matched children between the 2004 and 2006 waves was smaller, restricted by the lower number of children included in the 2004 wave, in which only resident children were included in the household rooster.

Mothers' perception of HIV risk

Our study is in a high HIV prevalence area, where HIV is widely perceived to be the primary cause of early mortality for prime age adults. Choosing a measure of individual-level HIV risks, for the purposes of this article, however, is not straightforward and several possibilities exist in the data. The natural first option might seem to be the actual HIV status. Such measure was collected by MDICP through blood tests in 2004, 2006 and 2008. But there are some disadvantages in using it for the analyses in this paper: First, the key variable in our approach is the mother's survival perception; and there are some reasons to believe that our respondents – and potentially also individuals in rural Malawi -- might not know or might not believe or understand the results of HIV tests[11]. Second, there might be self selection in decisions to get tested[12].

The MDICP data provide another interesting option: the individual's perception of being infected with HIV, which has been repeatedly asked in the 2004, 2006 and 2008 survey round. The wording of the question is as follows: how likely are you of being infected with HIV now?: 0 (no likelihood) 1

[11] Tabulations in De Paula, Shapira and Todd (2008) show that more than half the individuals receiving HIV positive test results in 2004, still in the next wave, 2006, classify themselves as "no likelihood of having HIV".
[12] For example, both Matovu, Gray, Makumbi, Wawer, Serwadda, Kigozi, Sewankambo and Nalugoda 2005 and Nyblade, Menken, Wawer, Sewankambo, Serwadda, Makumbi, Lutalo, and Gray 2001 find self selection using data from Uganda.

(low) 2 (medium) and 3 (high)[13]. This variable 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 2009).

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 HIV likelihood of future infections and spouse's report on subjective HIV likelihood. Each of these variables are recoded for our purpose as 1 ("medium" or "high") and 0 ("no likelihood" and "low"), and then the three are summed. The final variable, thus, goes from zero to three. The idea of recoding each component on a zero/one basis is to focus on extreme answers ("medium" or "high") under the assumption that they are more informative[14].

Mothers' health, included as a control in our robustness tests, is taken from a widely-used question: how well you rate your general health?: 1 (very poor), 2 (poor), 3 (normal), 4 (good) and 5 (very good). As a subjective, self reported variable, some shortcomings in interpretation may arise. However, this variable predicts mortality even after controlling for several other health indicators (Iddle 1990, Idler1997, Singh-Manoux 2007).

Quality of children

For children's human capital we use two measures: grades of schooling attainment and general health level, as reported by the mothers. Reported grades of schooling attainment are probably a good report on the true variable. In a few cases, the level of schooling in 2008 was lower than the level in 2006; those cases where eliminated.

Maternal reports on children's health raise more concern about measurement error, as they are a subjective statement. The children health variable used in this article is computed from the answers to "What is your child's general health?"[15], is your child's usually ill?, and has your child been ill in the past six months?. Each of this variables are recoded as 1 ("yes") and 0 ("no"), and them summed. Still, there is possibly a spurious association between HIV likelihood and child's health if HIV likelihood is correlated with mothers' health, and mothers in bad health are more likely to report their child as being in bad health (Waters et al 2000). This effect could be mitigated by including mother's health as a control variable. Besides, the combination of three health-related questions could be less affected by this kind of measurement error.

Quantity of children

When analyzing quantity of children, only mother's fertility who were not pregnant in period one (2006 survey) are going to be followed until period two (2008 survey). Women already pregnant in 2006 will probably have a small chance to be pregnant again in 2008, and thus the effect of changes in HIV risk will be too small to be detected with our sample sizes. For the same reason, women who

[13] The exact wording of the question depends on the language of the interview. Most of them were conducted in Tumbuka and Chichewa (District of Rumpi, north Malawi), Chichewa (District of Mchinji, central Malawi) and Ciao (District of Balaka, south Malawi).

[14] We are not aware of evidence about the better *predictive power* of these extreme answers; Iddle 1997 presents evidence in relation to self reports on health.

[15] Recoded as 0: "Very good" or "Good", and 1: "poor" or "very poor"

have an own children of one ore less years old in 2006 are not going to be considered in the analysis, either.

Thus women who were not pregnant and had not a year-or-less own children in 2006 are followed until year 2008. A dichotomous variable fertility in 2008 is created for those women, with "1" if pregnant in 2008 or gave birth between 2006 and 2008, and "0" otherwise. The information on pregnancy is directly taken from a survey question, while recent deliveries are inferred from the information in the household rooster.

Descriptive statistics

The main descriptive statistics are in Table 2. Variables going from 0 to three (HIV likelihood and children' health) are rescaled as 0 to 1[16].

Table 2: Descriptive statistics

	Mean	N. Obs	Mean	N. Obs
Survey year	2006		2008	
Children's schooling attainment (grades)*	3.77	2,485	4.50	1,933
Children's general health	0.66	3,663	0.67	3,048
Children's sex (1:male 0:female)	50%		50%	
% Not pregnant or recent delivery	58%	762		
Pregnant or recent delivery**			41%	301
Mothers' HIV likelihood	0.78	1,016	0.86	1,118
Mothers' general health	3.65	995	3.80	1,179
Mothers' age	33.26			
Average number of children	3.12			
Household consumption***	3,040	1,274	3,246	1,274

* Includes children of four and more years old. **Includes only women who were not pregnant and had not a recent delivery in 2006. ***The data contains consumption in the last three months. 3040 Kwacha ≈ 22 US dollars. This mean value excludes people reporting zero, which is 17% of the individuals.

Mothers' perception of HIV and children's health increased a little between 2006 and 2008. Schooling attainment increases by a fair amount, which is consistent with a substantial proportion of children observed in 2006 attending school afterwards.

Section 4: Regression of Q and N on mother's perceived risk of HIV

This section separately regress children's education, children's health and mother's fertility into mother's perceived HIV risk. In short, 2006-2008 variation in the dependent variable is mapped into 2004-2006 variation in Mother's perceived risk of HIV. We use this inter temporal effect because changes on investments take time to materialize onto changes in human capital. Those the reallocation of resources would show up as changes in fertility and children's quality later in time. However, we have data on every other year only, thus some of the variation in, say, 2004-2006 HIV will induce variation in 2004-2006 Q or N. We finally choose to focus on the inter temporal effect, only, because the "simultaneous" association is way less robust to confounding factors.

[16] For unmarried women, for whom the husband likelihood of HIV makes no sense, 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.

To better control for non observables, fixed effects at the child-level or mother-level are included in the analysis of Q and N, respectively. The fixed effects model turned out to be significantly different than the random effect model in all regressions performed in this article[17]. To better control for observable, confounding factors, different controlling variables are added. The regressed equation is:

$$DEP_{8/6}=\alpha+ \beta^{*}HIV_{6/4}+\gamma^{*}controls_{6/4}+fe+e \qquad (4)$$

Where $DEP_{8/6}$ means variation from 2006 to 2008 in either children's education, children's health or mothers' fertility. $HIV_{6/4}$ represents variation from 2004 to 2006 in mothers' perceived risk of HIV and *fe* represent either children fix effects or mothers fix effects, depending on whether the dependent variable is children's quality of quantity. *e* represent and exogenous shock.

The *controls* are detailed next. First, the initial level of child's quality might play an important role in determining mothers' decisions, and this role might be correlated with perceived risk of HIV. For example, Datar et al (2007) shows that higher mortality gaps among children in rural India produce, later on, higher gaps in schooling, because of parents' allocation of resources. If higher risk of HIV is correlated with child mortality for reasons different than the ones analyzed in this article, then omitting this variable will bias the results. Thus, $Q_{6/4}$ is included as a control variable[18].

Second, shocks in wealth might affect both mother's *P* and child human capital. Furthermore, since all variables used in this article are self reported, misreports could be correlated with the level of (also reported) wealth. Included controls for wealth are: number of cows, goats, pigs, and poultry, separately[19]. Third, mothers in bad health may underreport their children's human capital (Waters et al 2000), and also might expect lower wages and higher medical costs, which produce similar implications than wealth shocks. Besides, children might also be required to stay at home to take care of sick adults or to replace them in the household duties, which will affect their Q. Two measures of mothers' health are included: self report of general health and household medical expenses as a proportion of total expenses. Fourth, a pure time effect is added to control for changes in the administration of the survey or supply-side changes in education or health resources.

Results are shown in table 3. Children are grouped by different age intervals because age is related to different processes of dependence and vulnerability. Also, if children's marginal productivity, which is not observed, is included in mother's optimization, then using age intervals and controls should attenuate such bias.

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[17] The difference in the coefficients of interest between the fix and the random effects models is tested by the regular Durvin-Wu-Hausman. 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 HIV status.

[18] Q_2 and Q_1, as dependent variables, are taken from MDICP 2008 and MDICP 2006. Q_1 and Q_0, as control variables, are taken from MDICP 2006 and MDICP 2004. But, MDICP 2004 does not contain the required measure of child' health. Thus, the included control for child health (Q'_1 and Q'_0) are the answers to "is your children ill?", as included in MDICP 2006 and 2004.

[19] Another option was the number of crops produced by the household, but given that the survey was conducted in the dry season, crop accounts have to rely on retrospective reports. Besides, crop variables showed little significance in the exploratory regression analysis (not shown).

Table 3: Results of regressing Q or N on perceived risk if HIV

	Without controls			With controls		
Children's health						
Age	*Β*	p-value	Obs	*β*	p-value	Obs
8-12	-0.03	0.51	1,501	-0.16	0.07	1,061
13-18	-0.04	0.42	1,241	-0.10	0.20	849
Children's education						
Age	*Β*	p-value	Obs	*β*	p-value	Obs
5-9	-0.54	0.00	1,473	-0.27	0.05	1,040
10-16	-0.36	0.01	1,693	-0.36	0.04	1,132
Mother's fertility						
Age	*Β*	p-value	Obs	*β*	p-value	Obs
18-23	-0.48	0.34	93	-0.69	0.05	90
24-38	-0.64	0.00	437	-0.28	0.05	415
39-45	0.04	0.57	262	0.03	0.52	246
	Girls			Boys		
Children's health						
Age	*Β*	p-value	Obs	*β*	p-value	Obs
8-12	-0.18	0.10	433	-0.14	0.32	413
13-18	-0.06	0.71	292	-0.17	0.06	334
Children's education						
Age	*Β*	p-value	Obs	*β*	p-value	Obs
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 a time fixed effect and a child or mother fixed effect. Controls include mother's reported health (categorized), total number of cows, total number of pigs, total number of goat, total number of poultry, the percentage of total consumption that correspond to medical expenses and, in the case of children's quality, the level of children quality in period 1. Liner regressions are used, with a robust estimator of the covariance's matrix. Perceived risk of HIV risk takes five values from 0 (very low) to 1 (very high); a quadratic term of HIV is added in the regression and results are shown at a value of HIV=0.5. Age intervals where no significative results were found for children quality are omitted. The regressions for girls and boys in the lower half of the table do include controls.

Higher perceived risk of HIV is clearly associated with lower investment in child's quality and lower investment in child's quantity. Except for the case of children's health, adding several controls to this relation does not produce a substantial change. Children's health is affected by mother's perception of HIV at slightly later ages than children's education. The clearer effect for children's health appear between 8 And 12 years old, while education seems affected in basically the whole relevant age interval, 5-16 years old. It is interesting that, for both kinds of children's quality, the estimated coefficient have similar magnitude across age intervals. About gender differentials, it seems that boys and girls show basically the same effects. It could be a gender difference in the case of children's health, but sample sizes do not seem big enough to have a clear conclusion.

Mother's fertility in the young (18-23) and middle age (24-38) interval seem influenced my mother's perceived risk of HIV, while relatively older women (39 to 45) do not show any effect. Fertility in the young age interval, however, appeared unstable to changes in the specifications, thus the bulk of the evidence is concentrated in women 24-38 years old.

The magnitudes of the effects are not straightforward. The HIV variable is zero if the women reported no likelihood of current HIV, no future likelihood of future infection and no likelihood of spouse's infection. High likelihood reported in any of these variables maps into an increase of 0.33 in the HIV variable. According to table 4, an increase in HIV by 0.33 is associated, over an observed time span of two years, with 0.33*-0.3=-0.1 years of education, i.e. roughly around 10% of the average increase in schooling between 2006 and 2008 for the children in our data. An increase in

HIV by 0.33 is associated, over an observed time span of two years, with a change of 0.33*-0.15=-0.05 in children health, which is represent a 7% decrease over the average value of this our measure of health. An increase in HIV by 0.33 is associated, for mothers not pregnant and without a recently born baby, with a change of 0.33*-0.3=-10% in the probability of getting pregnant over the next two years, which is a sizable effect considering that the average probability in our sample was 41%.

Section 5: Estimating the model for child's quality

So far the interpretation given to perceived risk of HIV is the prediction of mortality. Clearly, there this is not the only one, as HIV risk could also sing future changes in wealth, for example. The model developed in section two is deeply rotted in the mortality interpretation. In this section we assume structural forms for the functions involved in the model and estimate them from the data. Only women of 40 or more years old are used because at those ages fertility is presumably fixed, which is one of the assumptions of the model.

Mother's self reported risk of HIV is conceptualized in the model as *mother's* likelihood of not surviving to the next period. Thus child mortality is left out of the model. However, in the short period of time considered in this article, 2006 to 2008, reported HIV risk is probably capturing variability in mother's mortality rather variability in child's mortality. Child's mortality (related to HIV), is an event that pertain to a much distant future than mother's mortality (related to HIV), thus 2008/2006 variation in perceived risk of HIV might be only tenuously correlated with child's mortality. Besides, child fix effects are included, so if their mortality does not vary much then it is going to be ruled out of the estimation.

After taking the first order conditions, the model produces the following equilibrium condition between consumption in period one and children's quality in period two:

$$U'_{c1} = H^* I'_i *(V'_{Q2} - W'_{Q2}) + I'_i *W'_{Q2} \qquad (5)$$

In this section we place the perceived risk of HIV, a variable that goes from zero to one, as H. The following forms of U, W, and V are assumed: b_u*log(C_1), b_w*log(Q_2) and b_v*log(Q_2). I_i' is assumed to be a constant b_i. These functions are very restrictive but are chosen because the equilibrium condition became a simple equation:

$$Q_2 = (b_v - b_w)(b_i/b_c)*HIV*C + b_w(b_i/b_c)*C = \alpha*HIV*C + \beta*C \qquad (6)$$

Thus α captures the difference between the orphan and the non-orphan component, up to a constant b_i/b_c, while β captures the non-orphan component, also up to a constant. Random and child fix effects are added[20] and results are presented in table 4.

[20] The random disturbance could be conceptualized as a random shock to Q_2, not foreseen by mothers in period one, or as (random) heterogeneity in the marginal utility of consumption. The fix effect, along the same lines, might be viewed as fixed heterogeneity in the marginal utility of consumption or as a fixed (at child or mother level) component of the transformation of investments into human capital.

Table 4: Model results for children's Q among mother of age 40 or more

With controls					
Children's health					
Age	α	p-value	β	p-value	Obs
8-12	-0.90	0.08	0.05	0.80	346
13-18	0.27	0.39	0.07	0.64	453
Children's education					
Age	α	p-value	β	p-value	Obs
5-9	-1.49	0.07	0.24	0.62	270
10-16	-1.95	0.01	0.71	0.11	543

*All regressions include a time fixed effect and a child or mother fixed effect. Consumption is top-coded at its 95 percentile value. Controls include mother's reported health (categorized), total number of cows, total number of pigs, total number of goat, total number of poultry, the level of children quality in period 1 and the percentage of total consumption that correspond to medical expenses. Liner regressions are used, with a robust estimator of the covariance's matrix. Perceived risk of HIV risk takes five values from 0 (very low) to 1 (very high).

The α', i.e., the coefficient on HIV*C, play a significant role in the level of Q. Both education and health show that negative and significative effect of HIV*C (again, with the exception of children's health in the 13-18 age interval). The α' are negative, suggesting that b_w's are bigger than b_v's. This is a sign that non-orphan components are dominant and thus the sign of dQ/dH is likely to be negative[21].

Although the exact value of dQ/dH implied by regression's results can not be stated without additional assumptions[22], the sign of dQ/dH is given by $2\alpha+\beta$. Except for children's health in the 13-18 age interval, where none of the coefficients is significant, all regressions show that dQ/dH is negative. The regression without controls (not shown) shows the same thing.

However, while the estimated β's are always positive, as expected, the estimated values are non significant and too low[23]. It is unclear whether this is due to sample sizes, inadequacy of the model or inadequacy of the assumed functions. In the case of children's education, however, β's are statistically equal to a's, which imply that b_v's are zero and thus dQ/dH is negative. Furthermore, in the regression without control, the β's are numerically equal to the a's.

Conclusion and discussion

While children or adult infected with HIV are shown to be disadvantaged on several dimensions, non infected individuals could also be affected by the HIV epidemic. This is an important point since most of the population is HIV negative but still might be affected by the HIV epidemic. Studies found, in general, a negative association between HIV rates and education, and an unclear association between HIV rates and fertility. Interpreting the results is complex since several pathways may underlie those associations. Nevertheless, HIV rates as a measure of mortality risk is a commonly discussed pathway.

In this article we focus on the relation between HIV risk, interpreted as mortality risk, and investments in children's quantity (N) and quality (Q). We first highlight that, conceptually, higher

[21] The non-orphan or the orphan components will dominate depending on the level of H and the magnitude of the b_w and b_v parameters. If the non-orphan component dominates, then dQ/dH is negative. Thus if b_w's are bigger than b_v', there is a sign that non-orphan component might dominate.

[22] $dQ/dH=2\alpha+\beta/((2-H)+ (\alpha H+\beta)/b_i)$. Thus the exact value require and estimator of b_i. The denominator, however, is unambiguously positive, thus the sign of dQ/dH is given by the numerator, $2\alpha+\beta$.

[23] If b_v is zero then $\beta = -\alpha$. If b_v is bigger than zero then $\beta > -\alpha$.

child's mortality predicts lower Q and has no prediction for N. We add to this theoretical ground the role of mother's mortality, because HIV risk implies higher mortality for both the mother and the child; we highlight that higher *mother's* mortality predicts lower N but has no prediction for Q. If this two effects act together, though, is likely that both Q and N will be found negatively associated with HIV risk.

We estimate a linear regression between mother's HIV risk "today" and children's Q or N "tomorrow". To better control for observable and non observable confounding factors, we use children-level follow-up micro data collected in rural Malawi between the years 2004 and 2008. Self perception of HIV risks, as reported by the mother, is our key right hand side variable. To gain confidence in the results, we also include children's health in the study of Q.

Our results indicate that mother's self perceived risk of HIV is linked to lower levels of children's quality *and* quantity. Children education is found negatively associated for boys and girls between 5 and 16 years old. Children's health is negatively associated for boys and girls at a slightly older age interval, 8-18. The likelihood of giving birth in the two years after 2006, for mothers who were not pregnant and haven't had a recent delivery in 2006 was found to be negatively associated to perceived HIV risk. Although it is not straightforward to magnify the effects, each HIV-risk-question answered "high" is related with a 10 % decrease in children's education, a 7% decrease in children's health, and a 25% reduction in the likelihood of birth over a period of two years.

Among the shortcomings of this study, there is the validity of the reported risk of HIV, a concept that respondents might interpret in a very subjective way or not understand well. Nevertheless, this variable appears significant in all regressions, consistently with a negative sign, even though controls for mother's health, wealth, time effects, medical expenses and child or mother fix effects are added. Another problem is relation between HIV risk and mortality, which might be changing as people in our sample learn about medication for HIV. Also, HIV risk is not uniquely interpreted as a predictor of mortality; it could also be a predictor, for example, lower health or lower wealth. However, we also estimate a model for HIV and Q, deeply rooted in the mortality interpretation, and we again found that a negative effect for education and, less clear, health. An extra problem might be sample sizes, especially for the study of children's health. Finally, because of the inter temporal nature of investments and human capital, we consider only the effects of 2004/2006 variation in HIV risk on 2006/2008 variation in Q or N. However, some of the effects might show up in the 2004/2006 period, though estimation is challenged by confounding factors.

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